Master's Thesis

Does Trait Mindfulness Play an Influencing Role in the Association Between Trait Rumination and Affective Stress Reactivity?

Mirjam U. Kühne

Department of Behavioural Management and Social Sciences (BMS), University of Twente,

Positive Clinical Psychology & Technology (PCPT)

Dr. T.R. Vaessen (1st Supervisor)

Dr. M. Radstaak (2nd Supervisor)

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Abstract

Background Stress can cause diverse health problems such as depression or fatigue, especially when responses to stress are strong and prolonged. Individuals with increased responses are assumed to have poorer health outcomes compared to less reactive individuals. One possible mechanism that has been found to predict higher reactivity to stress is trait rumination. Furthermore, for people high on trait mindfulness, this association might be reduced. Accordingly, individuals with higher levels of trait mindfulness are more aware of their own inner experiences in the present and pay more attention to them. For people who are more prone to rumination, this awareness might be key in reducing their levels of affective stress reactivity, as they can notice when their ruminative tendencies occur.

Objective The study investigated whether trait mindfulness weakens the association between trait rumination and levels of affective stress reactivity in healthy adults.

Method A modified version of an often-used experimental stress task in healthy volunteers was used to induce psychosocial stress. The analysis was conducted with 53 participants aged between 19 and 32 (M_{age}=23.9*;* 86.8% female). The participants' level of affective stress reactivity was measured through negative affect. Trait rumination was assessed with the rumination subscale of the Cognitive Emotion Regulation Questionnaire and trait mindfulness was assessed with the Five Facets Mindfulness Questionnaire. Multiple linear regression analysis was used to test whether trait mindfulness moderates the association between trait rumination and affective stress reactivity.

Results Trait rumination was marginally significantly associated with affective stress reactivity (β = .24, p = .08). Trait mindfulness was not found to be a significant moderator in the association between trait rumination and affective stress reactivity (β = .97, p = .51).

Conclusion A trend towards significance was found for trait rumination to be related to higher levels of affective stress reactivity. This finding indicates that people who tend to ruminate might be at increased risk for developing health problems due to their increased affective stress reactivity. However, this finding was not statistically significant. Furthermore, trait mindfulness did not play a role in the association between trait rumination and levels of affective reactivity to stress. The generalizability of these findings should be examined with a larger sample.

Does Trait Mindfulness Play an Influencing Role in the Association Between Trait Rumination and Affective Stress Reactivity?

Even though psychological stress is an integral part of everyday life, it has become a major global health concern. More specifically, stress has been identified as a notable cause of diverse health problems such as fatigue, cardiovascular diseases, and depression and can potentially cause suicidal thoughts and self-harming behaviour (Kotera et al., 2021). Stress thus has an impact on health. However, the relationship between stress and health is very complex and results from an interaction of biological, psychological and environmental factors. Due to these factors, individuals respond very differently to stress (Ebner et al., 2017; Nasso et al. 2019). In addition, health outcomes also vary due to individual differences in the strength and frequency of stress responses (Lovallo, 2015; Kiecolt-Glaser et al., 2020; Kühnel et al., 2020). In general, research assumes that individuals with the strongest and most prolonged responses have poorer health outcomes compared to less reactive individuals (Lovallo, 2015). However, to date, the mechanisms and cognitive processes underlying successful and unsuccessful responses remain inadequately understood.

Stress and Affective Stress Reactivity

Stress has not only been a topic of interest to many different professions, like social scientists, medical professionals and psychologists but it also has been defined by many people in different ways (Burman et al., 2018). Early definitions of stress focused on stress either as a *stimulus* and/or as a *response* (Folkman, 2020; Selye, 1957). Stress as a *stimulus*, also known as *stressor*, refers to something that happens to a person such as a loss of a job. Stress as a *response* is marked by negative affect and physiological arousal. Stress as a response is often in support of efforts to manage a stressful event and protect the body from harm (Folkman, 2020; Salomon, 2020).

A disposition that is considered to underlie individual differences in response to stressors is affective stress reactivity. Affective stress reactivity is defined as the tendency or the ability to respond to a particular stressor often characterized by negative affect (Schlotz et al., 2020). According to Turner et al. (2020), dysregulation of affective stress reactivity may be a mechanism by which psychological stress affects physical and mental health over time. Specifically, a strong and prolonged reactivity may predict dangerous long-term physical and mental health outcomes (Lovallo, 2015). Consequently, an increased affective stress reactivity is considered a vulnerability factor for the development of disorders like depression, psychosis, and anxiety (Schlotz, 2020).

To assess affective reactivity, a repeated measures/multiple laboratory-based stressors design has been found to be a reliable method (Velozo et al., 2021). This design enables comparison between sessions as it allows any change in stress reactivity to be attributed to individuals rather than repeated exposure to the same task (Velozo et al. 2021). However, most of the present research has been limited to cross-sectional studies, in which the exposure and outcome coincide, or to subjective measures, which confuse individual stress reactivity with the frequency of stress exposure in everyday life (Kiecolt-Glaser et al., 2020; Schlotz, 2020).

In addition to the importance of a reliable method for assessing affective stress reactivity, it is essential to investigate the underlying mechanisms that influence affective stress reactivity to understand and determine the risk for mental disorders and their development in the long term.

Trait Rumination in Relation to Affective Stress Reactivity

A well-studied psychological construct that has been linked to altering stress responses by increasing/exacerbating negative affect is rumination (Moberly et al., 2008). Rumination includes negative, persistent, and unwanted thoughts that relate to the past and consists of components of depression, anger and emotional upset (Gianferante et al., 2014; Watkins et al., 2020). Rumination can be seen as a ‘reaction-style’; meaning that when people are confronted with a stressful experience, they tend to ruminate about it rather than engage in a different coping style such as distracting themselves from the stressor (Gianferante et al., 2014; Nolen-Hoeksema et al., 2006; Watkins et al., 2020).

Rumination can be conceptualized as a trait and a state. In trait measures, rumination is defined as a dispositional quality or general tendency. In contrast, state measures assess individuals' ruminative responses to specific situations or points in time (Gidron, 2020; Zoccola et al., 2012). Based on present research, that suggests that rumination is a fairly stable coping strategy and that certain individuals are more prone to ruminate than others, the present study assesses rumination as a trait (Key et al., 2008; Moberly et al., 2008; Zoccola et al., 2012). Trait measures of neuroticism or negative affectivity have been associated with the tendency to ruminate. Especially the link between trait neuroticism and trait rumination has been well-established in several studies (Hervas et al, 2011; Denovan et al., 2019; Muris et al., 2005). In a study by Charles et al (2013) neuroticism is a predictor of higher levels of affective stress reactivity. As trait rumination is linked to trait neuroticism and is even assumed to be an “important cognitive manifestation of neuroticism” (Roberts et al.1998,

p.419) it is suggested that people with the predisposition to ruminate also experience increased levels of affective stress reactivity.

Furthermore, Capobianco (2018) already researched the link between trait rumination and stress recovery. More specifically, Capobianco (2018) showed that rumination appears to cause a delay and a prolonged recovery from stress. Prolonged recovery from stress in turn may ultimately contribute to poorer health and disease outcomes (Lovallo et al., 2015). However, to date, it has not been established whether trait rumination predicts not only prolonged stress recovery but also higher affective stress reactivity. Nevertheless, there is a growing body of evidence that trait rumination indeed predicts levels of affective stress reactivity. In a study by Aldao et al., (2014) participants who scored high on trait rumination showed greater negative affect in response to a laboratory-based stressor. This study focused on adolescence and a high proportion of these adolescence had experienced maltreatment during childhood.

As trait rumination has been associated with an increase in negative affect, it is important to investigate whether participants who are prone to ruminate have poorer health or disease outcomes due to increased affective stress reactivity. Such an understanding will allow us to understand the differences in levels of affective stress reactivity that affect individuals' health outcomes,

Trait Mindfulness in Relation to Trait Rumination and Affective Stress Reactivity

While trait rumination has been associated with an increase in negative affect, trait mindfulness has been associated with a decrease in negative affect (Moberly et al., 2008; Raes et al., 2010). Trait mindfulness captures an individual’s disposition toward adopting an open, accepting and non-judgmental attitude towards one’s own present experience rather than trying to control or change it (Carpenter et al., 2019a). Additionally, trait mindfulness has been associated with positive mental health outcomes, including optimism, life satisfaction, and self-esteem (Brown et al., 2003). It has also been shown to have negative correlations with symptoms of anxiety, depression and stress-related symptoms, neuroticism, cognitive reactivity and difficulties in emotion regulation (Bullis et al., 2014).

Furthermore, trait mindfulness has been associated with less affective stress reactivity (Bullis et al., 2014). For instance, Lin et al. (2020), found that male college students who exhibited higher levels of trait mindfulness showed lower stress reactivity to a social appraisal threat. Additionally, Bullis et al. (2014) researched whether mindfulness as a trait predicts less affective stress reactivity while engaging in suppression and they were able to confirm this hypothesis. Moreover, trait mindfulness has also been shown to counteract

ruminative tendencies (Raes et al., 2010). More specifically, individuals with higher trait mindfulness can notice when their mood deteriorates, monitor this mood decline along with their reactive ruminative tendencies, and then shift to a non-ruminative state of mind. By extension, by observing their ruminative tendencies non-judgmentally and immediately examining the bodily sensations that accompany them, people with a high level of mindfulness are aware of their ruminative tendencies at an early stage (Raes et al., 2010). This way, individuals might be able to distance themselves from their ruminative tendencies and decrease their levels of affective reactivity to stress.

Purpose of this study

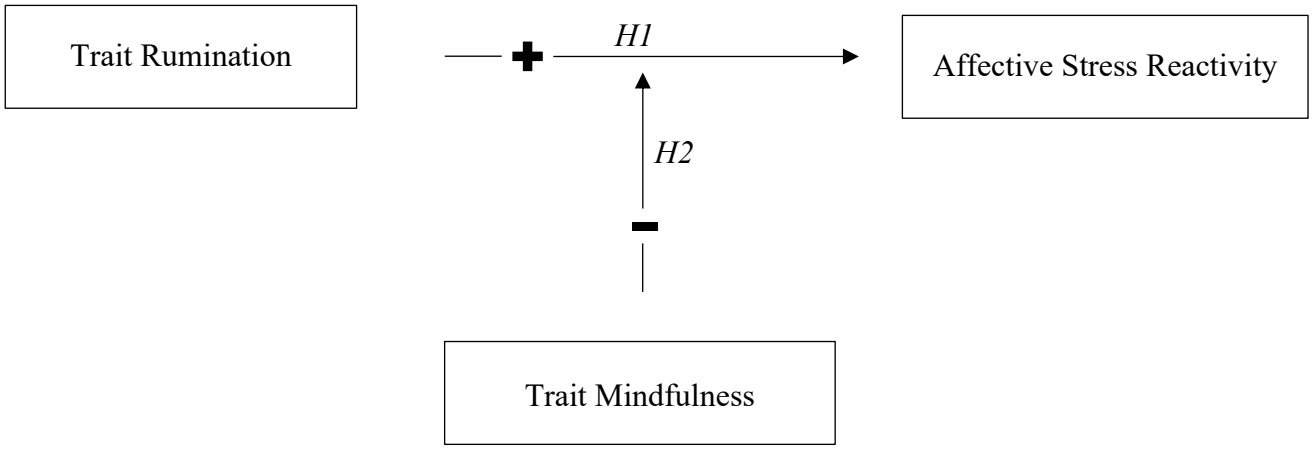
The current study explores if trait mindfulness plays a role in the association between trait rumination and affective stress reactivity. The proposed model is visualized in Figure 1. Based on previous research findings, the two corresponding hypotheses are:

H1: Trait rumination predicts higher levels of affective stress reactivity.

H2: In individuals with higher levels of trait mindfulness, the association between trait rumination and affective stress reactivity is less strong than in individuals with lower levels of trait mindfulness.

Figure 1

The Positive Association Between Trait Rumination and Affective Stress Reactivity, Weakened by Trait Mindfulness



Method

Participants

This study was part of a larger study investigating which factors and mechanisms influence affective stress reactivity and recovery. For this purpose, this study consisted of a secondary analysis of the data retrieved from a study by Velozo et al. 2021, who applied a

modified version of an often-used experimental stress task in healthy volunteers to induce psychosocial stress.

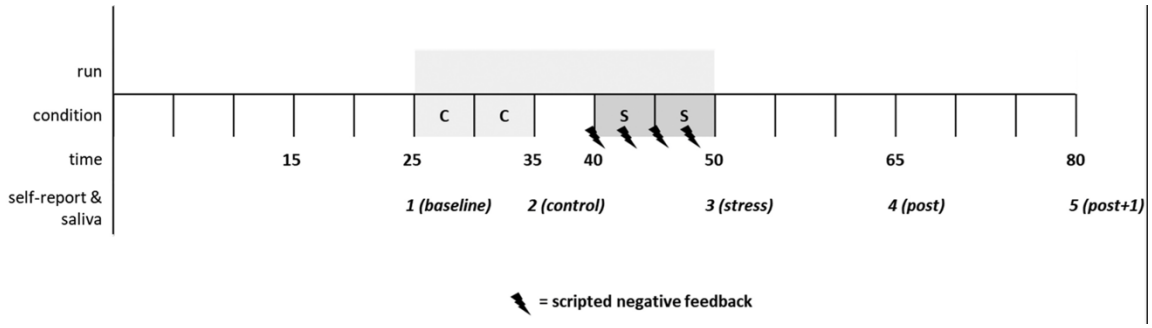
In the study by Velozo et al. 2021, university students from various disciplines (e.g., medicine, biomedical science, history, art, etc.) as well as working adults were included. Additionally, these participants were aged between 19 and 35. As a recruitment method, flyers were distributed throughout the city and published online. Before participating in the study by Velozo et al., 2021, all participants signed an informed consent form and were paid 30€ per session. The study was approved by the KU Leuven's Sociaal-Maatschappelijke Etische Commissie (SMEC) (Velozo et al., 2021).

Procedure

Socio-evaluative stress was induced using the repeated Montreal Imaging Stress Task (rMIST), which is a modified version of the MIST, a psychosocial stress paradigm, which comprises a computerized mental arithmetic task with an induced failure component (Dedovic et al., 2005). To be able to use this task repeatedly in different sessions, the protocol was changed to strengthen the social defeat component and add the element of novelty to each subsequent trial (see Velozo et al. 2021 for details). The study of Velozo et al. 2021 includes two different designs: a single-run design and a multiple-run design. In the present study, the single-run design was used, which is shown in Figure 1.

Figure 1

Single-run Design



Note. This figure was produced by Velozo et al. (2021), showing the rMIST single-run design with C=control, S= stress, with the time from arrival in minutes, the five sampling measures of self-reported stress and saliva samples, and the moments where feedback was given.

Regarding the procedure of the single-run design, first, baseline measurements were taken 25 minutes after the participant's arrival, which is a standard time for the stabilization

of the physiology (Petrowski et al., 2012). In addition to demographic characteristics, baseline measurements included in this study were trait mindfulness and trait rumination. Second, these baseline measurements were followed by a testing phase. The testing phase was composed of a control period, a 300-second rest in between, and a stress exposure, in which participants had to perform a computerized mental arithmetic task. During the testing period, two participants were tested simultaneously in two different rooms. Although there was no direct competition, the participants were told that they were competing against each other. The competitive aspect of the stress condition was required to force participants to exert greater mental effort. Therefore, their performance was a direct indicator of their effort and ability. In addition to the competitive aspect, the experimenter also provided the participant with negative feedback after each stress condition on their performance to improve individual performance. Third, after the testing period, participants were watching a neutral movie for an hour.

The data retrieved from the baseline measures trait rumination and trait mindfulness (e.g. minute 20-25) and from the testing phase to assess affective stress reactivity (e.g. minute 25-50) was used for this study (see Figure 1). Affective stress reactivity, which was assessed through negative affect (NA), was measured seven times during each testing session through questionnaires.

Measures

Trait Rumination

Trait rumination was measured with the rumination subscale of the Cognitive Emotion Regulation Questionnaire (CERQ) (Garnefski et al., 2007). The sub-scale consists of four self-administered items referring to the extent an individual ruminates after the experience of a threatening or stressful life event (Garnefski et al., 2007). Respondents indicated their answers on a 5-point Likert scale ranging from 1 = *almost never* to 5= *almost always*. A sample question was: *"I often think about how I feel about what I have experienced."* Individual scores were obtained by calculating the sum scores (ranging from 4 to 20). Higher scores indicated a greater tendency to use the cognitive strategy of rumination. Cronbach's alpha was calculated for the subscale rumination and was good (α=.86).

Trait Mindfulness

Trait mindfulness was measured using the Five Facets Mindfulness Questionnaire (FFMQ), which is a 39-item self-report measure and consists of five subscales (Observe, Describe, Act with Awareness, Non-judge and Nonreactivity) used to assess an individual's tendency to be mindful in daily life. For the purpose of this study, the full scale is used. The

FFMQ was derived through a factor analysis from five different mindfulness questionnaires, and thus represents an empirically based amalgamation of different overlapping conceptualizations of trait mindfulness (Baer, 2011; Carpenter et al., 2019a; Christopher et al., 2012; Lilja et al., 2011). Items are rated on a 5-point Likert-type scale ranging from 1 (*never* or *very rarely true*) to 5 (*very often* or *always true*). Sample items were: "I pay attention to sensations, such as the wind in my hair or sun on my face." and: "I am good at findings the words to describe my feelings." (Carpenter et a., 2019a). Some items were direct descriptions of the mindfulness component being measured, whereas others described the absence of that component and were reverse scored (Baer et al., 2004). After reverse scoring, the sum score was obtained (Baer et al., 2004). In this study, FFMQ showed good internal consistency with $\alpha = 0.90$.

Affective Stress Reactivity

Affective Stress Reactivity was assessed through NA. NA is composed of two items: *"At the moment, I feel down."* and *"At the moment, I feel annoyed."* These items were rated on a 7-point Likert scale ranging from 1 (*not at all*) to 7 (*extremely*) (Velozo et al., 2021). To compute affective stress reactivity, the self-reported questionnaires for the control condition as well as for the stress condition were used. First, the average score for the stress condition and for the control condition was obtained. To calculate the score for affective stress reactivity the average score of the control condition was subtracted from the average score of the stress condition. Cronbach's alpha values were acceptable $\alpha = .68$.

Data Analysis

Sample and Descriptive Statistics

The analyses were carried out in SPSS 25.0. To handle missing data, the procedural method of pairwise deletion was applied. Next, participants' demographic characteristics, including age, gender, nationality, marital status and employment status, were examined. Additionally, for descriptive statistics, means and standard deviations were computed for the variable's trait rumination, affective stress reactivity and trait mindfulness.

Inferential Statistics

Assumptions. The assumptions of normality, no multicollinearity, independence, homogeneity and linearity were checked. First, the Shapiro-Wilk test was used with a p-value higher than .05 indicating that affective stress reactivity is normally distributed. Second, Pearson's correlation coefficient was computed to check for no multicollinearity between the predictor variables rumination and mindfulness. A value above 0.8 or 0.9 indicates multicollinearity (Franke, 2010). Third, to check for independence, a histogram of residuals

was conducted and compared with a normal curve. Additionally, a normal probability-probability plot (P-P plot) was computed to check whether the standardized residuals showed normally distributed error. Fourth, for linearity and homogeneity, a scatterplot was conducted. For the assumption of linearity to be met, the relationship between the predictor variables trait rumination and trait mindfulness and the dependent variable affective stress reactivity must be linear. Furthermore, regarding homogeneity, the scatterplot of residuals must show equally distributed residuals above and below.

Hypothesis. To test hypothesis 1, that trait rumination predicts higher levels of affective stress reactivity, a simple linear regression was performed. The dependent variable for this analysis was affective stress reactivity and the predictor variable was trait rumination. To control for age and gender, these were added as covariates. To test the second hypothesis**,** whether in individuals with higher levels of trait mindfulness, the association between trait rumination and affective stress reactivity is less strong than in individuals with lower levels of trait mindfulness, a multiple linear regression analysis was performed. The dependent variable for this analysis was affective stress reactivity and the predictor variables were trait rumination and trait mindfulness. To investigate for a possible moderation, the trait rumination*trait mindfulness interaction term was added to the model. Age and gender were added as covariates to control for them.

Results

Sample and Descriptive Statistics

The final sample consisted of 53 participants. The average participant was a female aged 24 with a Belgian citizenship, who is unemployed and in a relationship. Demographics of the total sample can be found in Table 1. Next, participants showed affective reactivity to the task *(M* = 1.38, *SD* = 1.26). Additionally, compared to norm scores trait mindfulness was average (*M* = 131.13, *SD* = 20.25) and participants showed average levels of trait rumination as well (*M* = 13.56, *SD* = 4.24) (Feliu-Soler et al., 2017; Kim et al., 2021). The descriptive statistics for the variables can be found in Table 2.

Table 1

Demographic Characteristics of Participants

	Full sample	
	n	*%*
Gender		
Female	46	86.8

Male	7	13.2
Nationality		
Belgian	46	86.8
Netherland	3	5.7
Greek	1	1.9
Other	3	5.7
Marital status		
In a relationship	31	59.6
Married or living together	9	17.3
Single	12	23.1
Employment status		
Working	21	40.4
Unemployed	31	59.6

Note. $N = 53$. Participants were on average 23.9 years old ($SD = 2.84$).

Table 2

Descriptive Statistics for Variables Affective Stress Reactivity, Trait Rumination and Trait Mindfulness

Variable	*n*	*M*	*SD*	*Scale range*	*Min*	*Max*
Affective Stress Reactivity	53	1.38	1.26	--	-1.5	5.00
Trait Rumination	52	13.56	4.24	4 - 20	4.00	20.00
Trait Mindfulness	52	131.13	20.25	39 - 195	69.00	166.00

Inferential statistics

Assumptions

A Shapiro Wilk value of $p = .25$ for affective stress reactivity indicated normally distributed data. Further, the assumption of no multicollinearity between the predictor variables rumination and mindfulness (r (52) = -.105; p = .46) was met. The histogram and the P-P plot of standardized residuals showed normally distributed errors and the scatterplot of standardized residuals revealed that the data met the assumptions of linearity and homogeneity as well.

Hypothesis Testing

The outcome of the linear regression showed that trait rumination was not significantly associated with affective stress reactivity. However, the results indicated a marginal significance ($\beta = .24$, $p = .08$) (Table 3). Next, to check the second hypothesis, the multiple linear regression analysis showed a non-significant interaction of trait rumination*trait mindfulness on affective stress reactivity ($\beta = .97$, $p = .51$) (Table 3). A scatterplot summarizes the results (Figure 1).

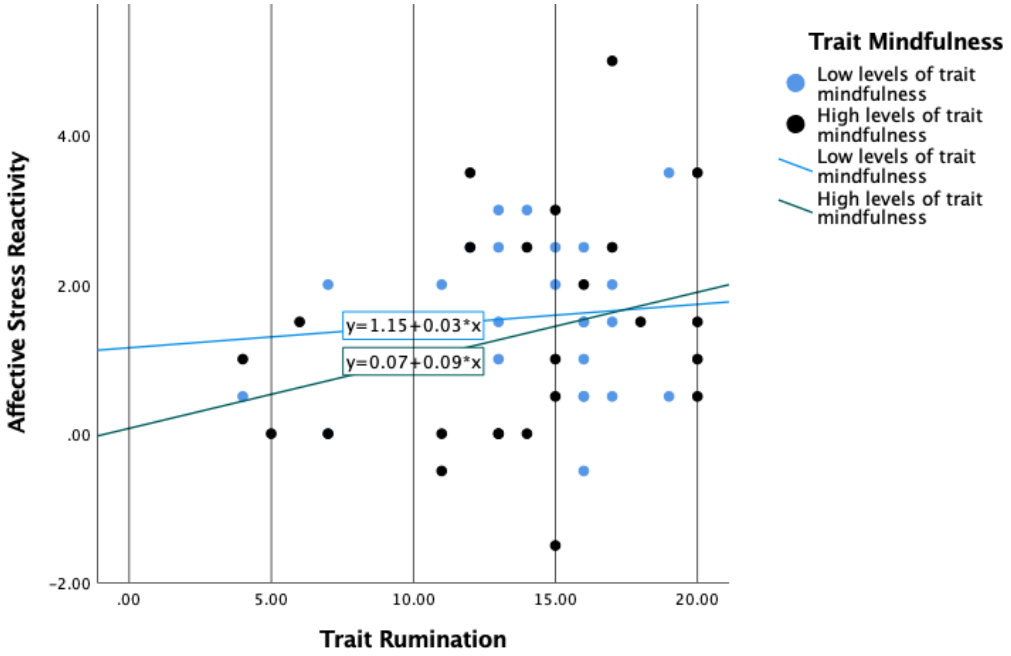
Table 3

Results of Multiple Regression with Dependent Variable Affective Stress Reactivity

Variable	*B*	*SE B*	*β*	*t*	*p*
Trait Rumination	.07	.04	.24	1.78	.08
Trait Mindfulness	-.04	.04	-.57	-.82	.42
Rumination*Mindfulness	.08	.11	.97	.67	.51

Figure 1

Levels of Affective Stress Reactivity as a Function of Trait Rumination by High and Low Levels of Trait Mindfulness



Note. Participants high on trait mindfulness and participants low on trait mindfulness are based on a median split.

Discussion

The current research aimed to investigate whether higher trait rumination predicts higher levels of affective stress reactivity. Additionally, the aim was to evaluate whether the association between trait rumination and affective stress reactivity is less strong in individuals with higher levels of trait mindfulness than in individuals with lower levels of trait mindfulness. Overall, there was evidence for a trend towards a positive association between trait rumination and affective stress reactivity. Further, trait mindfulness did not influence the association between trait rumination and affective stress reactivity.

Theoretical Implications

The Association Between Trait Rumination and Affective Stress Reactivity

The results obtained in this research revealed evidence for a trend towards a positive association between trait rumination and affective stress reactivity. This association was not significant, however, it might still be meaningful due to the relatively small sample in this study. This is in line with previous research that has shown that trait rumination indeed influences heightened affective reactions to psychological stress in adolescents aged between 13-17 (Aldao et al. 2014). Specifically, in a study by Aldao et al. (2014) adolescence who reported high levels of trait rumination responded to a laboratory-based stressor with more negative affect than adolescents who experienced lower levels of trait rumination. Furthermore, previous research has indicated that individuals who are prone to rumination may not be able to engage in proactive anticipation because the individual's cognitive resources are compromised (Nasso et al. 2019). As a result, this leads to increased levels of negative affect and, consequentially, difficulties regulating the stress response.

However, as the association between trait rumination and affective stress reactivity was not significant, it is important to investigate possible explanations for this finding. First, a study by Johnson et al. (2012) differentiates between two types of rumination, namely reflection and brooding. Specifically, reflection has been associated with the tendency to critically consider and reflect (Johnson et al., 2012; Moberly et al., 2008). On the contrary, brooding refers to the tendency to whimsical musing resulting in a frequent activation of stress responses (Johnson et al., 2012). It may be possible that brooding, rather than reflection, predicts higher levels of affective stress reactivity in the present study.

Second, in the present study, rumination was assessed as a trait, not as a state. However, it seems important to consider both aspects as well as possible interactions between state and trait rumination and their influence on levels of affective stress reactivity. Research indicates that states, unlike traits, fluctuate over time depending on the situation the person is in (Horstmann et al., 2020; Schmitt et al., 2020). As a result, because traits are highly stable,

they do not reflect high amounts of situation-specific variance. Therefore, additional information can be gained by assessing state rumination since trait scores reflect only the person whereas state scores reflect persons in a situation (Geiser et al., 2017).

Trait Mindfulness in Relation with Trait Rumination and Affective Stress Reactivity

In this research, trait mindfulness did not moderate the positive association between trait rumination and affective stress reactivity. This was not expected as previous research has highlighted that individuals with higher levels of trait mindfulness have increased awareness and attention to their own inner experiences in the present. This awareness is key in reducing affective stress reactivity in people who are more prone to ruminate, as they can notice when their ruminative tendencies occur (Bullis et al., 2014; Im et al., 2016; Raes et al., 2010).

However, several possible explanations can be found in the literature. First, not trait mindfulness but the amount of mindfulness practice may moderate the relationship between trait rumination and affective stress reactivity. Trait mindfulness is distinct from mindfulness practice, which involves the conscious performance of mindfulness exercises to promote a state of mindfulness (Glomb et al. 2011). Studies show a significant positive relationship between the duration of mindfulness practice (up to 45 minutes per day) and positive physical or psychological health outcomes (Britton, 2019). Therefore, mindfulness training may provide the skills necessary to regulate one's stress response (Lin et al., 2020).

Second, not the levels of trait mindfulness but the differences to what extent participants cope with social evaluation could have influenced the association between trait rumination and levels of stress reactivity. More specifically, during the testing phase of the repeated Montreal Imaging Stress Task (rMIST), participants received negative feedback and negative social comparisons were made. Dickerson et al. (2004) already found that in laboratory settings, when getting evaluated and the task feels uncontrollable while others were present, participants' physiological stress reactivity increased. Still, there are individual differences in the extent to which social evaluation is perceived as stressful (Smith et al., 2020). Therefore, in addition to the stress-inducing task itself, the impact of social evaluation on the individual may have had an influence on the association between trait rumination and affective stress reactivity.

Third, trait mindfulness was assessed through the FFMQ, which includes five different facets of trait mindfulness, namely, observe, describe, act with awareness, non-judge and nonreactivity (Christopher et al., 2012). Even though previous studies emphasize the beneficial effects of mindfulness on stress reduction, the literature suggests that higher levels of monitoring skills, which are measured by the "observing" facet, are associated with

increased levels of negative affect (Britton, 2019; Christopher et al., 2012; Lindsay et al., 2017). Therefore, the need to investigate and distinguish between the individual facets of mindfulness to gain insight into their influence on the association between trait rumination and affective stress reactivity is essential.

Strengths and Limitations

Strengths

This study has several key strengths. First, regarding the study design, it is notable that a well-established laboratory stress protocol under standardized conditions was followed. This enabled to access a high degree of standardization of affective stress reactivity (Kiecolt-Glaser et al., 2020; Schlotz, 2020). In addition, this study provides a stronger form of evidence for possible causality compared to cross-sectional studies where exposure and outcome coincide (Turner et al., 2020). This is due to the temporal sequence between exposure and outcome. For example, in the present study, affective stress reactivity, assessed through negative affect, is measured twice: after the control and after the stress condition.

Limitations

Regarding the quality of the study, some limitations need to be addressed. First, measuring stress responses in laboratory settings may affect the validity. Specifically, laboratory stress paradigms do not necessarily reflect affective stress reactivity in daily life which may limit the ecological validity (Schlotz, 2020). Additionally, the variables of trait rumination and trait mindfulness were assessed simultaneously. As a result, no causal relationship between these variables could have been established and, therefore, have affected the validity (Solem, 2015). Next, even though the rMIST is easy to standardize through its use of a computerized stressor, some difficulties remain in controlling human factors. As an example, regarding the human factor of interaction between participant and researcher, minor changes in body language and tone of voice may lead to different experiences between the participants (Velozo et al 2021).

Future Research

First, further research may benefit from considering state rumination as a possible mechanism influencing levels of affective stress reactivity. For this purpose, the exact content or nature of the participants' rumination before, during or after the testing phase can be assessed. Second, future research should also consider other forms of repetitive negative thinking besides rumination. In this context, Watkins et al. (2020) noted other forms that share the same underlying mechanism as rumination but differ in their concerns and content. For example, whereas rumination is more past-focused, worry is more future-oriented, and

assessing worry could provide additional insights into its impact on levels of affective stress reactivity (Watkins et al., 2020).

Third, a significance at trend level for trait rumination in predicting affective stress reactivity was found. However, the generalisability of this trend significance needs further research. As increases in sample size lead to a higher statistical power, a further suggestion is the replication of this study with a larger sample size (Suresh et al., 2012). Fourth, future research might benefit from differentiating between different types of rumination, namely reflection and brooding. Previous research suggested that brooding, not reflection, is associated with higher levels of negative affect (Moberly et al., 2008). Fifth, the FFMQ measures five different facets of trait mindfulness. As the facet "observe" has been found to influence negative affect, future research should investigate and differentiate between the different facets and their influence on levels of affective stress reactivity.

Sixth, future studies that examine the impact of trait rumination on affective stress reactivity may benefit from using a range of repeated stressors over varying time periods to investigate the generalisability of the findings in this study. As an example, one could include different types of stressors across and within studies and vary the time period between initial exposure and re-exposure to determine whether these variables have an impact on the affective stress reactivity. Moreover, considering that participants in this study were young healthy women and that women are more prone to ruminate, determining whether trait rumination in men has the same association with levels of affective stress reactivity would help to clarify any sex differences in rumination and patterns of levels in stress reactivity (Johnson et al., 2012).

Conclusion

In the present study, a trend towards trait rumination influencing levels of affective stress reactivity was found. Accordingly, people who are prone to ruminate might be at increased risk for health problems due to their increased affective reactivity to stress. This would be consistent with previous research. However, this finding was not significant. Nevertheless, it might still be meaningful due to the relatively small sample of 53 participants. Furthermore, trait mindfulness did not attenuate the association between trait rumination and affective stress reactivity. Future studies should examine the generalizability of these results, possibly with a larger sample. It remains important to investigate trait characteristics or mechanisms that decrease affective stress reactivity to prevent and treat potential health problems.

References

Aldao, A., McLaughlin, K. A., Hatzenbuehler, M. L., & Sheridan, M. A. (2014). The relationship between rumination and affective, cognitive, and physiological responses to stress in adolescents. *Journal of experimental psychopathology*, *5*(3), 272-288. https://doi.org/10.5127%2Fjep.039113

Baer, R. A. (2011). Measuring mindfulness. *Contemporary Buddhism*, *12*(1), 241-261. https://doi.org/10.1080/14639947.2011.564842

Baer, R. A., Smith, G. T., & Allen, K. B. (2004). Assessment of mindfulness by self-report: The Kentucky Inventory of Mindfulness Skills. *Assessment*, *11*(3), 191-206. https://doi.org/10.1177%2F1073191104268029

Britton, W. B. (2019). Can mindfulness be too much of a good thing? The value of a middle way. *Current opinion in psychology*, *28*, 159-165. https://doi.org/10.1016/j.copsyc.2018.12.011

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: mindfulness and its role in psychological well-being. *Journal of personality and social psychology*, *84*(4), 822. https://doi.org/10.1037/0022-3514.84.4.822

Bullis, J. R., Bøe, H. J., Asnaani, A., & Hofmann, S. G. (2014). The benefits of being mindful: Trait mindfulness predicts less stress reactivity to suppression. *Journal of Behavior Therapy and Experimental Psychiatry*, *45*(1), 57-66. https://doi.org/10.1016/j.jbtep.2013.07.006

Burman, R., & Goswami, T. G. (2018). A systematic literature review of work stress. *International Journal of Management Studies*, *3*(9), 112-132. http://dx.doi.org/10.18843/ijms/v5i3(9)/15

Capobianco, L., Morris, J. A., & Wells, A. (2018). Worry and rumination: do they prolong physiological and affective recovery from stress?. *Anxiety, Stress, & Coping*, *31*(3), 291-303. https://doi.org/10.1080/10615806.2018.1438723

Carpenter, J. K., Conroy, K., Gomez, A. F., Curren, L. C., & Hofmann, S. G. (2019a). The relationship between trait mindfulness and affective symptoms: A meta -analysis of the Five Facet Mindfulness Questionnaire (FFMQ). https://doi.org/10.1016/j.cpr.2019.101785

Carpenter, J. K., Sanford, J., & Hofmann, S. G. (2019b). The effect of a brief mindfulness training on distress tolerance and stress reactivity. *Behavior therapy*, *50*(3), 630-645. https://doi.org/10.1016/j.beth.2018.10.003

Charles, S. T., Piazza, J. R., Mogle, J., Sliwinski, M. J., & Almeida, D. M. (2013). The wear and tear of daily stressors on mental health. *Psychological science*, *24*(5), 733-741. https://doi.org/10.1177%2F0956797612462222

Christopher, M. S., Neuser, N. J., Michael, P. G., & Baitmangalkar, A. (2012). Exploring the psychometric properties of the five facet mindfulness questionnaire. *Mindfulness*, *3*(2), 124-131. https://doi.org/10.1007/s12671-011-0086-x

Dedovic, K., Renwick, R., Mahani, N. K., Engert, V., Lupien, S. J., & Pruessner, J. C. (2005). The Montreal Imaging Stress Task: using functional imaging to investigate the effects of perceiving and processing psychosocial stress in the human brain. *Journal of Psychiatry and Neuroscience*, *30*(5), 319-325. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1197276/

Denovan, A., Dagnall, N., & Lofthouse, G. (2019). Neuroticism and somatic complaints: concomitant effects of rumination and worry. *Behavioural and cognitive psychotherapy*, *47*(4), 431-445. https://doi.org/10.1017/S1352465818000619

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. *Psychological bulletin*, *130*(3), 355. https://psycnet.apa.org/doi/10.1037/0033-2909.130.3.355

Ebner, K., & Singewald, N. (2017). Individual differences in stress susceptibility and stress inhibitory mechanisms. *Current Opinion in Behavioral Sciences*, *14*, 54-64. https://doi.org/10.1016/j.cobeha.2016.11.016

Feliu-Soler, A., Reche-Camba, E., Borràs, X., Pérez-Aranda, A., Andrés-Rodríguez, L., Peñarrubia-María, M. T., ... & Luciano, J. V. (2017). Psychometric properties of the Cognitive Emotion Regulation Questionnaire (CERQ) in patients with fibromyalgia syndrome. *Frontiers in psychology*, *8*, 2075. https://doi.org/10.3389/fpsyg.2017.02075

Folkman, S. (2020). Stress: appraisal and coping. In *Encyclopedia of behavioral medicine* (pp. 2177-2179). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-39903-0_215

Franke, G. R. (2010). Multicollinearity. *Wiley international encyclopedia of marketing*. https://doi.org/10.1002/9781444316568.wiem02066

Garnefski, N., & Kraaij, V. (2007). The cognitive emotion regulation questionnaire. *European journal of psychological assessment*, *23*(3), 141-149. https://doi.org/10.1027/1015-5759.23.3.141

Geiser, C., Götz, T., Preckel, F., & Freund, P. A. (2017). States and traits: Theories, models, and assessment. *European Journal of Psychological Assessment*, *33*(4), 219. https://psycnet.apa.org/doi/10.1027/1015-5759/a000413

Gianferante, D., Thoma, M. V., Hanlin, L., Chen, X., Breines, J. G., Zoccola, P. M., & Rohleder, N. (2014). Post-stress rumination predicts HPA axis responses to repeated acute stress. *Psychoneuroendocrinology*, *49*, 244-252. https://doi.org/10.1016/j.psyneuen.2014.07.021

Gidron Y. (2020) Rumination. In: Gellman M.D. (eds) Encyclopedia of Behavioral Medicine. Springer, Cham. https://doi-org.ezproxy2.utwente.nl/10.1007/978-3-030-39903-0_140

Glomb, T. M., Duffy, M. K., Bono, J. E., & Yang, T. (2011). Mindfulness at work. In *Research in personnel and human resources management*. Emerald Group Publishing Limited. https://doi.org/10.1108/S0742-7301(2011)0000030005

Graham, J. R., West, L. M., & Roemer, L. (2013). The experience of racism and anxiety symptoms in an African-American sample: Moderating effects of trait mindfulness. *Mindfulness*, *4*(4), 332-341. https://doi.org/10.1007/s12671-012-0133-2

Hervas, G., & Vazquez, C. (2011). What else do you feel when you feel sad? Emotional overproduction, neuroticism and rumination. Emotion (Washington, D.c.), 11(4), 881–95. https://doi.org/10.1037/a0021770

Horstmann, K. T., & Ziegler, M. (2020). Assessing personality states: What to consider when constructing personality state measures. *European Journal of Personality*, *34*(6), 1037-1059. https://doi.org/10.1002/per.2266

Im, S., & Follette, V. M. (2016). Rumination and mindfulness related to multiple types of trauma exposure. *Translational Issues in Psychological Science*, *2*(4). https://psycnet.apa.org/doi/10.1037/tps0000090

Johnson, J. A., Lavoie, K. L., Bacon, S. L., Carlson, L. E., & Campbell, T. S. (2012). The effect of trait rumination on adaptation to repeated stress. *Psychosomatic medicine*, *74*(3), 258-262. https://doi.org/10.1097/PSY.0b013e31824c3ef2

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: past, present, and future. https://psycnet.apa.org/doi/10.1093/clipsy.bpg016

Key, B. L., Campbell, T. S., Bacon, S. L., & Gerin, W. (2008). The influence of trait and state rumination on cardiovascular recovery from a negative emotional stressor. *Journal of Behavioral Medicine*, *31*(3), 237-248. https://doi.org/10.1007/s10865-008-9152-9

Kiecolt-Glaser, J. K., Renna, M. E., Shrout, M. R., & Madison, A. A. (2020). Stress reactivity: what pushes us higher, faster, and longer—and why it matters. *Current directions in psychological science*, *29*(5), 492-498. https://doi.org/10.1177%2F0963721420949521

Kim, H., Li, N., Broyles, A., Musoka, L., & Correa-Fernández, V. (2021). Validity of the 15-item five-facet mindfulness questionnaire among an ethnically diverse sample of university students. *Journal of American College Health*, 1-11. https://doi.org/10.1080/07448481.2021.1892700

Kotera, Y., Dosedlova, J., Andrzejewski, D., Kaluzeviciute, G., & Sakai, M. (2021). From Stress to Psychopathology: Relationship with Self-Reassurance and Self-Criticism in Czech University Students. *International Journal of Mental Health and Addiction*, 1-12. https://doi.org/10.1007/s11469-021-00516-z

Kühnel, A., Kroemer, N. B., Elbau, I. G., Czisch, M., Sämann, P. G., Walter, M., & Binder, E. B. (2020). Psychosocial stress reactivity habituates following acute physiological stress. *Human brain mapping*, *41*(14), 4010-4023. https://doi.org/10.1002/hbm.25106

Lilja, J. L., Frodi-Lundgren, A., Hanse, J. J., Josefsson, T., Lundh, L. G., Sköld, C., & Broberg, A. G. (2011). Five facets mindfulness questionnaire—reliability and factor structure: a Swedish version. *Cognitive behaviour therapy*, *40*(4), 291-303. https://doi.org/10.1080/16506073.2011.580367

Lin, J., Massar, S. A., & Lim, J. (2020). Trait mindfulness moderates reactivity to social stress in an all-male sample. *Mindfulness*, *11*(9), 2140-2149. https://doi.org/10.1007/s12671-020-01422-6

Lindsay, E. K., & Creswell, J. D. (2017). Mechanisms of mindfulness training: Monitor and Acceptance Theory (MAT). *Clinical psychology review*, *51*, 48-59. https://doi.org/10.1016/j.cpr.2016.10.011

Lovallo, W. R. (2015). Can exaggerated stress reactivity and prolonged recovery predict negative health outcomes? The case of cardiovascular disease. *Psychosomatic Medicine*, *77*(3), 212-214. https://doi/10.1097/PSY.0000000000000173

Moberly, N. J., & Watkins, E. R. (2008). Ruminative self-focus and negative affect: an experience sampling study. *Journal of abnormal psychology*, *117*(2), 314. https://psycnet.apa.org/doi/10.1037/0021-843X.117.2.314

Muris, P., Roelofs, J., Rassin, E., Franken, I., & Mayer, B. (2005). Mediating effects of rumination and worry on the links between neuroticism, anxiety and

depression. *Personality and Individual Differences*, *39*(6), 1105-1111. https://doi.org/10.1016/j.paid.2005.04.005

Nasso, S., Vanderhasselt, M. A., Demeyer, I., & De Raedt, R. (2019). Autonomic regulation in response to stress: The influence of anticipatory emotion regulation strategies and trait rumination. *Emotion*, *19*(3). https://doi.org/10.1037/emo0000448

Ottaviani, C., Thayer, J. F., Verkuil, B., Lonigro, A., Medea, B., Couyoumdjian, A., & Brosschot, J. F. (2016). Physiological concomitants of perseverative cognition: A systematic review and meta-analysis. *Psychological bulletin*, *142*(3), 231. https://psycnet.apa.org/doi/10.1037/bul 0000036

Petrowski, K., Wintermann, G. B., & Siepmann, M. (2012). Cortisol response to repeated psychosocial stress. *Applied psychophysiology and biofeedback*, *37*(2), 103-107. https://doi.org/10.1007/s10484-012-9183-4

Raes, F., & Williams, J. M. G. (2010). The relationship between mindfulness and uncontrollability of ruminative thinking. *Mindfulness*, *1*(4), 199-203. https://doi.org/10.1007/s12671-010-0021-6

Roberts, J. E., Gilboa, E., Gotlib, I. H. (1998). Ruminative response style and vulnerability to episodes of dysphoria: gender, neuroticism, and episode duration. Cognitive Therapy and Research, 22(4), 401–423. https://doi.org/10.1023/A:1018713313894

Sala, M., Rochefort, C., Lui, P. P., & Baldwin, A. S. (2020). Trait mindfulness and health behaviours: A meta-analysis. *Health psychology review*, *14*(3), 345-393. https://doi.org/10.1080/17437199.2019.1650290

Salomon K. (2020) Stress. In: Gellman M.D. (eds) Encyclopedia of Behavioral Medicine. Springer, Cham. https://doi-org.ezproxy2.utwente.nl/10.1007/978-3-030-39903-0_285

Schlotz W. (2020) Stress Reactivity. In: Gellman M.D. (eds) Encyclopedia of Behavioral Medicine. Springer, Cham. https://doi-org.ezproxy2.utwente.nl/10.1007/978-3-030-39903-0_64

Schmitt, M., & Blum, G. S. (2020). State/Trait Interactions. *Encyclopedia of Personality and Individual Differences*, 5206-5209. https://doi.org/10.1007/978-3-319-24612-3_1922

Selye, H., & Lebensohn, J. E. (1957). The stress of life. *American Journal of Ophthalmology*, *43*(2), 315–316. https://doi.org/10.1016/0002-9394(57)92956-2

Sin, N. L., Graham-Engeland, J. E., Ong, A. D., & Almeida, D. M. (2015). Affective reactivity to daily stressors is associated with elevated inflammation. *Health Psychology*, *34*(12), 1154. https://psycnet.apa.org/doi/10.1037/hea0000240

Smith, A. R., Nelson, E. E., Kircanski, K., Rappaport, B. I., Do, Q. B., Leibenluft, E., & Jarcho, J. M. (2020). Social anxiety and age are associated with neural response to social evaluation during adolescence. *Developmental cognitive neuroscience*, *42*, 100768. https://doi.org/10.1016/j.dcn.2020.100768

Suresh, K. P., & Chandrashekara, S. (2012). Sample size estimation and power analysis for clinical research studies. *Journal of human reproductive sciences*, *5*(1), 7. https://doi.org/10.4103%2F0974-1208.97779

Solem, R. C. (2015). Limitation of a cross-sectional study. *American Journal of Orthodontics and Dentofacial Orthopedics*, *148*(2), 205. https://doi.org/10.1016/j.ajodo.2015.05.006

Turner, A. I., Smyth, N., Hall, S. J., Torres, S. J., Hussein, M., Jayasinghe, S. U., & Clow, A. J. (2020). Psychological stress reactivity and future health and disease outcomes: A systematic review of prospective evidence. *Psychoneuroendocrinology*, *114*, 104599. https://doi.org/10.1016/j.psyneuen.2020.104599

Velozo, J. D. C., Vaessen, T., Pruessner, J., Van Diest, I., Claes, S., & Myin-Germeys, I. (2021). The repeated Montreal Imaging Stress Test (rMIST): Testing habituation, sensitization, and anticipation effects to repeated stress induction. *Psychoneuroendocrinology*, *128*, 105217. https://doi.org/10.1016/j.psyneuen.2021.105217

Watkins, E. R., & Roberts, H. (2020). Reflecting on rumination: Consequences, causes, mechanisms and treatment of rumination. *Behaviour Research and Therapy*, *127*, 103573. https://doi.org/10.1016/j.brat.2020.103573

Zoccola, P. M., & Dickerson, S. S. (2012). Assessing the relationship between rumination and cortisol: A review. *Journal of psychosomatic research*, *73*(1), 1-9. https://doi.org/10.1016/j.jpsychores.2012.03.007