DOCTORAL (PhD) DISSERTATION

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# RUMINATION AS A TRANSDIAGNOSTIC RISK FACTOR TO PSYCHOPATHOLOGY

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# Rumination as a Transdiagnostic Risk Factor to Psychopathology

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*To all the ruminators out there.*

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| AIC | Akaike Information Criteria |
| AT | Anticipatory Thoughts Subscale of the Ruminative Thought Style Questionnaire |
| BD | Bipolar Disorder |
| BD-I | Bipolar I Disorder |
| BD-II | Bipolar II Disorder |
| BIC | Bayesian Information Criteria |
| BIS/BAS | Behavior Inhibition/Activation System |
| BPD | Borderline Personality Disorder |
| BPO | Borderline Personality Organization Level |
| BSI | Brief Symptom Inventory |
| BSL-23 | Borderline Symptom List |
| CBT | Cognitive-Behavioral Therapy |
| CERQ | Cognitive Emotion Regulation Questionnaire |
| CES-D | Center for Epidemiologic Studies Depression Scale |
| CFA | Confirmatory Factor Analysis |
| CFI | Comparative Fit Index |
| CMA | Comprehensive Meta-Analysis |
| CMV | Common Method Variance |
| COVID/COVID-19 | Coronavirus Disease Of 2019 |
| CRS | COVID-Related Rumination Scale |
| CT | Counterfactual Thinking Subscale of The Ruminative Thought Style Questionnaire |
| df | Degree of Freedom; |
| DSM | Diagnostic and Statistical Manual of Mental Disorders |
| EFA | Exploratory Factor Analysis |
| EMA | Ecological Momentary Assessment |
| ESEM | Exploratory Structural Equation Modelling |
| ESM | Experience Sampling Method |
| ETT TUKEB | Scientific and Research Ethics Committee of the Medical Research Council |
| fMRI | Functional Magnetic Resonance Imaging |

| | |
|---|---|
| GSI | General Symptom Index |
| HC | Healthy Control |
| ICD | International Classification of Diseases |
| ICHD-III | International Classification of Headache Disorders-III Criteria |
| ID | Identity Diffusion |
| IHS | International Headache Society |
| IPO | Inventory of Personality Organization |
| JBI | Joanna Briggs Institute |
| LESS | Leahy Emotional Schema Scale |
| M | Mean |
| MBCT | Mindfulness-Based Cognitive Therapy |
| MDD | Major Depressive Disorder |
| MIDAS | The Migraine Disability Assessment |
| MLR estimate | Maximum Likelihood Robust Estimate |
| NOS | Not Otherwise Specified |
| PCA | Principal Component Analysis |
| PD | Primitive Defense |
| PEPQ | Post-Event Processing Questionnaire |
| PfT | Problem-Focused Thoughts Subscale of The Ruminative Thought Style Questionnaire |
| PO | Personality Organization |
| PPO | Psychotic Level of Personality Organization |
| PSS/ PSS-4 | Perceived Stress Scale |
| RDoC | Research Domain Criteria |
| RFCBT | Rumination-Focused Cognitive-Behavioral Therapy |
| RMSEA | Root Mean Squared Error of Approximation |
| RPA | Responses to Positive Affect |
| RRS | Ruminative Response Scale |
| RSQ | Response Styles Questionnaire |
| RST | Response Styles Theory |
| RT | Reality Testing |
| RT | Repetitive Thoughts Subscale of the Ruminative Thought Style Questionnaire |

| | |
|---|---|
| RTSQ | Ruminative Thought Style Questionnaire |
| SCL-90 | Derogatis Symptom Checklist |
| SD | Standard Deviation |
| SEM | Structural Equation Modeling |
| SRMR | Standardized Root Mean Square Residual |
| STIPO-R | Structured Interview of Personality Organization-Revised |
| TLI | Tucker-Lewis Index |

## LIST OF PUBLICATIONS INCLUDED IN THE DISSERTATION

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# 1. GENERAL INTRODUCTION

Approximately one third to half of the time they are awake, humans think about things that are not currently happening around them, i.e., either dwelling on past events, or imagining future scenarios that may or may not occur (Killingsworth & Gilbert, 2010; Song & Wang, 2012). Indeed, neuroimaging studies have demonstrated that mind-wandering is an automatic, default process of the human brain (Kucyi et al., 2016; Raichle et al., 2001). This unique ability of planning, learning and abstraction facilitated the evolution of the human species, however, it may impose an emotional burden on people in their everyday lives (Shepherd, 2019). Numerous spiritual, religious and philosophical teachings underline the importance of being present in the moment to be contented, and modern psychological research findings appear to corroborate these suggestions (e.g., Kong et al., 2014; Mesmer-Magnus et al., 2017; Ritvo et al., 2013). Mind-wandering appears to occur more often when people are already in a low mood; it also prospectively predicts decreased momentary happiness, and the content of these thoughts appear to be more strongly associated with current mood than the type of activity people currently engage in (Killingsworth & Gilbert, 2010). In other words, we spend a considerable amount of time contemplating past events or future scenarios, the content of which can substantially affect our mood. Hence, these inner monologues we tell ourselves are crucial components to our well-being that are worth further investigation.

One such cognitive process that often occurs in response to negative mood is rumination, i.e., the tendency to think repetitively about one's negative emotional experience (Nolen-Hoeksema, 2000). Rumination has been associated with various psychological problems (Nolen-Hoeksema, 1991; Smith & Alloy, 2009), in other words, it is considered a transdiagnostic risk factor to psychopathology (Ehring & Watkins, 2008; Nolen-Hoeksema & Watkins, 2011). Transdiagnostic approaches aim to identify neurobiological, biopsychosocial, behavioral, and cognitive-emotional mechanisms that tend to be linked to a broad variety of psychiatric diagnoses (Dalgleish et al., 2020). Exploring these factors may aid in the investigation of the root causes behind the observed psychological symptoms linked with certain diagnostic categories, potentially leading to more precise diagnosis and more effective treatment (Sauer-Zavala et al., 2017). Therefore, they are of increasing importance in research and practice in clinical psychology and psychiatry (Insel et al., 2010).

In this dissertation we examined the associations between rumination and certain psychological problems from a transdiagnostic perspective through four empirical studies. In this chapter we focus on introducing rumination and its link with various psychological

problems from a broader transdiagnostic perspective. The aim of the dissertation will be outlined at the end of the *General Introduction* chapter, and the background and aim of each study will be described in more detail in their *Introduction* chapter separately.

### 1.1. Rumination, a Transdiagnostic Risk Factor to Psychopathology

Although there is a growing body of evidence suggesting that mental illnesses lie along a spectrum, present-day clinical psychology establishes diagnoses primarily on the concept of psychological illnesses fitting into discrete categories (Sauer-Zavala et al., 2017). In response to this focus, there has been an increasing interest in transdiagnostic psychological processes that cut across diagnostic categories and may underlie a wide range of psychological phenomena. Understanding variations in the underlying factors of observed symptoms holds the potential of helping to develop more valid diagnostic systems, as well as more effective treatment methods (Insel et al., 2010). Emotion regulation strategies are considered transdiagnostic variables related to mental health, correspondingly, there has been a large increase in emotion regulation research and related reviews and meta-analyses investigating their connection with various psychological variables (Gross, 2015).

Rumination occurs in response to emotionally relevant stimuli, and it amplifies the related emotional experience, therefore, rumination can be considered an emotion regulation strategy, i.e., a process that alters one's emotional experience (Gross, 1998; Thompson, 1990). According to the extended process model of emotion regulation (Gross, 2015), people engage in certain mechanisms to change the course of an emotion at various points of the emotion formation process, even if automatically and involuntarily. First, the emotion triggering situation is perceived (perception), then people evaluate this experience (valuation) and respond to it (action). In this framework, emotion is a form of valuation of the perceived stimuli, and emotion regulation is a form of action given in response, that comprises three stages: identification (decide whether they want to alter the emotional experience), selection (selecting a certain strategy for it), and implementation (using the selected strategy). Furthermore, emotion regulation strategies can be divided in to four domains based on their desired outcome: situation selection/situation modification, i.e., trying to actively change or select one's circumstances, e.g., problem solving or avoidance; attentional deployment, i.e., choosing where to divert one's attention, e.g., distraction or rumination; cognitive change, i.e., changing the way one thinks of the situation, e.g., reappraisal; and response modulation, i.e., to control one's

emotional response, the most typical example of which is suppression, but rumination may also occur at this phase (Gross, 1998).

Initially, rumination has been investigated regarding depressed mood and major depression (Nolen-Hoeksema, 1991). More specifically, Susan Nolen-Hoeksema in her graduate research under the supervision of Martin Seligman explored how learned helplessness, pessimistic explanatory style and negative life events may lead to depression, together with examining gender differences in depression (Lyubomirsky et al., 2015; Nolen-Hoeksema et al., 1986; Nolen-Hoeksema, 1987). In light of their previous research findings, Nolen-Hoeksema theorized that rumination in response to one's own depressed state further aggravated depressive symptoms, creating a downward spiral and hence being a risk factor to the maintenance and aggravation of depressive episodes, and carried out a series of studies to test this hypothesis (e.g., Nolen-Hoeksema, 1991). Her subsequent work was inspired by the discovery that in preadolescence, boys demonstrate more depressive symptoms, whereas this tendency reverses by adolescence, where girls tend to experience more depressive symptoms (e.g., Hilt et al., 2010), a gender difference that pertains in adulthood (Kuehner, 2003). Based on her results, she tested multiple theories and finally concluded that already during preadolescence, girls are more likely than boys to have risk factors for depression such as rumination, however, these risk factors only exacerbate depressed mood when they co-occur with a higher level of challenges(Nolen-Hoeksema, 1994), that girls appear to experience more of during early adolescence compared to boys (e.g., Aanesen et al., 2017; Lyubomirsky et al., 2015). Empirical findings support Nolen-Hoeksema's theory (Nolen-Hoeksema & Girgus, 1994; Rood et al., 2009; Hilt et al., 2010).

In the last two decades, rumination has been associated with several negative emotions beyond depressed mood, such as anxiety (McLaughlin & Nolen-Hoeksema, 2011), anger and aggression (Peters et al., 2015), shame (Peters et al., 2014), and with excessively elevated mood (Gruber et al., 2009). In the same vein, rumination has been linked with numerous psychological disturbances other than major depression, such as eating disorders, alcohol and drug abuse (D. P. Johnson et al., 2016; Nolen-Hoeksema & Watkins, 2011), anxiety disorders such as PTSD (Schaich et al., 2013), generalized anxiety disorder (M.-J. Yang et al., 2014), obsessive-compulsive disorder (Kim et al., 2012), social phobia (Abbott & Rapee, 2004), panic disorder and agoraphobia (Mahoney et al., 2012), self-harming tendencies such as non-suicidal self-injury (Hilt et al., 2008; Selby et al., 2009), suicidal ideation and suicide attempts (Rogers & Joiner, 2017), bipolar disorder (Ghaznavi & Deckersbach, 2012), insomnia (Carney et al., 2013) and psychosis (Sellers et al., 2018). Furthermore, it has been linked with several somatic

complaints via the stress-disease association (Brosschot & Doef, 2006; Gerin et al., 2012; D. P. Williams et al., 2017). Although most results rely on cross-sectional data, findings from longitudinal and experimental studies controlling for baseline symptom severity demonstrate that rumination may precede or prospectively aggravate these negative outcomes, and does not merely co-occur with them (E. R. Watkins & Roberts, 2020).

Many terms and definitions exist that show some overlap with rumination, e.g., perseverative cognition, repetitive negative thinking, and worry. Repetitive negative thinking or perseverative cognition is an umbrella term comprising rumination and worry (McEvoy et al., 2019). In this dissertational research we focus on rumination, a common manifestation of perseverative cognition (Clancy et al., 2016). Worry and rumination share features in common as both are repetitive, unproductive, and tend to be negatively valenced (Segerstrom et al., 2000). The most consistently reported difference is that people generally ruminate on past events, whereas worrisome thoughts focus on the future (Ehring & Watkins, 2008). Moreover, worry has been robustly associated with generalized anxiety disorder, whereas rumination is mostly linked with depression (Papageorgiou, 2006), however, the two are often comorbid (American Psychiatric Association, 2013). Empirical findings support that rumination and worry are similar cognitive mechanisms but with different content (E. R. Watkins et al., 2005). Rumination and worry mediate the relationship between neuroticism and symptoms of depression and anxiety, demonstrating that people with higher levels of neuroticism tend to ruminate and worry more, that in turn exacerbates their symptoms of depression and anxiety (Muris et al., 2005; Roelofs et al., 2008). This association was found to be stronger for rumination (especially brooding) than for worry (Roelofs et al., 2008).

Furthermore, some researchers argue that rumination should be conceptualized as a coping strategy to stress (e.g. Garnefski et al., 2001), however, other authors underline that due to its automatic, involuntary, passive nature rumination should not be considered an actively chosen coping strategy (e.g. Connor-Smith et al., 2000).

We can differentiate between trait and state rumination, where state rumination is the current act of dwelling on something, meanwhile trait rumination is one's general tendency to ruminate that is considered a more stable personality feature, enabling us to explore dispositional differences in the general tendency to ruminate, as well as transitory ruminative responses given to situational determinants. When we discuss rumination throughout this work, we refer to trait rumination unless otherwise noted.

## 1.2. Conceptualizations of Rumination and Corresponding Measures

Several conceptualizations of rumination exist. Here we review only those that are relevant to the studies included in the dissertation, together with their corresponding measures. For a more extensive review see Smith & Alloy (2009); E. R. Watkins & Roberts (2020).

### *1.2.1. Depressive Rumination – the Response Styles Theory*

Rumination as described by the Response Styles Theory (RST) is the passive contemplation of the reasons, contexts, and implications of one's own depressive symptoms, also referred to as depressive rumination (Nolen-Hoeksema, 1991). Depressive rumination aggravates depressive symptoms among patients with affective disorders (Nolen-Hoeksema et al., 1993), as well as among non-clinical adults (Michl et al., 2013), and anticipates the onset and reoccurrence of depressive episodes of mood disorder patients (Nolen-Hoeksema et al., 2008). The RST posits that rumination may account for the robust gender differences in the occurrence of depression: females are more likely to engage in rumination than males from early adolescence, leading to elevated depressive symptoms among women (Lyubomirsky et al., 2015). This difference pertains when current symptoms of depression are controlled for, suggesting that rumination is rather the cause than the consequence of depressed mood (Nolen-Hoeksema & Aldao, 2011).

The original measure based on the RST was the Response Styles Questionnaire (RSQ), that contained the subscales of Distraction and Problem-Solving besides ruminative responses (Nolen-Hoeksema, 1987), however, they were removed due to reliability issues. The other three subscales of the RSQ, namely brooding, reflection and depression comprised the 22-item Ruminative Response Scale (RRS), that became a widely used instrument in rumination research (Nolen-Hoeksema & Morrow, 1991). However, the 22-item RRS has been criticized due to the overlap of the depression subscale (e.g., "Think about how sad you feel") with scales measuring depressive symptoms (e.g., "I feel sad"), hence a 10-item version comprising only the brooding and reflection subscales was created (Treynor et al., 2003). The 10-item RRS is the most widely used rumination scale (Smith & Alloy, 2009). It is included in all the studies of this dissertation and is described in more detail in their *Methods* sections.

### *1.2.2. Ruminating about Unattained Goals – the Goal Progress Theory*

The Goal Progress Theory (L. L. Martin & Tesser, 1996) advocates a wider approach to rumination, in which ruminative thoughts stem from unreached goals, and hence can emerge in

relation to current or future events besides past experiences. According to this theory, state rumination will continue until the objective is either reached or discarded. This framework focuses less on the content and valence of ruminative thoughts, and more on their disruptive and uncontrollable aspect. The authors suggest that although ruminative thoughts may not be inherently negative, they may still increase negative emotions by serving as an intrusive, recurrent daily reminder of unfulfilled goals. This perceived lack of achievement may provoke feelings of inadequacy, anxiety, and depressed mood (Dickson et al., 2019).

Based on the Goal Progress Theory, Brinker & Dozois (2009) created the Ruminative Thought Style Questionnaire (RTSQ) that aims to measure rumination globally, unbiased by depressive content and without temporal restrictions. The RTSQ is a valid and reliable measure of rumination (Brinker & Dozois, 2009; Kovács, Kocsel, et al., 2021; Mihić et al., 2019; Tanner et al., 2013; Tonta et al., 2020), that we used in two of the four studies in this dissertation, where the scale's properties are discussed in more detail.

### *1.2.3. Rumination in Response to a Stressor*

Alloy et al. (2000) conceptualize rumination as a maladaptive thought process occurring in reaction to a stressful event. Rumination may intensify the perceived severity of the stressful situation and therefore may lead to an aggravated stress response and hamper adaptation, contributing to chronic stress (Gerin et al., 2012), reflecting that the mental representation and the attributed significance of stressors is crucial in adaptation (Del Giudice et al., 2011). Some authors suggest that rumination in response to stress is a voluntarily chosen coping strategy (e.g. Garnefski et al., 2001), whereas other theorists argue that rumination is rather automatic, hence cannot be considered a form of coping (e.g. Connor-Smith et al., 2000). Metacognitive beliefs about rumination support that it may be chosen on purpose at first, as people who frequently engage in rumination tend to believe that it facilitates problem solving (Papageorgiou & Wells, 2001). However, rumination may become an automatic reaction to emotionally burdensome events over time – in other words, may become a mental habit that is more stable and pervasive than occasional ruminative thinking (E. R. Watkins & Nolen-Hoeksema, 2014). Therefore, examining rumination in demanding circumstances is relevant, the most emblematic example of which nowadays is the coronavirus. Indeed, numerous studies have examined the relationship between rumination and stress related to COVID-19 since its outburst at the end of 2019 (e.g. Arslan et al., 2020; Hong et al., 2020; Satici et al., 2020; Ye et al., 2020), supporting that rumination may exacerbate and prolong stress response related to COVID-19. Alloy and colleagues developed the Stress-Reactive Rumination Scale (Alloy et

al., 2000), which is a modified version of the Response Styles Questionnaire (Nolen-Hoeksema & Morrow, 1991), such that participants are instructed to think of their responses in stressful situations instead of when being depressed. Another measure assessing rumination with four items – together with eight other emotion regulation strategies - in response to stressful events is the Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski et al., 2001). Another rumination measure in response to stressful social events is the Post-event processing questionnaire (PEPQ, (Rachman et al., 2000). It is a nine-item scale with a single-factor solution demonstrating good reliability (Cronbach $\alpha$= 0.85)(Rachman et al., 2000). When assessing rumination in response to a stressful situation (the outburst of the COVID-19 pandemic), we used the modified the version of the PEPQ, where the instruction and the items were adjusted so that they were related to the pandemic, instead of a general stressful social situation. We chose specific PEPQ items because of their ability to capture several aspects of ruminative thought such as intrusiveness ("My memories and thoughts about the event keep coming into my head even when I do not wish to think about it"), interfering with other activities ("Thoughts about the event interfere with my concentration"), negative emotionality ("When I think about coronavirus over and over again, my feelings about the event get stronger/more negative"), and uncontrollability ("If I start thinking about these things, I find it difficult to stop"). In the same vein, several content-specific rumination measures have also been developed, such as the Self-Critical Rumination Scale (SCRS, Smart et al., 2016)**,** or the Anger Rumination Scale (ARS, Sukhodolsky et al., 2001). Rumination and its link with psychopathology

Watkins & Nolen-Hoeksema (2014) suggested that rumination is acquired in childhood from the caregivers as a result of learned helplessness. Studies focusing on parental behavior found that children of controlling mothers (i.e., mothers who interfered when the child did not know what to do, instead of encouraging attempts of problem solving) were found to be more passive and incapable in challenging situations (Nolen-Hoeksema et al., 1995), that appears to be an antecedent of rumination as a habit (E. R. Watkins & Nolen-Hoeksema, 2014). This tendency may be stronger in the upbringing of girls, who are encouraged to focus on their emotions instead of taking actions more frequently than boys, which may explain why rumination is more common among women. This tendency has been proposed to account for gender differences in depression (Lyubomirsky et al., 2015; Nolen-Hoeksema et al., 1999, 2008). Moreover, positive metacognitive beliefs about rumination, i.e., thinking that rumination facilitates problem solving, can encourage ruminative response adverse events (Papageorgiou & Wells, 2001), and these metacognitive beliefs – together with rumination and worry themselves – may be directly learnt from parents (Chow & Lo, 2017; Seligman et al., 1984;

E.R. Watkins, 2008). Dispositional factors such as temperament (Mezulis et al., 2010), executive function deficits (Y. Yang et al., 2017) or elevated introspection and self-reflection may also underlie rumination (Bernstein et al., 2019).

On the other hand, rumination can be triggered and amplified by stressful life events (Michl et al., 2013; Nolen-Hoeksema & Morrow, 1991), that may exacerbate the negative mental health outcomes of such events and contribute to developing rumination as a mental habit (E. R. Watkins & Nolen-Hoeksema, 2014). This effect is even more pronounced in an abusive environment in childhood, where the child cannot escape the situation with the help of active problem solving, hence may try to analyze and understand his/her own thoughts and the behavior of the abuser, reinforcing ruminative responses to criticism/abuse/stress (E.R. Watkins, 2008).

According to a recent review by E. R. Watkins and Robert (2020), rumination may aggravate psychopathology in multiple ways. The earliest and most robustly reported negative consequence of rumination is that it can intensify and lengthen depressed mood and related negative thought processing (Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008). Second, it hampers problem-solving (Lyubomirsky et al., 1999) – although ruminators usually claim that they engage in rumination as a means of understanding a problem, empirical results indicate that this strategy is seldom successful (Papageorgiou & Wells, 2001). Third, rumination hampers instrumental behavior by increasing uncertainty (Ward et al., 2003), and exacerbate experiential avoidance (Giorgio et al., 2010). Furthermore, rumination may mitigate attention and responsiveness to fluctuating external circumstances by reducing executive control abilities (E. R. Watkins & Brown, 2002) and can impede attentional disengagement from self-critical negative thoughts (Koster et al., 2011). Thus, rumination may undermine the capability to flexibly adapt to changing conditions and update expectations (Kokonyei et al., 2019). Taken together, ruminating about negative self-relevant life events may amplify their perceived importance, leading to harmful consequences that contribute to the emergence or persistence of psychological problems (Aldao et al., 2010). These findings appear to pertain both within the laboratory and in studies with high ecological validity (e.g. Experience Sampling Method) (E. R. Watkins & Roberts, 2020), as well as longitudinally (McLaughlin & Nolen-Hoeksema, 2011; Michl et al., 2013).

To conclude, there is a growing body of evidence regarding the negative consequences of rumination on mental and somatic health, and how it is associated with their emergence, prolongation, and relapse (E. R. Watkins & Roberts, 2020). Among the numerous psychological

problems associated with rumination, here we focus on those that are relevant in the studies conducted within the framework of the dissertational research.

### *1.2.4. Rumination & Depression*

Depressive disorders are characterized by sadness, emptiness, negative or irritable mood, together with physical and cognitive changes that have a major impact on the individual's ability to perform. Depressive disorders are often accompanied by suicidal thoughts and suicide attempts. Based on their length, onset and presumed origin, depressive disorders can be categorized as major depressive disorder (MDD), persistent depressive disorder/dysthymia (when depressive symptoms pertain for at least two years) substance/medication-induced depressive disorder, depressive disorder due to another medical condition, premenstrual dysphoric disorder, other specified depressive disorder, and unspecified depressive disorder, among which major depressive disorder is the most common with a twelve-month prevalence of 7% in the U.S. (American Psychiatric Association, 2013). Key symptoms of MDD include depressed mood, anhedonia, and losing interest in previously performed activities, to the extent that they cause significant stress or impede everyday functioning (Uher et al., 2014). Other common symptoms include change in appetite (Simmons et al., 2016), psychomotor and cognitive symptoms (Koo et al., 2019), fatigue (Baldwin & Papakostas, 2006), and negative feelings such as shame, guilt, self-blame or worthlessness (Zahn et al., 2015), that are further exacerbated by ruminating on past mistakes or minor failures, a strategy that is more common among women (Garnefski et al., 2004) and younger adults (Sütterlin et al., 2012). Correspondingly, major depressive episodes are the most common among young adults (American Psychiatric Association, 2013), and are estimated to be approximately 1.5 times as common among females than males (Lim et al., 2018). Longitudinal studies indicate that rumination is not merely the by-product, but rather the antecedent of depression, and it has been proposed that rumination itself may account for these differences in prevalence, underlining its importance in the treatment of depression (Nolen-Hoeksema, 2000; Nolen-Hoeksema et al., 2008).

Due to its central role in depression, rumination has been described first and most extensively regarding major depression and depressive symptoms (Thomsen, 2006). Recent reviews corroborate that people with current and remitted major depression engage in rumination more often than healthy controls (HCs) (Liu & Thompson, 2017; Visted et al., 2018). Rumination appears to elevate negative attentional bias that may provoke negative thoughts and thus maintain or prolong depressed mood (Whitmer & Gotlib, 2012), both among

depressed individuals (Joormann & Stanton, 2016) and in university samples (Sanchez-Lopez et al., 2019). Neuroimaging results also indicate that, when left alone with their thoughts in a resting state condition, neural activity related to rumination (i.e. activity of the Default Mode Network) can be observed among depressed individuals, but not among HCs (Berman et al., 2011).

### *1.2.5. Rumination & Bipolar Disorder*

Bipolar disorder (BD) is a mood disorder that involves phases of enduring highly elevated mood (i.e., episodes of mania or hypomania), often but not necessarily alternated by periods of persisting low mood (i.e., depressive episodes) (*DSM-5*; American Psychiatric Association, 2013). Various subtypes of BD can be distinguished based on symptom severity, such as bipolar disorder II characterized by hypomanic and depressed episodes, bipolar disorder I characterized by episodes of severe depression and mania, as well as cyclothymia, where high and low mood episodes can be observed, but are less severe than in BD-I or BD-II (Goodwin & Jamison, 2007). This burdensome illness may be accompanied by difficulties in everyday life such as occupation (Kleinman et al., 2003) or social relationships (Miller & Bauer, 2014), and can be associated with suicide risk (Plans et al., 2019).

Belonging to the affective spectrum disorders, emotion regulation difficulties are key concepts in BD (Gruber, 2011a). However, the relationship between rumination and positive affect is much less documented than its link with negative affect. However, findings show that positive emotional states may also induce rumination (S. L. Johnson et al., 2008). Positive emotion can be amplified and sustained by continuously contemplating satisfying past experiences and positive mood states, i.e., by ruminating on positive affect, that can be rewarding within a brief period as it promotes positive feeling (Feldman et al., 2008). On the long-term, however, rumination on positive affect may limit one's capability to adapt to appropriate external stimuli, as it enhances experiencing positive feelings even when positive stimuli are not actually present (Gruber, 2011a). The most prolific measure of rumination on positive affect is two subscales of the Responses to Positive Affect Scale (RPA; Feldman et al., 2008), that measure emotion-focused (e.g., “Think about how happy you feel”) and self-focused (e.g., “Think about how proud you are of yourself”) rumination in response to positive emotional states.

Studies examining rumination in bipolar disorder or mania found that rumination is present across all phases of bipolar disorders, exacerbating affect regulation problems (Silveira & Kauer-Sant’Anna, 2015). While depressed, BD patients – similarly to MDD patients – tend

to engage in depressive rumination, while they may experience rumination on positive affect during manic episodes (Ghaznavi & Deckersbach, 2012). This tendency appears to be associated with disturbed reward processing and decreased neural flexibility in reaction to external cues in bipolar disorder (Gruber, 2011b; Schreiter et al., 2016). Results from cross-sectional studies indicate that rumination on positive as well as on negative affect is a risk factor to heightened mood disorder symptoms in all episodes of the disorder, however, longitudinal studies would be crucial to support these notions (S. L. Johnson et al., 2008).

### *1.2.6. Rumination & Borderline Personality Disorder*

Borderline personality disorder (BPD) is a debilitating mental illness characterized with high negative affectivity, social difficulties, and maladaptive impulsive behavior (American Psychiatric Association, 2013). BPD patients experience instability in their interpersonal relationships, in their own emotions and towards the self, starting in early adulthood and appearing in many different contexts. Paranoid thoughts, severe dissociative states, hallucinations, and suicidal ideations may occur under stress. Emotional lability and the lack of behavioral control are core features of BPD patients (Lieb et al., 2004). Emotional lability has been proposed as the mechanism that activates all the other symptoms of BPD patients, thus playing an important role in the course of the disease and the severity of symptoms (Trull et al., 2007). Impulsive, uncontrolled behavior observed in BPD (such as self-harm, substance use, excessive drinking, binge eating, etc.) can be considered as maladaptive attempts to reduce or avoid strong negative emotions (e.g., Lane et al., 2016; Nock & Prinstein, 2004). BPD is the most common personality disorder in clinical care: according to the DSM-5, 20% of psychiatric inpatients in the United States have BPD diagnosis, 75% of whom are women (American Psychiatric Association, 2013). BPD patients are overrepresented in both inpatient and outpatient psychiatric healthcare, which means substantial burden for healthcare services (Lieb et al., 2004).

In Kernberg's (1993) psychodynamic model the term borderline describes one of the three levels of personality organization (PO) that fall out of the range of mental well-being; the other two levels are psychotic and neurotic. These three levels embrace a broad range of psychopathologies from a psychodynamic perspective, thus Kernberg's structural model can help understand the background of different psychopathologies (Lenzenweger et al., 2012). According to this model, three ego-functions determine the level of PO: identity diffusion, primitive defense and reality testing. Borderline personality disorder, together with most personality disorders, falls to the borderline level of personality organization (BPO)(Hilsenroth

et al., 2003). Within this framework, lower PO is represented by higher rates of negative affectivity and emotion dysregulation, therefore, we hypothesized that it would also be associated with higher proneness to rumination, a form of maladaptive emotion regulation strategy that is strongly associated with negative affect (Nolen-Hoeksema, 2000). Since rumination is a cognitive process, it is mainly described from a cognitive perspective, hence we were the first to test the associations between Kernberg's psychodynamic approach and rumination in Study 3 of this dissertation, where Kernberg's model is described in more detail.

The most prolific cognitive theory describing the association between emotional lability and impulsive behavior in BPD is the Emotional Cascade Model, positing that overwhelming unpleasant situations elicit negative feelings, leading to rumination, which amplifies the negative impression of the unpleasant situation and gives rise to yet more rumination, resulting in a vicious circle (Selby et al., 2009). As patients with borderline personality disorder may not be able to recruit adaptive emotion regulation processes to interrupt this intense emotional phenomenon, they may be at risk for engaging in impulsive maladaptive behavior (e.g. drug abuse, non-suicidal self-injury or promiscuity) as an attempt to evade their overwhelming negative feelings (Baer et al., 2012). According to the authors, borderline personality disorder may be viewed as the "extreme end of a continuum of emotional cascades and impulsivity" (Selby et al., 2016), demonstrating the relevance of rumination in this disorder. Empirical studies provide support for the relevance of rumination in BPD in non-clinical (e.g. Selby et al., 2008) and clinical (e.g. Martino et al., 2015) populations. Peters et al. (2017) found that university students with higher BPD symptoms reported more rumination, and were inclined to ruminate on a wide variety of topics, among which anger rumination showed the strongest association with BPD symptoms. Ruminating about shame is also closely related to BPD features, and appear to fuel impulsive behavior (Peters et al., 2014).

### 1.3. Rumination and its Link with Physical Health

Besides leading to numerous psychological problems, rumination appears to have a negative impact on physical well-being. Psychosomatic reactions within the nervous, respiratory, muscular and gastrointestinal systems are often the direct consequences of elevated level of stress (Ansari et al., 2014; E. Y. Lee et al., 2011). In addition to this direct association, empirical evidence suggests that maladaptive emotion regulation strategies mediate the relationship between perceived stress and psychosomatic symptoms; in other words, higher

levels of perceived stress may exacerbate emotion regulation difficulties, that in turn may lead to more physical (and psychological) complaints (Teixeira et al., 2021).

Rumination may exacerbate perceived stress and related psychosomatic complaints by multiple pathways. On one hand, somatic symptoms and their negative concomitants may trigger ruminative thoughts, amplifying one's somatic sensations and their perceived importance, therefore they may appear more severe and may further increase emotional distress (Soo et al., 2009). Rumination and worry about one's own somatic symptoms may result in a perceptual bias where these complaints are magnified and misinterpreted, leading to excessive perception of illness that in turn triggers even more rumination about one's somatic complaints, resulting in a re-enforcing vicious circle and enhanced symptom perception (Brosschot & Thayer, 2004).

Another mechanism through which rumination can be associated with somatic complaints is that it maintains and prolongs the adverse effects of stressors (Ottaviani et al., 2016). The Perseverative Cognition Hypothesis (Brosschot et al., 2006) posits that the recurring mental representation of stressors that are currently not present can provoke a series of "fight-or-flight" responses and their physiological concomitants, e.g. elevated pulse, blood pressure, and stress hormone level. The prolonged, elevated stress level negatively affects somatic health; therefore, if it becomes habitual, rumination may serve as an important mediator between stressors and somatic problems.

The association between rumination and stress response has been widely supported in recent empirical research. Rumination has been attributed to decreased parasympathetic flexibility, inflated cardiovascular stress responses, and disturbances in the hypothalamic-pituitary-adrenal (HPA) axis involved in stress response (E. R. Watkins & Roberts, 2020). Rumination has also been linked with various vegetative symptoms of the fight-or-flight stress response, such as elevated heart rate, higher blood pressure (Busch et al., 2017), decreased heart rate variability (Carnevali et al., 2018; Ottaviani et al., 2016), elevated cortisol level, as well as inflammatory immune response (Zoccola et al., 2014). However, the empirical support of the above described trajectories suggest that rumination does not solely occur as a reaction to one's physical symptoms, but may be a precursor of these conditions, implying its causal role in their emergence (E. R. Watkins & Roberts, 2020). Taken together, rumination may have a variety of harmful consequences on somatic wellbeing, either via the (unconscious) amplification of somatic symptoms, and/or via contributing to a prolonged stress response (Sansone & Sansone, 2012).

### *1.3.1. Rumination in Migraine*

Rumination has been linked with chronic pain conditions and appears to have adverse effects in these disorders (Edwards et al., 2011). Rumination has been associated with less adaptive coping styles such as decreased problem solving and increased avoidance of physical activity among fibromyalgia patients (Malin & Littlejohn, 2015), with higher disability among chronic pain patients (Sullivan et al., 2002), and higher level of acute pain and distress following pain induction in a community sample (Gilliam et al., 2010).

Migraine is a chronic pain disease that is estimated to affect over a billion people all over the world (Stovner et al., 2018). Distress has been identified as one of the most prominent trigger of migraine attacks (P. R. Martin, 2016; Santos et al., 2014; Wacogne et al., 2003). The main characteristic of an attack is a moderate to severe one-sided pulsating headache that may last from a few hours up to 2-3 days and intensifies to physical activity (Leonardi & Mathers, 2000). Attacks can be accompanied by further symptoms such as nausea, sensitivity to noises (i.e. phonophobia) and/or to lights (i.e. photophobia), vomiting and cutaneous allodynia (i.e., when otherwise not painful stimuli of the skin are perceived as painful) (Annequin et al., 2000; Lipton et al., 2008). Moreover, in about 30% of the cases, migraine attacks may be preceded or accompanied by aura, a neurological disturbance that usually affects the visual, but sometimes the sensory or the motor cortex leading to various symptoms such as temporary hemianopsia or numbness in the limbs (Borsook et al., 2012). Therefore, migraine is a debilitating condition that may constrict well-being (Lipton et al., 2000). Migraine has been related to anxiety and depression, where the disease burden of migraine may exacerbate these symptoms, while symptoms of excessive worry may trigger and prolong migraine attacks; moreover, common underlying genetic or environmental factors may also account for their comorbidity(Amouroux & Rousseau-Salvador, 2008; Lipton et al., 2000; Peres et al., 2017). Symptoms of anxiety and depression have robustly been linked with rumination (e.g. McLaughlin & Nolen-Hoeksema, 2011). Neuropsychological evidence suggests that migraine patients may be especially sensitive to threatening stimuli (Andreatta et al., 2012; Szabó et al., 2019). Due to this hypersensitivity, migraineurs may have a lower threshold for reacting to interpret external events as stressful (Andreatta et al., 2012), which may evoke rumination (Robinson & Alloy, 2003). Therefore, one could assume that migraine patients may be more prone to ruminate than healthy controls, which have been supported by empirical findings (Kokonyei et al., 2016). On the other hand, rumination may lead to a prolonged/amplified stress response (Brosschot et al., 2006), which may be especially relevant as stress is the most frequently reported trigger of migraine attacks

(Kelman, 2007). The dynamic interplay of pain, stress and rumination may lead to a negative spiral for patients with chronic pain (Sansone & Sansone, 2012) such as migraineurs. Therefore, examining stress and rumination in migraine may be relevant for these patients' well-being.

### 1.4. Aims of Dissertational Research

In light of these findings, we carried out four studies that addressed various aspects of rumination as a transdiagnostic risk factor to psychopathology that are summarized in Table 1.1

| *Study* | **Validating the Hungarian RTSQ (Study 1)** | **Rumination in MDD and BD – meta-analysis (Study 2)** | **PO level, symptoms of BPD and depression (Study 3)** | **Perceived stress and rumination in COVID-19 among migraineurs and HCs (Study 4)** |
|---|---|---|---|---|
| *Background* | • Inconclusive results about the factor structure of RTSQ<br>• the psychometric properties of the Hungarian RTSQ have not been studied | • ER processes are crucial in mood disorders<br>• The importance of rumination has gained empirical support in both MDD and BD | • The role of rumination in borderline & depressive symptoms, as well as the connection between PO and borderline & depressive symptoms is well-established<br>• The mediating role of rumination between PO and symptoms have not been studied elsewhere | • Migraine patients may be at higher risk of developing stress-related symptoms during times of chronic stress (i.e., COVID-19) due to their higher stress reactivity<br>• Rumination may exacerbate the importance of the perceived stressor, leading to elevated distress |
| *Theoretical framework* | Goal Progress Theory | Response Styles Theory | Response Styles Theory, Emotional Cascade Model | Rumination in response to a stressor |
| *Aims/ research questions* | Validating the Hungarian RTSQ | Is there a difference in rumination among BD and MDD patients? | Exploring whether rumination mediates the relationship between PO level and rumination | Does rumination explain perceived stress in migraine patients and HCs? Is this association stronger among migraineurs than HCs? |
| *Sample* | Young adult N=1123; N=320 | Clinical adult, k=12, N=2071 | Young adult, N=179, N=261 | Migraineur (N=70) and HC (N=62) adult |
| *Procedure* | Cross-sectional self-report survey method | meta-analysis | Cross-sectional self-report survey method | |

*Table 1.1. Summary of the four studies.*

*Note. RTSQ = Ruminative Thought Style Questionnaire, MDD = major depressive disorder, BD = bipolar disorder, PO = personality organization, BPD = borderline personality disorder, HC = healthy control.*

The earliest and most thoroughly researched definition of rumination, the Response Styles Theory (Nolen-Hoeksema, 1991) defined rumination in response to one's own depressed mood. However, subsequent findings revealed that rumination is not restricted to depression and should rather be considered a transdiagnostic risk factor to psychopathology – thus, the need for self-report measures that conceptualize rumination more broadly emerged. The Goal Progress Theory (L. L. Martin & Tesser, 2006) offers a broader framework, as it emphasizes the importance of the intrusive and irrepressible nature of ruminative thoughts rather than their content. Based on this theory, the Ruminative Thought Style Questionnaire (RTSQ), a self-report scale was created, aiming to assess rumination as a general thinking style, unbiased by depressive symptoms (Brinker & Dozois, 2009). Thus, in our first study we examined the factor structure of the Hungarian RTSQ, as previous research about its psychometric properties reported inconclusive results. We also aimed to investigate whether the total score of the Hungarian RTSQ captures ruminative thinking reliably.

In the second article, we set out to accumulate previous findings about rumination in mood disorders. Empirical findings demonstrate that mood disorders exhibit several cognitive and affective communalities, making classification difficult, which is also represented in the overlapping symptoms of mood disorders in DSM-5 (American Psychiatric Association, 2013; Zimmermann et al., 2009). Some authors argue that mood disorders only differ in the severity of certain symptoms based on which they constitute a continuum, whereas others posit that they should be considered categorical as they differ qualitatively in their neuropsychological background. Therefore, studies examining cognitive-emotional phenomena such as rumination among both MDD and BD patients are of great relevance. Previous studies have shown that both MDD and BD are closely linked with rumination (e.g. S. L. Johnson et al., 2008). Either positive or negative in valence, rumination enhances mood symptoms by maintaining the person's attention on emotionally significant events (Alloy et al., 2009). Therefore, in this study we hypothesized that depressive rumination will be a significant process in both patient groups, whereas we expected rumination on positive affect to primarily characterize BD patients.

In our subsequent study we built on the Emotional Cascade Model (Selby et al., 2008), according to which rumination appears to lead to emotion regulation impairment and thereby fosters impulsive behavior, especially among BPD patients. We wished to extend this theory to the level of personality organization, which is a wider concept comprising various psychological disturbances. Within this framework, lower personality organization (PO) is characterized by affective lability, archaic defense mechanisms such as splitting, and diffuse representations of the self and significant others (Kernberg, 1993). Affective lability, negative

emotions and impulsive behavior, features that have been robustly associated with rumination, are key components of the entire borderline level of personality organization (comprising the majority of personality disorders) and are not specific to borderline personality disorder (Kernberg & Caligor, 2005). Given that rumination is a transdiagnostic risk factor to psychopathology (Ehring & Watkins, 2008), we considered it plausible to examine its link with another transdiagnostic concept, PO level, and how they relate to disorder-specific features. Thus, we proposed that rumination may mediate the well-known association between the level of PO and symptoms of borderline personality disorder and its frequent concomitant, depressed mood (American Psychiatric Association, 2013).

Our fourth study focused on rumination regarding the coronavirus pandemic, which is a predominating issue nowadays that triggered a secondary mental health crisis (Gruber et al., 2020). Elevated levels of psychological stress and negative mental health outcomes evoked by COVID-19 and related restrictions have been reported extensively worldwide (e.g. Husky et al., 2020; Rajkumar, 2020; Rehman et al., 2021; Rossi et al., 2020; Salari et al., 2020; Vindegaard & Benros, 2020; Xiong et al., 2020; Ye et al., 2020). Migraine is a stress-related condition, where acute stress is a prevalent migraine trigger, and migraine attacks and deriving disability may further increase stress (Sauro & Becker, 2009). Due to this multidirectional relationship, migraineurs may be especially vulnerable to stressors related to the COVID-19 pandemic and related restrictive measures. Therefore, we aimed to test whether being a migraine patient and the tendency to engage in rumination predicted perceived psychological stress during the coronavirus. We assessed two different types of rumination, brooding, a maladaptive, self-criticizing facet of depressive rumination (Treynor et al., 2003), as well as recurrent thinking about the COVID-19 situation. We assumed that the latter would be common among participants in the given circumstances, whereas brooding can be considered a fairly stable personality trait that may be intensified in stressful situations (Robinson & Alloy, 2003) such as the coronavirus, but is independent from it in content. Furthermore, we hypothesized that the relationship between rumination and perceived stress may be moderated by migraine diagnosis, i.e., we expected that the association between these factors will be stronger among migraineurs than healthy control subjects. We also aimed to test, in an exploratory manner, whether the relationship between COVID-related rumination and perceived stress was stronger among migraine patients than healthy controls.

## 2. VALIDATING THE BIFACTOR STRUCTURE OF THE RUMINATIVE THOUGHT STYLE QUESTIONNAIRE - A PSYCHOMETRIC STUDY (STUDY 1)[1]


### Abstract

The Ruminative Thought Style Questionnaire (RTSQ) is a self-report measure that aims to capture rumination globally, unbiased by depressive symptoms. We explored its psychometric properties among university students (N=1123), as the existing models about the factor structure of the RTSQ have been inconclusive. In a second study (N=320) we tested its convergent validity compared to the Ruminative Response Scale (RRS) and its construct validity compared to the Zung Self-rating Depression Scale (ZSDS). The results of Study 1 suggest that the factor structure of the RTSQ is best described with a 19-item bifactor Exploratory Structural Equation Modelling (ESEM), where most of the variance is explained by the general factor. The model was found to be invariant across genders. The correlations in Study 2 demonstrated that the RTSQ is congruent with the RRS, and that rumination captured by the RTSQ is rather maladaptive, as it was more strongly associated with the brooding subscale of the RRS than with reflective pondering. Significant positive associations were found with depressive symptoms, reaffirming the validity of the RTSQ due to the well-known association between rumination and depressive symptoms. Our results support that RTSQ assesses rumination globally, and it is a valid measure of ruminative thinking style that is rather negatively valenced but does not solely focus on depressive mood and symptoms.



*Keywords:* RTSQ, rumination, factor structure, Ruminative Thought Style Questionnaire, bifactor model, ESEM, measurement invariance


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## 2.1. Introduction

Rumination has become crucial in comprehending negative emotional states and depressive symptoms (Smith & Alloy, 2009). A gold standard or consensus about the definition of rumination is lacking. As Smith and Alloy (Smith & Alloy, 2009) in their review pointed out, there are many different conceptualizations of rumination. These theories differ in several dimensions: a) the degree to which they consider rumination as a stable construct or as a transitive, state-like phenomenon (Treynor et al., 2003; E. R. Watkins, 2008b); b) whether it is the frequency or the actual content of ruminative thought that is more important (E. R. Watkins, 2004); c) how rumination relates to other similar or partially overlapping constructs such as negative automatic thoughts, repetitive negative thinking or self-focused attention (Nolen-Hoeksema et al., 1993; E. R. Watkins, 2008b). According to the Response Styles Theory (RST) (Nolen-Hoeksema, 1991), rumination is the tendency to passively and repetitively dwell on one's own depressed mood, concentrating on the possible reasons and consequences of the distress. The RST has gained broad empirical support throughout the past three decades: it has been demonstrated that depressive rumination further increases depressive symptoms (Brinker & Dozois, 2009; Nolen-Hoeksema et al., 1993), predicts the commencement (Nolen-Hoeksema et al., 2008) and reappearance (Silveira & Kauer-Sant'Anna, 2015)of depressive episodes, and correlates with their severity (Lam et al., 2003). While these empirical findings have often been carried out on community samples, there is a growing body of evidence among clinical populations that confirms that the findings are applicable for patients diagnosed with affective disorders as well (Brinker & Dozois, 2009). Women are twice as likely to experience depression during their lives than men (Kuehner, 2003), a gender difference that, according to the RST, might be rooted in females' tendency to react with rumination to stressors (Nolen-Hoeksema, 1991), while men tend to use other strategies, such as social support or drinking (Nolen-Hoeksema, 2012). Ruminative response, accompanied by other psychosocial factors, appears to aggravate depressed mood from early adolescence in case of women (Lyubomirsky et al., 2015). The theory has gained substantial empirical support, as the difference between men and women remained unchanged even when controlling for current depressive symptoms, indicating that elevated ruminative tendencies do not simply occur in response to intensified depressed mood (Nolen-Hoeksema & Aldao, 2011).

The RST is certainly the most well-known and most extensively investigated conceptualization of rumination (E. R. Watkins & Roberts, 2020), and the Ruminative Response Scale (RRS) - derived from the Response Styles Questionnaire (RSQ) (Nolen-

Hoeksema & Morrow, 1991) that is based on this theory - is the most widely used self-report rumination measure. The RRS has been criticized of being biased by items related to depressive symptoms (Smith & Alloy, 2009), which led to the removal of such items, thus a shortened version of the scale with two facets was created (brooding and reflective pondering).

Since the RST conceptualized depressive rumination as a possible response to depressed/low mood (Nolen-Hoeksema, 1991), the RRS items refer to those thoughts and behaviors that make someone focus on their negative emotional state. Obviously, rumination is not restricted to low/depressive mood; other negative emotions or events can induce ruminative thoughts in everyday life or in the laboratory as well. Empirical studies have demonstrated that rumination is linked with other forms of negative affect beyond sadness and depression (Thomsen, 2006), such as anger (Martino et al., 2015), shame, guilt (Siedlecka et al., 2015), or feelings of inadequacy after a social situation (McEvoy & Kingsep, 2006). Moreover, although there are fewer studies addressing the relationship between rumination and positive affect, results suggest that positive emotional states may also trigger ruminative responses (S. L. Johnson et al., 2008). These findings support the relevance of defining rumination more broadly, as outlined by L. L. Martin & Tesser (1996), who proposed that rumination shall be considered as a broad style of thought processing, where the content, valence and even the temporal direction of ruminative thoughts are less important, allowing to extend the domain of rumination-related research.

Building on L. L. Martin & Tesser's conceptualization, Brinker & Dozois (Brinker & Dozois, 2009) constructed the Ruminative Thought Style Questionnaire (RTSQ), a 20-item self-report scale that can measure ruminative thoughts without being biased by their valence and temporal orientation. The RTSQ contains items that refer to the present or the future (e.g., ”When I am anticipating an interaction, I will imagine every possible scenario and conversation.”), as well as neutral or positive items (e.g. “When I am looking forward to an exciting event, thoughts of it interfere with what I am working on.”). Furthermore, while numerous items of the 22 item RRS appear to measure symptoms of depression (Smith & Alloy, 2009; Treynor et al., 2003), and both the 22-item and the 10-item RRS instruct participants to evaluate what they think or do when they feel “down, sad or depressed”, the authors of the RTSQ aimed to define rumination as a general thinking style, focusing on its intermittent and intrusive nature rather than on the mood or the content of its occurrence. This goal is reflected in both the phrasing of the items and the more general instructions, where participants are asked to indicate to what extent these items characterize them without specifying the (depressed) mood state. When examining the factor structure of the RTSQ, the authors found the single-

factor solution the most adequate. The retained 20 items showed high internal consistency (Cronbach's α= .92 and Cronbach's α= .87). Regarding convergent validity, the RTSQ demonstrated significantly stronger correlation (r=.64) with the Global Rumination Scale (McIntosh et al., 1995) than with the 22-item RRS (r=.31), implying that it successfully assesses ruminative tendencies in general, and does not solely focus on the depressive content of ruminative thoughts. Moreover, the authors of the RTSQ conducted a daily diary study on an undergraduate sample where they found that the RTSQ prospectively predicted depressed mood, even after controlling for baseline depressive symptoms, highlighting the clinical significance of rumination among university students, that appears to be well captured by the RTSQ.

Tanner et al. (2013) examined the factor structure of the RTSQ on two large adolescent samples (N = 1181 altogether). They removed five items (items 10,15,16,18,19) and suggested a second-order four-factor solution, with subscales named as Problem-focused thoughts (Items 9,11-14), Counterfactual thinking (Items 5-8), Repetitive thoughts (Items 1-4) and Anticipatory thoughts (Items 17, 20) where the items loaded on the four subscales together formulated a general higher-order rumination factor Thus, the authors concluded that the RTSQ measures rumination as a rather multidimensional, multifaceted construct. In a recent empirical study Bravo et al. (2017) found that the Problem-focused Thoughts subscale of the RTSQ mediated the relationship between depressive symptoms and drinking as a means of coping, supporting the scale's relevance among university students.

While Nolen-Hoeksema narrowly defined rumination as a potential response (or response style) to depressed mood, Tanner and colleagues (2013) provided a more integrative definition, highlighting the multifaceted nature of rumination. Similarly to Brinker and Dozois (2009), Tanner et al. also argue that repetitivity, intrusiveness or uncontrollability are core elements of rumination which might suggest non-productivity, but they also argued that that in some cases, rumination might be useful in identifying strategies and/or resources to cope with future eventualities (Tanner et al., 2013). Regarding content validity, the authors of the RTSQ focused on conceptualizing rumination as a generic thought pattern, emphasizing its recurrent and intermittent feature rather than its negative valence and past-oriented tendency. Additionally, the four subscales identified by Tanner and colleagues may reflect those core aspects of rumination that the RTSQ can capture. Past psychometric studies (Claycomb et al., 2015; Mihić et al., 2019) consistently found the Repetitive thought subscale (items 1-4), indicating that the RTSQ reflects the repetitive nature of ruminative thinking well. However, other important

aspects of rumination, such as automaticity, involuntariness, and goal insensitivity (E. R. Watkins & Roberts, 2020) may be reflected less by the items of the RTSQ.

In the past decade, most studies that evaluated the factor structure of the RTSQ either tested the unifactorial model suggested by Brinker and Dozois (e.g., Karatepe et al., 2013; Walsh et al., 2017), the four-factor solution described by Tanner et al. (Claycomb et al., 2015; Dzhambov et al., 2019; Tonta et al., 2020) or examined both (Bravo et al., 2018; Helmig et al., 2016; Mihić et al., 2019). Studies comparing the single-factor and the second-order four-factor models unequivocally found better model fits for the latter. Mihić et al. (Mihić et al., 2019) however suggested a third alternative, a bifactor model as the best solution, with the possibility to reconcile the unifactorial and the four-factor solutions. Mihić et al. (Mihić et al., 2019) found that once the general factor was controlled for, the four subscales did not contribute to the explained variance of the RTSQ significantly, thus the applicability of the subscales was not fully supported according to their results. A summary of previous studies assessing the factor structure of the RTSQ is demonstrated in Table 2.1.

*Table 2.1. Empirical studies assessing the factor structure of the RTSQ in different cultural and linguistic settings.*

| Author/year | Language of RTSQ | Sample(s)<br>N, $M_{age}$ (SD) | Method | Tested/preferred model (N of items),<br>fit indices |
|---|---|---|---|---|
| Brinker & Dozois, 2009 | English | 309 university students, $M_{age}$=18.96 (3.72) | PCA | one factor model (20)<br>fit indices: N/A |
| Tanner et al., 2013 | English | 2362 adolescents, $M_{age}$=13.95 (0.99) | EFA, PCA, CFA | higher order four factor model (15)<br>$\chi^2$=666.49, CFI=0.95, NFI=0.94, RMSEA=0.08, SRMR=0.07 |
| Karatepe et al., 2013 | Turkish | 262 university students, age not reported | PCA | one factor model (20)<br>fit indices: N/A |
| Claycomb et al., 2015 | English | 304 trauma-exposed primary care patients, $M_{age}$=42.56 (11.66) | CFA | four factor model (15)<br>$\chi$2=342.51, CFI=0.97, TLI=0.97, RMSEA=0.08 |
| Helmig et al., 2016 | German | 203 nonclinical individuals, $M_{age}$=40.6 (12.8); 201 clinical individuals, $M_{age}$=36.1 (12.8) | CFA | higher order four factor model (15)<br>nonclinical sample: $\chi$2/df = 2.17, CFI= 0.98, TLI=0.98, RMSEA=0.08;<br>clinical sample: $\chi$2/df = 1.40, CFI=0.99, TLI = 0.99, RMSEA=0.05 |
| Walsh et al., 2017 | English | Australian Sample:<br>369 university students, $M_{age}$=21 (SD not reported); | CFA | one factor model (20) |

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|---|---|---|---|---|
| | | Chinese (English-Chinese bilingual)<br>Sample: 123 university students, $M_{age}$=20 (SD not reported) | | Australian Sample: $\chi 2$=767.60, CFI=0.980, TLI=0.976, RMSEA=0.102;<br>Chinese Sample: $\chi 2$=201.20, CFI=0.988, TLI=0.986, RMSEA=0.085 |
| Bravo et al., 2018 | English, Spanish (Spain), Spanish (Argentina) | U.S sample:<br>924 university students, $M_{age}$=21.98 (6.33)<br>Argentinean sample:<br>403 university students, $M_{age}$=22.55 (4.17)<br>Spanish sample:<br>305 university students, $M_{age}$=21.03 (4.08) | CFA | four-factor model (15)<br>U.S sample: $\chi 2$=308.30, CFI=0.968, TLI=0.960, RMSEA=0.054, SRMR=0.044;<br>Argentinean sample:<br>$\chi 2$=271.65, CFI=0.921, TLI=0.901, RMSEA=0.074, SRMR=0.061;<br>Spanish sample:<br>$\chi 2$=201.49, CFI=0.936, TLI=0.921, RMSEA=0.068, SRMR=0.054; |
| Dzhambov et al., 2019 | Bulgarian | 529 university students, $M_{age}$=21(2)* | CFA | four factor model (15)<br>$\chi 2$=253.897, CFI=0.953, RMSEA=0.064, SRMR=0.044. |
| Mihić et al., 2019 | Serbian | heterogeneous adult sample, $M_{age}$=26.5(6.44) | CFA | bifactor model (19) |

| | | | | |
|---|---|---|---|---|
| | | | | $\chi$2=633.49, CFI=0.95, TLI=0.94, RMSEA=0.06-0.07, SRMR=0.04 |
| Tonta et al., 2020 | English | 735 university students, $M_{age}$ = 21.69 (6.12) | CFA | four factor model (15) $\chi$2=304.32, RMSEA=0.060, CFI=0.963, TLI = 0.953, SRMR=0.047 |

RTSQ, Ruminative Thought Style Questionnaire; EFA, Exploratory Factor Analysis; PCA, Principal Component Analysis; CFA, Confirmatory Factor Analysis; $\chi^2$, chi-square test statistic; df, degree of freedom; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; RMSEA, Root Mean Squared Error of Approximation; SRMR, Standardized Root Mean Square Residual.

* Median (interquartile range).

Although results about the cross-cultural validity of the RTSQ are scarce, Bravo et al. and Walsh et al. found that the RTSQ demonstrated measurement invariance across U.S, Spanish and Argentinian samples (Bravo et al., 2018), and across Chinese and Australian samples (Walsh et al., 2017).

Among the factor extraction methods described above, only the bifactor solution is capable of separating how much of the item response variance derives from a single latent variable, and how much is attributable to its subgroups, which is a crucial aspect when improving a scale that may contribute to better interpret the trait itself.

In summary, the psychometric evaluation of the RTSQ thus far has yielded inconclusive results, and the factor structure of the Hungarian RTSQ (Kocsel & Kökönyei, 2021) has not been investigated. Our primary goal was to see whether a strong common trait or factor – rumination - existed behind the different items or factors to see whether the sum score of the RTSQ could be reliably used in future studies. On the other hand, there is substantial heterogeneity in past studies not only in the language of the RTSQ, but also the research methodologies applied. Therefore, another aim of our research was to investigate the factor structure and psychometric properties of the Hungarian RTSQ by testing the models presented above on two demographically more homogenous adult samples in two different studies. Furthermore, due to the ambiguity of these models, we also aimed to examine the factor structure of the RTSQ with Exploratory Structural Equation Modelling (ESEM), a method that consists of both confirmatory and exploratory features (Marsh et al., 2014). CFA requires item cross-loadings to be fixed at zero, however, for many measurement models this restriction may be impractical and often contradicts the background theory of the measure (Asparouhov & Muthén, 2009). One clear advantage of CFA is the capability to build concise models and it is considered the go-to approach when a solid measurement model is available (Tóth-Király et al., 2017). ESEM, on the other hand allows for items to load on multiple factors, which may be a more accurate representation of reality when subscales are not entirely independent (Maïano et al., 2013). Also, when there is a lack of consensus regarding the measurement model, or its structure is more complex (and would be oversimplified by the CFA approach), the use of ESEM is recommended (Asparouhov & Muthén, 2009). In case of the RTSQ, theory posits that there is a latent overarching construct, rumination (Brinker & Dozois, 2009), and therefore the assumption that it comprises four independent subscales is highly improbable and such measurement specification may lead to error. Furthermore, given the inconclusive results in the literature, a solid measurement model of the RTSQ is unavailable. Therefore, we also wished to test its factor structure with ESEM.

In Study 1 our goals were to 1) evaluate the degree of fit of the four previously mentioned measurement models of RTSQ; 2) test the best fitting model with ESEM; 3) test the gender invariance of the best fitting model (B. Muthen & Asparouhov, 2013); 4) investigate the psychometric properties of RTSQ and 5) test its construct validity with the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977) and the Brief Symptom Inventory (BSI) [(Derogatis, 1993; Derogatis & Melisaratos, 1983). Based on previous results (Claycomb et al., 2015; Roley et al., 2015; Tanner et al., 2013) we expected that the RTSQ would have a significant positive relationship with the CES-D and the BSI scales.

In Study 2 we aimed to test the construct validity of the RTSQ using the short form of the Ruminative Response Scale (RRS) (Treynor et al., 2003), which measures two different facets of rumination: brooding and reflective pondering. Considering previous theoretical and empirical work (Mihić et al., 2019) we hypothesized positive associations between the RTSQ and the reflective pondering and brooding factors of the RRS.

## 2.2. Study 1

### *2.2.1. Methods of Study1*

*Sample and Procedure*

Two independent researchers translated the RTSQ from English to Hungarian. Differences were resolved by discussion and consensus with the help of a third native Hungarian-speaking researcher who used to live in an English-speaking country for years. Then a fourth researcher backtranslated the Hungarian version to English. A native English-speaking psychologist reviewed the two versions and found that the backtranslation adequately reflected the meaning of the original items.

Data collection was carried out within the framework of a larger research project examining the psychological and genetic factors of addictive behaviors (Kotyuk et al., 2019). Ethical consent was obtained from the Scientific and Research Ethics Committee of the Medical Research Council (ETT TUKEB) for the whole research project including this study. Approval number: 20707-0/2010-1018EKU (840/PI/010.) Written informed consent of participants was obtained. Students were recruited from several university dormitories, who participated in the study on a voluntary basis. Potential participants were contacted in person in their dormitories by research assistants in a systematic manner, where they could fill out the self-report measures on paper in their room at their own pace after providing written informed consent. Inclusion criteria were age of 18 years or older and active student status at the university, no further

restrictions applied. In all institutions, refusal to participate in the whole study was approximately 5%. Altogether 1139 university students agreed to participate, however, 16 of them did not fill out the relevant measures, thus they could not be included in the analysis. Therefore, the overall sample of the current study comprised of 1123 university students, with a fairly balanced gender ratio (percentage of female participants = 55%; N= 618), where the minimum age was 18, the maximum 37 years (M= 21.96; SD=1.96).

*Measures*

**Ruminative Thought Style Questionnaire** (RTSQ) (Brinker & Dozois, 2009). RTSQ is a 20-item self-report scale that is aiming to measure rumination regardless of the valence, temporal orientation, or content of such thoughts. Participants have to respond on a 7-point Likert-scale (*1=not at all descriptive of me; 7=describes me very well*) to items such as *"When I am expecting to meet someone, I will imagine every possible scenario and conversation"*. The RTSQ total score has shown excellent internal consistency (Cronbach α = .89 – .92) and high test-retest reliability after two weeks (r = .80, p < .01) (Brinker & Dozois, 2009), as well as its subscales suggested by Tanner et al. (2013) (Cronbach α= .71- .89). The Hungarian RTSQ also demonstrated high internal consistency in two independent studies (Cronbach α = .88; Cronbach α =.91) (Kocsel et al., 2019; Kovács, Schmelowszky, et al., 2021).

**The Center for Epidemiologic Studies Depression Scale** (CES-D) (Radloff, 1977). The CES-D has been designed for measuring depressive mood in the general population (Radloff, 1977). The original 20-item instrument was shortened to eight negative affect items (e.g. *"I felt lonely"; "I felt fearful"*) and two positive affect items (e.g. *"I felt hopeful about the future"; "I was happy"*). Participants are asked to evaluate on a four-point Likert scale from *0=never* to *3=always* how often they felt this way during the last seven days. The two positive affect items were reversed when calculating the sum score of the scale. The test's Hungarian adaptation demonstrated good internal consistency in a previous study (Cronbach α = .82) (Urbán et al., 2014), as well as in this sample (Cronbach α= .77).

**The Brief Symptom Inventory** (BSI) (Derogatis, 1993; Derogatis & Melisaratos, 1983) primarily aims to measure psychological symptoms of clinical patients. The BSI is the shortened form of the Derogatis Symptom Checklist (SCL-90) (Derogatis, 1975) that consists of nine subscales, measuring symptom domains on a five-point Likert scale ranging from *0=not at all to 4=extremely*. The mean score of the 53 items is referred to as the General Symptom Index (GSI). In a previous study, the Hungarian adaptation of the BSI demonstrated a bifactor solution with a solid global factor comprised of all items, where the subscales contributed little

to the explained variance (Urbán et al., 2014). Hence, we only included the GSI in our analyses, which demonstrated excellent internal consistency in the current sample (Cronbach α = .95).

*Data analysis strategy*

Data was analyzed using SPSS 25.0 (IBM SPSS, IBM Corp., Armonk, NY) and Mplus 7.4 software packages (Muthen & Muthen, 1998) . Firstly, structural equation modeling (SEM) was performed to estimate the degree of fit of three prior measurement models. The maximum likelihood robust (MLR) parameter estimates were used during the analyses with standard errors and chi-square test statistics that were robust to non-normality and non-independence of observations (Muthen & Muthen, 2007). Multiple fit indices were considered to evaluate model fit. The index of Root Mean Squared Error of Approximation (RMSEA) below .05 indicates optimal fit, while a value above .10 indicates poor fit. The non-significant value indicates acceptable model fit (Brown, 2006). Acceptable model fit also requires the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) to be around or higher than .90-.95 (Brown, 2006). The Standardized Root Mean Square Residual (SRMR) value was also used as an index to assess the fitness of the model, which indicates a good fit below .08 (Kline, 2015). The tested non-nested models were compared with Akaike Information Criteria (AIC), where the model with the lowest AIC value was considered as the best fitting model to the data.

In the next stage of analysis, we tested a bifactor ESEM on the bifactor model proposed by Mihić et al (Mihić et al., 2019). In the bifactor ESEM (Model 4), items loaded on their main factors, but cross-loadings were allowed (targeted, but not forced to be zero). After a thorough inspection of the items we did not include correlated uniquenesses (i.e. covariances between the error terms of items) to our model. The model fit was evaluated according to the above described criteria. In addition to considering fit indices of the models, the internal consistency of the RTSQ was analyzed. Besides Cronbach's alpha, we calculated the omega total coefficient (ω) to examine the proportion of variance in the (unit-weighted) RTSQ total score, attributable to all sources of common variance (McDonald, 1999; M. W. Watkins, 2013). Based on previous studies (Tóth-Király et al., 2017), the coefficient was calculated as follows: sum of factor loadings$^2$/ sum of factor loadings$^2$ + residual variance of items. Furthermore, we estimated the omega hierarchical coefficients ($\omega_h$), which indicates that proportion of the systematic variance in the test's total scores that may be due to between-subject dissimilarities on the general factor, by demonstrating the ratio of the general factor's variance in contrast to the total variance of the measure (M. W. Watkins, 2017). According to Reise and colleagues (Reise, 2012), an omega value of .75 or higher would be preferred.

In the next stage of data analysis, we tested the gender invariance of the best fitting model using a multigroup approach in Mplus 7.4. In the configural invariance model the same factor structure and same associations between items and factors were assessed among males and females, without equality constraints. In the metric invariance model, all factor loadings were constrained to be invariant, while in the strong or scalar invariance model both the factor loadings and items' intercepts were set to be equal across gender groups. In a subsequent model, we tested the strict measurement invariance as well, where all factor loadings, intercepts, and items' uniquenesses were constrained to be invariant across males and females. In addition, two further models were tested in which invariance constraints were specified at the level of the factor variances and covariances, and latent means, following the suggestions of Morin et al. (Morin, Tran, et al., 2016). The tested non-nested models were compared with Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC). In the past, the model with the lowest AIC or BIC value were considered as the best fitting model to the data, but subsequent studies pointed out that information criteria should be considered as a rough guideline that should be used in combination with parameter estimates and theoretical adequacy, especially outside of the CFA framework, such as ESEM (Morin, Arens, et al., 2016; Stenling et al., 2015). According to previous recommendations, the assumed invariance was accepted if the change in the value of CFI and RMSEA was below or equal to .010 and .015, respectively (Chen, 2007).

Finally, correlation analyses were conducted to test the construct validity of the RTSQ.

### *2.2.2. Results of Study 1*

*Comparing measurement models*

Four measurement models were compared during the analysis, including 1) the originally proposed one factor model by Brinker and Dozois (Brinker & Dozois, 2009) (Model 1); 2) the second-order four-factor solution found by Tanner and colleagues (Tanner et al., 2013) (Model 2); 3) and the bifactor model of Mihić and colleagues (Mihić et al., 2019) (Model 3). In the bifactor model of Mihić and colleagues (Mihić et al., 2019) almost every item (except Item 16) loaded to the general rumination factor, but several items were left out of group factors due to low factor loadings (i.e.: items 5,10,14,15,18). As we have outlined in the introduction, we tested a 4) bifactor ESEM as well (Model 4). Thanks to this approach we were able to combine the advantages of the explanatory and confirmatory methods, and we could build a theoretically more suitable model (i.e. in contrast to CFA, in ESEM cross-loadings between the specific factors were targeted but not forced to be 0) (Morin, Tran, et al., 2016; Tóth-Király et al., 2017).

Maintaining the factor structure proposed by Mihić and colleagues (Mihić et al., 2019), we formulated one general factor and four specific factors (*Problem-focused thoughts:* Items 9,11,12,13*; Counterfactual thinking:* Items 6-8*; Repetitive thoughts:* Items 1-4*; Anticipatory thoughts:* Items 17,19,20). After a thorough content check, we also decided to leave out Item 16 *("I like to sit and think about pleasant events from the past."*), which is in line with previous recommendations (Mihić et al., 2019; Tanner et al., 2013).

Table 2.2. shows the fit indices for each model. Model 1 did not fit the data, while both Model 2 and Model 3 indicated unsatisfactory fit. The only acceptable model was Model 4, implying that the variance was best explained by a bifactor ESEM structure, where 14 out of 19 items loaded on the subfactors besides the general factor. Standardized factor loadings of Model 4 are presented in Table 2.3.

*Table 2.2. Factor analyses of four measurement models of the Ruminative Thought Style Questionnaire.*

| | AIC/BIC | $\chi^2$ | df | CFI | TLI | RMSEA | 90% CI | SRMR |
|---|---|---|---|---|---|---|---|---|
| **Model 1** | 80702.246/ 81003.672 | 2579.555 | 170 | .699 | .663 | .112 | .11-.12 | .079 |
| **Model 2** | 58942.291/ 59188.455 | 576.214 | 86 | .916 | .897 | .071 | .07-08 | .059 |
| **Model 3** | 74569.131/ 74925.818 | 865.870 | 138 | .906 | .883 | .069 | .06-.07 | .047 |
| **Model 4** | 74008.382/ 74626.304 | 318.861 | 86 | .970 | .940 | .049 | .04-.06 | .020 |

*Model 1= One factor CFA; Model 2=Second-order four factor CFA; Model 3= bifactor CFA; Model 4= bifactor ESEM; AIC, Akaike Information Criteria; BIC, Bayesian Information Criterion, $\chi^2$, chi-square test statistic; df, degree of freedom; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; RMSEA, Root Mean Squared Error of Approximation; CI, confidence interval; SRMR, Standardized Root Mean Square Residual.*

*Table 2.3. Standardized factor loadings of the bifactor ESEM of the RTSQ.*

| Items | Bifactor | RT | CT | PfT | AT |
|---|---|---|---|---|---|
| I find that my mind goes over things again and again | **.50** | **.61** | -.05 | -.04 | -.07 |
| When I have a problem, it will gnaw on my mind for a long time | **.55** | **.61** | -.01 | .07 | -.03 |
| I find that some thoughts come to my mind over and over throughout the day | **.56** | **.63** | -.05 | -.02 | -.05 |
| I can't stop thinking about some things | **.52** | **.38** | .09 | .02 | .09 |
| When I am expecting to meet someone, I will imagine every possible scenario and conversation | **.55** | .08 | .23 | -.09 | .01 |
| I tend to replay past events as I would have liked them to happen | **.49** | -.05 | **.58** | .03 | -.01 |
| I find myself daydreaming about things I wish I had done | **.53** | .01 | **.57** | .05 | -.07 |
| When I feel I have had a bad interaction with someone, I tend to imagine various scenarios where I would have acted differently | **.60** | .00 | **.48** | -.06 | -.03 |
| When trying to solve a complicated problem, I find that I just keep coming back to the beginning without ever finding a solution | **.56** | .00 | .16 | **.23** | -.04 |
| If there is an important event coming up, I think about it so much that I work myself up | **.53** | .07 | .01 | .10 | .43 |
| I have never been able to distract myself from unwanted thoughts | **.56** | .14 | .03 | **.37** | .14 |
| Even if I think about a problem for hours, I still have a hard time coming to a clear understanding | **.49** | -.05 | .03 | **.71** | -.03 |
| It is very difficult for me to come to a clear conclusion about some problems, no matter how much I think about it | **.55** | -.01 | -.09 | **.57** | -.10 |

| | | | | | |
|---|---|---|---|---|---|
| Sometimes I realise I have been sitting and thinking about something for hours | **.64** | -.06 | -.06 | .11 | -.17 |
| When I am trying to work out a problem, it is like I have a long debate in my mind where I keep going over different points | **.72** | -.06 | -.22 | -.09 | -.18 |
| When I am looking forward to an exciting event, thoughts of it interfere with what I am working on | **.58** | -.09 | -.03 | .07 | **.41** |
| Sometimes even during a conversation, I find unrelated thoughts popping into my head. | **.56** | -.04 | .04 | .02 | .19 |
| When I have an important conversation coming up, I tend to go over it in my mind again and again | **.65** | .04 | .06 | -.16 | **.28** |
| If I have an important event coming up, I can't stop thinking about it | **.55** | .01 | -.07 | .03 | **.66** |

*RTSQ, Ruminative Thought Style Questionnaire; RT, Repetitive thoughts factor of the Ruminative Thought Style Questionnaire; CT, Counterfactual thinking factor of the Ruminative Thought Style Questionnaire; PfT, Problem-focused thoughts factor of the Ruminative Thought Style Questionnaire; AT, Anticipatory thoughts factor of the Ruminative Thought Style Questionnaire.*

*Internal consistency of the best fitting model (bifactor ESEM)*

The Cronbach αs of the total score of the RTSQ and its subscales demonstrated good internal consistency, in line with previous findings (Mihić et al., 2019; Tanner et al., 2013). In order to eliminate the errors in the estimation of internal consistency, the omega total and omega hierarchical coefficients were calculated (for details see Table 2.4).

*Table 2.4. Alpha and omega internal consistency for the bifactor ESEM of the RTSQ (Model 4).*

| **Model 4** | **Omega total (ω)** | **Omega hierarchical ($\omega_h$)** | **Cronbach α** |
|---|---|---|---|
| General bifactor | .939 | .851 | .910 |
| RT | .856 | .430 | .843 |
| CT | .806 | .384 | .800 |
| PfT | .826 | .356 | .793 |
| AT | .802 | .231 | .765 |

*RTSQ, Ruminative Thought Style Questionnaire; RT, Repetitive thoughts factor of the Ruminative Thought Style Questionnaire; CT, Counterfactual thinking factor of the Ruminative Thought Style Questionnaire; PfT, Problem-focused thoughts factor of the Ruminative Thought Style Questionnaire; AT, Anticipatory thoughts factor of the Ruminative Thought Style Questionnaire.*

Given that the omega total of the RTSQ was .939 and the omega hierarchical coefficient for the whole scale was .851 we could assume that only 15% of the total score variance was attributable to the group factors. The omega hierarchical values of the subscales were low compared to omega total values, indicating that the majority of the subscale score variances could be attributed to the general factor and not to the group factors (M. W. Watkins, 2013).

*Measurement invariance across gender*

The configural model showed a satisfactory fit to the data (see Table 2.5). Our findings also supported the metric, scalar and strict level gender invariance of bifactor ESEM model as adding constraints to the factor loadings or intercepts did not result in a significant decrease of model fit (according to the recommended cutoff scores of ΔCFI <.010; ΔRMSEA <.015) (Chen, 2007; M. W. L. Cheung, 2009; Dimitrov, 2010). The invariance model of latent variance-covariance was also supported, but the invariance of latent means was not supported, as the changes of fit indices exceeded the cutoff scores (ΔCFI=-.014). These results indicate that when latent means are constrained to zero in the reference group (males) and are freely estimated in the other group (females), latent means of the female group are significantly higher on the general bifactor (M=.308, p<.001), the problem-focused thoughts (M=.160, p<.05), repetitive thoughts (M=.433, p<.001) and anticipatory thoughts factors (M=.520, p<.001) compared to males.

*Table 2.5. Testing measurement invariance of the RTSQ across genders.*

| **Model** | **χ2(df)** | **AIC/BIC** | **RMSEA** | **RMSEA 90%CI** | **TLI** | **CFI** | **Model comparison** | **ΔRMSEA** | **ΔCFI** |
|---|---|---|---|---|---|---|---|---|---|
| A.) Configural invariance | 430.787(172)* | 73913.023/ 75148.868 | .052 | [.046-.058] | .932 | .966 | - | - | - |
| B.) Metric/weak invariance | 526.271(242)* | 73891.454/ 74775.636 | .046 | [.040-.051] | .947 | .962 | B-A | -.006 | -.004 |
| C.) Scalar/strong invariance | 555.960(256)* | 73893.351/ 74707.200 | .046 | [.040-.051] | .947 | .960 | C-B | <.001 | -.002 |
| D.) Strict invariance | 555.960(256)* | 73893.351/ 74707.200 | .046 | [.040-.051] | .947 | .960 | D-C | <.001 | <.001 |
| E.) Var-covariance invariance | 618.019(290)* | 73898.995/ 74542.036 | .045 | [.040-.050] | .949 | .957 | E-D | -.001 | -.003 |
| F.) Invariance of latent means | 724.556(295)* | 74008.382/ 74626.304 | .051 | [.046-.056] | .934 | .943 | F-E | .006 | -.014 |

*RTSQ, Ruminative Thought Style Questionnaire; $\chi^2$, chi-square test statistics; df, degree of freedom; RMSEA, Root Mean Squared Error of Approximation; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index, CI, confidence interval. *p<.05.*

*Descriptive statistics and construct validity*

Means, standard deviations and effect sizes by gender are shown in Table 2.6. Significant gender differences were found between the variables, but the Cohen's d values indicated small or medium effects.

*Table 2.6. Means and standard deviations of the variables, along with t-statistics and effect sizes by gender.*

| **Variables (α)** | **Total sample, M (SD)** | **Males, M (SD)** | **Females, M (SD)** | **t (p)** | **Effect size Cohen's d** |
|---|---|---|---|---|---|
| RTSQ total (α=.91) | 78.18(20.07) | 73.64(19.27) | 81.86(19.97) | 6.89(<.001) | 0.42 |
| PfT (α=.79) | 12.43(5.13) | 11.60(4.72) | 13.11(5.35) | 4.99(<.001) | 0.30 |
| CT (α=.80) | 13.11(4.66) | 12.74(4.54) | 13.41(4.74) | 2.41(.02) | 0.14 |
| RT (α=.84) | 19.99(5.16) | 18.72(5.30) | 21.03(4.80) | 7.63(<.001) | 0.46 |
| AT (α=.77) | 12.69(4.17) | 11.59(4.03) | 13.59(4.06) | 8.21(<.001) | 0.49 |
| BSI_GSI (α=.95) | 1.68(.50) | 1.60(.45) | 1.74(.53) | 4.99(<.001) | 0.28 |
| CES-D (α=.77) | 9.72(4.83) | 9.02(4.59) | 10.29(4.95) | 4.37(<.001) | 0.27 |

*Total Sample: N= 1123; Males: N= 505 (45%); Females: N= 618 (55%). RTSQ, Ruminative Thought Style Questionnaire; RTSQ subscales: RT, Repetitive thoughts; CT, Counterfactual thinking; PfT, Problem-focused thoughts; AT, Anticipatory thoughts; BSI_GSI, Brief Symptom Inventory General Symptom Index; CES-D, The Center for Epidemiologic Studies Depression Scale; M, mean; SD, standard deviation.*

In order to test the construct validity of the RTSQ, correlations analysis was conducted (see Table 2.7 for details). In line with our expectations, the RTSQ showed significant positive correlation both with the CES-D and the BSI scores.

*Table 2.7. Correlations between RTSQ, BSI and CES-D scores (Study 1).*

| | **total sample** | | **female** | | **male** | |
|---|---|---|---|---|---|---|
| | **BSI_GSI** | **CES-D** | **BSI_GSI** | **CES-D** | **BSI_GSI** | **CES-D** |
| RTSQ total | .53 | .46 | .53 | .44 | .50 | .45 |
| PfT | .50 | .45 | .52 | .44 | .51 | .44 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CT | .36 | .33 | .39 | .34 | .30 | .31 |
| RT | .41 | .37 | .46 | .38 | .44 | .38 |
| AT | .35 | .29 | .36 | .27 | .35 | .31 |
| CES-D | .71 | 1.00 | .71 | 1.00 | .69 | 1.00 |

*Total Sample: N= 1123; Males: N= 505 (45%); Females: N= 618 (55%). RTSQ total, Ruminative Thought Style Questionnaire total score; RTSQ subscales: RT, Repetitive thoughts; CT, Counterfactual thinking; PfT, Problem-focused thoughts; AT, Anticipatory thoughts; BSI_GSI, Brief Symptom Inventory General Symptom Index; CES-D, The Center for Epidemiologic Studies Depression Scale; M, mean; SD, standard deviation. All correlations are significant at p < .001 level.*

To further investigate the construct validity of RTSQ, we estimated a model with covariates to explore the total score and the subscales' relationship with depression across gender. The standardized regression weights for the total sample and by gender can be found in Table S8.1 of the supporting material.

### *2.2.3. Discussion of Study 1*

In Study 1, we examined four competing models of the RTSQ factor structure based on previous recommendations in the literature on a large sample of university students. Considering the guidelines of Hu & Bentler (1999), Model 3 did not demonstrate an adequate fit due to their low CFI and TLI values, thus we could not accept it as our best model. However, when subscales do not represent distinct entities, forcing items to load on one single factor will not represent the construct accurately (Tóth-Király et al., 2017)]. RTSQ was aimed to measure rumination globally(Brinker & Dozois, 2009)– assuming that its subscales are not interrelated seems arbitrary and contradicts its theoretical background. ESEM allows for item cross-loadings, thus it is preferred in case of complex scales that lack consensus about their factor structure (Marsh et al., 2014), such as the RTSQ. Additionally, although a bifactor model may not be appropriate for all measures, especially those with homogenous item content, it is considered the best model for those instruments where we *theoretically* expect a strong common trait behind the responses, but also a multidimensionality caused by well-defined clusters (Reise, 2012). Therefore, we proposed a fourth model, a bifactor ESEM solution containing 19 items on the general factor, and 14 items on the subscales that demonstrated the best model fit. This finding appears to reconcile the original unidimensional suggestion of the authors of the

RTSQ (Brinker & Dozois, 2009) with the multifactorial proposition of Tanner et al. (Tanner et al., 2013), in line with the findings of Mihić et al. (Mihić et al., 2019). Allowing for cross-loadings substantially improved the factor scores of the model too, supporting that this approach represents the structure of the RTSQ better. Moreover, the exploratory feature of the ESEM may unravel where ambiguous items belong to. For instance, by replicating the model proposed by Mihic and colleagues, we only allowed item 10 to be loaded on the general factor, however, the ESEM approach revealed that it may belong to the AT subscale, that is in line with its content ("If there is an important event coming up, I think about it so much that I work myself up.").

Taken together, these results indicate that the RTSQ factor structure can be best described as bifactorial, where the global factor is accountable for most of the explained variance, and the subscales' applicability is limited. However, since the subscales also contributed to the explained variance, and the bifactorial ESEM showed the most adequate model fit, it is unequivocally preferred over the single-factor solution.

We sought to test for the gender invariance of the RTSQ, i.e., whether systematic differences can be found in the way males and females reply to the items. Since most studies applying self-report rumination measures report significant gender differences, presenting that women tend to ruminate more than men (D. P. Johnson & Whisman, 2013; Nolen-Hoeksema & Aldao, 2011), it is important to examine whether this is attributable to the lack of gender invariance of the measure. Based on the chi-squared difference statistics, the invariance was only supported for the configural model and not for more constrained models. However, given that the chi-square difference test is often criticized because of its sensitivity to the sample size and to normal distribution (Brown, 2006), additional analyses of other indices is worthwhile (Dimitrov, 2010). Cheung and Rensvold (G. W. Cheung & Rensvold, 2002) recommended that CFI or RMSEA delta values be investigated before conclusions are made about the lack of invariance. Decreases of .01 or more in CFI across the models provide more certainty that the hypothesis should be rejected (Chen, 2007). CFI and RMSEA delta values in our sample suggested configural, metric, scalar, strict and var-covariance invariance of our proposed bifactor ESEM, indicating that the RTSQ is a reliable measure across gender. The latent mean score of women was higher, suggesting that women tend to ruminate more than men, and this difference is not attributable to measurement bias (Tóth-Király et al., 2017).

Rumination has been extensively described as a risk factor to the onset, maintenance and relapse of depression (e.g., Nolen-Hoeksema et al., 1993; Olatunji et al., 2013). Recent studies however suggest that rumination is a transdiagnostic risk factor to psychopathology in general,

rather than being specific to depressive disorders (McLaughlin et al., 2014; Nolen-Hoeksema & E. R. Watkins, 2011), pointing out on one hand that measures not restricted to depressive rumination are required and on the other hand that the outcome of rumination can be diverse. Thus, we wished to test the construct validity of the RTSQ with the help of the CES-D depression scale, and the BSI, that measures psychological symptom patterns in general. In line with our expectations, we found moderate significant correlations between the RTSQ and both clinical scales. Furthermore, the regression model (S1 Table) showed that depressive symptoms were significantly associated with the RTSQ total score and subscales, except for AT, which is plausible given the more positive and future-oriented content of its items. The strongest predictor of depressive symptoms was the RTSQ total score, indicating the relevance of the total score in clinical settings.

## 2.3. Study 2

### *2.3.1. Methods of Study 2*

*Sample and Procedure*

In Study 2, our primary goal was to test the construct validity of the RTSQ in order to support the findings of Study 1. Moreover, as that the factor structure of the Hungarian RTSQ had not been examined elsewhere, we considered it important to reexamine it on an independent – albeit relatively small - sample. Undergraduate psychology students were recruited in exchange for partial class credit. Eligibility criteria included being 18 years old or older with no previous history of mental or neurological illness. The students completed self-report questionnaires online in the computer lab within a bigger study framework for 45 minutes. The study was approved by the Institutional Review Board of the Faculty of Education and Psychology, Eotvos Lorand University (approval number: 2018/396), and data collection was carried out in accordance with the Declaration of Helsinki. Participation in the study was voluntary and anonymous, and written informed consent was obtained. A total of 320 participants (268 females; mean age=23.28, SD=2.93 years) could be included for analysis. In Study 2 instead of the CES-D, we applied the Zung Self-Rating Depression Scale, another widely used and reliable measure of depression. Empirical findings support that the two scales are interchangeable (Ruiz-Grosso et al., 2012; Saltukoğlu & Tatar, 2017). Appling another measure of depression enabled us to see whether the findings of Study 1 regarding the associations of RTSQ and depression would be generalizable to another depression scale,

reducing the probability that any association between the two constructs is due to item-level biases.

*Measures*

**Ruminative Response Scale** (RRS) (Treynor et al., 2003)]. The RRS contains 10 items rated on a four-point Likert scale from *1 = never to 4 =always*, forming two subscales labelled brooding and reflective pondering. Reflective pondering is a more adaptive way of repetitive thought processing (at least in long-term), where analyzing one's own emotions and thoughts may facilitate problem solving, while brooding can be characterized as the passive, self-criticizing dwelling on past stressful situations (Treynor et al., 2003)]. The sum of the scores for each subscale were used in the analyses, where higher scores indicated more usage of the specific response style. Both subscales of the Hungarian adaptation demonstrated good internal consistency in a previous study (Cronbach αs: .71 and .73, respectively) (Kokonyei et al., 2016), as well as in the current sample (Cronbach αs were .71 for brooding and reflective pondering).

The **Zung Self-rating Depression Scale** (ZSDS) (Simon, A, 1998; Zung, 1965) was used to measure depressive symptoms. The ZSDS is a 20-item instrument (e.g. *"I have trouble sleeping at night"*) where each item is rated on a 4-point scale (*1= a little of a time; 4=most of the time*). The total score (ranged between 20-80) of ZSDS was calculated and used in the analysis, where higher scores indicates more depressive symptoms. Internal consistency of the scale was acceptable (Cronbach α=.67).

RTSQ described above was also used in Study 2.

*Statistical analysis*

Pearson correlation analyses were applied to test the construct validity of the RTSQ using Mplus 7.4. Coefficients between RRS, ZSDS and RTSQ were interpreted and the level of significance was set to .05. We examined the factor structure of the RTSQ the same way as we did in Study 1.

### *2.3.2. Results of Study 2*

*Descriptive statistics and construct validity*

Means, standard deviations, Cronbach's alphas and correlations between measures are presented in Table 2.8. As expected, the RTSQ showed significant positive correlations with the ZSDS total score (similarly to Study 1) and both subscales of the RRS, but the strength of the associations was considerably different for the two RRS subscales: the RTSQ total score

(as well as its subscales) was weakly associated with reflective pondering (r= .23) but showed stronger positive correlations with brooding (r= .60). No significant gender differences were found.

*Table 2.8. Pearson correlations between measures along with the means, standard deviations and Cronbach's alphas (Study 2).*

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. |
|---|---|---|---|---|---|---|---|---|---|
| 1.RTSQ total(α=.90) | | | | | | | | | |
| 2. PfT(α=.79) | .79** | | | | | | | | |
| 3. CT (α=.80) | .70** | .45** | | | | | | | |
| 4. RT(α=.84) | .79** | .55** | .46** | | | | | | |
| 5. AT(α=.75) | .72** | .43** | .33** | .47** | | | | | |
| 6. RRS total | .54** | .49** | .40** | .50** | .33** | | | | |
| 7.RRS Brooding(α=.71) | .60** | .50** | .52** | .50** | .32** | .78* | | | |
| 8.RRS Reflective pondering(α=.71) | .23** | .14* | .10 | .26** | .14* | .78** | .21** | | |
| 9. ZSDS(α=.67) | .58** | .63** | .40** | .45** | .28** | .41** | .54** | .09 | |
| Total sample, M (SD) | 75.41 (19.19) | 11.12 (4.87) | 11.47 (4.74) | 20.59 (4.93) | 12.90 (4.11) | 23.59 (4.93) | 10.73 (3.17) | 12.87 (3.16) | 39.28 (7.70) |
| Males, M (SD) | 72.88 (20.24) | 10.56 (4.89) | 11.79 (5.31) | 19.63 (5.02) | 12.06 (4.02) | 23.23 (5.33) | 10.21 (3.16) | 13.02 (3.48) | 37.78 (6.32) |
| Females, M (SD) | 75.90 (18.99) | 11.23 (4.88) | 11.41 (4.63) | 20.78 (4.90) | 13.06 (4.12) | 23.66 (4.85) | 10.83 (3.17) | 12.84 (3.10) | 39.57 (7.92) |
| t-statistics (p) | 1.03 (.31) | 0.90 (.37) | 0.53 (.60) | 1.54 (.13) | 1.61 (.11) | 0.58 (.56) | 1.29 (.20) | 0.38 (.70) | 1.51 (.13) |

*Total Sample: N= 320; Males: N= 52 (16%); Females: N= 268 (84%); RTSQ total, Ruminative Thought Style Questionnaire total score; RTSQ subscales: RT, Repetitive thoughts; CT, Counterfactual thinking; PfT, Problem-focused thoughts; AT, Anticipatory thoughts; RRS, Ruminative Response Scale; ZSDS, Zung Self-rating Depression Scale; M, mean; SD, standard deviation; *p<.05; ** p<.001.*

We also performed a regression model (Table 2.9) to be able to control for gender and age, and to see whether ZSDS is significantly associated with RTSQ even after controlling for the RRS subscales.

*Table 2.92. Association between RTSQ total scores, trait rumination (measured by RRS) and depressed mood (ZSDS scores) after controlling for gender and age.*

| | B | SE | β | $R^2$ | $\Delta R^2$ |
|---|---|---|---|---|---|
| Step 1 | | | | .397 | |
| Constant | 50.700 | 9.469 | | | |
| gender | .621 | 2.369 | .012 | | |
| Age | -.994 | .299 | -.153** | | |
| RRS Brooding | 3.369 | .281 | .559*** | | |
| RRS Reflection | .803 | .291 | .128** | | |
| Step 2 | | | | .479 | .081*** |
| Constant | 23.115 | 9.710 | | | |
| gender | .172 | 2.209 | .003 | | |
| age | -.717 | .282 | -.111* | | |
| RRS Brooding | 2.301 | .305 | .381*** | | |
| RRS Reflection | .797 | .272 | .127** | | |
| ZSDS total | .854 | .126 | .342*** | | |

*RTSQ total, Ruminative Thought Style Questionnaire total score; RRS, Ruminative Response Scale, ZSDS, Zung Self-rating Depression Scale. *p<.05; ** p<.01; ***p<.001.*

Similarly to Study 1, the bifactor ESEM showed good fit to the data in Study 2 ($\chi^2$= 169.632, df=86, CFI=.96, TLI=.93, RMSEA=.06, SRMR=.03). Further details about CFA models and internal consistency can be found in S8.2 and S8.3 Tables.

### *2.3.3. Discussion of Study 2*

In Study 2, we tested the construct validity of the RTSQ compared to the RRS, one of the most extensively used rumination measures (Parola et al., 2017) and we also measured its unique relation to depressive symptoms (as assessed by the ZSDS). The analyses revealed that the RTSQ was more strongly associated with the brooding subscale than the reflective pondering subscale of the RRS, thus, it appears that the RTSQ captures the maladaptive aspect of rumination more distinctively than the reflective pondering component. Our results also demonstrated significant positive association with depressive symptoms measured by the ZSDS, reaffirming its validity due to the well-known association between rumination and depressive symptoms (Nolen-Hoeksema, 1991). Our results and previous empirical evidence (Mihić et al., 2019) on the association of the RTSQ factors with the RRS subscales could also suggest that ruminative thoughts are associated, but not redundant with the response style assessed by RRS. Furthermore, we managed to provide further support for the findings of Study 1 regarding the factor structure of the RTSQ, as the proposed bifactor ESEM demonstrated good model fit on an independent sample.

## 2.4. General discussion

The goal of our study was to explore the psychometric properties of the RTSQ. We wished to see whether rumination as an underlying construct emerged behind the different items, in other words, to see whether the RTSQ total score is a valid measure of rumination. As rumination is a transdiagnostic risk factor to psychopathology (Ehring & Watkins., 2008) that should be a target of interventions (Schmaling et al., 2002), it is crucial to define reliable rumination measures for assessment and treatment purposes - in case of the RTSQ, to disentangle whether the global score or the subscales are more advised to use for such purposes. This is especially important in case of a university student sample, as that age range is considered a sensitive period for the emergence of psychological problems such as mood disorders (Kadison & DiGeronimo, 2004), for which rumination is considered a substantial risk factor, primarily among women (Nolen-Hoeksema, 1991), highlighting the relevance of examining gender invariance of rumination measures such as the RTSQ. Moreover, rumination has been the target of specific therapeutic interventions (E. R. Watkins, 2016), hence a reliable rumination scale could help to accurately measure post-therapeutic change in ruminative tendencies. Prior research about the factor structure of the RTSQ was indefinite, hence we examined several previously proposed models: the unidimensional solution suggested by the

authors of the RTSQ (Brinker & Dozois, 2009), the four-factor structure introduced by Tanner et al. (Tanner et al., 2013), and the bifactor model presented by Mihić et al. (Mihić et al., 2019). In addition, we proposed a fourth model, a bifactor ESEM solution containing 19 items on the general factor, and 14 items on the subscales, as suggested by Mihić et al. (Mihić et al., 2019).

Our results supported the bifactor ESEM solution, were most of the variance is explained by the general rumination factor. This indicates that the original aim of the authors of the RTSQ was attained, i.e. to construct a scale that assesses rumination globally (Brinker & Dozois, 2009). To conclude, our results align with the findings of Mihić et al. (Mihić et al., 2019), i.e. that the bifactor solution is the most adequate model, where the total score of the RTSQ can be used reliably, and the application of the subscales is ambiguous. We managed to provide further support to this finding on a smaller independent sample in Study 2. The differences in factor loadings may be attributed to cultural or idiomatic differences, as well as to certain sample characteristics, thus we did not find it justifiable to rule more items out based on the results of our study. Furthermore, we did not wish to strictly follow the subscales recommended by Tanner et al. (Tanner et al., 2013), as they conducted their research on an adolescent sample, thus their results may not entirely apply for adults. It appears that more studies are needed to clarify the applicability of certain ambiguous items.

Our study indicated that the RTSQ is a reliable measure across genders, which is important due to the well-documented gender differences in rumination, namely that women generally report more rumination than men (D. P. Johnson & Whisman, 2013; Nolen-Hoeksema & Aldao, 2011). This variation has been suggested to account for the gender difference, at least partially, in depression, i.e. that women are twice as likely to suffer from major depressive disorder during their lifespan than men (Lyubomirsky et al., 2015; Nolen-Hoeksema, 1987). Thus, investigating whether men and women tend to interpret the items of self-report rumination measures equivalently is crucial for the practical implication of their results. Our results support that the gender difference in the RTSQ total score is not attributable to response bias.

In terms of internal consistency, the RTSQ total score seems to be a valid measure of ruminative thought style. Besides Cronbach alpha, the omega coefficient also supported the internal consistency of the scale. Since the omega hierarchical values were low compared to the omega total values, we could assume that most of the subscale score variances could be attributed to the general factor, and not to the group factors.

The authors of the RTSQ were aiming to design a scale that assesses rumination globally. The correlational analyses in Study 1 revealed that the RTSQ is strongly associated with general

symptom severity, implying that the goal of Brinker and Dozois (Brinker & Dozois, 2009) was successfully attained. The correlations in Study 2 demonstrated that the RTSQ is congruent with one of the most extensively used rumination measures, the RRS (Parola et al., 2017). Moreover, it revealed that the thought style captured by the RTSQ is rather maladaptive, as it was more strongly associated with the brooding subscale of the RRS than with reflective pondering. Brooding, the maladaptive facet of rumination, defined as a tendency to passively dwell on negative emotions (i.e. What am I doing to deserve this?) was more strongly associated with concurrent distress than reflective pondering (the latter defined as a purposeful self-reflective response of understanding and solving the problem) (Treynor et al., 2003). In addition, brooding also related to depression scores prospectively (Schoofs et al., 2010; Treynor et al., 2003), while reflective pondering (or reflection) did not. Studies that tested the unique contributions of brooding and reflective pondering to different internalizing or externalizing symptoms and disorders found that brooding is the most maladaptive (even pathological) form of depressive rumination (Adrian et al., 2014; E. R. Watkins & Roberts, 2020), while reflective pondering could serve as a protective factor against the detrimental effects of these unconstructive, often self-deprecating thoughts (Andrews & Thomson Jr., 2009; Thomsen, 2006). However, recalling negative events and affects, even in this adaptive way, could temporally elevate the level of negative emotions, which could explain why reflective pondering is significantly associated with concurrent distress in cross-sectional studies (Kokonyei et al., 2016; Michl et al., 2013). Taken together, our results support the construct and convergent validity of the RTSQ, indicating that it is a valid measure of ruminative thinking style that is rather negatively valenced, but does not solely focus on depressive mood and symptoms. From a theoretical point of view, it is important to mention that Tanner and colleagues' solution on the four facets of the 15-item version could be considered as an attempt to identify key dimensions of ruminative thinking. E. R. Watkins and Roberts (2020) in their recent review, for instance, claim that besides the frequency of ruminative thoughts, other relevant dimensions of ruminative thinking should be targeted. Based on the habit-goal theory, rumination can easily become a mental habit if this maladaptive thinking repeatedly occurs in the same context (including mood, social event or physical location) (E. R. Watkins & Nolen-Hoeksema, 2014). E. R. Watkins and Roberts (2020) mention that automaticity, involuntariness, and goal insensitivity are of great relevance. Whereas certain items are not always found to belong to the same subscale, the *Repetitive thoughts* (items 1-4) subscale of the RTSQ has been consistently identified by numerous psychometric studies e.g. (Claycomb et al., 2015; Mihić et al., 2019; Tanner et al., 2013), as well as in our study, suggesting that the

RTSQ captures well the repetitive nature of ruminative thinking. Many papers emphasize the repetitive nature of rumination, making it an example of repetitive negative thinking (McEvoy & Brans, 2013).

A strength of our research is that we conducted two consecutive studies with converging results on two homogenous samples of university students, as opposed to the more heterogeneous samples observed in previous studies. However, it is a limitation that most of the participants were female, especially in Study 2, where the sample size was also much smaller. Although our sample comprised of university students that may reduce generalizability, we consider it important to examine rumination among young adults, as rumination and depressive symptoms are commonly observed in this population (Slavish & Graham-Engeland, 2015; Topper et al., 2017). Another limitation is that the models we wished to replicate were tested on different translations of the RTSQ (e.g. English and Serbian), whereas we tested the factor structure of the Hungarian translation. Although beyond the scope of our work, it would be crucial for future studies to investigate whether diverging results reflect inconsistency in the measurement of rumination as a construct per se, or rather reflect idiomatic differences. Furthermore, we did not examine the discriminant validity of the RTSQ. Although rumination is associated with a wide array of psychological (and somatic) problems (e.g., Kokonyei et al., 2016; E. R. Watkins & Roberts, 2020), Agreeableness, a Big Five personality trait defined as accommodating, amiable, friendly, and trustworthy (Shi et al., 2018) appears to be an unrelated construct (Kocsel et al., 2017) that could be used for such purposes. However, this was beyond the scope of our current paper.

To sum up, our results demonstrate that the Hungarian adaptation of the RTSQ reliably measures rumination across gender, and it can be considered a valid measure to assess ruminative thinking in general with its total score, meanwhile the use of its subscales is ambiguous. Moreover, the global RTSQ score appears to primarily measure the maladaptive aspect of rumination, hence, it can be associated with psychopathology in general.

### 2.5. Acknowledgements

We would like to thank everyone who helped our work by participating in this study.

## 3. RUMINATION IN MAJOR DEPRESSIVE AND BIPOLAR DISORDER – A META-ANALYSIS (STUDY 2)[2]


### Abstract

**Background:** rumination, defined as repetitive thoughts about emotionally relevant experiences, has been linked extensively with mood disorders, especially major depressive disorder (MDD). However, there is a growing body of evidence suggesting the importance of rumination in bipolar disorder (BD) as well.

**Methods:** we searched for studies that investigated rumination in both BD and MDD in four databases. Our systematic search identified 12 studies with an overall sample size of 2071 clinical patients. The full study protocol was pre-registered and is available at Open Science Framework (https://osf.io/hjenm)

**Results:** results demonstrated no significant difference in the ruminative tendencies of the two patient groups when all rumination measures were included. We tested for the effect of rumination subtype, BD subgroups, and the current mood state of BD and MDD patients. There were no significant differences in terms of depressive rumination, however, BD patients reported more rumination on positive affect. This difference remained significant when examining in BD-I and BD-II patient groups, with similar effect sizes.

**Limitations:** due to the lack of sufficient data in the literature, only a few self-report studies qualified to be included in our analysis. Thus additional moderating factors, such as the current mood state of the two patient groups could not be analyzed.

**Conclusions:** this review demonstrates that rumination is a significant process in both MDD and BD, highlighting the importance of interventions to reduce rumination in mood disorders. The two patient groups share several commonalities in terms of rumination, however, rumination subtype was found to be an important moderating variable underlining a difference in positive rumination.


[2] Kovács, L. N., Takacs, Z. K., Tóth, Z., Simon, E., Schmelowszky, Á., & Kökönyei, G. (2020). Rumination in major depressive and bipolar disorder—A meta-analysis. *Journal of Affective Disorders, 276,* 1131–1141. https://doi.org/10.1016/j.jad.2020.07.131

### 3.1. Introduction

Depressive disorders are extremely common conditions that, especially when untreated, cause huge burdens on the level of the individual as well as the society (Malhi et al., 2015). The two primary manifestations of depressive disorders are major depressive disorder (MDD) and bipolar disorder (BD). While the most common features of MDD are severely depressed mood and the incapability of showing interest or experiencing pleasure, BD conditions are characterized by acute dysfunctional mood states of mania (in bipolar I disorder - BD-I) or hypomania (bipolar II disorder - BD-II), with or without depressive episodes (American Psychiatric Association, 2013). MDD is the most common mental disorder, with an estimated lifetime prevalence of 16% (Angst et al., 2011; Kessler et al., 2003), and while BD (including both subtypes) is considered much less prevalent (approximately 0.9 -2.1% (Hirschfeld et al., 2002)), it is important to note that BD conditions are often mistakenly diagnosed as MDD, where the manic pole remains unnoticed and therefore untreated (Angst et al., 2011). This may be due to the fact that BD patients tend to develop depressive episodes more frequently and for longer times than [hypo]manic episodes (Judd et al., 2002), during which they experience severe relational and occupational disabilities (Calabrese et al., 2004), thus they tend to seek help during their depressed phase. Prospective studies show that patients who initially seek help with MDD have a high risk of developing manic or hypomanic features over the upcoming years (Goldberg et al., 2001).

The various types of BD lie along a spectrum ranging from milder cyclothymic conditions to BD-II, and to the most severe BD-I (Goodwin & Jamison, 2007), where the early milder manifestations of the disorder may shift towards the more severe end of the continuum over time (Shen et al., 2008). Congruently, a growing body of evidence indicates that MDD is a rather heterogeneous condition with frequent subliminal [hypo]manic features (Zimmermann et al., 2009). This phenomenon is also reflected by the numerous mixed or overlapping diagnostic categories within mood disorders listed in the DSM-5 (American Psychiatric Association, 2013), posing that depressive disorders are hard to consider distinct nosological categories, and should rather be conceptualized dimensionally (Benazzi, 2006, p. 20). Furthermore, the dimensional approach of mood disorders, as suggested for instance by the Research Domain Criteria, is more likely to yield a better understanding of their etiology than the categorical view (Frank, 2011). In the same vein, MDD and BD patients exhibit numerous features in common, such as impairments in cognitive performance (Baune & Malhi, 2015; Yen et al., 2011), elevated use of negative cognitive biases (Rowland et al., 2013; Rude et al., 2003),

as well as the extensive use of rumination (Green et al., 2011), which together may indicate impaired inhibitory executive function both in BD and MDD (Joormann & Gotlib, 2010). However, currently there is a lack of consensus whether BD and MDD share the same cognitive-emotional features with quantitative differences or they rather represent distinct nosological categories with qualitatively diverse neuropsychological background (Samamé et al., 2017). This current debate supports the need for studies that systematically compare rumination in BD and MDD.

Rumination is a transdiagnostic emotion regulation strategy that has been associated with various forms of psychopathology such as depression, anxiety, substance abuse, binge eating, and self-injurious behavior (McLaughlin et al., 2014). According to the Response Styles Theory (Nolen-Hoeksema, 1991), the most widely used conceptualization of rumination (Smith & Alloy, 2009), people characterized by a ruminative response style tend to react to their own negative mood states by dwelling on them passively and repeatedly (Nolen-Hoeksema, 2000), which is also referred to as depressive rumination. It is well-established that rumination further increases depressive symptoms (Brinker and Dozois, 2009; Nolen-Hoeksema et al., 1993), and it can be considered as a predictor of the onset (Nolen-Hoeksema et al., 2008), severity (Lam et al., 2003) and reoccurrence (Silveira & Kauer-Sant'Anna, 2015) of major depressive episodes. An example of depressive ruminative thought is "Why am I the only one facing difficulties and suffer from unhappiness?"

Ruminative response to positive emotional states, i.e. rumination on positive affect and its role in affective disorders has also come to the focus of research (Gilbert, 2012). Ruminating on positive affective states, i.e. constantly recalling rewarding past events and positive mood states amplifies and sustains the positive feeling (Feldman et al., 2008). An example of rumination on positive affect could be "I performed very well at that presentation at work last week". Ruminating on positive affect may be gratifying on the short term, however, as it fosters positive emotional response even in the lack of positive emotional cues, it may reduce the flexibility in adjusting one's emotional response to the appropriate external stimuli (Gruber et al., 2011).

Although much less studies have focused on rumination in BD or mania than in unipolar depression, its negative impact among these patients is also well-established (Ghaznavi & Deckersbach, 2012). Rumination appears to be more common among BD patients than among their relatives (Green et al., 2011) and healthy controls, even after controlling for current mood state (Alloy et al., 2009), and has been associated with elevated depressive and hypomanic symptoms (Green et al., 2011). Emotion regulation impairment and affective lability are core

features of BD in the depressed and the manic phases (Townsend & Altshuler, 2012), as well as in euthymia (Henry et al., 2008). According to a systematic review, rumination accompanies all episodes of BD, aggravating emotion dysregulation and affective lability in both the depressive and the manic phases (Silveira & Kauer-Sant'Anna, 2015). A longitudinal study found that the occurrence of hypomanic or manic episodes among BD patients was not predicted by depressive rumination, meanwhile it did prospectively predict the number of depressive episodes during the 3.5-year long follow-up period (Alloy et al., 2009). This is in line with the notion that both MDD and BD patients tend to engage in depressive rumination, while rumination on positive affect only characterizes BD patients (S. L. Johnson et al., 2008), and appears to aggravate their manic symptoms (Carver & Johnson, 2009).

To sum up, extensive amount of research has demonstrated that depressive rumination is strongly associated with depressive symptoms in both MDD and BD (S. L. Johnson et al., 2008). Furthermore, a growing body of neurological studies suggest there are strong associations between rumination on positive affect and manic/hypomanic symptoms that appears to involve disturbed reward processing (Phillips & Vieta, 2007; Rey et al., 2016). In other words, while depressed, MDD and BD patients appear to ruminate on negative mood, while BD patients tend to engage in rumination on positive affect in [hypo]mania (Ghaznavi & Deckersbach, 2012), suggesting that ruminative tendencies, regardless their valence, lead to increased vulnerability to emotional disturbances by magnifying the significance of emotionally relevant events (Alloy et al., 2009). The current study attempts to address possible distinctions and commonalities regarding the ruminative tendencies of the two patient groups with the help of meta-analytic techniques. Based on previous findings, we hypothesized that both patient groups tend to engage in depressive rumination without significant differences, whereas we expected that BD patients report more rumination on positive affect. Because of this, we also hypothesize that BD patients tend to report more rumination in general.

Furthermore, since the level of rumination varies across the different episodes of BD and MDD (Silveira & Kauer-Sant'Anna, 2015; Visted et al., 2018), we were also aiming to test whether the current mood status of MDD (remitted/currently depressed) and BD (euthymia/hypomania/mania/depression) is associated with the level of rumination.

## 3.2. Methods

### *3.2.1. Search strategy*

The full study protocol was pre-registered and is available at Open Science Framework (https://osf.io/hjenm). We applied a systematic literature search order to find studies that assessed rumination among patients with BD and MDD. The last literature search was conducted on May 30, 2019 until inception in the following databases: PubMed, Science Direct, Web of Science and EBSCO, applying the following search string: ((((ruminat* OR "ruminative thought" OR brooding or pondering))) AND ((bipolar OR mani* OR "manic episode" OR BD or cyclothymi* OR euthymi* OR hypomani*))) AND ((depressi* or MDD OR "major depressive disorder" OR "unipolar depression" OR dysphori* OR dysthymi*)). The reference lists of the identified articles, as well as of relevant reviews and metaanalyses (Dodd et al., 2019; Ghaznavi & Deckersbach, 2012; Silveira & Kauer-Sant'Anna, 2015) were also screened for potential additional studies to include.

### *3.2.2. Study selection*

We only included studies that recruited a group of patients formally diagnosed with BD, as well as a group of patients formally diagnosed with MDD based on the Diagnostic and Statistical Manual of Mental Disorders (DSM) or the International Classification of Diseases (ICD). We only wished to search for papers published in peer-reviewed journals that were available in English. Furthermore, studies had to contain at least one rumination measure (e.g. self-report rumination questionnaire, ecological momentary assessment studies investigating current level of rumination, treatment studies with baseline rumination assessment, or studies utilizing rumination induction). Review articles and case studies were excluded.

After removing duplicates, 488 studies remained, on which we conducted an initial screening process based on title and abstract. During this initial screening 331 studies were excluded. The full texts of the remaining 157 articles were reviewed by two researchers independently in order to determine which articles should be included. We contacted the authors of ten articles to provide data in order to be able to calculate the effect sizes, four of whom provided the necessary data. As shown in Figure 3.1, the study selection process resulted in 12 articles (for details see Table 3.1 below) that could be included in the present analysis, all of which were published in peer-reviewed journals.

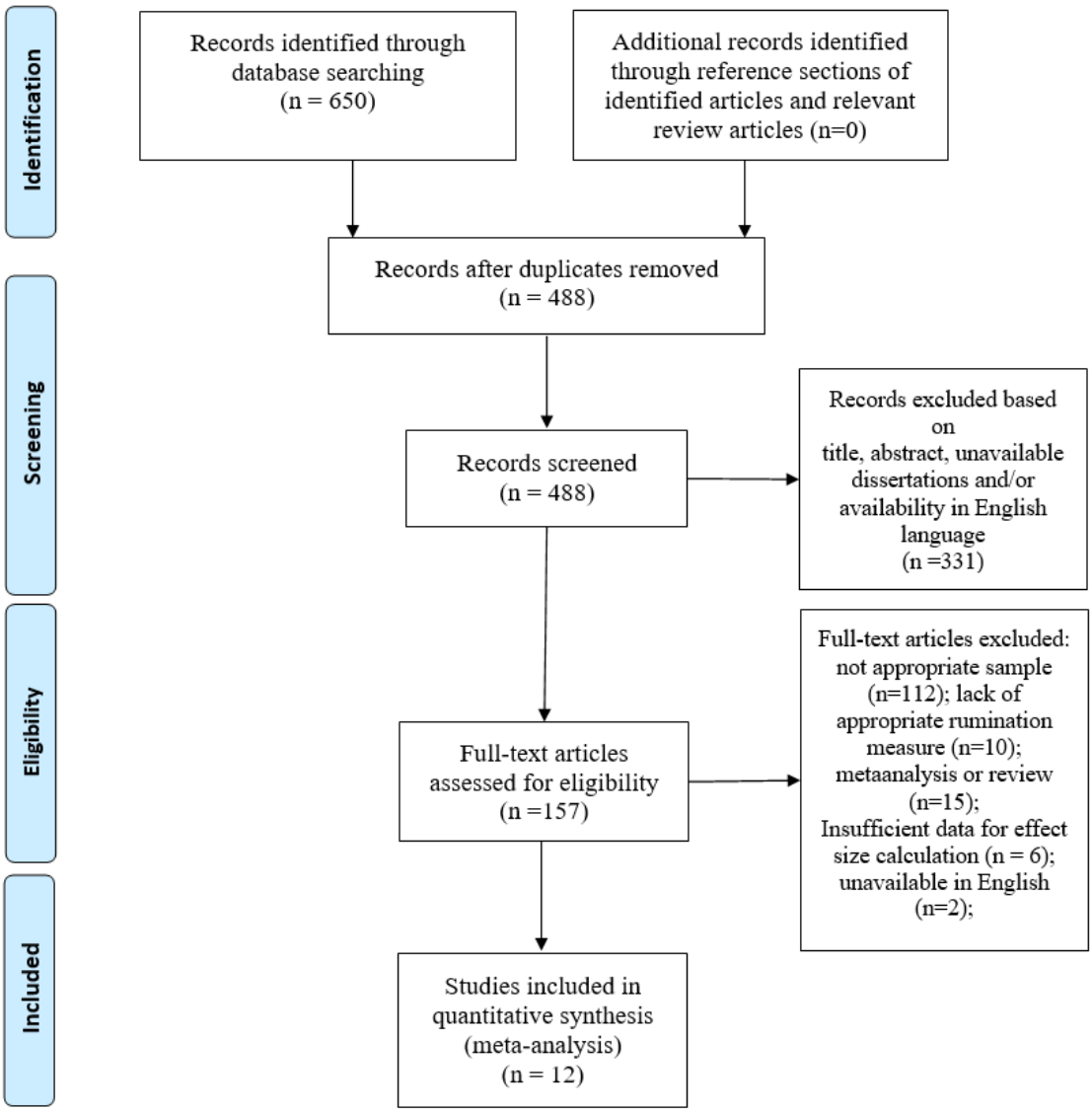


*Figure 3.1. PRISMA flow diagram of study selection.*

### *3.2.3. Data extraction*

Our systematic search only yielded studies that measured rumination with self-report questionnaires. Four studies assessed rumination on positive affect, all of which applied the Responses to Positive Affect (RPA) Scale (Feldman et al., 2008). The RPA contains two subscales that assess rumination when feeling happy or excited, namely emotion focus, the core feature of which is the pleasant emotional impression, and self-focus, that aims to capture the meaning of a favorable event for the person's confidence and self-esteem. Depressive rumination was assessed by either the rumination subscale of the Response Styles Questionnaire (RSQ, Nolen-Hoeksema and Morrow, 1991) (k=2), or the Ruminative Response Scale (RRS, Treynor et al., 2003) (k=4), both of which instruct participants to report about their rumination when feeling sad or depressed. Two studies reported the total score of the RRS, two studies

reported its brooding subscale, and one study reported its depression subscale. The following rumination measures were also used in the primary studies: the reflection subscale of the RRS (k=1), the rumination subscale of the Leahy Emotional Schema Scale (LESS,(Leahy, 2002) (k=1), the rumination subscale of the Cognitive Emotion Regulation Questionnaire (CERQ,(Garnefski et al., 2001) (k=2), and the Ruminative Thought Style Questionnaire (RTSQ; Brinker and Dozois, 2009) (k=1). The reflection subscale of the RRS measures a more adaptive form of rumination, where analyzing feelings and thoughts may help problem solving. The LESS is a self-report emotional schema questionnaire that contains 14 dimensions of emotional response. The rumination subscale of the LESS contains five items (two of which are reversed) that have to be answered on a 6-point Likert-scale. The rumination scale of CERQ assesses ruminative response to stressful events. The RTSQ aims to assess rumination globally, unbiased by depressive symptoms (Brinker and Dozois, 2009). We categorized the questionnaires according to their objectives as depressive rumination, rumination on positive affect, reflection, whereas the additional questionnaires that measure rumination more globally and does not specify the mood state in the instruction were categorized as “rumination not otherwise specified” (NOS). The exact scales used in each study and their classification are shown in Table 3.1.

*Table 3.1. Summary of reviewed studies (k=12).*

| | | | | | Rumination score | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study name** | **Country** | **BD group diagnosis** | **Rumination scale** | **Rumination subtype** | **BD** | | **MDD** | | **HC** | | **Current BD episode** | **Current MDD episode** | **Rumination scale reliability** |
| | | | | | n | M (SD) | n | M (SD) | n | M (SD) | | | |
| **Batmaz et al., 2014** | Turkey | BD I | LESS rumination subscale | Rumination NOS | 140 | 19.22 (3.16) | 166 | 19.59 (3.80) | 151 | 14.86 (3.98) | mix | not reported | not reported |
| **Fletcher et al., 2013** | Australia | BD I | CERQ rumination subscale | Rumination NOS | 86 | 13.70 (3.30) | 96 | 14.50 (3.40) | 90 | 10.40 (3.20) | not reported | not reported | not reported |
| **Fletcher et al., 2013** | Australia | BD I | RPA emotion focus subscale | Rumination on positive affect | 86 | 13.70 (3.30) | 96 | 12.30 (3.30) | 90 | 41.40 (9.40) | not reported | not reported | >0.70 |
| **Fletcher et al., 2013** | Australia | BD I | RPA self-focus subscale | Rumination on positive affect | 86 | 9.40 (2.70) | 96 | 8.40 (2.50) | 90 | 13.20 (3.20) | not reported | not reported | >0.70 |
| **Fletcher et al., 2013** | Australia | BD I | RSQ rumination subscale | Depressive rumination | 86 | 63.80 (13.1) | 96 | 63.40 (11.3) | 90 | 9.70 (2.50) | not reported | not reported | not reported |
| **Fletcher et al., 2013** | Australia | BD II | CERQ rumination subscale | Rumination NOS | 107 | 14.00 (3.40) | 96 | 14.50 (3.40) | 90 | 10.40 (3.20) | not reported | not reported | not reported |
| **Fletcher et al., 2013** | Australia | BD II | RPA emotion focus subscale | Rumination on positive affect | 107 | 13.80 (3.90) | 96 | 12.30 (3.30) | 90 | 41.40 (9.40) | not reported | not reported | >0.70 |
| **Fletcher et al., 2013** | Australia | BD II | RPA self-focus subscale | Rumination on positive affect | 107 | 9.30 (3.20) | 96 | 8.40 (2.50) | 90 | 13.20 (3.20) | not reported | not reported | >0.70 |
| **Fletcher et al., 2013** | Australia | BD II | RSQ rumination subscale | Depressive rumination | 107 | 65.80 (12.9) | 96 | 63.40 (11.3) | 90 | 9.70 (2.50) | not reported | not reported | not reported |
| **Forgeard et al., 2018** | USA | mix | RRS brooding subscale | Depressive rumination | 60 | 11.98 (3.81) | 122 | 12.38 (3.50) | — | — | mix | mix | >0.70 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Forgeard et al., 2018** | USA | mix | RRS depression subscale | Depressive rumination | 60 | 29.32 (9.40) | 121 | 31.28 (7.80) | — | — | mix | mix | not reported |
| **Forgeard et al., 2018** | USA | mix | RRS reflection subscale | Reflection | 60 | 11.50 (3.68) | 121 | 11.36 (3.07) | — | — | mix | mix | >0.70 |
| **Gilbert et al., 2013** | USA | BD I | RPA emotion focus subscale | Rumination on positive affect | 31 | 14.26 (3.66) | 31 | 13.29 (3.57) | — | — | remitted/ euthymic | remitted | >0.70 |
| **Gilbert et al., 2013** | USA | BD I | RPA self-focus subscale | Rumination on positive affect | 31 | 10.29 (3.39) | 31 | 9.16 (3.06) | — | — | remitted/ euthymic | Blank | >0.70 |
| **Hanssen et al., 2018** | Netherlands | BD I | RPA emotion focus subscale | Rumination on positive affect | 96 | 13.13 (2.71) | 175 | 10.52 (3.45) | — | — | mix | mix | >0.70 |
| **Hanssen et al., 2018** | Netherlands | BD I | RPA self-focus subscale | Rumination on positive affect | 96 | 8.65 (2.66) | 175 | 7.23 (3.15) | — | — | mix | mix | >0.70 |
| **Hanssen et al., 2018** | Netherlands | BD II | RPA emotion focus subscale | Rumination on positive affect | 27 | 12.93 (2.69) | 175 | 10.52 (3.45) | — | — | mix | mix | >0.70 |
| **Hanssen et al., 2018** | Netherlands | BD II | RPA self-focus subscale | Rumination on positive affect | 27 | 8.78 (2.81) | 175 | 7.23 (3.15) | — | — | mix | mix | >0.70 |
| **Kearns et al., 2016** | Australia | mix | RRS total score | Depressive rumination | 20 | 50.60 (15.0) | 182 | 52.61 (11.7) | — | — | mix | mix | >0.70 |
| **Kim et al., 2012** | South Korea | mix | RRS total score | Depressive rumination | 54 | 61.94 (13.6) | 227 | 54.21 (13.1) | — | — | mix | not reported | not reported |
| **Liu et al., 2009** | USA | not reported | RSQ rumination subscale | Depressive rumination | 84 | 44.38 (12.6) | 139 | 44.97 (13.2) | 112 | 28.00 (4.00) | mix | mix | >0.70 |
| **Taylor Tavares et al., 2007** | United Kingdom | BD II | RSQ rumination subscale | Depressive rumination | 17 | 26.70 (5.03) | 22 | 30.20 (4.97) | 25 | 14.20 (4.1) | depressed | depressed | not reported |
| **Weinstock et al., 2018** | USA | BD I | RPA emotion focus subscale | Rumination on positive affect | 30 | 14.20 (3.20) | 30 | 12.00 (3.20) | 30 | 2.80 (3.10) | depressed | depressed | >0.70 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Weinstock et al., 2018** | USA | BD I | RPA self-focus subscale | Rumination on positive affect | 30 | 9.50 (2.80) | 30 | 8.40 (2.70) | 30 | 12.20 (3.30) | depressed | depressed | >0.70 |
| **Weinstock et al., 2018** | USA | BD I | RRS brooding subscale | Depressive rumination | 30 | 11.10 (3.10) | 30 | 10.00 (3.00) | 30 | 8.60 (2.90) | depressed | depressed | >0.70 |
| **Wolkenstein et al., 2014** | Germany | mix | CERQ rumination subscale | Rumination NOS | 42 | 11.36 (3.79) | 43 | 12.16 (3.55) | 39 | 7.21 (2.71) | remitted/ euthymic | remitted | not reported |
| **Yavuz et al., 2016** | Turkey | not reported | RTSQ total score | Rumination NOS | 35 | 97.66 (23.3) | 168 | 77.83 (23.4) | — | — | not reported | not reported | not reported |

*Note. LESS= Leahy Emotional Schema Scale ; CERQ=Cognitive Emotion Regulation Questionnaire; RPA=Responses to Positive Affect; RSQ=Response Styles Questionnaire; RRS=Ruminative Response Scale ; RTSQ=Ruminative Thought Style Questionnaire; NOS= not otherwise specified.*

A coding sheet was created to extract descriptive statistics regarding the sample and study procedures, and quantitative information about the rumination measures in order to compute effect sizes from each study. It is also important to examine how much the two groups differ in terms of clinical and demographic factors, as such inequalities may serve as confounds. More specifically, the coded variables were the rumination measure and the subscale, rumination subtype (depressive rumination/rumination on positive affect/reflection/rumination not further specified), continent and country (according to the place of data collection), publication year, sample size, gender and age data for both patient groups (% of female participants), diagnosis of BD sample (BD-I/BD-II/mix/not reported), current episode of BD participants (depression/mania/euthymic/mix/not reported), and current mood status of MDD participants (depressed/remitted/mix/not reported). We also extracted data regarding the methodological quality of the articles: we registered whether the articles reported on the reliability of the rumination measure, whether the two groups had normally distributed scores on the rumination measure, whether any calculations were done for statistical power, and whether the patients groups were matched in the primary studies. We also aimed to compare the two patient groups regarding years with the disorder, ongoing psychotherapy and pharmacotherapy, and dropout rates. However, these characteristics were scarcely or heterogeneously reported, thus could not be evaluated systematically.

Every article was coded by two researchers independently. Acceptable agreement was found between the coders on categorical variables. Interrater reliability was high regarding the outcome measure (e.g. type of rumination, rumination score, rumination scale reliability) ranging from 90.48% to 100%, whereas it ranged from acceptable (e.g. gender data 76.15%) to high (e.g. BD subtype diagnosis 100%) in terms of demographic data and descriptive statistics. Coders resolved any disagreements by discussion. Based on the recommendations of Ma et al. (2020), we used the Joanna Briggs Institute's (JBI) critical appraisal tool for cross-sectional studies to estimate the risk of bias by assessing the methodological quality of the primary papers (Moona et al., 2017). It comprises of eight items that could be answered with "yes", "no", "unclear" or "not applicable (n/a)". Each primary article was evaluated independently by two of the authors (L.N.K & Zs.T) with 84.5% agreement. The authors resolved the discrepancies by involving the last author (Gy.K.). A total score was also calculated for each study, where every affirmative answer counted as one, any other answer scored as zero. Seven items were applicable for the current studies, thus that was the highest possible score. The details of the risk of bias assessment are presented in Table 3.2.

*Table 3.2. Quality assessment of the primary studies.*

| | JBI critical appraisal checklist | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Study** | **1 inclusion** | **2 study description** | **3 exposure** | **4 condition measurement** | **5 confounds identified** | **6 strategies for confounds** | **7 outcome measurement** | **8 statistical analysis** | **Total score** |
| **Batmaz et al., 2014** | yes | yes | N/A | yes | yes | yes | yes | yes | 7 |
| **Fletcher et al., 2013** | yes | yes | N/A | yes | yes | yes | yes | yes | 7 |
| **Forgeard et al., 2018** | yes | yes | N/A | yes | yes | yes | yes | yes | 7 |
| **Gilbert et al., 2013** | yes | yes | N/A | yes | yes | yes | yes | yes | 7 |
| **Hanssen et al., 2018** | yes | yes | N/A | yes | yes | no | yes | yes | 6 |
| **Kearns et al., 2016** | yes | yes | N/A | yes | yes | yes | yes | yes | 7 |
| **Kim et al., 2012** | yes | yes | N/A | yes | yes | yes | yes | yes | 7 |
| **Liu et al., 2009** | yes | yes | N/A | yes | yes | yes | yes | yes | 7 |
| **Taylor Tavares et al., 2007** | yes | yes | N/A | yes | yes | yes | no | yes | 6 |
| **Weinstock et al., 2018** | yes | yes | N/A | yes | yes | yes | yes | yes | 7 |
| **Wolkenstein et al., 2014** | yes | yes | N/A | yes | yes | no | yes | yes | 6 |
| **Yavuz et al., 2016** | unclear | no | N/A | unclear | no | no | yes | yes | 2 |

*Note. Possible answers: Yes, No, Unclear or N/A (Not Applicable). Checklist Items: 1. Were the criteria for inclusion in the sample clearly defined?2. Were the study subjects and the setting described in detail? 3. Was the exposure measured in a valid and reliable way? 4. Were objective, standard criteria used for measurement of the condition? 5. Were confounding factors identified? 6. Were strategies to deal with confounding factors stated? 7. Were the outcomes measured in a valid and reliable way? 8. Was appropriate statistical analysis used?*

*From: Moola S, Munn Z, Tufanaru C, Aromataris E, Sears K, Sfetcu R, Currie M, Qureshi R, Mattis P, Lisy K, Mu P-F. Chapter 7: Systematic reviews of etiology and risk. In: Aromataris E, Munn Z (Editors). Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute, 2017.*

### *3.2.4. Statistical analysis*

We conducted the analyses with the Comprehensive Meta-Analysis (CMA) Version 3 (Borenstein et al., 2006). First, the effect size for each contrast for the standardized mean difference between the BD and the MDD patient groups on the rumination subscales were calculated, where the raw means and standard deviations of the rumination scores were used. A positive effect size indicated that the BD group was more prone to rumination in terms of the given rumination subtype, while a negative effect suggested that the MDD group reported more rumination. We used the effect size of Hedges's *g* that corrects for sample sizes (Borenstein et al., 2009). In studies that reported more than one rumination measure, the Hedges's *g* value of the study is the average of the Hedges's *g* values on each rumination scale, as these effect sizes are not considered independent. Studies with a standardized residual exceeding ±3.29 were considered outliers (Tabachnick & Fidell, 2012).

We compared the two patient groups regarding gender ratio and mean age with t-tests using IBM SPSS Software Version 25.0 (IBM Corp., Armonk, NY). We conducted meta-regression analyses to assess the impact of potential confounds such as publication year, gender ratio of the BD and MDD group, mean age of the BD and MDD group, and the total scores of the critical appraisal tool on the dependent variable. Then, we conducted five meta-analyses. We included all the rumination measures in the first average to see whether there is a significant difference between the ruminative tendencies of the two patient groups in general. In order to examine whether there are significant differences between the two groups according to the different subtypes of rumination, we conducted four additional meta-analyses, one for each subtype (depressive rumination / reflection / rumination on positive affect / rumination not further specified). The random-effects model using DerSimonian and Laird method was used to calculate the average effect sizes, which allows for between-study variance beyond sampling error (Borenstein et al., 2009). The heterogeneity of the effect was determined by the Q-statistics and the $I^2$ index, based on which we conducted additional analyses. First, we examined the contrasts where only BD-I patients were included in the study, followed by an analysis where only BD-II patients were included. Then, we examined the effect sizes according to the current mood state of BD and MDD patients. Publication bias was inspected using funnel plots. In case of significant average effect sizes, Rosenthal's fail-safe *n* was also calculated (Rothstein et al., 2005). Publication bias was assessed with the help of the Egger's test and funnel plots including Duval and Tweedie's trim-and-fill method (Duval & Tweedie, 2000; Egger et al., 1997).

## 3.3. Results

### *3.3.1. Descriptive information*

Our literature review yielded 12 studies published in peer-reviewed journals that examined rumination among both MDD and BD patients, with an overall sample size of 2071 (n of BD patients= 671, n of MDD patients= 1400). BD sample sizes ranged from 17 to 140 (Mean= 55.92, SD=36.04), MDD sample sizes ranged from 22 to 227 (Mean= 116.67, SD=70.77). The mean sample age was 35.01 years (SD= 6.05) among BD patients, and 36.1 years (SD= 5.41) among MDD patients. The majority of both samples were female (% of females$_{BD}$= 63.9%, % of females$_{MDD}$= 67.28%). The 12 studies altogether contained 26 patient groups, 14 with bipolar and 12 with major depressive disorder, while six studies also assessed rumination among healthy controls (HC) (n= 447). Five studies recruited bipolar patients without specifying BD subtype, while six studies had homogenous BD samples, i.e. included either BD-I (k=3), or BD-II (k=1) patients only, while two studies had both a homogenous BD-I and a homogenous BD-II group. Information regarding BD subtype was missing in case of one study. Ten studies contained information regarding the current episode of BD patients: two studies recruited currently depressed BD patients, two studies reported currently euthymic BD patients, while six studies included BD patients regardless their current mood state. Eight studies reported the episode of MDD patients: two studies recruited currently depressed MDD patients, two studies recruited currently remitted MDD patients, while four studies included MDD patients who were either depressed or remitted. Eight studies described the reliability of the rumination scale(s) they used, and three studies reported a priori or post-hoc power calculations. The two patient groups were matched in one study, whereas in seven studies the groups were not matched, but it was tested whether the two groups differed significantly in terms of clinical and/or demographic factors, such as age and gender. The 6$^{th}$ item of the JBI critical appraisal checklist (Table 3.2) describes whether the revealed group differences were addressed. The remaining four studies did not report any information about potential confounding group differences.

### *3.3.2. Group differences in rumination*

We assessed whether there were significant differences in age and the percentage of females between the MDD and BD groups by paired sample t-tests. We did not find any significant difference in terms of age (t=0.727, p= 0.488), however, there was significant difference in female percentage (t=2.615, p= 0.26), thus we calculated its group difference, and

added it as a moderator for each study. Then we conducted meta-regressions to assess the impact of potential confound variables. We ran several models testing for the effect of publication year (β = 0.056, p= 0.11, k = 12), gender ratio of BD group (β = -1.76, p= 0.33, k = 9), gender ratio of MDD group (β = -1.53, p= 0.31, k = 9), difference in the percentage of females (β = -3.17, p= 0.27, k = 11), age of BD group (β = 0.003, p= 0.79, k = 9) age of MDD group (β = 0.002, p= 0.83, k = 9), and the JBI critical appraisal checklist score (β = -0.13, p= 0.07, k = 12). None of these moderators had a significant effect, however, the JBI checklist score demonstrated a tendency level effect due to the low score of one article, calling for further examination.

Then, we conducted a meta-analysis including all rumination measures, in order to test whether there was a significant difference between the ruminative tendencies of the two patient groups in general. The funnel plot (Figure S8.1 of the Supplemental Material) did not indicate any publication bias. As Figure 3.2 demonstrates, we did not find a significant difference between the two patient groups in terms of rumination in general (*g* =0.16, *k*=12, SE=0.11, 95% CI [-0.06, 0.38], *p* =0.16).

| Study name | Comparison | Outcome | Hedges's g | Standard error | Variance | Lower limit | Upper limit | Z-Value | p-Value |
|---|---|---|---|---|---|---|---|---|---|
| Taylor Tavares (2007) | Blank | RRS (RSQ) total (22 items) | -0,686 | 0,326 | 0,106 | -1,325 | -0,048 | -2,107 | 0,035 |
| Wolkenstein (2014) | Blank | CERQ rumination subscale | -0,216 | 0,216 | 0,046 | -0,639 | 0,207 | -1,002 | 0,317 |
| Kearns (2016) | Blank | Combined | -0,148 | 0,238 | 0,056 | -0,614 | 0,318 | -0,622 | 0,534 |
| Forgeard (2018) | Blank | Combined | -0,115 | 0,157 | 0,025 | -0,423 | 0,194 | -0,729 | 0,466 |
| Batmaz (2014) | Blank | Leahy Emotional Schema Scale rumination subscale | -0,105 | 0,115 | 0,013 | -0,329 | 0,120 | -0,915 | 0,360 |
| Liu (2009) | Blank | RRS (RSQ) total (22 items) | -0,046 | 0,138 | 0,019 | -0,316 | 0,224 | -0,331 | 0,741 |
| Fletcher (2013) | Combined | Combined | 0,170 | 0,145 | 0,021 | -0,114 | 0,454 | 1,175 | 0,240 |
| Gilbert (2013) | Blank | Combined | 0,305 | 0,252 | 0,064 | -0,189 | 0,800 | 1,210 | 0,226 |
| Weinstock (2018) | Blank | Combined | 0,476 | 0,259 | 0,067 | -0,031 | 0,984 | 1,840 | 0,066 |
| Kim (2012) | Blank | RRS (RSQ) total (22 items) | 0,583 | 0,153 | 0,023 | 0,283 | 0,883 | 3,813 | 0,000 |
| Hanssen (2018) | Combined | Combined | 0,624 | 0,174 | 0,030 | 0,284 | 0,964 | 3,597 | 0,000 |
| Yavuz (2016) | Blank | RTSQ | 0,844 | 0,190 | 0,036 | 0,472 | 1,216 | 4,447 | 0,000 |
| | | | 0,159 | 0,113 | 0,013 | -0,062 | 0,380 | 1,407 | 0,159 |

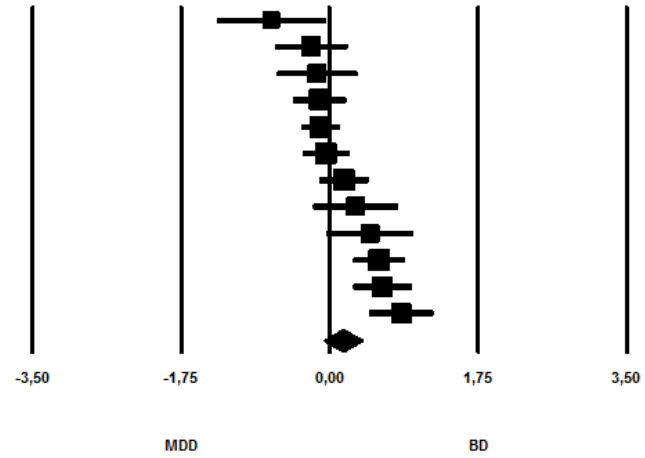


*Figure 3.2. Forest plot for rumination in BD compared to MDD.*

Since one article performed weaker on the quality assessment, we also conducted the analysis after excluding it, which only resulted in minor change in the effect size (g=0.09, k=11, SE=0.11, 95% CI [-0.11, 0.30], p=0.354]), thus we decided to keep it. The effect found was heterogeneous (Q= 51.71, p<0.01, $I^2$=78.73), supporting the need to assess possible moderators. Thus, we conducted four additional meta-analyses, one for each rumination subtype (depressive rumination, rumination on positive affect, reflection, rumination not further specified). The results are summarized in Table 3.3. The funnel plots including the Duval and Tweedie trim and fill method (Figure S8.2 - S8.4 of the Supplemental Material) did not indicate publication bias when all studies were included (Egger's regression intercept = 0.33, p = 0.44), and neither for rumination on positive affect (Egger's regression intercept = 0.05, p = 0.49). However, they indicated publication bias for the analyses of depressive rumination (Egger's regression intercept = -2.15, p = 0.23) and rumination NOS (Egger's regression intercept = 4.15, p = 0.29). Since reflection was only assessed by one study, publication bias estimation was not applicable.

*Table 3.3. Meta-analyses according to rumination subtype.*

| | | **Effect size and 95% confidence interval** | | | | | **Heterogeneity** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rumination subtype** | k | Hedges's g | SE | CI | Z | p | Q | df | p | $I^2$ | Fail-safe N |
| **depressive rumination** | 7 | 0.03 | 0.13 | -0.23-0.30 | 0.26 | 0.80 | 22.11 | 6 | <0.01 | 72.86 | - |
| **rumination on positive affect** | 4 | 0.46 | 0.10 | 0.28-0.65 | 4.88 | <0.00 | 1.67 | 3 | 0.64 | 0.00 | 20 |
| **reflection** | 1 | 0.04 | 0.16 | -0.27-0.35 | 0.27 | 0.79 | 0.00 | 0 | 1.00 | 0.00 | - |
| **rumination not further specified** | 4 | 0.08 | 0.22 | -0.36-0.51 | 0.34 | 0.74 | 23.37 | 3 | <0.01 | 87.17 | - |

*Note. Random models. Positive Hedges's g values indicate BD group mean > MDD group mean.*

As hypothesized, we could not find significant difference between the two patient groups in terms of depressive rumination in the seven available studies. However, as expected, based on the four relevant studies the BD group reported more rumination on positive affect. Relying on Cohen's guidelines (J. Cohen, 1962), this was a moderate-sized difference. The results are demonstarted in Figure 3.3. There was only one article that assessed reflection among the two patient groups, which did not find any significant difference. No significant differences were found between the BD and the MDD group on the NOS rumination scales either (the effect size altered marginally when excluding one study with ambiguous quality: g=-0.15, k=3, SE=0.08, 95% CI [-0.31, 0.12], p=0.07]).

| Study name | Comparison | Outcome | Hedges's g | Standard error | Variance | Lower limit | Upper limit | Z-Value | p-Value |
|---|---|---|---|---|---|---|---|---|---|
| Gilbert (2013) | Blank | Combined | 0,305 | 0,252 | 0,064 | -0,189 | 0,800 | 1,210 | 0,226 |
| Fletcher (2013) | Combined | Combined | 0,379 | 0,145 | 0,021 | 0,094 | 0,664 | 2,608 | 0,009 |
| Weinstock (2018) | Blank | Combined | 0,537 | 0,260 | 0,068 | 0,027 | 1,046 | 2,065 | 0,039 |
| Hanssen (2018) | Combined | Combined | 0,624 | 0,174 | 0,030 | 0,284 | 0,964 | 3,597 | 0,000 |
| | | | 0,463 | 0,095 | 0,009 | 0,277 | 0,649 | 4,879 | 0,000 |

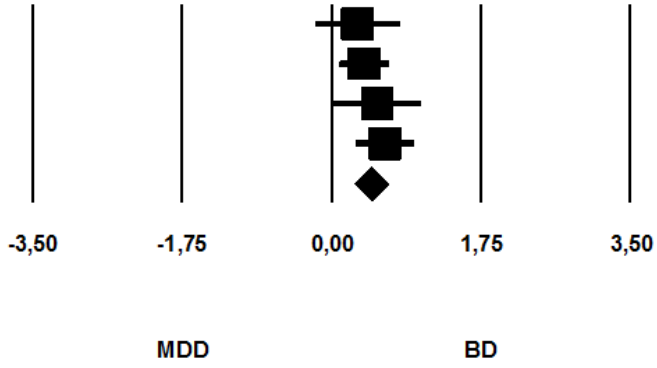


*Figure 3.3. Forest plot for rumination on positive affect in BD compared to MDD.*

In order to check whether our non-significant results derive from the lack of statistical power or they truly indicate no differences between the two patient groups, we conducted a meta-analysis on the six studies that also assessed rumination on a HC sample besides the two patient groups. We calculated effect size for the difference between the HC group and the BD patients, where we expected the BD group to report significantly more rumination. We included all rumination subtypes in the analysis. The funnel plot (Figure S8.5 of the Supplemental Material) did not indicate any publication bias (Egger's regression intercept = 1.15, p = 0.37). The results revealed that the BD group reported more rumination with a large effect size (*g* =1.39, *k*=6, SE=0.25, 95% CI [0.91, 1.87], p<0.01). The fail-safe N was 356 which suggests a robust effect. The effect was heterogeneous (Q= 36.44, p<0.01, $I^2$=86.28).

We could not find any significant difference between BD and MDD patients when all rumination subtypes were included in the analysis. However, a highly heterogeneous effect was found, thus we conducted additional analyses to further explore possible distinctions between the two patient groups. First, we tested for BD group diagnosis, and compared BD-I patients and BD-II patients to MDD patients separately, where we hypothesized that the difference in rumination would be more articulated between BD-I and MDD patients than between BD-II and MDD patients, given that BD-I patients tend to experience the most labile and severe affect states among these patient groups. We could only include articles that recruited homogenous BD patient groups, which resulted in a reduced number of studies and smaller statistical power. Nonetheless, we found tendency level difference between BD-I patients and MDD patients in terms of rumination, whereas we could not find any significant difference between BD-II and MDD patients. The results are summarized in Table 3.4.

*Table 3.4. Meta-analyses according to BD diagnosis.*

| | | **Effect size and 95% confidence interval** | | | | | **Heterogeneity** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **BD diagnosis** | k | Hedges's g | SE | CI | Z | p | Q | df | p | $I^2$ | Fail-safe N |
| **BD-I vs. MDD** | 5 | 0.28 | 0.17 | -0.04-0.60 | 1.69 | 0.09 | 19.96 | 4 | <0.00 | 79.96 | - |
| **BD-II vs. MDD** | 3 | 0.09 | 0.29 | -0.48-0.66 | 0.32 | 0.75 | 11.19 | 2 | <0.00 | 82.13 | - |

*Note. Random models. Positive Hedges's g values indicate BD subgroup mean > MDD group mean.*

Since the BD group reported more rumination on positive affect than the MDD group, we explored whether this difference remains significant when testing for the two BD subgroups separately. Albeit few studies could be included in these analyses too, our results support that

both BD-I (g=0.51, k=4, SE=0.086, 95% CI [0.34, 0.68], p<0.01]) and BD-II patients (g=0.44, k=2, SE=0.12, 95% CI [0.21, 0.67], p<0.01) report more rumination on positive affect than MDD patients, with similar moderate effect sizes. The effect was homogenous in case of both BD-I (Q= 2.29, p=0.52, $I^2$<0.01) and BD-II patients (Q= 0.95, p=0.33, $I^2$<0.01). The funnel plots (Figure S8.6-S8.7 of the Supplemental Material) did not indicate any publication bias. Egger's regression intercept was 2.03 (p=0.31) and -3.15 (p=0.33), respectively.

Moreover, we aimed to test whether the current mood state of MDD patients (depressed vs. remitted) and BD patients (depressed/manic/remitted) moderated the difference in rumination between the two patient groups. Although the heterogeneity of effect sizes would favor such analyses, due to the fact that most of the studies (k=8) did not delineate the current episode of patients, these moderation analyses could not be performed.

### 3.4. Discussion

A growing body of evidence indicates that mood disorders share numerous cognitive-emotional features in common, hampering their nosological categorization that is also reflected in the overlapping diagnostic categories of the DSM-5 (American Psychiatric Association, 2013; Zimmermann et al., 2009). The ongoing debate whether BD and MDD merely exhibit quantitative differences and shall be examined dimensionally, or they represent diverse neuropsychological features and should be considered distinct (Benazzi, 2006; Samamé et al., 2017) supports the need for studies that systematically compare cognitive-emotional features, such as rumination, in BD and MDD.

According to our knowledge, this is the first meta-analysis to compare rumination in BD and MDD. Twelve studies assessing rumination among both BD and MDD patients were found and reviewed. We did not find significant differences between the two patient groups on rumination in general. More specifically, however, while no differences appeared on depressive rumination, the BD group reported more rumination on positive affect, which remained significant when examining for BD-I and BD-II patient groups separately, with similar effect sizes. These findings suggest that both patient groups tend to engage in depressive rumination, whereas rumination on positive affect evidently mainly characterizes BD patients. The lower level of positive rumination in MDD may be due to the fact that these patients experience less positive emotions, or that they tend to ignore positive events and rather focus on their past negative experiences (Everaert et al., 2012). Moreover, research found that neural circuits associated with reward processing show heightened and prolonged activation patterns among

BD patients (Phillips & Vieta, 2007). This is in line with the concept that BD patients tend to intensify and prolong positive emotions, which they often pursue by ruminating on positive affect, especially with a rewarding content, e.g. achievement (Gruber et al., 2011).

Additionally, when comparing BD-I and BD-II subgroups with the MDD group separately, a tendency-level effect size favoring BD-I patients was found for rumination in general. Our results also indicate that overall BD-I patients report slightly more rumination, which is plausible given that they experience both depressive and manic episodes to the greatest extent. When all rumination measures were included, such systematic difference could not be found between BD-II and MDD patients, suggesting that even if there was a slight difference favoring BD-II patients, the effect size is considerably smaller than in terms of the BD-I group. This is in line with recent functional magnetic resonance imaging (fMRI) studies, that demonstrated altered functioning in regions associated with emotion regulation among BD patients during task performance (Rey et al., 2014), as well as in resting state (Meda et al., 2012), suggesting irregular functionality involving the Default Mode Network (DMN) and areas associated with affect regulation processes (Rey et al., 2016).

Given its transdiagnostic nature, rumination appears to play an important role in numerous disorders, accounting for the co-occurrence of several symptoms (McLaughlin et al., 2014), especially when related to mood disturbances (S. L. Johnson et al., 2008). The excessive use of rumination characterizes both depression and mania (Townsend & Altshuler, 2012), thus synthetizing the empirical results about rumination in MDD and BD - where it has been studied less extensively - could yield important insights for future research. Furthermore, it appears that the ability to regulate intrusive, ruminative thoughts and broadening the repertoire of adaptive emotion regulation strategies (Berking et al., 2008) may help to prevent depressive (Nolen-Hoeksema & Aldao, 2011) and manic episodes (S. L. Johnson et al., 2008), thus a better understanding of how rumination might lead to affective disturbances in BD and MDD may foster the development of novel treatment strategies.

However, our study has certain limitations that should be considered when interpreting the results of this review. First and foremost, since we posited very specific questions in this paper, only a few studies qualified to be included in our analysis, resulting in a fairly reduced scope and applicability. On the other hand, this underlines that despite the ever-growing support to the continuum approach of mood disorders, there are still relatively few studies measuring emotion regulation strategies such as rumination both among BD and MDD individuals. It is also important to note that the small number of studies might have resulted in limited statistical power. Thus, we conducted a meta-analysis on the six studies that assessed rumination on a HC

sample besides the two patient groups. The BD group reported more rumination, suggesting that our non-significant results may not simply derive from the lack of statistical power, but rather indicate that there is no significant difference between the two patient groups in depressive rumination, reflection and ruminative tendencies in general. However, we would need more data for firm conclusions.

Second, we found heterogeneous effects in many of the executed analyses, possibly related to the diverse mood state of the patients in the primary studies. This also calls attention to an important issue of the field: studies that assess emotion regulation in mood disorders often lack measuring and controlling for current affective episode, let alone current medication, years with the disorder, comorbidity or psychotherapeutic treatment, which makes the synthesis of the results difficult. Therefore, even though we wished to test for the moderating effect of these factors, especially the current episode of illness, the data gathered from the primary articles did not enable us to do so. Ideally, studies shall assess emotion regulation strategies in the whole spectrum of mood disorders prospectively, closely monitoring the changes in emotion regulation throughout the course of the illness, although designing such research is evidently challenging. Nonetheless, it is interesting that none of the included studies attempted to assess state rumination within these patient groups, i.e. the ruminative response given to a current mood state or stressor (LeMoult et al., 2013).

Hence, multiple questions remain unanswered, such as whether rumination on positive affect leads to, or simply accompanies elevated positive mood. One possibility is that rumination on positive affect leads to increased emotional reactivity and thus trigger symptoms of mania (Feldman et al., 2008). Although some results suggest that rumination may intensify not only negative, but positive affective states depending on the valence and content of the ruminative thought (Gilbert & Gruber, 2014), another study did not find any difference in the emotional or physiological response between BD patients and HCs to rumination induction (Gruber et al., 2011). Future research applying longitudinal, experimental or ecological momentary assessment design could shed light to the connection between current mood state and the momentary changes of emotion regulation strategies, which are particularly sought for concerning rumination on positive affect.

Moreover, while Egger's regression intercept was not significant for neither of our analyses, the Duval and Tweedie trim and fill method indicated publication bias in depressive rumination, suggesting that studies reporting more depressive rumination among BD patients than MDD patients are missing. This conveys that although the [hypo]manic pole of BD is more salient, it is important to keep in mind that BD patients also experience depressive symptoms

and may ruminate on them to a similar, or perhaps even a bit greater extent than MDD patients. However, it is important to note that these publication bias methods would require more studies to obtain adequate statistical power, thus can only be interpreted cautiously (Sterne & Harbord, 2004).

Another important methodological issue is the quality of the original studies. 11 out of 12 studies got high quality scores, whereas one study was rated considerably weaker. This paper was included in the analyses of all rumination measures and rumination NOS only. Since the effect sizes differed negligibly when excluding this paper, and the lower performance of this article on the quality checklist may partially be due to its different focus compared to the other papers (i.e. the psychometric evaluation of a self-report scale in a clinical and non-clinical sample), we decided to keep it.

The fact that only self-report studies were included posits further limitations: for instance, recall biases play an articulated role in mood disorders (Tavares et al., 2003) that may decrease the validity of retrospective cross-sectional studies utilizing self-report measures. Also, while depressive rumination measures have been criticized for being biased by depressive symptoms (Smith and Alloy, 2009), the same question arises regarding the RPA: some of its items (e.g. "I am achieving everything") appear to overlap with manic symptoms, while, on the other hand, its capability to capture the repetitive nature of such thoughts is arguable. Furthermore, the RPA instructs participants to indicate whether they think or do something "when feeling happy, excited, or enthused". It would be interesting to explore whether BD patients they tend to recall their manic or remitted episodes when instructed to do so.

In summary, the findings of the current meta-analytic review suggest that rumination as assessed with self-report measures is present among both MDD and BD subjects, and that these patients may not differ in terms of depressive rumination, which they most probably experience during their depressive episodes. Rumination on positive affect mainly characterizes BD patients and appears to be linked with disturbed reward processing experienced in [hypo]mania. However, more studies are needed to be able to draw conclusions regarding the connection between current mood state/episode of illness and state rumination, which could also yield important insights about plausible interventions to reduce rumination in the different phases of mood disorders. Such interventions appear to have utmost importance in BD-I, as these patients experience the most severe affective symptoms in both directions, and therefore tend to ruminate the most.

## 4. RUMINATION MEDIATES THE RELATIONSHIP BETWEEN PERSONALITY ORGANIZATION AND BORDERLINE-DEPRESSIVE SYMPTOMS (STUDY 3)[3]


### Abstract

This manuscript presents two studies examining cross-sectional mediational models between self-report assessments of personality organization, rumination, borderline personality disorder symptoms and depressive symptoms. The relationship between rumination and symptoms of borderline personality disorder (BPD) and depression has been demonstrated by numerous empirical studies. In our research we used Kernberg's theoretical frame of personality organization (PO) where normal and pathological personality features are not distinct entities but make a spectrum of increasing severity. In the current study we hypothesized that the relationship between PO and borderline as well as depressive symptoms is mediated by rumination on non-clinical samples. According to our results a less structured personality appears to be associated with more borderline and depressive symptoms, a higher proneness to rumination, and the relationship between PO level and borderline-depressive symptoms is mediated by rumination. These results provide important insights regarding the concomitants of borderline and depressive symptoms, as well as their treatment.



*Keywords:* personality organization, rumination, borderline personality disorder, borderline symptoms, transdiagnostic variables, identity diffusion, primitive defense


[3] Kovács, L. N., Schmelowszky, Á., Galambos, A., & Kökönyei, G. (2021). Rumination mediates the relationship between personality organization and symptoms of borderline personality disorder and depression. *Personality and Individual Differences, 168,* 110339. https://doi.org/10.1016/j.paid.2020.110339

## 4.1. Introduction

### *4.1.1. Conceptualizations of Rumination*

Difficulties with emotion regulation are one of the highlighted transdiagnostic risk factors to psychopathology, as they are present in most psychological problems, and besides aggravating behavioral symptoms, make treatment difficult (Aldao et al., 2010). Rumination is one such emotion regulation strategy, that is becoming more and more significant in clinical research: it has first been explored regarding depression, but lately has been associated with numerous other psychological problems (e.g. Nolen-Hoeksema & Watkins, 2011). In a review by Smith & Alloy (2009) it has been broadly characterized as an avoidant coping strategy, because it may be a means of escape from undesired affect states, nonetheless it happens to aggravate negative mood. There are several conceptualizations of rumination among which we present the ones applied in this research, along with their corresponding measures.

*Depressive Rumination – The Response Styles Theory*

The Response Styles Theory defines rumination as the passive dwelling on the causes, circumstances and consequences of emotionally relevant events that elevates the perceived importance of the stressor, thus aggravates negative mood states (Nolen-Hoeksema, 1991). Empirical results appear to validate this theory regarding the etiology of depression, as it has been shown that rumination on one's own depressed mood leads to elevated depressive symptoms (Brinker & Dozois, 2009; Nolen-Hoeksema et al., 1993), and predicts the initiation of depressive episodes (Nolen-Hoeksema et al., 2008). These findings appear to pertain not only among mood disorder patients, but also among community samples (Brinker & Dozois, 2009). Studies where current depressed mood was controlled for suggest that rumination is not merely a reaction to, but rather an antecedent of negative affect states (Nolen-Hoeksema & Aldao, 2011). One of the most widely used self-report rumination measures building on the Response Styles Theory is the Ruminative Response Scale (RRS, Treynor et al., 2003), that divides rumination into two facets, brooding and reflective pondering, where brooding is the maladaptive, passive dwelling on past negative episodes, while reflective pondering is defined as an attempt to analyze one's own emotions and thoughts in order to facilitate problem solving.

*Ruminating about Unattained Goals – the Goal Progress Theory*

The Goal Progress Theory (L. L. Martin & Tesser, 2006) proposes a broader, multifaceted conceptualization, where ruminative thoughts derive from unattained goals, and thus can arise

regarding past, present or future events, and are not necessarily negative in content. However, because of their intrusive and uncontrollable nature, ruminative thoughts interfere with problem solving and tend to elevate negative mood by acting as a constant reminder of unachieved objectives (L. L. Martin & Tesser, 2006). Moreover, the discrepancy between the ideal and the actual self deriving from unattained goals may trigger rumination, which appears to mediate the occurrence of depressive and anxious symptoms among university students (Dickson et al., 2019). Smith and Alloy (2009) defined rumination as an avoidant emotion regulation strategy that is triggered by the dissonance between one's actual and ideal state, and the negative affect associated with this notion. This definition aims to bridge the Goal Progress Theory and the Response Styles Theory, conceptualizations we adhered to in our studies.

#### *4.1.2. Rumination in BPD – the Emotional Cascade Model*

Rumination has also been demonstrated as an important risk factor that may aggravate borderline personality disorder (BPD) symptoms (e.g. Peters et al., 2014; Selby & Joiner, 2009). BPD is a severe mental illness that is estimated to reach up to 6% in the general population, and is characterized by emotional lability, impulsivity, conflicted interpersonal relationships and serious impairments in everyday life, as well as high prevalence of suicidal (10%) and parasuicidal (70%) behavior (Black et al., 2004; Fertuck et al., 2007; Levy & Johnson, 2016). BPD, together with other personality disorders, is known to demonstrate high comorbidity rates with depression, attenuating remission (American Psychiatric Association, 2013; Smith et al., 2006). According to the Emotional Cascade Model, negative events evoke negative emotions that in return trigger a ruminative response, which then intensifies the negative perception of the original stressful situation, leading to even more rumination (Selby & Joiner, 2009). This phenomenon is especially articulated in case of BPD patients who lack constructive emotion regulation strategies (Dixon-Gordon et al., 2017; Linehan, 1993; Links et al., 2007), resulting in an emotionally escalating vicious circle that is difficult to terminate. According to the model, behavioral symptoms of BPD such as substance use, binge eating or self-harm represent the person's attempt to interrupt the cascade (Baer et al., 2012). These maladaptive behavioral strategies may bring a short-term ease, however on the long run they tend to generate shame, guilt and self-blame, which may trigger more rumination and another emotional cascade (Selby & Joiner, 2009). Empirical investigations of the Emotional Cascade Model suggest that rumination mediates the relationship between emotion dysregulation and impulsive behavior among BPD patients (Martino et al., 2015) and non-clinical adults (Selby et al., 2008).

### *4.1.3. Levels of Personality Organization*

Kernberg's model (1993) of personality organization (PO) describes psychopathology in a dimensional way with key domains of personality functioning. Instead of focusing on external symptoms, this model aims to capture the personality structure behind the observed behavior. The normal personality can be described as flexible, while ego function impairments that cause rigidity are considered signs of personality pathology (Lenzenweger et al., 2001). In Kernberg's theoretical frame there are three ego functions that primarily define the level of PO: identity diffusion, primitive defense and reality testing. Identity diffusion implicates poorly integrated representations of self and significant others, while primitive defense mechanisms distort the person's interactions and compromise the way of functioning, among which splitting is the most typical of the borderline personality organization (BPO) level (Lenzenweger et al., 2001). Reality testing describes the person's capacity to differentiate the self and the non-self, the intrapsychic and the external stimuli (Kernberg & Caligor, 2005). At the borderline personality organization (BPO) level, reality testing is intact, however, sometimes restricted or unstable (Oliveira & Bandeira, 2011), whereas the psychotic level of personality organization (PPO) is mainly characterized by an impaired sense of reality (Lenzenweger et al., 2012). BPD, together with the majority of personality disorders, belongs to the BPO level, thus the two concepts demonstrate numerous common features, however, they do not fully overlap: by definition, BPO is a broader concept that mainly focuses on the internal experience, while BPD rather aims to capture external behaviour (Hilsenroth et al., 2003). This is also reflected by the moderate (but not high) positive correlation between measures of PO level and BPD in clinical samples (e.g. Redondo Rodríguez et al., 2019). Accordingly, the lower the personality functioning is, the more behavioral symptoms will appear (Scala et al., 2018). To sum up, chronic ego weakness characterized by primitive defense, a lack of impulse control, emotion dysregulation and identity diffusion are indicators of personality pathology (Kernberg, 1993). These impairments may lead to emotional lability and impulsive behavior, manifested via a broad variety of symptoms observed among patients with personality disorders (Bender & Skodol, 2007; Lenzenweger et al., 2012). The level of PO can be measured by assessing one's ego functions with the help of a clinical interview, STIPO-R (Structured Interview of Personality Organization-Revised; Clarkin et al., 2015), or a quantitative questionnaire, the IPO (Inventory of Personality Organization, Kernberg & Clarkin, 1995).

### *4.1.4. Rumination as a potential mediator between PO level and Symptoms of BPD and Depression*

It is well-established that lower PO is accompanied by more severe BPD symptoms and depressed mood (e.g. Lenzenweger et al., 2001), both of which have been associated with more rumination (e.g. Martino et al., 2015; Nolen-Hoeksema, 2000). We assumed that impaired personality functioning may provoke ruminative thinking, as patients with personality disorders (i.e. lower PO level) often lack constructive emotion regulation strategies and seek maladaptive ways of avoiding negative emotions (Levy & Johnson, 2016), which may be pursued via rumination (Smith & Alloy, 2009). However, instead of reducing negative affect, rumination appears to increase depressed mood, affective lability and impulsive behaviour, i.e. core features of BPD and depression. Thus, we wished to explore whether people with lower PO would be more prone to ruminate, and whether this maladaptive avoidant emotion regulation strategy (Smith & Alloy, 2009) enhances symptom of BPD and negative mood. More specifically, in the current research we hypothesized that rumination would mediate the relationship between personality functioning and symptoms of BPD and depression. Results of longitudinal studies (Lyubomirsky et al., 2015) and studies where depression was controlled for (Nolen-Hoeksema & Aldao, 2011) suggest that rumination is rather the antecedent than the symptom of negative affect, and the empirically supported Emotional Cascade Model defines core BPD symptoms such as impulsive behavior as the outcome of ruminative cascades (although clearly, subsequent guilt may also trigger another emotional cascade, resulting in a negative spiral). The order of appearance of these processes may also provide support for the suggested mediation model: rooted in the development of object-relations and early attachment styles, personality structure deficits are theorized to derive from the first years of life (Clarkin et al., 2007; Lenzenweger & Clarkin, 2005), meanwhile rumination may first appears at pre-adolescence (Rood et al., 2009). BPD and depressive symptoms can typically be observed during adolescence, however, findings suggest that both disorders are developmental in nature, and identifying earlier cues would be crucial (Hankin, 2015; Stepp, 2012). Based on these considerations we assumed that rumination may rather be the mediator than the outcome in this model. Rumination is a transdiagnostic risk factor to psychopathology rather than being disorder-specific (Aldao et al., 2010), thus linking it with PO, a conceptualization that spans distinct diagnostic categories and is relevant for psychotherapeutic intervention may yield clinical contribution.

#### *4.1.5. Considerations for sampling and measurement*

BPD patients with severe symptoms are overrepresented in clinical studies compared to BPD patients with milder symptoms, as the former group tends to receive treatment more often and for longer periods (Trull et al., 1997). Previous studies suggest that undergraduates, although well-functioning in general, typically cover a rather broad range of personality organization (i.e. Ellison & Levy, 2012; Lenzenweger et al., 2001), and that symptoms of BPD, such as anger, emotional lability, impulsive behaviour and self-harm are common among university students (Gratz, 2001). Trull (1995) found substantial amount of borderline symptoms among nonclinical young adults, which is conceivable as the prevalence of BPD among the whole population is estimated to reach up to 6% (American Psychiatric Association, 2013), and many affected people refuse to seek help (Bagge et al., 2004). Non-clinical samples may represent a broader range of personality functioning than clinical samples, thus examining our hypotheses among non-clinical young adults might be a more powerful way to look at the full range of the relevant constructs.

As both BPD symptoms and rumination tend to decrease with age (Nolen-Hoeksema & Aldao, 2011; American Psychiatric Association, 2013), young adults may be more prone to experience emotional cascades than the general population, thus we recruited university students for the first study. Due to the challenges of the academic environment, past, present and future events and unattained goals may play a crucial part in evoking rumination among university students (Van Boekel & Martin, 2014), therefore we conceptualized rumination in Study 1 as proposed by the Goal Progress Theory (L. L. Martin & Tesser, 2006). In the second study we wished to replicate the findings of our mediation model on a community sample that is more heterogeneous in terms of age and education. Moreover, in Study 2 we hypothesized that the brooding component of rumination may be more strongly associated with impaired personality functioning and symptoms of BPD and depressed mood than reflective pondering.

### 4.2. Study 1

#### *4.2.1. Materials and Methods of Study 1*

*Sample and Procedure*

The work has been carried out in accordance with the Declaration of Helsinki. After obtaining the ethical consent of the Institutional Review Board, we conducted two self-report studies on non-clinical samples. Informed consent of was acquired. Participants who have

never been diagnosed by any psychiatric or neurological diseases were included in the study. In the first study, we recruited university students (n= 179) currently enrolled in a Masters' Program via course mailing lists who received partial course credit for participating. The sample was predominantly female (84.9%; n = 152). The minimum age was 20, the maximum 43 years (M= 24.35; SD=3.23).

*Measures*

**Ruminative Thought Style Questionnaire** (RTSQ, Brinker & Dozois, 2009) has been constructed based on L. L. Martin & Tesser's (1996) conceptualization, which tends to assess rumination as a general, multi-dimensional construct. RTSQ is a self-report survey of 20 items that is aiming to assess rumination globally, without specifying the valence, content and temporal orientation of ruminative thoughts. It contains items like 'I tend to replay past events as I would have liked them to happen' or 'If I have an important event coming up, I can't stop thinking about it', that participants have to answer on a 7-point Likert-scale thus its possible score range is from 20 to 140. The total score of RTSQ has shown excellent internal consistency (Cronbach $\alpha$ = .89 – .92) and high test-retest reliability after two weeks (r = .80, p < .01) (Brinker & Dozois, 2009). In the current study we used the total score that has been shown a reliable measure of rumination by psychometric studies (e.g Brinker & Dozois, 2009; Mihić et al., 2019; Walsh et al., 2017). This is an important aspect, as the measurement of the mediator is crucial for correct model estimation (Gonzalez & MacKinnon, 2020). The RTSQ also demonstrated excellent reliability in our sample (Cronbach $\alpha$ = 0.91).

**Borderline Symptom List** (BSL-23, Bohus et al., 2009) is the shortened version of BSL-95, a self-report survey that aims to measure BPD symptoms based on the diagnostic criteria of DSM-IV. Participants have to determine on a five-point Likert scale from zero to four whether they experienced symptoms often reported by BPD patients during the previous week, e.g. 'I thought of hurting myself', or 'I suffered from shame'. The mean score is divided by the number of items, so it can be compared to the mean score of the BSL-95, thus the minimum score on the scale is zero, the maximum score is four. Previous research suggests that a mean score above 1.5 reflects sub-clinical BPD symptoms, while a score of two or above indicates the presence of BPD (Meaney et al., 2016). The scale has a one-factor structure that has shown high internal consistency on various samples (Cronbach $\alpha$ = .94 –. 97) (Bohus et al., 2009), as well as in the current study (Cronbach $\alpha$ = .92 - .94).

**Inventory of Personality Organization** (IPO, Kernberg & Clarkin, 1995) is a 57-item questionnaire where each statement is rated on a 5-point Likert-scale from 1 (never true) to 5

(always true). It is based on Kernberg's model that includes both the pathological and non-pathological range of personality functioning, thus it is well applicable in both clinical and sub-clinical populations (Lenzenweger et al., 2001). It contains three primary clinical scales, identity diffusion (ID), primitive defense (PD) and reality testing (RT), corresponding to the personality functions described by Kernberg (1993). The three primary scales are known to be intercorrelated, especially ID and PD, as they both reflect the ego functions characteristic of the BPO level, i.e. of personality disorders (Lenzenweger et al., 2001). Furthermore, the two-factor model where ID and PD load on a single factor appears to represent the latent structure of the IPO better than considering the three subscales separate (Smits et al., 2009). This is in line with Kernberg's model (1993), where PD and ID are strongly associated theoretical constructs and both represent the BPO spectrum, while RT characterizes the psychotic level. The following items belong to the PD and ID subscales, respectively: 'I think people are basically either good or bad; there are few who are really in between' or 'My goals keep changing'. The RT scale contains items such as 'I can't tell whether certain physical sensations I'm having are real, or whether I am imagining them.' Since we wished to assess personality structure deficits associated with personality disorder symptoms, and one can expect marginal incidence of psychotic-like symptoms in a non-clinical sample, we only included the PD and ID subscales in our model, combined as a single latent variable. The PD scale contains 16 items, thus its reachable score ranges from 16 to 80, while the ID scale comprises of 21 items, thus its reachable score ranges from 21 to 105. Both subscales have shown excellent psychometric properties in a number of studies (Lenzenweger et al., 2012; Stern et al., 2010), and they also demonstrated excellent internal consistency in the current sample (Cronbach α of PD = .801, Cronbach α of ID = .900). To date, cutoff scores associated with the different levels of PO are not available.

The Center for Epidemiologic Studies Depression Scale (CES-D, Radloff, 1977) was constructed in order to assess depressive symptoms in the general population (Radloff, 1977). It is a short self-report measure made up of 20 items investigating depressed mood during the past week, each of which has to be evaluated on a four-point Likert scale from zero to three, thus the lowest possible score is zero, while the highest possible score is 60. It contains items such as "I felt lonely". Most studies recommend a score of 16 or above as a cutoff indicating clinical depression, however, findings of a recent meta-analysis suggest that the cutoff score of 20 is more adequate in terms of specificity and sensitivity (Vilagut et al., 2016). The Hungarian CES-D demonstrated excellent internal consistency in the current sample (Cronbach αs: 0.75 - .89), as well as in a previous study (Cronbach α = .82)(Urbán et al., 2014).

*Statistical analysis*

Descriptive statistical analyses and reliability testing were performed with IBM SPSS 24 software (2016). Then, we carried out structural equation modelling with MPlus software (Version 8, Muthen & Muthen, 1998) in order to test whether the connection between personality structure deficits, i.e. PO level, and symptoms of BPD and depression is mediated by rumination, as measured by the RTSQ. We performed ML estimation and bootstrapping using 500 bootstrap samples, as it improves accuracy and power without assuming normal distributions (MacKinnon et al., 2004). PO level was used as a single latent variable indexing the two subscales of IPO that are associated with personality disorder symptoms, ID and PD. Gender and age were controlled for in the model, as rumination, BPD and depressive symptoms are more common among women than men, and rumination and BPD symptoms tend to decrease with age (American Psychiatric Association, 2013; D. P. Johnson & Whisman, 2013; Nolen-Hoeksema, 2000; Nolen-Hoeksema & Aldao, 2011). We followed the guidelines of Torgrimson and Minson (2005) regarding the use of the terms sex and gender, based on which we chose to apply the term 'gender' in this article. We found high correlation between the BSL-23 and CES-D scores ($r = .700$, $p < .01$), reflecting the high comorbidity rates between the two disorders (Smith et al., 2006), thus we combined the two outcome measures as a single latent variable and tested whether this modification would cause any changes in the model. We calculated the proportion mediated for each mediation by dividing the unstandardized indirect effect by the unstandardized total effect (M. W. L. Cheung, 2009). However, a sample size above 500 is recommended for calculating this ratio (MacKinnon et al., 1995), thus it should be interpreted carefully.

### *4.2.2. Results of Study 1*

In the first study we did not find any significant difference between men and women on the mean scores of the assessed measures. The descriptive statistics split by gender and mean differences are available in Table 4.1.

*Table 4.1. Gender differences of the assessed variables of Study 1.*

| **Measure** | **Female M (SD) (n= 152)** | **Male M (SD) (n= 27)** | **t** | **p** |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **IPO primitive defense** | 29.41 (7.84) | 30.70 (8.76) | 0.778 | .438 |
| **IPO identity diffusion** | 38.43 (12.64) | 42.22 (12.08) | 1.444 | .150 |
| **BSL-23** | 0.70 (.64) | 0.66 (.56) | 0.325 | .746 |
| **CES-D** | 18.70 (7.29) | 16.59 (4.55) | 1.454 | .148 |
| **RTSQ** | 78.31 (20.39) | 77.22 (19.50) | 0.258 | .796 |

*Note. n = 179. IPO = Inventory of Personality Organization; BSL-23 = Borderline Symptom List; CES-D = The Center for Epidemiologic Studies Depression Scale; RTSQ = Ruminative Thought Style Questionnaire.*

Non-parametric correlations were performed due to non-normality of the variables. The descriptive statistics and the correlational matrix of the variables assessed in the first study are shown in Table 4.2.

*Table 4.2. Minimum-maximum values, means, standard deviations of the measures assessed in Study 1, and non-parametric correlations of the variables.*

| **Measure** | **Minimum - Maximum values** | **M (SD)** | **IPO identity diffusion** | **BSL-23** | **CES-D** | **RTSQ** |
|---|---|---|---|---|---|---|
| **IPO primitive defense** | 16-56 | 29.60 (7.97) | .781 | .516 | .381 | .440 |
| **IPO identity diffusion** | 21-91 | 39.01 (12.59) | | .583 | .456 | .550 |
| **BSL-23** | 0.04-3.22 | 0.69 (0.23) | | | .700 | .503 |
| **CES-D** | 5-48 | 18.39 (6.98) | | | | .434 |
| **RTSQ** | 23-137 | 78.15 (20.20) | | | | |

*Note. n = 179. All correlations are significant at p < .01. IPO = Inventory of Personality Organization; BSL-23 = Borderline Symptom List; CES-D = The Center for Epidemiologic Studies Depression Scale; RTSQ = Ruminative Thought Style Questionnaire.*

In the first study, our mediation model showed an excellent model fit ($\chi^2 = 8.034$, df = 6, RMSEA = 0.044 [0.000-0.113], SRMR = 0.040, CFI = 0.996, TLI = 0.986). According to the

results, lower PO level - i.e. the low integrity of internalized representations of self and others and related emotional experience, as well as the use of immature defense mechanism such as splitting - was directly associated with more BPD symptoms (β = .566, p < .001), more depressive symptoms (β =.424, p < .001), and more rumination (β = .556, p < .001). In addition, rumination was a weak, but significant mediator between PO level and BPD (standardized indirect effect: .092, p = .033; proportion mediated = 0.14), as well as between PO level and depressive symptoms (standardized indirect effect: .108, p = .049; proportion mediated = 0.20), providing support for our hypothesis. Age and gender were controlled for in the mediation model. The total explained variance of BPD symptoms were 46.5% (p < .001), whereas the total explained variance of depressive symptoms were 33.3% (p < .001). The model is shown in Figure 4.1.

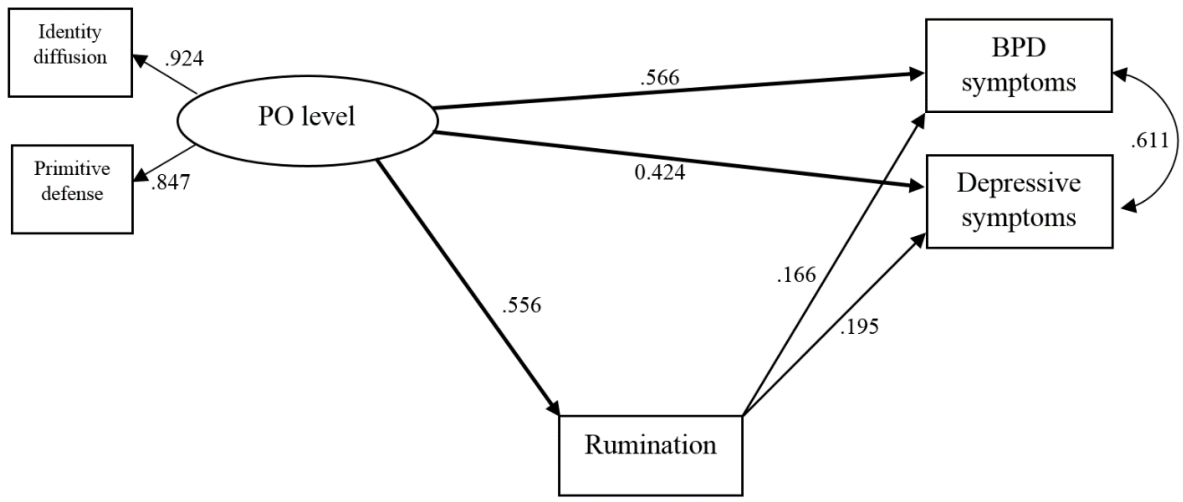


*Figure 4.1. The mediation model of Study 1 and its standardized path coefficients.*

*Note: All drawn paths are significant at p < .001, except between rumination and depressive symptoms (p = .038), and rumination and BPD symptoms (p= .035). PO = Personality Organization, BPD = Borderline Personality Disorder. Gender and age were controlled for in the model.*

In order to handle the high correlation between the CES-D and the BSL-23 scores, we combined these two outcome measures as a single latent variable and found that it changed the results marginally. This alternative model can be found as Figure S8.8 in the Supplementary Material.

### *4.2.3. Discussion of Study 1*

In this study we examined whether rumination mediated the relationship between personality structure and symptoms of BPD and depression among university students. Although the connection between PO level and symptoms of BPD and depression is well-established, and rumination is known to aggravate depressed mood (e.g. Nolen-Hoeksema, 1991, 2000) and symptoms of BPD (e.g. Peters et al., 2014), the connection between PO level and rumination has not been assessed before. According to the theory of Kernberg (1993), lower level of PO results in emotional instability, that fosters the development of maladaptive behavioral patterns. Linehan (1993) underlines that emotional dysregulation is crucial in BPD, as people with BPD features lack more constructive strategies to alleviate their emotional distress, thus they tend to engage in maladaptive impulsive behavior instead, resulting in a negative spiral. Rumination exacerbates this emotionally unstable pattern, that is often accompanied by depressed mood (Selby & Joiner, 2009). Consistent with these theories, we hypothesized that participants with a less structured personality tend to ruminate more, and report more borderline and depressive symptoms. Furthermore, we assumed that the connection between symptoms and PO level is mediated by rumination. Our results provide support for these hypotheses: PO level was strongly associated with rumination, and we found a weak but significant mediation path between PO level and BPD symptoms, as well as between PO level and depressive symptoms.

In Study 1, we examined the reported associations on a sample of university students, while in Study 2 we wished to replicate our findings on a more heterogeneous community sample. Moreover, in Study 1 we conceptualized rumination as a broad, general thought processing mode unbiased by valence, temporal orientation and content, as we found this conceptualization the most relevant for university students (Van Boekel & Martin, 2014). However, rumination is often conceptualized as a two-faceted construct, comprised of brooding, the maladaptive and often self-blaming repetitive thinking style about past negative experiences, and reflective pondering, defined as an attempt to understand one's own feelings in order to facilitate emotional coping (Treynor et al., 2003). The results of previous studies suggest that brooding may be more strongly associated with emotion dysregulation and negative affect than reflective pondering (Selby et al., 2008; E. R. Watkins, 2009). Thus, in the second study we hypothesized that brooding has a stronger mediating effect between PO level and symptoms of BPD and depression than reflective pondering.

## 4.3. Study 2

### *4.3.1. Materials and Methods of Study 2*

*Sample and Procedure*

We recruited our participants (n= 261) with convenience sampling method online via social media posts. Informed consent was acquired. Participants who have never been diagnosed by any psychiatric or neurological diseases were included in the study. In terms of highest level of education, 61% of the participants (n= 159) had a Bachelor's degree or above, 8.4% (n= 22) were university students, 24.5% (n= 64) had a high school diploma, 1,5% (n= 4) only attended primary school, and 4.6% (n= 12) did not answer this question. 67% of the participants (n= 175) were women. The minimum age was 18, the maximum 68 years (M= 37.91; SD= 11.51).

*Measures*

In the second study, we assessed borderline symptoms with BSL-23, depressive symptoms with CES-D, and PO level with the ID and PD subscales of the IPO questionnaire. These scales are described in details in Study 1.

We measured rumination with the 10-item version of the *Ruminative Response Scale* (RRS, Treynor et al., 2003) that contains two subscales, brooding and reflective pondering. Items of the RRS are rated on a four-point Likert scale from 1 (never) to 4 (always), thus the possible total score ranges from 10 to 40. Brooding can be characterized as a self-criticizing thinking style that focuses on past negative experiences, containing items such as Think "Why can't I handle things better?" Reflective pondering, on the other hand, is a rather adaptive way of repetitive thinking where one is making an effort to understand their own emotional processes. This subscale contains items like "Go away by yourself and think about why you feel this way". Both the brooding and reflective pondering subscales of the Hungarian version have shown good internal consistency in a previous study (Cronbach αs: 0.71 and 0.73, respectively)(Kokonyei et al., 2016), as well as in the current sample (Cronbach αs: 0.67 and 0.72, respectively).

*Statistical Analysis*

In Study 2, we assumed that the mediating effect of rumination is stronger in case of brooding than reflective pondering. After performing the descriptive statistical analyses and reliability testing with IBM SPSS 24 software (2016), we carried out structural equation

modelling with ML estimation and bootstrapping using 500 bootstrap samples with MPlus software (Version 8, Muthen & Muthen, 1998). PO level was used as a single latent variable indexing ID and PD subscales. Gender and age were controlled for in our model. We calculated the proportion mediated for each mediation by dividing the unstandardized indirect effect by the unstandardized total effect (M. W. L. Cheung, 2009). However, a sample size above 500 is recommended for calculating this ratio (MacKinnon et al., 1995), thus it should be interpreted carefully. The correlation between BSL-23 and CES-D scores was high in this sample (r=.770, $p < .01$), similarly to Study 1, thus, we combined the two outcome measures as a single latent variable as we did in Study 1, on order to test whether this modification changes the mediation model significantly.

### *4.3.2. Results of Study 2*

In the second study we did not find any significant difference between men and women on the mean scores of the assessed measures. The descriptive statistics and mean differences split by gender are shown in Table 4.3.

*Table 4.3. Gender differences of the assessed variables in Study 2*

| **Measure** | **Female M (SD) (n= 175)** | **Male M (SD) (n= 86)** | **t** | **p** |
|---|---|---|---|---|
| **IPO primitive defense** | 30.50 (8.64) | 31.81 (10.06) | 1.095 | .275 |
| **IPO identity diffusion** | 37.67 (12.12) | 36.24 (11.66) | 0.877 | .381 |
| **BSL-23** | 0.44 (.46) | .47 (.56) | 0.457 | .648 |
| **CES-D** | 13.56 (10.19) | 11.54 (6.89) | 1.623 | .106 |
| **RRS brooding** | 9.84 (2.50) | 9.24 (2.67) | 1.774 | .077 |
| **RRS reflective pondering** | 10.85 (2.92) | 10.55 (3.07) | 0.755 | .451 |

*Note. n = 261. IPO = Inventory of Personality Organization; BSL-23 = Borderline Symptom List; CES-D = The Center for Epidemiologic Studies Depression Scale; RRS = Ruminative Response Scale.*

The descriptive statistics for the total sample and the correlational matrix of the variables assessed in the second study are shown in Table 4.4. Non-parametric correlations were used due to the non-normality of the variables.

*Table 4.4. Minimum and maximum values, means, standard deviations of the measures assessed in Study 2, and non-parametric correlations of the variables.*

| Measure | Minimum-maximum values | M (SD) | IPO identity diffusion | BSL-23 | CES-D | RRS brooding | RRS reflective pondering |
|---|---|---|---|---|---|---|---|
| **IPO primitive defense** | 16-80 | 30.93 (9.13) | .739 | .537 | .474 | .448 | .215 |
| **IPO identity diffusion** | 21-105 | 38.16 (12.82) | | .630 | .512 | .489 | .281 |
| **BSL-23** | 0-4 | .45 (.49) | | | .770 | .499 | .450 |
| **CES-D** | 0-45 | 12.90 (9.28) | | | | .466 | .275 |
| **RRS brooding** | 5-20 | 9.64 (2.57) | | | | | .354 |
| **RRS reflective pondering** | 5-20 | 10.75 (2.97) | | | | | |

*Note. n = 261. All correlations are significant at p < .01. IPO = Inventory of Personality Organization; BSL-23 = Borderline Symptom List; CES-D = The Center for Epidemiologic Studies Depression Scale; RRS = Ruminative Response Scale.*

The relative goodness of fit indices showed good model fit for the mediation model of the second study $\chi^2 = 22.543$, df = 7, RMSEA = 0.092 [0.051-0.136], SRMR = 0.059, CFI = 0.982, TLI = 0.931). We found strong direct associations between PO level and brooding ($\beta = 0.595$, $p < .001$), BPD symptoms ($\beta = 0.562$, $p < .001$), and depression ($\beta = 0.477$, $p < .001$). Our results showed that brooding mediated the relationship between personality functioning and symptoms of BPD and depression. The mediation paths between PO level, reflective pondering and symptoms of BPD and depression were also significant, but considerably weaker. Standardized indirect effects were 0.134 ($p = .001$) between PO level, brooding and depressive symptoms (proportion mediated = 0.22), and 0.030 ($p = .066$) for PO level, reflective pondering and depressive symptoms (proportion mediated = 0.06). Standardized indirect effects were 0.110 ($p < .000$) between PO level, brooding and BPD symptoms (proportion mediated =

0.17), and 0.052 (p = .002) between PO level, reflective pondering and BPD symptoms (proportion mediated = 0.09). These results support our hypotheses that personality functioning and symptoms would be more strongly associated with brooding than with reflective pondering, and that the mediation effect of rumination is stronger in case of brooding than reflective pondering. The total explained variance of depressive symptoms was 47.1% (p < .001), the total explained variance of BPD symptoms was 58.9% (p < .001). The model is shown in Figure 4.2.

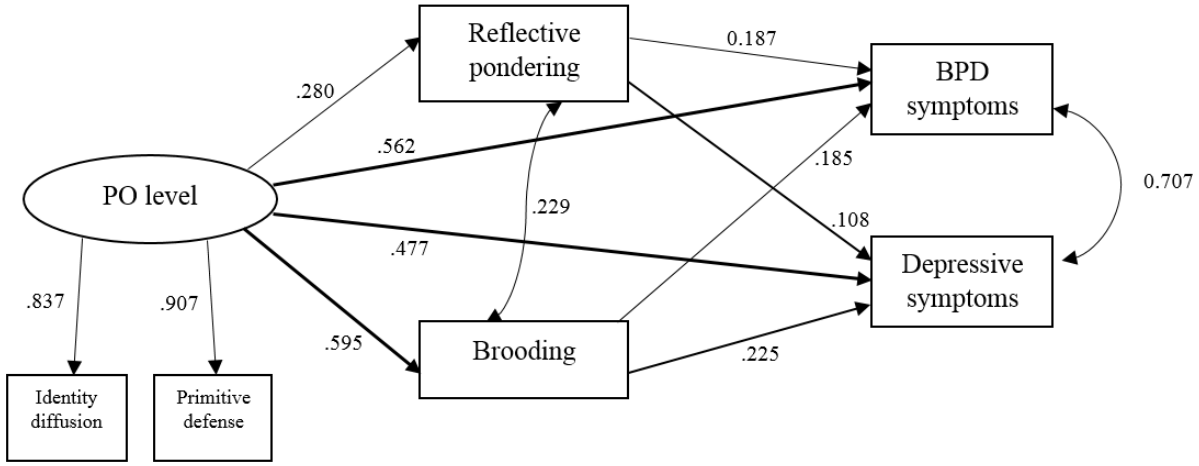


*Figure 4.2. The mediation model of Study 2 and its standardized path coefficients.*

*Note: All drawn paths are significant at p ≤.01, except between reflective pondering and depressive symptoms (p=.032). Gender and age were controlled for in the model. PO = Personality Organization, BPD = Borderline Personality Disorder.*

In order to address the issue of multicollinearity, i.e., the high correlation between the CES-D and the BSL-23 scores, we combined these two outcome measures as a single latent variable. This alternative model demonstrated minor changes in the obtained results and is provided as Figure S8.9 in the Supplementary Material.

### *4.3.3. Discussion of Study 2*

In Study 2 we examined whether the results of Study 1, i.e. the strong association between personality structure and rumination, the mediating role of rumination between PO level and symptoms of BPD and depression can be replicated on a more heterogeneous non-clinical sample. Furthermore, we explored whether this connection is stronger in case of brooding than reflective pondering. The results of our second study are congruent with the results obtained in Study 1, and indicate that brooding, a less adaptive repetitive thought processing plays a more

considerable role in mediating the connection between PO level and borderline as well as depressive symptoms than reflective pondering. Our findings highlight the importance of maladaptive thought processing in the development of borderline-depressive symptoms, and hint at the relevance of extending the exploration of these associations to other emotional regulation strategies.

### 4.4. General Discussion

Lately, interest has been rising in clinical psychology towards transdiagnostic constructs, i.e., psychological processes that appear to be related to a wide range of diagnostic categories. These constructs can help to explore the underlying factors of observed symptoms, thus may contribute to more accurate diagnoses (Sauer-Zavala et al., 2016). Furthermore, exploring the connection between these transdiagnostic variables may help to reduce the phenomenological heterogeneity within different diagnostic categories, and shift towards a more plausible classification system of mental disorders by bridging disorder-specific features with possible underlying factors (Lenzenweger et al., 2008; Lyubomirsky et al., 2015), which could result in better treatment methods on the long run. This study focuses on such variables, namely rumination, a maladaptive emotion regulation strategy and its relation to key domains of personality functioning, which has not been studied elsewhere.

In the first study we hypothesized that the relationship between PO level and borderline and depressive symptoms is mediated by rumination, while in the second study we also tested whether this association is stronger in case of brooding than reflective pondering, all of which hypotheses gained support. Our results are consistent with previous empirical studies that investigated the relationship between rumination and borderline symptoms among university students (Meaney et al., 2016) and non-clinical adults (Selby et al., 2008), as well as between rumination and depression among young adults (Slavish & Graham-Engeland, 2015; Topper et al., 2017). However, to our knowledge our study is the first to link these associations to the level of personality organization. Our results indicate that a less structured personality, namely the use of primitive defense mechanisms and identity diffusion may be associated with higher proneness to rumination, especially brooding. This implies that the intense unprocessed negative affect and the emotion dysregulation attributed to lower personality organization (Levy, Clarkin, et al., 2006) may trigger maladaptive emotion regulation strategies such as rumination (Carpenter & Trull, 2013; Selby et al., 2009), that in return may aggravate psychological symptoms.

It is important to note that our models revealed stronger associations between PO level and symptoms of BPD and depression, than between rumination and these symptoms. Although rumination has been identified as a risk factor to depression (e.g. Nolen-Hoeksema, 1991; Smith et al., 2006) and BPD (e.g. Martino et al., 2015; Selby et al., 2009), it is improbable that rumination alone would explain the emergence of borderline or depressive symptoms (i.e. equifinality). At the same time, rumination appears to be a transdiagnostic risk factor to psychopathology (Nolen-Hoeksema & Watkins, 2011), thus it may lead to various other psychological disorders in the presence of other protective and/or risk factors that were not examined here (i.e. multifinality). Therefore, our results indicate that rumination (especially brooding) is one factor that may mediate the relationship between PO level and disorder-specific symptoms, but other determinants should also be considered. This is also reflected in the effect sizes of the mediation paths (i.e., the standardized indirect effect and the proportion mediated), that indicated small to negligible effect sizes. The effects were the lowest in terms of reflective pondering, as hypothesized. However, in order to calculate the proportion mediated, having a sample size above 500 is desirable (MacKinnon et al., 1995), thus it should be interpreted cautiously.

Our results suggest that lower personality organization and the emergence of disorder-specific symptoms can be linked with brooding and reflective pondering on different levels, indicating that specifying the relationship between personality functioning and other subtypes of rumination are worthy of further investigation. Anger and shame are two outstanding negative emotions in BPD, and empirical studies demonstrate that anger rumination triggered by the feeling of shame may substantially contribute to the emergence of BPD symptoms (Peters et al., 2014). Thus, we expect robust associations between anger rumination and PO level, a hypothesis that should be tested empirically in future studies. Furthermore, in this research we only addressed the mediating role of rumination, however, a less structured personality can probably be associated with other maladaptive emotion regulation strategies as well, such as expressive suppression (Richmond et al., 2017), thought suppression or experiential avoidance (Carpenter & Trull, 2013). Moreover, in line with the Emotional Cascade Model (Selby et al., 2009), future studies could also address whether low PO level and rumination is associated with important behavioral outcomes of BPD and comorbid depression, e.g. self-injury or substance abuse (Levy & Johnson, 2016).

Our results provide important insights regarding the development of BPD and comorbid depressive symptoms, as they suggest that rumination may mediate the path during which unstable representations of self, others and related affects, the use of immature defense

mechanism and compromised social reality testing lead to the manifestation of borderline symptoms and depressed mood. However, one may argue that ruminating about the negative affect states experienced widely in both BPD and depression may be a symptom of, and not a risk factor to these disorders. Our study design does not enable us to determine temporal precedence and infer causal relationships, as cross-sectional data is correlational in its nature. However, the systematic, strictly theorized work of Susan Nolen-Hoeksema involving longitudinal studies provide support for our model, where rumination is rather the antecedent than the consequence of negative affect (for a review see Lyubomirsky et al., 2015). Concurrently, experiencing negative affective states that are core features of both BPD and depression may also foster maladaptive emotion regulation responses such as rumination, resulting in a vicious circle (e.g., Selby et al., 2009).

Strengths of this research include a transdiagnostic and transtheoretical approach to conceptualization, the use of two samples to replicate and extend findings, and study of an important topic, rumination, that is increasingly the target of a range of interventions. However, it has a number of limitations that need to be acknowledged. We recruited non-clinical participants with convenience sampling method, which inevitably leads to selection bias. We only applied self-report measures that may lead to Common Method Variance (CMV). CMV is the bias introduced by the fact that both the predictor and the outcome were estimated by relying solely on the participants' introspection, as one may overestimate or underestimate their own psychological problems, leading to false positive or false negative correlations (Tehseen et al., 2017). Furthermore, unlike in previous research, we did not find any significant difference between men and women on the mean scores of the assessed measures in either of the studies, which may be due to the uneven gender distribution of our samples. Both samples are highly educated and does not represent the general population. Moreover, previous research shows that non-clinical samples mainly cover the neurotic and high-functioning borderline range of PO (Ellison & Levy, 2012; Lenzenweger et al., 2001), whereas a sample of BPD patients would represent the low-functioning borderline and sometimes the psychotic domain (Lenzenweger et al., 2012). It is important to note that in Study 1 only 14 participants (7.8%), in Study 2 only 12 participants (4.6%) had a mean score of 1.5 or above on the BSL-23, indicating that the presence of subclinical BPD symptoms was scarce, especially in the second sample (Meaney et al., 2016). Regarding depressive symptoms, 31.84% of the sample in Study 1 (n=57), whereas 19.54% of the sample in Study 2 (n=51) scored 20 or above on the CES-D, which may indicate that they are at risk for clinical depression (Vilagut et al., 2016). Compared to other studies recruiting university students, depressive symptoms in Study1 were moderately higher (Jiang

et al., 2019; Slavish & Graham-Engeland, 2015), whereas the incidence of BPD symptoms was similar (Lu et al., 2018) or lower (Meaney et al., 2016). This conveys that the results of our studies should be replicated either on enriched non-clinical samples overrecruited for these symptoms (especially for BPD features), or on clinical samples in order to cover a broader PO spectrum which would help to understand generalizability.

Furthermore, there are a few methodological considerations regarding our mediation models. We focused on the mediation model rather than the thorough psychometric evaluation of the applied scales, as drawing firm psychometric conclusions is beyond the scope of this paper, and our sample size would not enable us to do. Thus, we relied on the results of prior research regarding the psychometric evaluation of the applied scales. Another important issue is multicollinearity, however, in our model it was only present among the outcome measures, which is less problematic than at the level of the predictors (Kelava et al., 2008). In order to justify that, we combined the two outcome measures as a single latent variable, which caused marginal change in the models. These alternative models are available as Supplementary Material. BPD features are often comorbid with depression (American Psychiatric Association, 2013), however, most clinical psychologists and psychopathologists consider them two discernible constructs, thus they are typically not merged in either theoretical or clinical discussions. One may argue that merging them would make it difficult to determine whether the effects described in these analyses are rather accounted for depressive symptoms or BPD features. Nonetheless, the fact that merging the two outcomes caused little change demonstrates that the models presented in the Results section are methodologically acceptable and based on the above mentioned theoretical and clinical considerations, we preferred them against the models with a single latent outcome.

Our results may also raise important questions regarding psychotherapeutic interventions: we assume that treatment modalities that are aiming to contribute to a more integrated personality functioning may also be effective in reducing ruminative thoughts, as higher functioning may be accompanied by less emotion dysregulation (Levy, Clarkin, et al., 2006), which may alleviate symptoms. However, before drawing such conclusions, further research is needed to replicate our findings on clinical samples, relying on measures other than self-report (e.g. structured clinical interviews), and ideally within a longitudinal framework to infer causality, for example by testing the level of PO and rumination before and after a certain psychotherapeutic intervention.

### 4.5. Conclusions

In line with other studies (e.g. Dickson et al., 2019; Rivière & Douilliez, 2017), our results indicate that rumination is a transdiagnostic mediator that may bridge certain personality features with the occurrence of clinical symptoms. This implies that when low personality functioning is accompanied by rumination, this maladaptive emotion regulation strategy may exacerbate symptoms of BPD and depression. Personality functioning - such as the representations of self and significant others, affective lability, or the use of primitive defense mechanisms - and rumination appear to be clinically relevant regarding the prevention and treatment of BPD and depression, thus they merit further investigation. Therefore, the relationship between personality structure deficits, maladaptive emotion regulation strategies and symptoms of BPD and depression should be explored to better understand their role in the emergence of psychological disorders.

## 5. PERCEIVED STRESS IN THE TIME OF COVID-19: THE ASSOCIATION WITH BROODING AND COVID-RELATED RUMINATION IN ADULTS WITH AND WITHOUT MIGRAINE (STUDY 4)[4]


### Abstract

**Background:** The main goal of this research was to explore whether migraineurs had a higher level of perceived stress than healthy controls during the times of the coronavirus and related restrictive measures, and to examine the relationship between different subtypes of rumination and perceived stress in these groups. We measured two facets of depressive rumination, brooding and reflection, along with rumination about the current COVID-19 situation to see whether these different subtypes of rumination explained perceived stress among migraineurs and healthy controls.

**Methods:** Healthy adults (n=64) and migraine patients (n=73) filled out self-report questionnaires online. A multiple linear regression model was used to test whether depressive rumination (i.e. brooding and reflection) and COVID-related rumination explained perceived stress among adults with and without migraine during the times of COVID-19, after controlling for gender, age, migraine/control group status and migraine disability.

**Results:** Although we did not find any difference in the level of perceived stress among migraineurs and the control group, perceived stress was more strongly associated with brooding as well as COVID-related rumination among migraineurs than healthy controls. COVID-related rumination and brooding (but not reflection) explained the level of perceived stress after controlling for gender, age, migraine/control group status and migraine disability.

**Conclusions:** The similar degree of perceived stress among migraineurs and the control group may imply that there is great variation in the personal experience of people regarding the pandemic, that may be determined by numerous other factors. Our results demonstrate that ruminating about the pandemic and related difficulties, as well as brooding (but not reflection) appear to be associated with higher level of perceived stress during the times of the coronavirus. This association was slightly stronger among migraineurs, hinting at the increased vulnerability of this patient group in stressful situations like the COVID-19 pandemic. Our results also


[4] Kovács, L. N., Baksa, D., Dobos, D., Eszlári, N., Gecse, K., Kocsel, N., Juhász, G., & Kökönyei, G. (2021). Perceived stress in the time of COVID-19: The association with brooding and COVID-related rumination in adults with and without migraine. *BMC Psychology, 9*(1), 68. https://doi.org/10.1186/s40359-021-00549-y

suggest that ruminating about the pandemic and its consequences is weakly associated with trait-level depressive rumination, thus may be more contingent on specific factors.

*Keywords:* COVID-19, perceived stress, migraine, depressive rumination, rumination, brooding, COVID-related rumination

## 5.1. Introduction

Besides directly threatening people's health, the COVID-19 pandemic has severe consequences for everyday life via bringing about financial insecurity, social distancing and restrictive measures (Xiang et al., 2020). Thus, the situation since March 2020 until now can be considered a severe stressor affecting most of the population. COVID-19 and related restrictions may cause significant changes in people's psychological symptoms (Rodríguez-Rey et al., 2020; C. Wang et al., 2020), provoking a secondary mental health crisis (Gruber et al., 2020).

Stress has long been a significant concept of study in health science since has been vastly associated with different health outcomes (S. Cohen et al., 2007), however, there is great variability in its definition (Kopp et al., 2010). In stress-related research, stress can be broadly conceptualized in three different ways. The environmental approach focuses primarily on the outer stressor, the psychological approach targets the person's subjective evaluation of a stressful situation and their psychological response to it, while the biological approach mainly investigates the physiological responses given to a stressor (E.-H. Lee, 2012). In the current study we aimed to conceptualize stress according to the psychological approach, i.e. we were investigating to what extent people consider their life conditions frustrating or overwhelming (S. Cohen et al., 1983), as this is a crucial aspect of withstanding the challenges provoked by COVID-19 (Kar et al., 2020). Within this approach, our conceptualization is in accordance with Lazarus and Folkman's definition of stress as the product of the discrepancy between perceived external challenges and the individual's subjective intra- and interpersonal capacity to live up to those challenges (Lazarus & Folkman, 1984).

Empirical evidence from stress-related research underlines that the cognitive-emotional response given to stressful situations may play a more important part in adaptation than the stressor itself (Del Giudice et al., 2011b; Ellenbogen et al., 2006). Rumination, i.e. the continuous unproductive dwelling on a negative event (Nolen-Hoeksema, 1991) can be considered as a maladaptive stress response, as it may exacerbate the importance of the perceived stressor and may lead to serious negative psychological (Aldao et al., 2010) and physiological (Ottaviani et al., 2016) outcomes. By mentally representing a stressor that may not actually be present or by elevating its perceived importance, rumination can trigger a fight-or-flight stress response with physiological consequences, such as elevated heart rate and cortisol level (Gerin et al., 2012). By constantly recalling the stressor even without its presence, it may prolong stress exposure and negatively impact mental and physical well-being (Ottaviani

et al., 2016). Although people generally think that constantly dwelling on stressful situations facilitates problem solving and choose this coping strategy on purpose, research suggests that it is hardly productive, and should rather be considered a maladaptive reaction to stress (Aldao et al., 2010). Therefore, exploring rumination in difficult, stress-provoking times like the COVID-19 pandemic is of utmost importance to understand stress response and psychological well-being.

Rumination can be categorized in various subtypes based on the content of ruminative thinking. According to its most widespread conceptualization, the Response Styles Theory, rumination can be described as recurrently thinking about the concomitants of one's own negative mood and depressive symptoms, i.e. depressive rumination (Nolen-Hoeksema, 1991). Depressive rumination can be categorized as brooding and reflection, where brooding is considered a maladaptive, self-criticizing aspect of recurrent thinking about emotionally relevant life events, while reflection is a more constructive thinking style that may foster problem solving (Joormann et al., 2006). Brooding has been repeatedly associated with depressive symptoms (Kovács, Schmelowszky, et al., 2021; Schoofs et al., 2010), anxiety (Olatunji et al., 2013) and prolonged stress reaction (Gerin et al., 2012). Additionally, the current situation can be considered a serious stressor that may evoke ruminative thoughts regarding the pandemic and its possible consequences such as people's health, occupation, personal relationships etc. (Ye, Wu, et al., 2020). In support, recent findings suggest that COVID-related ruminative thoughts may elevate the perceived importance of the stressor and enhance perceived stress, similarly to depressive rumination (Swainston et al., 2020). Trait-level depressive rumination has been associated with elevated stress-related physical, behavioral and psychological symptoms in the presence of COVID-related stressors (Ye, Wu, et al., 2020), while COVID-specific rumination was found to be associated with distress, fatigue and depressive symptoms (Ye, Zhou, et al., 2020). However, the relationship between different subtypes of rumination and their specific contributions to perceived stress have not been reported elsewhere. Thus, investigating the associations between psychological distress and both depressive and COVID-related rumination is important, and may be especially relevant among patients with diseases related to stress (Borsook et al., 2012) and rumination (Kokonyei et al., 2016), such as migraine. Psychological stress, i.e. the perceived disparity between demands and one's own capacities (Lazarus & Folkman, 1984), has been robustly reported as the most frequent factor to provoke migraine attacks (P. R. Martin, 2016; Santos et al., 2014; Sauro & Becker, 2009), as well as to prolong their duration (Wacogne et al., 2003). Migraine is a common and debilitating headache disorder affecting more than one billion people

worldwide (Stovner et al., 2018). However, there are still many uncertainties about the exact causes for the activation of attacks, as it probably comprises a complex interplay of genetic and environmental factors (Chasman et al., 2016; Juhasz et al., 2017). As a painful disease, migraine attenuates the quality of life (Lipton et al., 2000) and has been associated with elevated levels of anxiety and depressed mood (Peres et al., 2017), that are well-known concomitants of rumination (Michl et al., 2013). A recent fMRI study found elevated brain activation to faces expressing fear among migraine patients compared to healthy controls (HCs) in areas associated with the attentional network, suggesting that these patients may be more vigilant to potentially threatening stimuli (Szabó et al., 2019). Hypersensitivity to potentially threatening stimuli and ruminating in response to negative events - frequently observed among migraine patients (Shabani & Ghari Saadati, 2019) - may elevate the perceived importance of the stressor and hamper adaptation (Michl et al., 2013; O'Donovan et al., 2013). Correspondingly, a study found that migraine patients reported more rumination and higher levels of anxiety and depressed mood than HCs, and the connection between migraine and symptoms of anxiety and depression was mediated by brooding in two independent European samples (Kokonyei et al., 2016). Thus, it appears that personal characteristics in emotion regulation strategies such as rumination may also contribute to the level of psychological well-being of migraine patients (Kokonyei et al., 2016). In addition, anticipating and experiencing a migraine attack is a great source of stress itself, resulting in a negative spiral (Sauro & Becker, 2009). Taken together, patients with migraine may be more prone to magnify stressful events due to their hypersensitivity to threatening stimuli and their elevated tendency to ruminate compared to HCs, further elevating their level of perceived stress. Therefore, this group may be especially vulnerable to develop stress-related symptoms during the current situation caused by the COVID-19 pandemic and related restrictive measures.

In the current study we aimed to explore whether the level of perceived stress was higher among migraineurs than HCs, and whether migraine status and rumination predicted elevated perceived stress, after controlling for gender, age, and disability caused by headache. We aimed to distinguish rumination about COVID-19 from depressive rumination, as the former may be an acute, specific response to the current situation that probably characterizes most of the population nowadays (Arslan et al., 2020), whereas the latter is considered a more stable personality trait that is not distinctive to the current situation (although may be enhanced by it). To date, the association between COVID-related rumination and depressive rumination - i.e. whether people who tend to dwell on their depressed mood may or may not engage in rumination specific to COVID-19 – has not been reported, thus we also aimed to explore their

relationship in this study. Additionally, as brooding is considered a maladaptive aspect of rumination, whereas reflection may be more constructive (Joormann et al., 2006), we expected brooding to show a stronger relationship with perceived stress than reflection. Furthermore, we assumed that perceived stress will be the highest among migraineurs who display high levels of rumination. In other words, we expected an interaction between migraine status and brooding - the maladaptive facet of depressive rumination – in predicting the perceived level of stress. In the same vein, we also aimed to explore whether there was an interaction between migraine status and COVID-related rumination, which, according to our knowledge, has not been studied elsewhere.

## 5.2. Methods

### *5.2.1. Sample and Procedure*

Data analyzed in the current study was collected in May-June 2020. We contacted 311 people who had participated in previous studies between 2014-2019 and agreed to be approached for future research. Inclusion criteria for these previous studies included aged between 18 and 50 years, and no history of severe somatic, neurological or psychological problems – except migraine - or psychotropic medication. In order to verify these criteria, potential subjects first had to undergo an interview where a trained research assistant administered the Mini International Neuropsychiatric Interview (Sheehan et al., 1998) to screen for potential psychiatric disorders and explored the medical history of the participant. If found eligible (for these previous studies), participants had to attend a medical examination by a headache specialist, who established the diagnosis of episodic migraine without aura based on the International Classification of Headache Disorders-III criteria (ICHD-III, beta version; Headache Classification Committee of the International Headache Society (IHS, 2013).

Power analysis for the current study was conducted using G*Power software (Erdfelder et al., 1996). An estimated minimum sample size in a linear regression containing eight predictors, with an expected medium effect size of 0.15 (J. Cohen, 1988) necessary to gain 0.80 power was 109. We sent the link of the study to 311 potential respondents in e-mail. Participation was anonymous and voluntary, informed consent was acquired. 73 patients with episodic migraine without aura and 64 HCs filled out the questionnaires. Four people reported that they have been in quarantine designated by the epidemiological authority, and only one participant reported to have been tested positive to COVID-19. We considered these factors as high-level stressors that may influence the perceived level of stress and rumination regarding

COVID-19 substantially, thus we excluded the affected participants from the analyses. No participants reported to have lost a relative or close acquaintance due to COVID-19 (otherwise, they would have been excluded for the same reason). The final sample comprised of 132 participants. The sample was predominantly female (73.5%; n= 97), and highly educated: 21.2% had a high school diploma, 74.8% had a university degree. The minimum age was 20, the maximum 50 years (M= 30.76; SD= 7.10). The original study, as well as the current data acquisition was approved by the Scientific and Research Ethics Committee of the Medical Research Council (Hungary) and is in accordance with the Declaration of Helsinki.

### *5.2.2. Measures*

**Demographic data** (gender, age, education), and potential confounding factors related to the pandemic were assessed. We asked participants whether they had been obliged to stay in quarantine by the epidemiological authority or chose to stay in quarantine voluntarily since the outburst of the COVID-19 in Hungary (March, 2020), whether they or their close family members tested positive to COVID-19, and whether they lost a relative or close acquaintance due to COVID-19.

The 10-item **Ruminative Response Scale** (RRS; (Treynor et al., 2003) was used to measure depressive rumination, where respondents are instructed to evaluate their repetitive thinking style when feeling sad or depressed. The RRS contains two subscales, brooding and reflection, each measured by 5 items rated on a four-point Likert scale from 1 (never) to 4 (always). Brooding is considered a maladaptive, often self-blaming aspect of repetitive thinking about stressful life event. Reflection, on the other hand, is a more constructive way of rumination that may facilitate problem solving (Joormann et al., 2006). The brooding and reflection subscales of the Hungarian RRS have shown good internal consistency in a previous study (Cronbach $\alpha$= 0.71 and Cronbach $\alpha$= 0.73, respectively) (Kokonyei et al., 2016), as well as in the current sample (Cronbach $\alpha$= 0.71 for brooding and Cronbach $\alpha$= 0.70 for reflection).

The four-item **Perceived Stress Scale** (PSS-4; (S. Cohen et al., 1983) was used to measure how participants appraised their own levels of stress in their lives during the past 3 months. We defined this time period because it corresponded to the appearance of the COVID-19 pandemic in Hungary, hence it covered a potentially stressful period for most people due to the threat of the virus, restrictive measures and social distancing. Items are rated on a five-point Likert scale ranging from 0 to 4, two of which are positively stated and reversed. The PSS-4 have demonstrated good psychometric properties in various studies (Vallejo et al., 2018; Warttig et al., 2013). The Hungarian PSS-4 demonstrated good internal consistency in a

previous study (Cronbach α= 0.79) (Stauder & Thege, 2006), as well as in this sample (Cronbach α= 0.85).

**COVID-related Rumination Scale** (CRS) consisted of four items retrieved from the Post-event processing questionnaire (PEPQ; (Rachman et al., 2000) that measures repetitive thoughts after a stressful social situation. The instruction and the wording of the items were tailored in order to focus on the content of repetitive thinking regarding COVID-19. Participants were instructed to think about the current COVID-19 situation and related events (e.g. reports on new cases and mortality) and restrictive measures and indicate to what extent have they experienced these processes. Modifications and translation to Hungarian were carried out by Gy.K., N.K. & L.N.K. We aimed to capture the intrusive nature of repetitive thoughts *(1. My memories and thoughts about the event keep coming into my head even when I do not wish to think about it; 2. Thoughts about the event interfere with my concentration.)* and the amplification of the perceived stressor *(3. When I think about coronavirus over and over again, my feelings about the event get stronger/more negative.).* In addition, Item 7 of the PEPQ (Did you try to resist thinking about the event?) was altered more exhaustively, as the verb 'resist' already implies repetitive recurrent thoughts about the event - besides the difficulty to stop these thoughts - which may not apply to everyone. Thus, we aimed to separate these two assumptions by rephrasing it as "*4. If I start thinking about these things, I find it difficult to stop.*" to capture the difficulty to control repetitive thoughts. Cronbach α of the CRS was 0.84 in the current sample.

The Migraine Disability Assessment (MIDAS; (Stewart et al., 2000) questionnaire was used to measure the burden caused by headache. As migraine attacks and everyday activities missed due to headache are great sources of stress by themselves, we aimed to control for the number of days with debilitating headache in the regression model. Scores of the first five items of the scale was summed for each participant to capture headache-related disability (e.g. missed days and/or reduced productivity in work/school, household and social activity due to headache) in the last three months. Because of the COVID-19 situation, an additional instruction was added to the first item assessing missed work/school days: "*If you are at home because of the pandemic, how many days did you skip work or school due to headache in the past 3 months?*". Similarly, the fifth item (missed days in family, social and leisure activity) was completed with the following sentence: "*If you are at home because of the pandemic, also count online or home family, social or leisure activities.*" We assessed the MIDAS among HCs as well and asked them to answer these questions regarding their headaches in general (if they had any).

### *5.2.3. Statistical analyses*

Statistical analyses were performed with IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, N.Y., USA). Descriptive statistical analyses and reliability testing of the assessed measures were carried out first. We tested whether there was significant difference in gender and age between the migraine and the HC group. In order to address the effects of potential confounding factors, possible significant differences in the level of perceived stress were examined between those who stayed in quarantine voluntarily and those who did not; and also between participants who had a family member (or members) infected with COVID-19 and those who did not have such relatives.

Correlations of the assessed scales were calculated for the total sample and for the migraine and HC groups separately. Furthermore, we estimated whether the difference in the correlational coefficients between the two groups was significant as suggested by Eid et al. (Eid et al., 2015). Then, we conducted a multiple linear regression on the obtained data to test whether depressive rumination – especially brooding – and rumination specific to COVID-19 (measured by the CRS) explained perceived stress during the times of the coronavirus, after controlling for gender, age, headache status (i.e. migraine/HC group), disability due to headache (i.e. the MIDAS score). We entered our variables to the model in three blocks starting with gender, age, headache status and disability due to headache, followed by the CRS in the second step, and the brooding and reflection subscales of the RRS in the third step. In the fourth step, we also aimed to test whether there was an interaction between brooding and headache status regarding perceived stress, for which we centered the brooding variable. We performed post-hoc tests to check for model assumptions, i.e. homoscedasticity, multicollinearity and the normal distribution of residuals.

## 5.3. Results

Descriptive statistics of age and the assessed measures are shown in Table 5.1 for the total sample, as well as for the migraine and the control group separately. Participants in the migraine group were slightly older and – as expected - showed higher level of migraine-related disability than HCs, but no other significant differences were found between the two groups in brooding, reflection, COVID-related rumination and perceived stress. We performed Mann-Whitney U tests due to the non-normality of the variables. Besides age, gender distribution ($\chi^2$=14.27, p<0.001) of the participants showed significant difference between the two groups: there were 9 males and 61 females in the migraine group, whereas there were 26 males and 36 females in

the HC group. This is not surprising given that migraine is much more common among women (Cutrer & Huerter, 2007). Thus, we controlled for gender and age in the regression model.

*Table 5.1. Descriptive statistics of age, assessed measures, and group differences between participants with and without migraine.*

| Scales | Total sample Mean (SD) n=132 | Migraine group Mean (SD) n=70 | HC group Mean (SD) n=62 | Mann-Whitney U | p |
|---|---|---|---|---|---|
| **age** | 30.76 (7.10) | 31.86 (7.28) | 29.48 (6.73) | 2597 | .05 |
| **MIDAS** | 5.81 (9.18) | 9.91 (10.70) | 1.18 (3.23) | 3803 | <.001 |
| **RRS brooding** | 10.13 (2.90) | 10.33 (2.99) | 9.90 (2.81) | 2274 | .53 |
| **RRS reflection** | 11.79 (2.93) | 11.78 (3.08) | 11.81 (2.77) | 2118 | .92 |
| **CRS** | 6.20 (2.71) | 6.56 (3.01) | 5.81 (2.28) | 2402 | .28 |
| **PSS-4** | 5.64 (2.99) | 5.84 (3.08) | 5.41 (2.90) | 2350 | .41 |

*Note. MIDAS = Migraine Disability Assessment, RRS = Ruminative Response Scale, CRS = COVID-related Rumination Scale, PSS-4 = Perceived Stress Scale, SD = standard deviation.*

We estimated the effect of potential confounding factors, i.e. stayed in voluntary quarantine (n=47) or not (n=85), family member infected with COVID-19 (n=11) or not (n=121) by examining group differences regarding perceived stress with Mann-Whitney U tests. None of these group differences were significant (Mann-Whitney U=1897, p=.632; Mann-Whitney U=650, p=.898, respectively), thus we did not include them in the regression model as control variables.

We performed Spearman correlations of the assessed measures for the total sample and for the migraine and HC group separately. Non-parametric correlations were applied due to the non-normality of the variables. The results are summarized in Table 5.2.

*Table 5.2. Spearman correlations of the assessed measures for the total sample and for the migraine and control group separately.*

| | Total sample n=132 | | | | Migraine group n=70 | | | | Control group n=62 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RRS r. | CRS | PSS | MIDAS | RRS r. | CRS | PSS | MIDAS | RRS r. | CRS | PSS | MIDAS |
| RRS b. | .27** | .24** | .49** | -.04 | .28* | .30* | .58** | -.14 | .27* | .13 | .41** | -.24 |
| RRS r. | | -.01 | .08 | .05 | | -.07 | .05 | .04 | | .06 | .12 | .02 |
| CRS | | | .32** | .06 | | | .44** | .03 | | | .12 | -.23 |
| PSS | | | | .13 | | | | -.02 | | | | .21 |

*Note. *p<0.05; **p<0.01. RRS b. = Ruminative Response Scale brooding subscale, RRS r. = Ruminative Response Scale reflection subscale, CRS = COVID-related Rumination Scale, PSS = Perceived Stress Scale, MIDAS = Migraine Disability Assessment.*

As Table 5.2 demonstrates, brooding, COVID-related rumination and perceived stress were significantly correlated in the total sample. However, when examined separately, COVID-related rumination correlated with perceived stress and brooding only in the migraine group. Where correlation coefficients differed substantially between the two groups, we calculated whether these differences were significant following the method suggested by Eid et al. (Eid et al., 2015). We found a tendency-level difference in the correlation coefficients in case of brooding and perceived stress (Z=1.27, p=.10), and significant difference in case of COVID-related rumination and perceived stress (Z=1.97, p=.02), . , where the association was stronger in the migraine group ($r = .44$, $p < .01$) than among HCs ($r = .12$, $p = .37$). Since this difference may indicate that the association between COVID-related rumination and perceived stress is stronger among migraineurs than HCs, we also tested whether there is an interaction between migraine status and COVID-specific rumination in the regression model. We consider this an explorative step based on the group differences that emerged from the correlational analyses, as the available data in this subject is still scarce. Multiple linear regression was used to test whether rumination specific to COVID-19 (as measured by the CRS) and depressive rumination (i.e., brooding and reflection, as measured by the corresponding subscales of the RRS) explained perceived stress (as measured by the PSS) during the times of the coronavirus, after controlling for gender, age, headache status (i.e. migraine/HC group) and disability caused by headache (as measured by the MIDAS). We entered our variables to the model stepwise starting with gender, age, migraine/HC group status and the MIDAS score, followed by the CRS in the second, the brooding and reflection scales in the third step, and the interaction terms of brooding-headache status and COVID-related rumination-headache status in the fourth step. CRS and brooding were significant predictors of perceived stress, where more rumination predicted higher levels of perceived stress, after controlling for gender, age and headache status. We also aimed to test whether there was an interaction between brooding and headache status regarding perceived stress, however, we did not find significant interaction, and accordingly the change in $R^2$ was not significant. The total explained variance of the regression model was 31.3% ($R^2$=.313; $df$=130). Then, we included the interaction between COVID-related rumination and headache status in our model instead, however, this interaction was not significant either ($\beta = .052$; $p = .693$), and only resulted in marginal change ($F(1, 122) = .16$, $p = .69$) in the total explained variance ($R^2 = .308$; $df = 130$). Model assumptions, i.e. the normal distribution of the standardized residual, homoscedasticity and multicollinearity were fulfilled. The model is presented in Table 5.3.

*Table 5.3. Multiple linear regression model with subtypes of rumination explaining perceived stress, after controlling for gender, age, headache status and headache disability.*

| Model | Predictors | β | *p* | $R^2$ |
|---|---|---|---|---|
| 1 | Gender | -.029 | .762 | |
| | Age | -.067 | .458 | |
| | Migraine/HC | -.080 | .459 | |
| | MIDAS | .034 | .737 | .012 |
| 2 | Gender | -.091 | .315 | |
| | Age | -.036 | .668 | |
| | Migraine/HC | -0.45 | .656 | |
| | MIDAS | .032 | .734 | |
| | CRS | .364 | <.001 | .138 |
| 3 | Gender | -.049 | .548 | |
| | Age | .004 | .957 | |
| | Migraine/HC | .034 | .711 | |
| | MIDAS | .117 | .182 | |
| | CRS | .260 | .001 | |
| | RRS brooding | .448 | <.001 | |
| | RRS reflection | -.050 | .536 | .308 |
| 4 | Gender | -.039 | .644 | |
| | Age | .009 | .909 | |
| | Migraine/HC | .042 | .650 | |
| | MIDAS | .125 | .155 | |
| | CRS | .255 | .002 | |

| | | | |
|---|---|---|---|
| RRS brooding | .373 | .002 | |
| RRS reflection | -.053 | .512 | |
| RRS brooding * Migraine/HC | .105 | .365 | .313 |

*Note. n=132. RRS = Ruminative Response Scale, CRS = COVID-related Rumination Scale, PSS = Perceived Stress Scale, MIDAS = Migraine Disability Assessment.*

### 5.4. Discussion

Ruminating on current problems and adverse events may be a risk factor for the onset and exacerbation of various psychiatric and somatic symptoms (Aldao et al., 2010; Ottaviani et al., 2016), therefore exploring repetitive negative thinking styles is particularly important in the current situation among the whole population, as well as in vulnerable subgroups such as migraine patients, who may be especially sensitive to stressful life events (Borsook et al., 2012). At present, not much data is available about the effect of COVID-19 on migraineurs' well-being, and the available information is ambiguous. According to our knowledge, this is the first study that examines the associations between perceived stress and rumination during the COVID-19 pandemic among migraineurs. In the current study, we found no difference between migraineurs and the control group in the degree of perceived stress, brooding, or COVID-related rumination. Perceived stress was correlated more strongly with brooding as well as COVID-related rumination among migraine patients than HCs. The level of perceived stress was explained by both rumination subtypes, COVID-related rumination and brooding, but not reflection, after controlling for gender, age, migraine/control group status and migraine impairment.

Owing to their hypersensitivity to threatening stimuli and their increased propensity to ruminate relative to HCs, migraine patients may be more vulnerable to amplifying stressful experience, further increasing their level of perceived stress. This group may therefore be particularly vulnerable to the development of stress-related symptoms during the current situation triggered by the COVID-19 pandemic. Therefore, we explored whether the level of perceived stress was higher among migraine patients and HCs, however, we did not find significant difference in the level of perceived stress among the two groups. Also, despite stress being the primary trigger of migraine attacks and the attacks themselves being significant stressors (Vallejo et al., 2018), perceived stress did not show any association with migraine-related disability in our sample. One possible explanation is that many migraineurs experience

more frequent migraine attacks not during the times of heightened level of stress, but when stress decreases (Satici et al., 2020). Furthermore, some clinicians report that migraine patients seek treatment more frequently since the beginning of the pandemic (Chowdhury & Datta, 2020) and that the majority of patients report more frequent and more severe attacks (Al-Hashel & Ismail, 2020), while others observed a decrease in migraine attack frequency during this period (Parodi et al., 2020). A novel study showed a decrease in migraine frequency as the number of days spent home increased during COVID-19 (Delussi et al., 2020), suggesting that the relieve of staying at home may exceed the stress and anxiety related to the pandemic for some people, and underlying the substantial interindividual differences in the subjective experience of the pandemic and related restrictions. Moreover, our participants suffered from episodic migraine, and a recent study has shown that after controlling for education, depression and anxiety, perceived stress was higher among patients with chronic migraine, but not among patients with episodic migraine compared to HCs (Zhou et al., 2020).

Migraineurs and HCs did not differ in the level of brooding, reflection, COVID-related rumination and perceived stress either, however, we found certain differences regarding the association of these measures within the two groups. Brooding was associated with perceived stress in both groups; however, a stronger correlation was found among migraineurs demonstrating a tendency-level difference between the two groups. Furthermore, COVID-related rumination and brooding were uncorrelated among HCs and only showed moderate association in the migraine group, indicating that people may find themselves dwelling on the pandemic and its concomitants regardless of their general tendency of brooding. It appears more plausible that COVID-related ruminative thoughts are triggered by specific problems, such as losing one's job, financial difficulties, social isolation, difficulties related to homeschooling, worrying about one's own health or the health of elderly relatives etc., and may be less contingent on one's general tendency to dwell on negative events.

We also investigated whether migraine status and higher depressive rumination – especially its maladaptive form, brooding - explained elevated perceived stress, after controlling for potential confounds, namely gender, age, headache status and migraine disability. Also, we considered it important to examine the relationship between COVID-related rumination and perceived stress, as the whole population of the world is exposed to the pandemic as a constant stressor and faces its consequences in everyday life, and rumination may enhance the perceived threat of these difficult times (Satici et al., 2020). Our results revealed that both COVID-related rumination and brooding were significant predictors of perceived stress in the total sample, and brooding significantly contributed to the explained

variance of perceived stress after controlling for COVID-related rumination, implying that this self-focused, self-blaming subtype of ruminative thinking may be an important risk factor in the current situation, and not only among migraineurs. However, we could not find an interaction neither between headache status and brooding, nor between headache status and COVID-related rumination. Taken together, although neither groups were characterized by more rumination or higher levels of stress, the differences in the correlations indicate that rumination, especially about COVID-19, may be more strongly associated with perceived stress among migraineurs than HCs. This result may hint at the vulnerability of this group to stressful situations like the current coronavirus pandemic. However, we need to interpret these results carefully, as it is only supported by the correlational analysis, while we did not find significant interaction neither between brooding and headache status, nor between COVID-related rumination and headache status in the regression model.

Our study has certain limitations. Most importantly, our cross-sectional study design does not allow us to infer causation, and it is important to keep in mind that the relationship between stress, rumination and somatic symptoms should be considered multidirectional and multifactorial (Sauro & Becker, 2009). Although the a priori power analysis indicated that our sample size is sufficient for this type of analysis, the relatively small sample size of the study may be another limitation. For instance, the significant difference in the correlation of COVID-related rumination and perceived stress between the two groups implies a stronger relationship between these variables in the migraine group, however, no significant interaction was found between headache status and COVID-related rumination. This may be due to the small number of participants per group, therefore further studies are needed to explore these associations on bigger samples. Furthermore, our participants were maximum 50 years old, and the mean age of our sample was 30.76 years, whereas COVID-19 and related difficulties may be more burdensome for the elderly due to their higher risk of mortality and developing severe symptoms (Banerjee, 2020; Fontes et al., 2020). However, other results suggest that younger age was associated with more worries about the challenges posited by COVID-19, whereas older age was associated with better emotional adaptation and stress reactivity in the current situation (Klaiber et al., 2021). Similarly, only healthy adults without severe somatic, neurological or psychological problems were included, although people with such conditions may be more prone to experience severe stress in the current situation (Hao et al., 2020; Saqib et al., 2020). Although beyond the scope of this paper, examining the associations of perceived stress and rumination among at-risk groups would be crucial (for a review of at-risk groups, see Panchal et al., 2021). Other forms of repetitive thinking such as worry, anticipation and health

anxiety may also be relevant to the level of perceived stress and would be important to explore in the current situation.

### 5.5. Conclusions

We did not find any difference in the level of perceived stress among migraineurs and the control group, that may be explained by individual differences in the subjective experience of the COVID-19 situation; some people may feel more relaxed than usual by being able to stay at home, while others may experience more stress and anxiety due to the pandemic. In the complex interplay of stress and migraine, the reaction given to the stressor appears to be more relevant than the stressor itself, highlighting the need for protective factors. In line with this, our results showed that both COVID-related rumination and brooding were associated with higher levels of perceived stress, and these relationships appear to be slightly stronger among migraineurs – however, these can only be inferred from our correlational analyses and need to be interpreted cautiously. These results may imply the increased vulnerability of this patient group in stressful situations like the COVID-19 pandemic, however, the current situation has triggered a mental health crisis among the whole population (Gruber et al., 2020). This conveys that interventions aiming to reduce depressive and COVID-related rumination and enhance the use of more adaptive coping strategies (Zhou et al., 2020) may contribute to people's well-being, especially in case of vulnerable groups with stress-related disorders such as migraine patients. Psychoeducation on stress reduction could contribute to healthy adults' wellbeing, and may ease migraineurs' disease burden by reducing one of the most frequent migraine triggers (Lipton et al., 2014). For instance, implementing the daily use of electric diaries may help to control the level of perceived stress and related rumination. Interventions aiming to reduce stress and rumination, such as mindfulness-based stress reduction and autogenic training may also be effective (Seminowicz et al., 2020; Zsombok et al., 2003). Making telemedicine available for migraineurs could also contribute to reduce their level of stress by offering help safely (Friedman et al., 2019).

# 6. GENERAL DISCUSSION

There is an ongoing transition in the way we think about mental health, shifting from the dichotomist view of being sick versus being healthy to a dimensional perspective of mental strengths and weaknesses, giving rise to examining transdiagnostic factors that may underlie several diagnostic categories (Cuthbert, 2014). This paradigm shift is important in reducing the stigma around mental illness by openly accepting that most people experience psychological problems to some extent during their lives, rather than distinguishing the "mentally ill" from the "mentally healthy". In order to facilitate the transition towards an empirically tested diagnostic system with a dimensional approach, the National Institute of Mental Health (NIMH) initiated the Research Domain Criteria (RDoC) project that supports research related to transdiagnostic variables, providing data that enables the revision of the current diagnostic systems (Insel et al., 2010). Rumination, together with other emotion regulation strategies, has been identified as one such transdiagnostic factor that merits further investigation (Fernandez et al., 2016).

Throughout the studies presented in this dissertation, we examined rumination from different angles, focusing on certain aspects of this repetitive maladaptive emotion regulation strategy. Since we have already discussed the findings and limitations of these articles individually, here we focus on the main conclusions and their relevance in a broader perspective.

Rumination has been associated with a wide range of disorders beyond depression, i.e. anxiety (McLaughlin & Nolen-Hoeksema, 2011), eating disorders (S. B. Wang et al., 2017), post-traumatic stress disorder (Michael et al., 2007), as well as more general negative psychological outcomes, such as hampered interpersonal problem solving (Lyubomirsky & Nolen-Hoeksema, 1995), attention bias (Hur et al., 2019), impaired executive function (Y. Yang et al., 2017), or diminished social support (Nolen-Hoeksema et al., 2008), demonstrating its transdiagnostic nature. Furthermore, rumination about stressful past experiences negatively impacts physical well-being, mainly by magnifying and prolonging stress response and its physical concomitants (Robinson & Alloy, 2003).

There is theoretical and empirical support that rumination is rather the antecedent than the consequence of psychopathology. Nolen-Hoeksema and E.R. Watkins (2011) described distal and proximal risk factors to psychological problems, where distal risk factors appear early in the trajectory of illness (e.g., congenital biological factors, childhood neglect or trauma) and therefore have an indirect effect, meanwhile proximal risk factors (e.g., biologically defined

vulnerabilities, cognitive features or personality traits) are closer in time and directly influence symptom occurrence. Illness trajectories can further be influenced by moderators (e.g., environmental factors). The complex interplay of distal and proximal risk factors, together with moderators may define which psychological symptoms will or will not appear. Within this framework, rumination represents a proximal risk factor that precedes or coincides with the emergence of psychological problems, and could interfere with moderators (e.g., stressful environment). This model can capture how the same risk factors could lead to multiple disorders (multifinality), and how the same disorder can be the result of various pathways (equifinality), and therefore represents a paradigm shift in investigating the causes of mental health problems from earlier disorder-specific models towards a transdiagnostic approach (Lyubomirsky et al., 2015).

Empirical findings support this theory; for instance, longitudinal studies controlling for baseline symptom levels indicate that rumination, and emotion dysregulation in general, is rather the precursor than the outcome of psychopathology, such as depressive symptoms (e.g. Kuster et al., 2012; Robinson & Alloy, 2003; Wilkinson et al., 2013). In the same vein, emotion dysregulation (i.e., rumination, dysregulated anger and sadness, and emotional understanding) prospectively predicted anxiety and disordered eating even after controlling for baseline symptoms, but none of these symptoms predicted higher emotion dysregulation after accounting for baseline emotion dysregulation (McLaughlin et al., 2011). Furthermore, rumination may interfere with potential moderators, such as environmental stressors by exacerbating stress response (Brosschot et al., 2006; Robinson & Alloy, 2003), that could result in a downward spiral aggravating various forms of psychopathology through multiple pathways depending on the person's distal and proximal risk factors (Nolen-Hoeksema & E. R. Watkins, 2011).

Rumination in association with particular personality traits have also been identified in the background of certain psychological problems. One such extensively reported association is that higher trait neuroticism is characterized by more rumination, that may lead to higher levels of anxiety (e.g., Brinker et al., 2014; Muris et al., 2005; Roelofs et al., 2008). Furthermore, the Behavior Inhibition/Activation Systems (BIS/BAS), i.e., inhibiting one's behavior in the face of anticipated punishment or threatening stimuli versus activating approach behavior in the face of incentives (Gray et al., 1987) has consistently been linked with rumination, such that a more active BIS is associated with more rumination and more internalizing symptoms, whereas a more active BAS is associated with more externalizing symptoms (Keune et al., 2012; Khoshfetrat et al., 2022). Moreover, a recent study found

significant positive associations between rumination and certain facets of alexithymia, i.e., the difficulty in identifying and describing one's own feelings, and these associations were stronger among patients with psoriasis than healthy controls (Baysak et al., 2020). However, other empirical results indicate that the positive association between alexithymia and rumination may not hold when controlling for depressive symptoms (Di Schiena et al., 2011).

Recently, E. R. Watkins and Roberts (2020) proposed the H-EX-A-GO-N model to describe the five key factors that – in interaction with each other – may contribute to the emergence of the habit of maladaptive depressive rumination, namely 1) Habit development, 2) EXecutive control, 3) Abstract processing, 4) GOal discrepancies, and 5) Negative information-processing biases. The authors argue that perceived differences between the current self and unattained goals may trigger state rumination. When such conditions pertain, rumination may occur more and more frequently, gradually becoming a habit. Abstract processing, i.e., when the person perceives the unattained goals permanent and pervasive instead of a temporary state related to one specific situation (e.g., "I failed the exam, so I am a failure who will never succeed in anything") also aggravates habitual rumination and impairs instrumental behavior. Rumination may foster negative bias, and negative biases may lead to more rumination as individuals with negative thought processing may interpret a broader variety of situations as failed attempts of attaining goals. In the same vein, state rumination (i.e., momentary, ongoing rumination) hampers executive functioning, whereas executive function deficits make it difficult for ruminators to inhibit their maladaptive negative train of thoughts, easily resulting in a vicious circle. Impaired executive functioning may also make it difficult to inhibit habitual responses and abstract thought processing, contributing to the pervasive, uncontrollable nature of rumination. The complex interplay of these factors may lead to the habit of rumination, which may contribute to the development of various negative psychological and physiological outcomes.

As for specific prevention and treatment strategies, the five key factors described by the H-EX-A-GO-N model above should be addressed. One way of acquiring abstract processing (A), negative information-processing biases (N), as well as the habit to focus on one's emotions instead of problem solving (H) may occur as a result of neglectful, abusive or overcontrolling parenting and socialization (E. R. Watkins & Roberts, 2020), or simply by modeling the caregiver's ruminative or worrisome responses (E. R. Watkins, 2008a), therefore, psychoeducation of parents is one way of early intervention whenever possible. However, other factors such as temperament (Schweizer et al., 2018), poorer executive function (Y. Yang et al., 2017), or higher self-reflective capacity (Bernstein et al., 2019) may also account for the

occurrence of ruminative response style. Once the habit of rumination has developed, interventions targeting rumination specifically are the most successful in reducing ruminative thoughts. One such approach is Behavioral Activation, a method that reconstructs the triggers and circumstances of the emergence of ruminative thoughts in order to design a more adaptive alternative response when they next occur (Dimidjian et al., 2011), i.e., aiming to change ruminative response as a maladaptive habit (H). Another approach is to teach clients a more adaptive response style to stress with the help of directed imagery, behavioral experiments and analyzing past situations where rumination occurred, where participants are trained to think concretely (instead of abstractly - A), less critically and more positively (instead of negatively - N). These two approaches are incorporated in Rumination-focused Cognitive Behavior Therapy (RFCBT), a modified CBT that aims to reduce rumination specifically (E. R. Watkins & Roberts, 2020). Another method to prevent ruminative thoughts is mindfulness training that helps staying present in the here-and-now by focusing on one's own breath and bodily sensations via meditational techniques instead of engaging in rumination about past or future scenarios (Teasdale et al., 1995). Both RFCBT and mindfulness-based cognitive therapy (MBCT) appear to be more effective in reducing rumination and preventing depressive relapse than treatment as usual (Cladder-Micus et al., 2019; E. R. Watkins, 2016). However, these interventions can only be successful in overwriting the old maladaptive habit of rumination when practiced regularly (E. R. Watkins & Nolen-Hoeksema, 2014).

As rumination widely characterizes nonclinical populations and the associated negative outcomes are not limited to clinical patients (e.g., Moulds et al., 2007; Wahl et al., 2011; E. R. Watkins et al., 2005), it is important to examine it among community samples. Furthermore, university students appear to be characterized by elevated risk for poor mental health, risky behavior, depressive symptoms, and suicidal ideation (Kadison & DiGeronimo, 2004), hence examining rumination, a potential risk factor for these symptoms, could be of great relevance for this population. In this dissertation we carried out four studies recruiting university students and adult community samples that are summarized in Table 6.1.

| *Study* | **Validating the Hungarian RTSQ (Study 1)** | **Rumination in MDD and BD – meta-analysis (Study 2)** | **PO level, symptoms of BPD and depression (Study 3)** | **Perceived stress and rumination in COVID-19 among migraineurs and HCs (Study 4)** |
|---|---|---|---|---|
| *Aims/ research questions* | Validating the Hungarian RTSQ | Is there a difference in rumination among BD and MDD patients? | Exploring whether rumination mediates the relationship between PO level and BPD & depressive symptoms | Does rumination explain perceived stress in migraine patients and HCs? Is this association stronger among migraineurs than HCs? |
| *Theoretical framework* | Goal Progress Theory | Response Styles Theory | Response Styles Theory, Emotional Cascade Model | Rumination in response to a stressor |
| *Conclusions* | • The Hungarian RTSQ is a valid rumination measure<br>• The total score is more reliable than the subscales<br>• Captures the maladaptive aspect of rumination globally, not only regarding depressive symptoms | • Rumination is a significant process in both MDD and BD<br>• Rumination subtype is an important moderator<br>• Our synthesis highlights methodological limitation of the field, e.g., heterogeneity in reporting clinical data | • Rumination plays an important role in the emotion dysregulation and negative affectivity of individuals with lower PO<br>• Treatments to reduce rumination can contribute to treatment efficacy in a wide range of mental disorders | • Vulnerability of migraine patient group in stressful situations like COVID-19<br>• Chronic stressors like the pandemic might trigger rumination even in individuals who otherwise do not ruminate |
| *Limitations* | • Disproportionate gender distribution in Study 2 (male<female)<br>• Cannot account for cultural and language differences between various translations | • Specific scope → few studies qualified → limited applicability<br>• The role of rumination in mood disorders and should also be examined longitudinally | • Convenience sampling → upper domain of PO & few BPD symptoms<br>• Cross-sectional self-report survey method → biases, cannot infer causality | • Small sample size<br>• Specific scope → limited applicability<br>• Cross-sectional self-report survey method → biases, cannot infer causality |

*Table 6.1. Summary of the main conclusions of the four studies.*
*Note. RTSQ = Ruminative Thought Style Questionnaire, MDD = major depressive disorder, BD = bipolar disorder, PO = personality organization, BPD = borderline personality disorder, HC = healthy control.*

In the **first article**, we examined the factor structure of the Ruminative Thought Style Questionnaire (RTSQ) among university students, as previous work about its factor solution was inconclusive, and it had not been assessed on a Hungarian sample. On our sample the bifactor ESEM demonstrated the best model fit, where most of the variance was explained by the total score, suggesting that the total score is a valid measure of rumination. Furthermore, the RTSQ demonstrated concurrent validity in relation to the Ruminative Response Scale (RRS), one of the most widely used rumination scale. RTSQ was more strongly associated with the more self-criticizing subscale of the RRS, i.e., with brooding, indicating that RTSQ rather captures the maladaptive component of rumination. However, our results also revealed that the RTSQ was slightly more strongly correlated with general symptoms of psychopathology than with symptoms of depression, supporting that RTSQ is not limited to depressive rumination, but rather captures rumination globally, concurring with the original aim of its authors (Brinker & Dozois, 2009). Given that rumination is a transdiagnostic risk factor to various psychological problems, psychotherapeutic intervention techniques aiming to reduce rumination have been developed. Randomized controlled trials testing the efficacy of such interventions should be able to measure ruminative tendencies properly to draw valid conclusions about therapeutic change, underscoring the clinical relevance of our psychometric study. Furthermore, due to the well-known gender difference in rumination that may partially account for the robust gender differences in major depression (Nolen-Hoeksema, 2012), we considered it crucial to examine the measurement invariance of the RTSQ across gender, i.e. to see whether both genders interpret the items of the scale the same way. Although gender invariance of other translations had been tested before, our study was the first to test the gender invariance of the Hungarian RTSQ. Our results supported the gender invariance of the Hungarian RTSQ, suggesting that when gender differences are found in rumination as measured by this scale, it indeed reflects the differences in ruminative tendencies, rather than a gender difference in interpreting its items. This is an important finding that aids the interpretation of gender differences in rumination in subsequent research where the Hungarian RTSQ is used. Moreover, assessing rumination among college students is particularly important, since they are typically in a critical period of age when numerous mental health issues may arise, to which rumination may be a significant risk factor (Topper et al., 2017). Taken together, our study was the first to translate and validate the Hungarian RTSQ, and our results support that the Hungarian RTSQ is a valid measure of rumination across genders, where the use of its total score is advised instead of its subscales, in line with the intention of its authors (Brinker & Dozois, 2009). Conversely, although the aim of the authors was to create a fairly "neutral" rumination scale that is unbiased by depressive

content, valence and temporal orientation, our results indicate that rumination as measured by the RTSQ is rather negatively valenced, which is important to consider when using it in research.

Besides being a commonly observed emotion regulation strategy of university students, rumination is considered a significant risk factor to mood disorders (S. L. Johnson et al., 2008). In the **second article**, we compared rumination in bipolar disorder and major depressive disorder. Our research was the first to systematically compare rumination in BD and MDD based on the results of existing studies. We found that MDD and BD patients engage in depressive rumination to a similar extent, whereas rumination on positive affect was more common among BD patients, which is understandable given that these patients tend to experience episodes of elevated positive affect and may be characterized by disturbed reward processing (Schreiter et al., 2016). Therefore, our results underscore that rumination is an important emotion regulation process in both major depressive and bipolar disorders that may enhance and maintain low as well as high mood for patients with mood disorders. This highlights the importance of interventions aiming to reduce rumination in mood disorders, as ruminative thoughts may enhance positive as well as negative affect and thus contribute to the occurrence of manic episodes in BD as well as depressive episodes in both BD and MDD (e.g. S. L. Johnson et al., 2008; Michalak et al., 2011; Silveira & Kauer-Sant'Anna, 2015). In major depressive disorder, rumination appears to longitudinally predict the relapse to and perpetuation of depressive episodes (Nolen-Hoeksema, 2000; Spasojević & Alloy, 2001), thus rumination is a crucial cognitive process to be addressed in treating depression. In addition, findings suggest that excessive trait rumination is linked with reduced response to both medical and psychotherapeutic treatment, even after controlling for baseline depressive symptoms (Schmaling et al., 2002). However, psychotherapeutic methods targeting rumination more specifically, such as rumination-focused cognitive-behavioral therapy (RFCBT) and mindfulness-based cognitive therapy (MBCT), two modified types of cognitive-behavioral therapies, appear to be more effective in reducing rumination, and hence may contribute to prevent depressive relapse among MDD patients (Cladder-Micus et al., 2019; E. R. Watkins, 2016). Moreover, results of a recent randomized controlled trial suggest that RFCBT may prevent the occurrence of depressive episodes among university students characterized by high levels of rumination, worry and stress, who are therefore considered a high-risk population to develop depressive episodes (Cook et al., 2019).

Although evidence shows that bipolar patients engage in more trait-level rumination about both positive and negative affect than healthy controls, which

is associated with more severe mood symptoms (Gruber et al., 2011), research about psychotherapeutic interventions aiming to reduce rumination and hence prevent relapse in BD are scarce. Standard Cognitive-Behavioral Therapy (CBT) is an effective treatment approach in BD (Moshier & Otto, 2013), and preliminary results suggest that MBCT may also be effective in reducing residual depressive symptoms among interepisode BD patients (Deckersbach et al., 2012; Ives-Deliperi et al., 2013; J. M. G. Williams et al., 2008). According to a recent review, MBCT may be beneficial for BD patients and importantly, does not seem to induce mania - however, randomized controlled trials with adequate power are necessary to corroborate these findings (Lovas & Schuman-Olivier, 2018). Based on these preliminary results, it is plausible that RFCBT may also be beneficial for bipolar patients, yet, to our knowledge, RFCBT efficacy has not been investigated among these patients.

To sum up, rumination in BD is understudied compared to MDD, however, empirical evidence supports its relevance in affective symptom relapse in both MDD and BD (e.g. Gruber et al., 2011; Michalak et al., 2011; Michl et al., 2013). Our meta-analysis underlines the importance of rumination in mood disorders, and the scarcity of research findings about rumination in BD, and even more so in BD compared to MDD. Future studies should investigate emotion regulation processes such as rumination, and promising therapeutic approaches such as the RFCBT and MBCT in BD compared to HCs, as well as in BD compared to MDD.

Furthermore, our study highlighted several methodological gaps in the literature that should be addressed in the future. First and foremost, despite the increasing consensus for the spectrum model of mood disorders (Angst & Cassano, 2005), research examining emotion regulation in both BD and MDD patients are relatively scarce. Our results, in line with the RDoC framework (Fernandez et al., 2016), accentuate the need for studies that assess emotional processes in the mood disorder spectrum, rather than be restricted to recruiting participants of a single diagnostic category. Moreover, this transdiagnostic framework suggests that clinicians should focus on transdiagnostic risk factors in treatment such as emotion regulation, representing a paradigm shift from earlier treatment modalities focusing primarily on the categorical diagnosis of the patient (Fernandez et al., 2016; Khakpoor et al., 2019). Interventions that address a transdiagnostic variable may have an impact on all of the pathologies to which it is linked (Nolen-Hoeksema & E.R. Watkins, 2011); correspondingly, interventions focusing on emotion regulation impairments are on the rise (Berking et al., 2008; Mennin & Fresco, 2010; Roemer et al., 2009; E. R. Watkins, 2016; J. M. G. Williams et al., 2008).

Furthermore, our study revealed the scarcity and heterogeneity in reporting clinical sample characteristics, such as current episodes/mood symptom scores, despite their importance as potential moderators. This pinpoints the need to unify these standards in mood disorder research to make the results of this field comparable in the future.Rumination appears to play an important role in numerous psychological problems apart from mood disorders, accounting for the co-occurrence of several symptoms (e.g. Fernandez et al., 2016; McLaughlin et al., 2014). Its role in illness trajectories between certain underlying factors and a wide variety of psychological disturbances has been investigated extensively (Grierson et al., 2016; Luca, 2019). This is not surprising given the complexity of psychological disorders, where a broad array of interacting agents could lead to a certain outcome, i.e., equifinality, whereas the interplay of similar factors could lead to several different outcomes, i.e., multifinality. Transtheoretical approaches could be beneficial in understanding and treating complex psychological processes (Luyten et al., 2008). In our **third article** that stems from both the cognitive-behavioral and psychodynamic therapeutic approaches, we found that rumination mediated the relationship between personality organization and borderline-depressive symptoms, demonstrating how an emotion regulation process may serve as a link between certain personality traits and the development of clinical symptoms. More specifically, our results imply that people with less integrated personality functioning may be more prone to engage in elevated ruminative tendencies, which in turn may aggravate symptoms of BPD and depression. Transference-focused psychotherapy (TFP) is a psychodynamic therapeutic method targeting to increase the level of personality functioning by re-integrating split representations of self and others and improve one's reflective ability (Levy, Clarkin, et al., 2006). Concurrently, RFCBT primarily aims to reduce the cognitive process of rumination, and therefore may contribute to the reduction of negative affect and related disturbances and prevent depressive relapse (E. R. Watkins, 2016). Both have been shown to be effective in helping clients implement more adaptive emotion regulation strategies, which could result in more stable affect and less clinical symptoms (e.g. Levy, Meehan, et al., 2006; E. R. Watkins et al., 2011). To date, these two specific therapeutic methods have not been compared to each other directly, however, empirical findings from randomized controlled trials comparing standard CBT to psychodynamic psychotherapy found both methods equally effective in the treatment of depressive symptoms (Leichsenring, 2001; Thase, 2013). Therapeutic methods specifically targeting borderline symptoms, such as TFP or Dialectical Behavioral Therapy, a modified CBT, appears to be more effective in reducing borderline features than treatment-as-usual (Oud et al., 2018). Furthermore, results suggest that integrative approaches combining CBT and

psychodynamic techniques could be more effective in reducing clinical symptoms such as generalized anxiety than CBT alone (Orvati Aziz et al., 2020). These results highlight the importance of studies with a transdiagnostic and transtheoretical approach in clinical research.

In our model, PO level represents a distal risk factor in the emergence of borderline and depressive symptoms as it is defined by early childhood experiences, hence appears early in the course of symptom development (Kernberg & Caligor, 2005), whereas rumination can be considered a proximal risk factor that slightly precedes/cooccurs with the symptoms (Nolen-Hoeksema & E. R. Watkins, 2011). There is an abundance of studies assessing how certain distal or proximal risk factors distinctively relate to psychological symptoms, therefore it has been suggested that subsequent studies should rather address how the relationship between distal risk factors (e.g., early experiences, PO level) and outcome variables (e.g., disorder-specific symptoms) are mediated by proximal risk factors (e.g., emotion regulation strategies) (Nolen-Hoeksema & E.R. Watkins, 2011). In the same vein, a growing body of empirical results indicate the mediating role of rumination in a wide array of distal risk factors and outcomes, such as childhood maltreatment and depression (Deguchi et al., 2021), stress and impaired sleep (Berset et al., 2011), emotional intelligence and aggression (García-Sancho et al., 2016), chronic stress and hypertension (Gerin et al., 2012), low self-esteem and depression (Kuster et al., 2012), self-esteem, perfectionism and work addiction (Kun et al., 2020). Our study was the first to extend this knowledge about the mediating role of rumination between PO level and borderline-depressive symptoms, that had not been studied elsewhere. Taken together, or results accentuate the crucial role of rumination - and emotion regulation in general - as a mediator that can bridge the gap not only between diagnostic categories, but between theoretical approaches and treatment modalities. Building on Nolen-Hoeksema's definition of rumination as the recurrent thinking about one's own depressed mood (Nolen-Hoeksema, 1991), past-oriented depressive rumination has been in the focus of rumination-related research (Smith & Alloy, 2009). However, subsequent studies have gradually extended the domain of content one may ruminate about, as well as the symptoms typically associated with it. Anger rumination has been found relevant in borderline personality disorder (Peters et al., 2017), meanwhile self-critical rumination appears to be linked with perfectionism and low self-esteem accompanied by psychological distress (Fearn et al., 2021), work-related rumination may play a role in burnout (Mullen et al., 2020), ruminating on the failure/underperformance in a social context (i.e. post-event processing) may be relevant in social phobia (McEvoy & Kingsep, 2006), whereas rumination on positive affect may be a risk factor to mania (Feldman et al., 2008). Furthermore, brooding has been associated with symptoms of PTSD after experiencing a

natural disaster (García et al., 2015; Nolen-Hoeksema & Morrow, 1991). Given the relevance of rumination in a broad content domain including stressful, traumatic events such as natural disasters, we sought to explore its role during COVID-19, a long-term world-wide stressor (Maraz & Yi, 2021). In our **fourth article**, we aimed to explore the connections between rumination about COVID-19 and depressive rumination – in other words, to understand whether people who frequently engage in depressive rumination tend to ruminate on difficulties related to COVID-19 as well. Our results suggested that depressive rumination was moderately associated with COVID-related rumination among migraineurs but did not correlate significantly among HCs. Furthermore, brooding was a stronger predictor of perceived stress than COVID-related rumination. These results imply that while dwelling on a current stressor appears to be associated with the level of perceived stress, the self-deprecating aspect of rumination (i.e., brooding) seems to be more maladaptive, hinting on the relevance of other factors of ruminative thinking beyond its content. For instance, the other subtype of depressive rumination besides brooding, i.e. reflection or reflective pondering (e.g. "Analyze recent events to try to understand why you are depressed"), is a more constructive way of repetitive thinking that may yield a better understanding of one's own problems or symptoms (Treynor et al., 2003). As such, regardless of its depressive content, it has been found to be only weakly or not at all associated with depressive symptoms, and has also been proposed as an adaptive emotion regulation strategy (e.g. Alleva et al., 2014; Joormann et al., 2006; A. W.T. Wang et al., 2021), which is in line with our results in the first, third and fourth article. In the same vein, recent studies have highlighted several characteristics of ruminative thinking – other than its content - that may make this cognitive process especially maladaptive, such as its self-critical nature (e.g. "Why can't I handle my problems better?"), pervasiveness, involuntariness, automaticity, (i.e. that they may occur in any kinds of situation without the person's intention, occupying one's mind for a long time, making it hard to concentrate on anything else), uncontrollability (i.e. being hard to stop them) and goal insensitivity (i.e. ignoring that these thoughts are not facilitating problem solving) (E. R. Watkins & Roberts, 2020). Another recent study argues that the distress associated with repetitive negative thinking and the perceived difficulty to stop these thoughts are two core aspects when assessing daily fluctuations in repetitive negative thinking (Rosenkranz et al., 2020).

Exploring specific aspects of rumination (i.e., a proximal risk factor) under chronic stress (i.e., a moderator) among vulnerable populations with pre-existing conditions (i.e., a distal risk factor) may contribute to a better understanding of specific illness trajectories and corresponding interventions (Nolen-Hoeksema & E.R. Watkins, 2011). Within this framework,

our fourth study underscores that the self-deprecating aspect of rumination may be more detrimental than its specific content, in line with other recent findings (Kocsel et al., 2022; Kolubinski et al., 2021). However, more studies are needed that aim to uncover which aspects of rumination lead to maladaptive outcomes the most. Furthermore, the negative effect of rumination may be more pronounced among people with a pre-existing psychosomatic disease such as migraine. Furthermore, the weak association between brooding and COVID-related rumination implies a chronic stressor such as the COVID-19 pandemic can elicit ruminative thoughts even among people who otherwise might not ruminate. Migraine patients may be at higher risk of developing adverse stress-related symptoms during times of chronic stress due to their higher stress reactivity (Borsook et al., 2012; Holm et al., 1997; Maleki et al., 2012), and our results suggest that this distal risk factor may lead to a higher stress response when the proximal risk factor of rumination is present. This highlights the importance of interventions aiming to reduce rumination for the general public, and especially for vulnerable populations such as migraineurs.

Since the groundbreaking work of Nolen-Hoeksema in the field, substantial empirical evidence has been accumulated about the ruminative response style and associated psychological problems. However, there are certain limitations of this line of research that need to be acknowledged. First and foremost, most of our knowledge about rumination, or emotion regulation in general, are based on cross-sectional self-report studies. While asking people about their subjective inner states is an important research method, as getting information about one's subjective inner state is hardly accessible any other way, such study designs have limited ecological validity due to retrospective bias, metacognitive assumptions, or current mood (Rosenkranz et al., 2020). Furthermore, cross-sectional studies do not enable us to draw causal conclusions, hindering the applicability of the results. These limitations imply to our studies as well, as we collected cross-sectional self-report data. While it may be challenging to overcome these constraints when obtaining information about one's thought processing, there are several innovative methodological examples in rumination research aiding to draw valid conclusions. For instance, multimodal study designs, e.g., laboratory studies applying rumination induction, often combined with physiological or neuroimaging data collection can broaden our understanding of repetitive thinking and associated processes in the central and peripheral nervous system. Eyetracking studies are also promising, as empirical data indicates that eye movement may be an indicator of rumination through selective attention (Hilt et al., 2017). Furthermore, there is a growing number of studies utilizing Experience Sampling Method/Ecological Momentary Assessment (ESM/EMA) (Csikszentmihalyi & Larson, 1987),

i.e. a structured diary technique where (nowadays) a smartphone application gives randomly assigned prompts to participants multiple times a day for several consecutive days. At each prompt, participants are required to answer short questionnaires regarding their current mood, inner state, behavior, and (social) context. This data collection method has numerous advantages that increase the validity of the results – it helps to eliminate retrospective bias and enables to assesses contextual factors at each timepoint of data collection, and can also be accompanied by physiological measures, such as pulse or heart rate variability (Myin-Germeys et al., 2018). Furthermore, the obtained multilevel data is both longitudinal and cross-sectional, thus it is possible to disentangle between- and within-subject variance (Nezlek & Kuppens, 2008). Therefore, it would be worthwhile to examine whether our results could be replicated in an ESM/EMA framework in the future, potentially accompanied by physiological assessments.

To sum up, our results are in line with previous rumination-related research shifting away from the view that rumination is only relevant in terms of major depression and suggest that rumination is a transdiagnostic risk factor. Our studies demonstrate that rumination is relevant in various psychological problems, such as bipolar disorder, borderline features, lower personality organization, and perceived stress. The connection with these symptoms was strongest in case of brooding compared to other subtypes of rumination (e.g., reflection and COVID-related rumination). These findings highlight that rumination has various components that need to be considered to understand what makes it maladaptive. Our findings hint at the possibility that features of rumination that are unique to brooding, such as its self-deprecating, counterfactual nature, may be more detrimental than other components, such as the repetitiveness or the depressive content, that may also characterize reflection, or than a specific negative content, that also characterizes COVID-related rumination. Future research should focus on core elements of rumination beyond content and frequency, such as its habitual nature, goal-insensitivity, automaticity, and involuntariness, as these are considered crucial in developing a wide array of psychological difficulties and may hamper therapeutic change (E. R. Watkins & Roberts, 2020). Disentangling which of these components are the most harmful would help design more effective psychoeducational and psychotherapeutic intervention programs.

Although our work has focused on rumination, we denote that many of these results may also pertain for repetitive negative thinking in general, i.e., an umbrella term comprising rumination and worry. Recent studies pinpoint the advantages of examining repetitive negative thinking globally, rather than focusing on single processes (McEvoy et al., 2019; Rosenkranz et al., 2020; E. R. Watkins & Roberts, 2020). Furthermore, Coifman & Summers (2019) argue

that emotion inflexibility, i.e. the inability to choose from a broad range of emotion regulation strategies and recruit the one that seems the most adequate to the situation, appears to be a significant risk factor to psychopathology, highlighting the importance of examining emotion regulation strategies in a broader framework. Besides addressing the methodological limitations of rumination-related research, future studies should also take this suggestion into consideration.

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# 8. APPENDICES

## 8.1. Supporting information for Study 1 (Validating the Bifactor Structure of the Ruminative Thought Style Questionnaire - a Psychometric Study)

*Table S8.1. Standardized regression weights between the RTSQ total scores and covariates in Study 1.*

| | total sample | | | | | male | | | | | female | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Covariates** | RTSQ | PfT | CT | RT | AT | RTSQ | PfT | CT | RT | AT | RTSQ | PfT | CT | RT | AT |
| **Gender** | 0.08* | 0.09* | -0.04 | 0.23*** | 0.26*** | - | - | - | - | - | - | - | - | - | - |
| **Age** | -0.01 | -0.01 | -0.09* | 0.05 | -0.04 | 0.04 | -0.07 | -0.01 | 0.06 | -0.05 | -0.04 | 0.06 | -0.11* | 0.02 | -0.04 |
| **CES-D** | 0.39*** | 0.32*** | 0.16** | 0.17*** | 0.02 | 0.38*** | 0.35*** | 0.16* | 0.15 | 0.06 | 0.38*** | 0.30*** | 0.16** | 0.20*** | -0.02 |
| **$R^2$** | 0.16*** | 0.11*** | 0.03*** | 0.09*** | 0.07*** | 0.15*** | 0.12*** | 0.03*** | 0.03*** | 0.01*** | 0.15*** | 0.09*** | 0.04*** | 0.04*** | 0.002*** |

*Total Sample: N =1123; Males: N =505 (45%); Females: N =618 (55%). RTSQ, Ruminative Thought Style Questionnaire total score; CES-D, The Center for Epidemiologic Studies Depression Scale; BSI_GSI, Brief Symptom Inventory General Symptom Index; PfT, Problem-focused thoughts factor of the Ruminative Thought Style Questionnaire; CT, Counterfactual thinking factor of the Ruminative Thought Style Questionnaire; RT, Repetitive thoughts factor of the Ruminative Thought Style Questionnaire; AT, Anticipatory thoughts factor of the Ruminative Thought Style Questionnaire. *p<.05.; **p<.01.; ***p<.001.*

*Table S8.2. Factor Analyses of four measurement models of the Ruminative Thought Style Questionnaire in Study 2.*

| | AIC/BIC | $\chi^2$ | df | CFI | TLI | RMSEA | 90% CI | SRMR |
|---|---|---|---|---|---|---|---|---|
| Model 1 | 22927.011/ 23153.110 | 886.192 | 170 | .689 | .653 | .115 | .11-.12 | .084 |
| Model 2 | 16665.819/ 16850.467 | 225.810 | 86 | .917 | .899 | .071 | .06-08 | .061 |
| Model 3 | 21198.533/ 21466.084 | 365.921 | 138 | .899 | .874 | .072 | .06-.08 | .057 |
| Model 4 | 21074.542/ 21538.045 | 169.632 | 86 | .963 | .926 | .055 | .04-.07 | .025 |

*Model 1= One factor CFA; Model 2= Second-order four factor CFA; Model 3= bifactor CFA; Model 4= bifactor ESEM; AIC, Akaike Information Criteria; χ2, chi-square test statistic; df, degree of freedom; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; RMSEA, Root Mean Squared Error of Approximation; CI, confidence interval; SRMR, Standardized Root Mean Square Residual.*

*Table S8.3. Alpha and Omega reliability for the bifactor ESEM (Model 4) in Study 2.*

| Model 4 | Omega total (ω) | Omega hierarchical ($\omega_h$) | Cronbach α |
|---|---|---|---|
| General bifactor | .935 | .846 | .902 |
| RT | .856 | .397 | .841 |
| CT | .814 | .448 | .800 |
| PfT | .817 | .331 | .804 |
| AT | .763 | .429 | .745 |

*RT, Repetitive thoughts factor of the Ruminative Thought Style Questionnaire; CT, Counterfactual thinking factor of the Ruminative Thought Style Questionnaire; PfT, Problem-focused thoughts factor of the Ruminative Thought Style Questionnaire; AT, Anticipatory thoughts factor of the Ruminative Thought Style Questionnaire.*

## 8.2. Supporting information for Study 2 (Rumination in Major Depressive and Bipolar Disorder – a Meta-analysis)

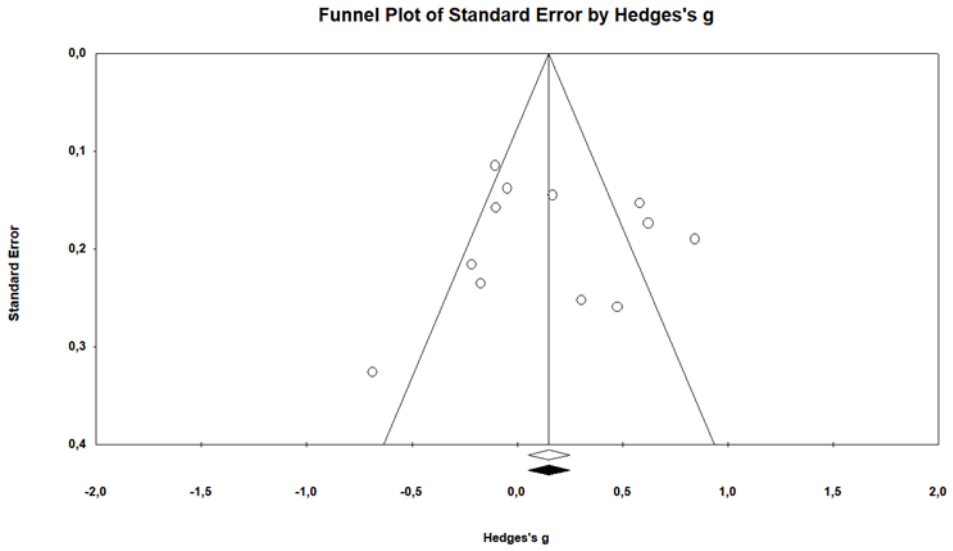


*Figure S8.1. Funnel plot for rumination in BD compared to MDD, all rumination measures included.*
*Note. Duval and Tweedie's point estimate = 0.158 [-0.063 – 0.379]. Open circles represent the observed studies, and the open diamond shows the observed point estimate. The filled diamond represents the imputed point estimate.*

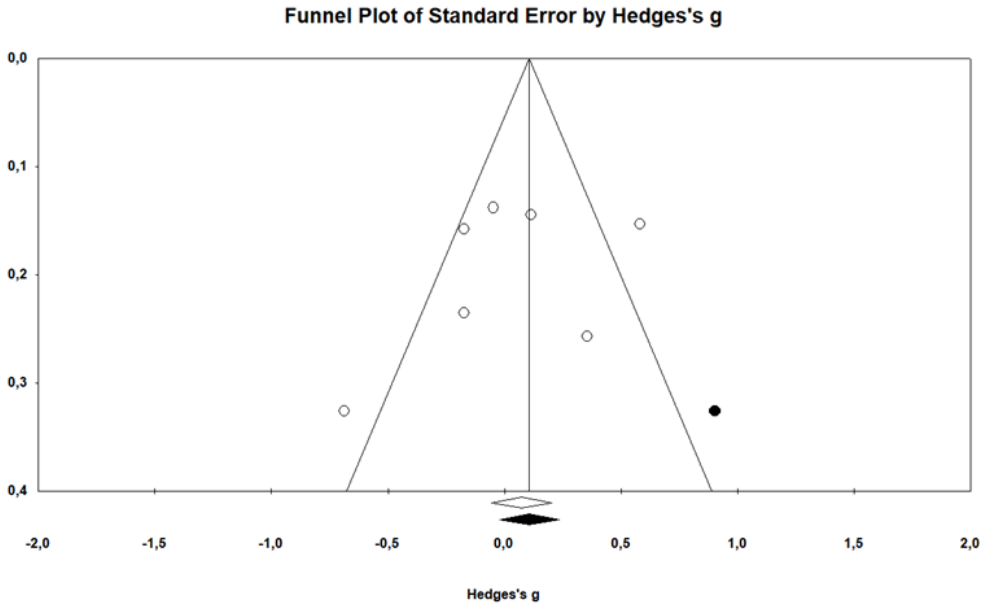


*Figure S8.2. Funnel plot for depressive rumination in BD compared to MDD.*
*Note. Duval and Tweedie's observed point estimate = 0.035 [-0.228 – 0.298]; imputed point estimate=0.109 [-0.163 – 0.381]. Open circles represent the observed studies, and the open diamond shows the observed point estimate. Filled circles represent imputed studies, and the filled diamond represents the imputed point estimate.*

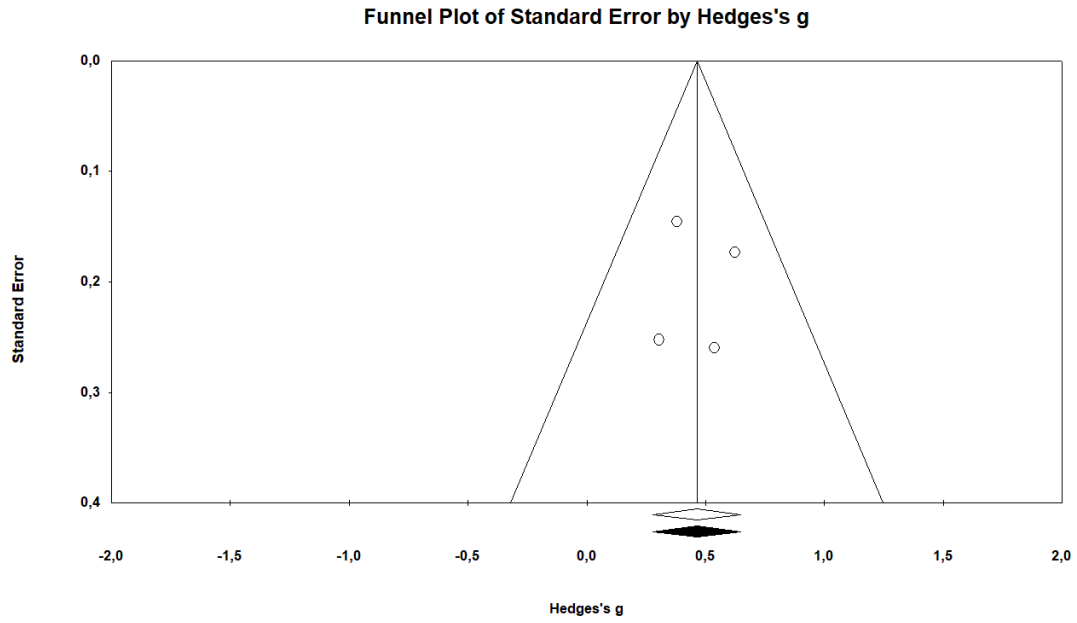


*Figure S8.3. Funnel plot for rumination on positive affect in BD compared to MDD.*
*Note. Duval and Tweedie's point estimate = 0.463 [-0.277 – 0.649]. Open circles represent the observed studies, and the open diamond shows the observed point estimate. The filled diamond represents the imputed point estimate.*

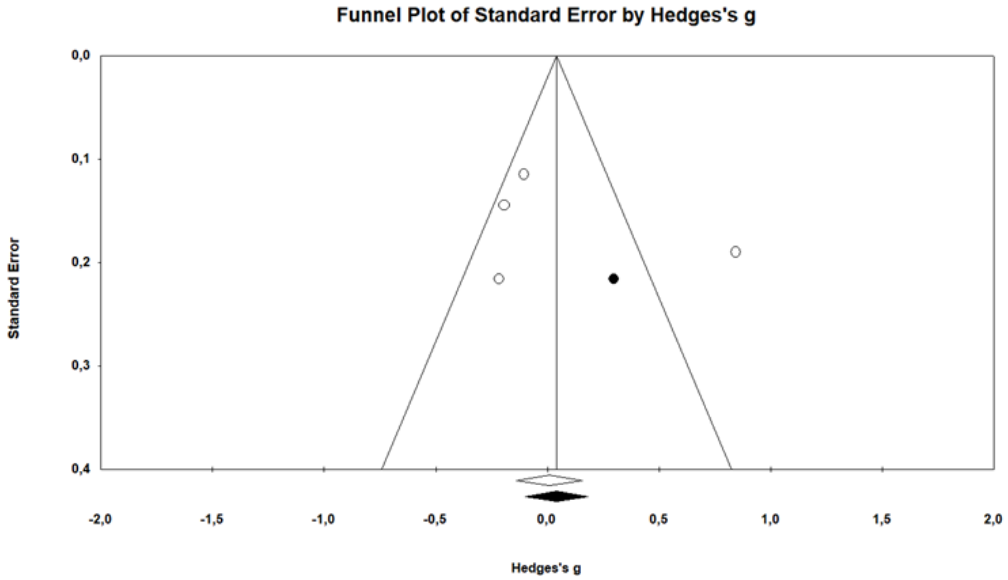


*Figure S8.4. Funnel plot for rumination not otherwise specified in BD compared to MDD.*
*Note. Duval and Tweedie's observed point estimate = 0.075 [-0.361 – 0.512]; imputed point estimate = 0.115 [-0.253 – 0.483]. Open circles represent the observed studies, and the open diamond shows the observed point estimate. Filled circles represent imputed studies, and the filled diamond represents the imputed point estimate.*

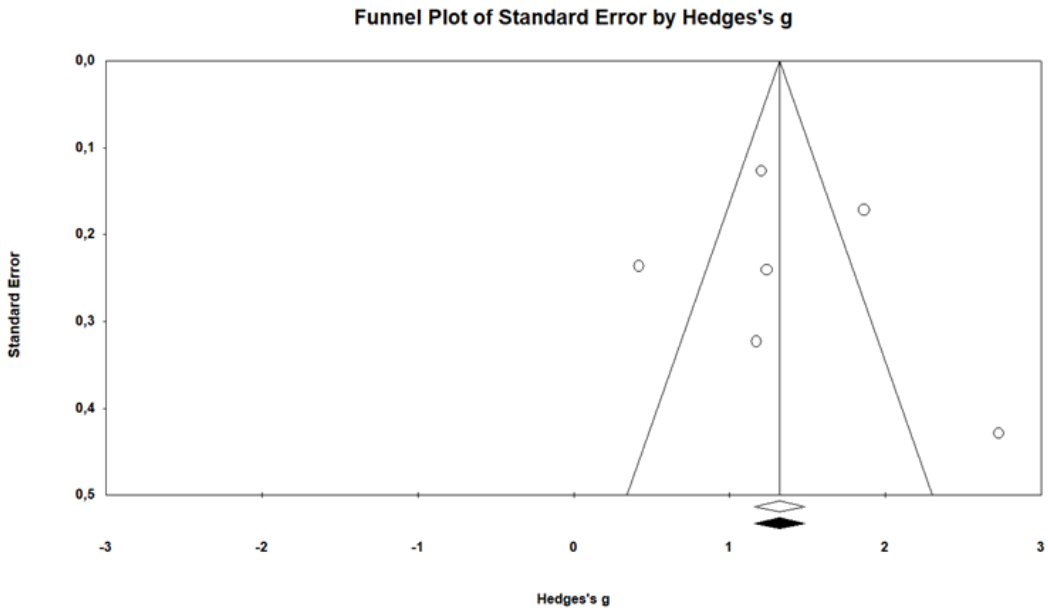


*Figure S8.5. Funnel plot for rumination in BD compared to healthy controls.*
*Note. Duval and Tweedie's point estimate = 1.389 [0.905 – 1.867]. Open circles represent the observed studies, and the open diamond shows the observed point estimate. The filled diamond represents the imputed point estimate.*

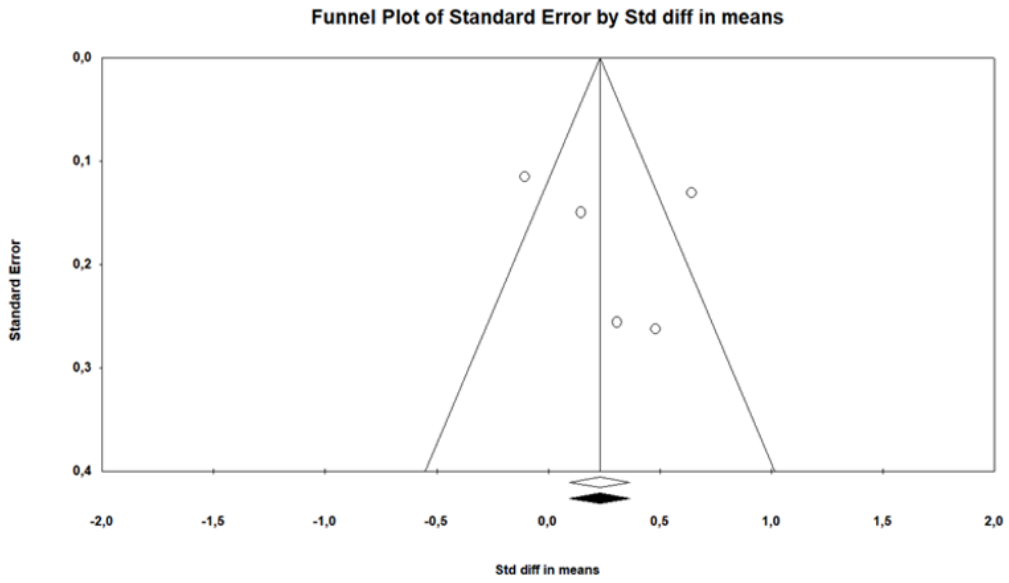


*Figure S8.6. Funnel plot for rumination in BD-I compared to MDD, all rumination measures included.*
*Note. Duval and Tweedie's point estimate =0.281 [-0.044-0.605]. Open circles represent the observed studies, and the open diamond shows the observed point estimate. The filled diamond represents the imputed point estimate.*

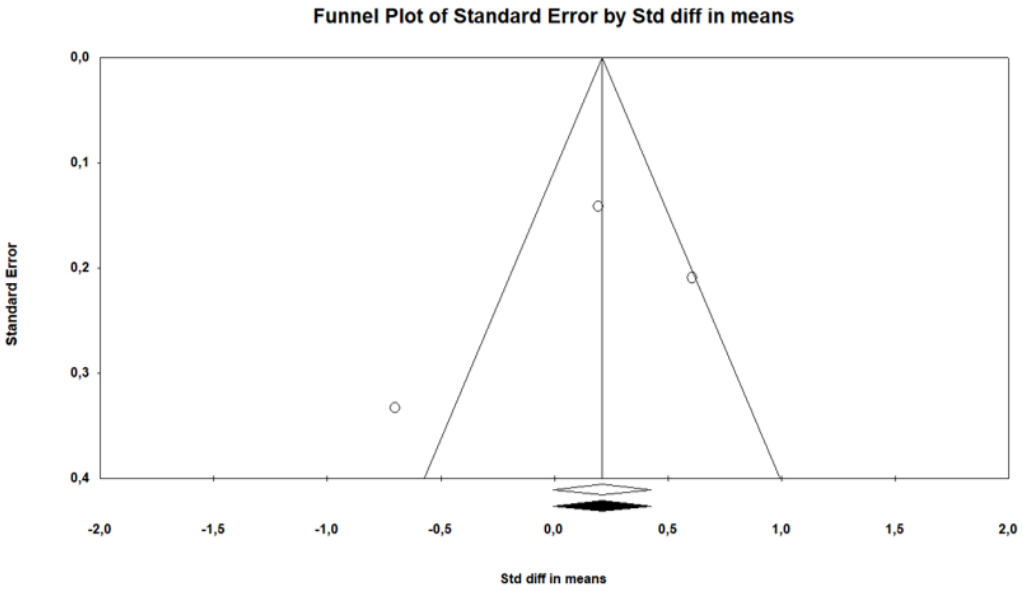


*Figure S8.7. Funnel plot for rumination in BD-II compared to MDD, all rumination measures included.*

*Note. Duval and Tweedie's point estimate =0.093. Open circles represent the observed studies, and the open diamond shows the observed point estimate. The filled diamond represents the imputed point estimate.*

## 8.3. Supporting information for Study 3 (Rumination mediates the Relationship between Personality Organization and Borderline-Depressive Symptoms)

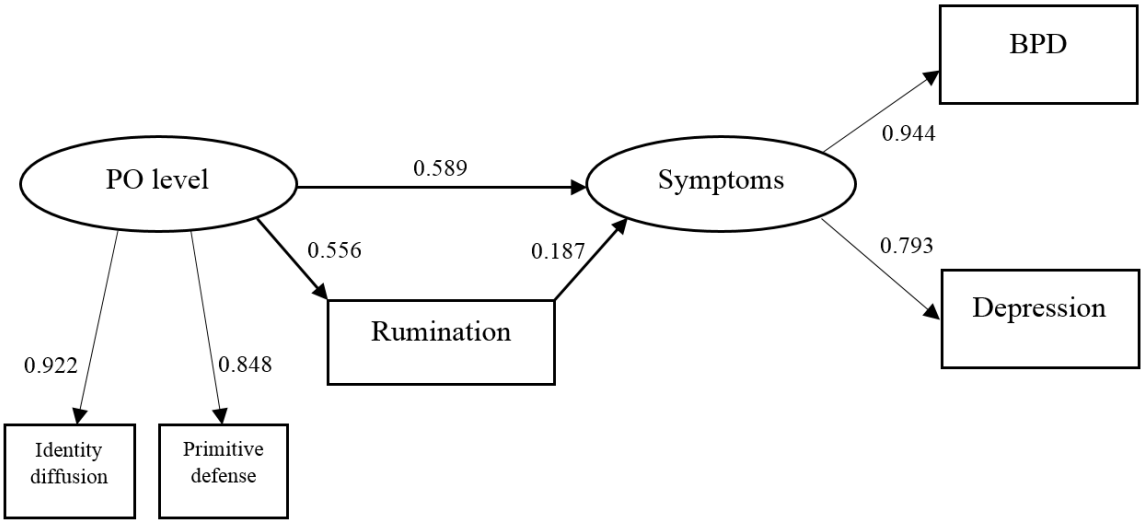


*Figure S8.8. The mediation model of Study 1 and its standardized path coefficients.*
*Note: All drawn paths are significant at p < .001, except between Rumination and Symptoms (p= .124). Gender and age were controlled for in the model. $\chi^2$ = 14.428, df = 9, RMSEA = 0.05 [0.000-0.111], SRMR = 0.045, CFI = 0.989, TLI = 0.975. PO = Personality Organization, BPD = Borderline Personality Disorder.*

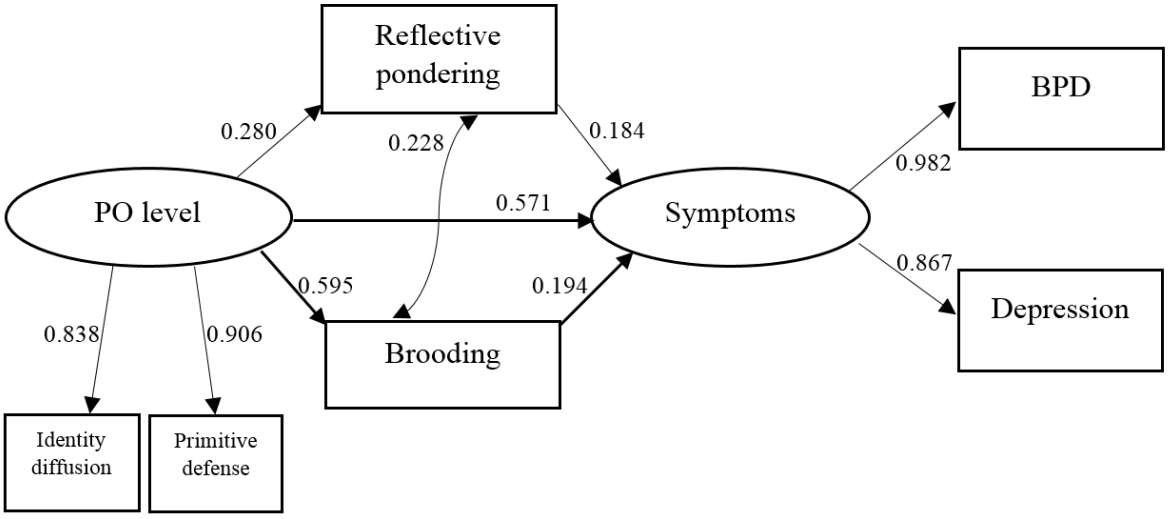


*Figure S8.9. The mediation model of Study 2 and its standardized path coefficients.*
*Note: All drawn paths are significant at p < .001, except between brooding and symptoms (p=.003). Gender and age were controlled for in the model. $\chi^2$ = 31.044, df = 11, RMSEA = 0.084 [0.050-0.119], SRMR = 0.058, CFI = 0.977, TLI = 0.944). PO = Personality Organization, BPD = Borderline Personality Disorder.*