Resilience to Stress: The Effect of Subclinical Psychopathology and State Rumination on Affective Stress Recovery

Kara Tönsmeier

2103869

Positive Clinical Psychology and Technology

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1st Supervisor: Dr. Thomas Vaessen

2nd Supervisor: Dr. Matthijs L. Noordzij

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Abstract

Background. To prevent stress from negatively impacting mental health, successful affective stress recovery is essential. Existing studies pointed to an association between psychopathology and delayed affective recovery from daily stressors. It was suggested that delayed stress recovery may indicate a risk for mental illness before it manifests, underscoring a possible influence of subclinical psychopathology on stress recovery. Yet, laboratory studies examining this association in a controlled environment are scarce. Furthermore, maladaptive emotion regulation strategies were associated with delayed stress recovery. It remains questionable whether rumination following a stressor (i.e., state rumination) amplifies the potential relationship between subclinical psychopathology and affective stress recovery. **Objective.** The purpose of the present study was to examine whether subclinical psychopathology predicts slower affective stress recovery and whether state rumination plays a moderating role within that association. **Method**. A sample of 53 participants aged between 19 and 35 years completed the repeated Montreal Imaging Stress Test (rMIST). Before the task, the participant's level of subclinical psychopathology was assessed using the SCL-90-R. Negative affect was measured at five different time points (i.e., after the baseline, control, stress, and recovery phase). State rumination was assessed during the recovery phase. **Results.** The results of a multiple regression analysis revealed no significant effect of subclinical psychopathology on affective stress recovery. The moderation analysis resulted in a non-significant interaction effect. **Conclusion.** Neither the hypothesis that subclinical psychopathology predicts delayed affective stress recovery nor the hypothesis that this relationship is moderated by state rumination was supported by the research findings. Future studies with a more representative sample and a higher degree of subclinical psychopathology are required to replicate the results. Moreover, state rumination should be considered as a mediator in future research.

Keywords: Stress, affective stress recovery, subclinical psychopathology, state rumination, laboratory stress task

Resilience to Stress: The Effect of Subclinical Psychopathology and State Rumination on Affective Stress Recovery

Stress is ubiquitous in our society and, according to the World Health Organization (WHO), one of the major health threats of the 21st century (Heinrichs et al., 2015). Especially prolonged and chronic stress contribute to the development of psychological, psychosomatic, and somatic disorders (e.g., Cohen et al.,2007; Miller et al., 2009; Segerstrom & Miller, 2004). One of the most important variables that prevent stress from negatively impacting mental health is successful affective and physiological recovery from stress (Waugh et al., 2008). Yet, little is known about the factors that influence an individual's affective stress recovery. Previous daily-life research suggested a link between psychopathology and delayed affective stress recovery (e.g., De Calheiros Velozo et al., 2022; Vaessen et al., 2019). It appears that delayed recovery from stress may be indicative of the development of psychopathology, emphasizing the significance of examining the effect of subclinical psychopathology on affective stress recovery. Furthermore, maladaptive emotion regulation strategies, such as rumination, that an individual employs in response to stressful events negatively influence stress recovery (Capobianco et al., 2018). It remains of interest whether state rumination strengthens the relationship between subclinical psychopathology and affective stress recovery.

Affective Stress Recovery

Stress is regarded to be an adaptive process that temporarily promotes homeostasis but is harmful to health when it occurs frequently or for an extended period of time (McEwen, 2017). Generally, stress results from a threat to an individual's physiological and/or psychological integrity that requires an adaptive physiological, behavioural, emotional, and cognitive response (Heinrichs et al., 2015). The magnitude of the stress response is determined by an integration of the individual's psychobiological stress response, subjective evaluation of the threat, and assessment of available coping resources. Thus, stress represents a short-term imbalance between perceived stress demands and available regulatory resources (Heinrichs et al., 2015). Chronic stress occurs when the adaptive response is ineffective in coping with the stressor and the imbalance persists (Heinrichs et al., 2015). In particular, prolonged exposure to stress can sensitize the stress system, leading to exaggerated responses to minor stressors, which in turn promotes the development of psychological disorders (Collip et al., 2007; Harkness et al., 2015). One of the most important variables that prevent stress from negatively impacting mental and physical health is successful physiological and

affective recovery from stress (Waugh et al., 2008), which can be defined as a relatively rapid and/or complete return to baseline levels from a previous activation level (Brosschot et al., 2006; McEwen, 1998). Regarding the affective stress response, a distinction can be made between positive and negative affective states (Diener & Emmons, 1984; Watson, 2000). Positive affect reflects feelings such as enthusiasm, interest, and satisfaction, whereas negative affect is characterized by feelings such as nervousness, irritation, tension, and guilt (Peeters et al., 2003). According to studies using snapshot techniques, minor stressful events in everyday life are associated with mood changes, with positive affect decreasing and negative affect increasing (e.g., Marco et al., 1999; Myin-Germeys et al., 2003; Peeters et al., 2003; Smyth et al., 1998; van Eck et al., 1998). Ideally, this affective stress response is followed by a rapid return to pre-stress levels. Individuals who require more time to recover from a stressor are likely to be exposed to the deleterious effects of stress for a longer period, which exacerbates the negative health effects (De Calheiros Velozo et al., 2022). This emphasizes the significance of examining the mechanisms underlying affective stress recovery.

Different methodologies, ranging from experimental designs, where stress is generated in the laboratory, to the experience sampling method (ESM), where data is collected via electronic diaries in everyday life, can be used to examine stress recovery. Using ESM, the time course of the stress recovery phase can be mapped by taking a series of snapshots in a natural environment throughout the day (Vaessen et al., 2019). Crucially, these measures cannot fully describe stress trajectories until they can capture the onset, peak, and recovery of responses to everyday events (Epel et al., 2018). Experimental laboratory studies, on the other hand, provide the opportunity to gain more detailed insight into the recovery phase. Because the use of laboratory stressors allows for a high temporal resolution of the stress phase, researchers can accurately determine the time course of stress responses before, during, and after the onset of the stressor (Crosswell & Lockwood, 2020). Yet, experimental laboratory research has been scarce in the context of affective stress recovery and underlying mechanisms.

Subclinical Psychopathology

One potential factor influencing an individual's stress recovery is subclinical psychopathology (Kuranova et al., 2020). Commonly, the term "subclinical" is used to describe the early stages of a disease process (Ji, 2012). Symptoms are present but not severe or persistent enough to warrant a diagnosis. In particular, in the context of stress recovery,

examining subclinical levels of psychopathology appears to be essential, as delayed recovery from stress may signal risk for mental illness before these manifest (Kuranova et al., 2020). This highlights the importance of examining the relationship between subclinical psychopathology and affective stress recovery.

Previous research pointed to an association between mental illness and slower affective stress recovery. Accordingly, results from a laboratory study by Sanchez et al. (2013) demonstrated that individuals with depression showed delayed affective stress recovery. Furthermore, evidence from daily life studies indicated that (subclinical) psychopathology affects an individual's affective recovery from stress. An ESM study conducted by Vaessen et al. (2019), examined the speed of affect recovery from daily stressors in groups displaying different levels of psychopathology. Results showed that individuals in early stages of psychosis display a slower speed of affect recovery compared to healthy individuals and individuals in advanced stages of psychosis. Another recent ESM study by De Calheiros Velozo et al. (2022) found that affective stress recovery from daily stressors appears to be slower in individuals at risk for depression compared to the speed of affective stress recovery in healthy individuals. Moreover, results from an ESM study conducted by Kuranova et al. (2020) showed that individuals in subclinical stages of mental illness show delayed affective recovery from small daily life perturbations. Furthermore, slower recovery was shown to predict the future development of psychopathology (Kuranova et al., 2020). In fact, results from a one-year follow-up study showed that individuals with subclinical psychopathology whose symptoms increased over the year required, on average, additional 90 minutes to recover from stress compared to individuals whose symptoms remained unchanged.

These research findings, which suggest that individuals in the early stages of mental illness show delayed affective recovery from stress and that slower recovery may predict the development of psychopathology in the future (Kuranova et al., 2020), underscore the importance of more thoroughly investigating the influence of overall levels of subclinical psychopathology on affective stress recovery. Moreover, besides the ESM studies, there are no experimental laboratory studies examining a possible relationship between subclinical psychopathology and affective stress recovery in a controlled environment.

State Rumination

A second mechanism that potentially affects an individual's affective stress recovery is rumination. Research has shown that the emotion regulation strategies (e.g., rumination)

that individuals employ during and after stressful situations play an important role in recovery from a stressful event (Capobianco et al., 2018). Generally, rumination can be conceptualized as a dysfunctional response strategy involving repetitive and passive thinking about one's negative feelings and the circumstances that caused them (e.g., Nolen-Hoeksema et al., 2008). Rumination differs from problem-solving in that the repetitiveness of thoughts is nonconstructive and associated with negative affect and does not lead to an action that alters the circumstance (Gerin et al., 2006). It can be distinguished between state and trait rumination. Trait rumination refers to an individual's general tendency to ruminate after a stressor (personality trait) and state rumination refers to the act of ruminating following a stressor (Key et al., 2008).

In numerous studies, rumination has been associated with the onset and maintenance of a number of mental disorders (Aldao et al., 2010; Nolen-Hoeksema & Watkins, 2011; Nolen-Hoeksema et al., 2008). Consequently, rumination was identified as a transdiagnostic pathological process. A process that is evident in various mental disorders and causally contributes to their onset and maintenance (Ehring & Watkins, 2008; Nolen-Hoeksema & Watkins, 2011). For this reason, the determinants of a ruminative response style have been increasingly studied. A particular focus in this context is exposure to stress. Although a stressor is often experienced transiently, it triggers a cascade of negative cognitions and emotions that create a mental image of the stressor (Gerin et al., 2012). Ruminating on this mental image of the stressful event can trigger autonomic activity similar to the response to the original stressor. Due to the role of rumination in maintaining amygdala activation in response to negative emotional information (Ray et al., 2005; Siegle et al., 2002), it is likely that rumination is linked to prolonged periods of negative affect after stressful events (Morrow & Nolen-Hoeksema, 1990; Nolen-Hoeksema & Morrow, 1993; Nolen-Hoeksema et al., 1993). Results from several studies confirmed this conjecture, showing that individuals who habitually ruminate (i.e., trait rumination) exhibit higher emotional responses to stress and/or have more persistent negative affect than individuals who do not ruminate (see review Nolen-Hoeksema et al., 2008). Congruently, the results of a study by Aldao et al. (2014) showed that adolescents who reported high levels of trait rumination experienced greater negative affect and slower physiological recovery in response to a standardized laboratory-based stressor than adolescents who habitually ruminate less. Lines of research that examined the effects of experimentally manipulated rumination (i.e., state rumination) also confirmed that participants who were instructed to ruminate exhibited increased intensity and longer duration of negative mood (for a review, see Nolen-Hoeksema et al., 2008).

As mentioned previously, the use of emotion regulation strategies such as rumination in response to a stressor influence an individual's stress recovery. Since rumination is likely to influence the intensity and duration of negative affect following a stressor (Nolen-Hoeksema et al., 2008), it is assumed that individuals who actively ruminate (i.e., state rumination) following a stressor will experience longer periods of negative affect than individuals who do not ruminate. For this reason, it is proposed that state rumination may strengthen a possible link between subclinical psychopathology and affective stress recovery.

The Present Study

The present study aims to investigate whether subclinical psychopathology is associated with delayed affective stress recovery following a laboratory stressor. In addition, it will be examined whether state rumination strengthens the potential link between subclinical psychopathology and affective stress recovery. In the present study, an experimental laboratory stress task is used to elicit a stress response and examine an individual's immediate affective stress recovery. Accordingly, individuals from a nonclinical sample without a psychiatric diagnosis are asked to perform the repeated Montreal Imaging Stress Test (rMIST), a modified version of a commonly used experimental stress task that induces psychosocial stress (De Calheiros Velozo et al., 2021).

The overarching research question examined in this study is formulated as follows: *"What is the between-person association between subclinical psychopathology and momentary affective stress recovery following a laboratory stress task and does state rumination play a moderating role in this association?"*

Two hypotheses are tested to provide an answer to the research question:

Hypothesis 1 (H1): Individuals with higher levels of subclinical psychopathology show a slower affective stress recovery within 15 minutes after the stress task.

Hypothesis 2 (H2): Individuals with higher levels of subclinical psychopathology who ruminate in response to the stress task show a slower affective stress recovery within 15 minutes after the task than individuals with higher levels of subclinical psychopathology who do not ruminate.

Methods

Design

This study comprised a secondary analysis of the data gathered by De Calheiros Velozo et al. (2021). The original study utilized the repeated Montreal Imaging Stress Test (rMIST) within two studies to test habituation, sensitisation, and anticipation effects to

repeated stress induction. The first study utilized a single-run design, meaning one stress exposure per session. Using this data set a potential influence of subclinical psychopathology and state rumination on affective stress recovery was investigated.

Participants

Participants were recruited via convenience sampling. Flyers were distributed in the city as well as shared online. Participation was rewarded with 30 Euros. Eligibility criteria required participants to be aged between 18 and 35 years and to have a sufficient command of the Dutch language. Furthermore, all participants were required to provide informed consent. Exclusion criteria included a history of endocrine or cardiovascular diseases, chronic or ongoing use of medications (except birth control pill), use of illegal drugs in the past three months, allergy to conductive gels and specific patches, as well as working night shifts. The study obtained ethical approval from the Sociaal-Maatschappelijke Etische Commissie (SMEC) of KU Leuven.

Procedure

The participants were unaware of the purpose of the study. They were informed that the study was about mental effort. During the first 25 minutes after their arrival, participants were required to complete a baseline questionnaire (De Calheiros Velozo et al., 2021). This included several demographic items (e.g., age gender, nationality) as well as a measurement regarding the participant's level of subclinical psychopathology. Thereafter, the actual task phase began. The task phase was divided into three parts: a control phase, a break, and a stress period. One run involved 600 seconds of control and 600 seconds of stress, with a 300-second break in between. Furthermore, a mood questionnaire assessing the participant's negative affect was administered after the baseline, control, stress, and recovery condition. An item measuring state rumination in response to the stress task was completed during the recovery condition.

To induce socio-evaluative stress, the repeated Montreal Imaging Stress Test (rMIST) was utilized (De Calheiros Velozo et al., 2021). The rMIST is a modified version of the MIST, an arithmetic task during which the participant feels compelled to perform well (Dedovic et al., 2005). Using a computer application, the participant was presented with a mental arithmetic task, a button to enter the solution, a text box with feedback on the solution ("correct," "incorrect," or "timeout"), and two performance indicators, one for the participant's performance and one for the average performance of all participants (Dedovic et al., 2005). In contrast to the original procedure, in this study, two participants were assessed simultaneously

and informed that they would be competing against each other. Instead of the original performance indicators, the two arrows were marked with the participants' names and the monitor bar indicated the participant's performance compared to their opponent's performance. In reality, there was no direct competition between the two participants, and the task was manipulated so that each participant performed worse compared to their opponent (De Calheiros Velozo et al., 2021). The competitive nature of the stress condition was considered as required to motivate participants to exert increased mental effort, with their performance serving as a direct reflection of their effort and talents. Furthermore, participants were provided with scripted negative feedback throughout the stress period. Similar to the traditional MIST, feedback was formulated to encourage participants to improve their performance. During the session, feedback was delivered four times (De Calheiros Velozo et al., 2021). After the task phase, participants were instructed to stay in the room for an hour and to watch a neutral muted film. To reduce the influence of circadian fluctuations, laboratory sessions were conducted between 1 and 3 pm.

Measures

Subclinical Psychopathology (SCL-90-R)

To assess symptoms indicative of psychopathology, the Symptom Checklist-90-R (SCL-90-R) was administered. The SCL-90-R is a multidimensional self-report inventory used to measure the extent to which an individual was affected by psychopathological symptoms and distress during the past week (Derogatis, 1994). Nine symptom dimensions (i.e., somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety hostility, phobic anxiety, paranoid ideation, and psychoticism) are assessed. The questionnaire consists of 90 items measured on a five-point Likert scale ranging from 0 (not at all) to 4 (extremely). A General Severity Index (GSI) can be obtained by averaging the scores of all items (Rytilä-Manninen et al., 2016). The GSI serves as an overall measure of psychiatric distress. In this study, the SCL-90-R demonstrated excellent internal consistency with a Cronbach's alpha of .97.

State Rumination

To measure state rumination in response to the stress task, participants were asked to complete the item "Right now, I keep thinking about my feelings and problems" during the recovery phase following the rMIST. The item was measured on a seven-point Likert scale ranging from 1 (not at all) to 7 (extremely).

State Affect and Affective Stress Recovery

To assess negative affect, the participants were asked to complete self-questionnaires. The measure was composed of the following five mood items “I feel annoyed”, “I feel down”, “I feel tensed”, “I feel restless”, and “I feel under pressure”. Items were rated on a seven-point Likert scale ranging from 1 (not at all) to 7 (extremely). The scale demonstrated good internal consistency with a Cronbach’s alpha of .84. To assess an individual’s affective stress recovery a new variable was constructed by subtracting the mean of the NA items measured during recovery from the average of the NA items during the stress condition. Higher positive scores indicated faster recovery.

Data Analysis

All analyses were carried out using IBM SPSS Statistics, version 25. Prior to conducting statistical analyses, the data set was screened for missing data. Thereafter, descriptive statistics (i.e., frequency and per cent) were computed for the demographic as well as study variables (i.e., mean, standard deviation, minimum and maximum scores). Next, the assumptions of a multiple linear regression were checked. To verify whether the rMIST was effective in eliciting socio-evaluative stress, a manipulation check was conducted. Thus, paired sample t-tests were executed to evaluate whether the rMIST was able to significantly change the participants' affect.

In order to test hypothesis one, a multiple linear regression analysis was conducted. By employing a multiple regression, it can be determined whether the independent variable subclinical psychopathology predicts slower affective stress recovery. In order to control for potential confounding effects of age and gender, the variables were added as covariates. To examine the second hypothesis, a standardized interaction effect was added to a multiple regression analysis. Thereby it was tested whether state rumination moderates the relationship between subclinical psychopathology and affective stress recovery. Furthermore, age and gender were added as covariates.

Results

A total sample of 58 participants was recruited. Five participants were excluded from the analyses as they did not complete the self-report questionnaires measuring negative affect.

Descriptive Statistics

To obtain an overview of the participant’s demographic characteristics, frequencies and percentages of the demographic variables were calculated. Participants were aged

between 19 and 35 years (*M* = 23.94, *SD* = 3.03). 60 per cent of the participants were university students and 40 per cent were working adults. Further demographic characteristics are displayed in table 1. Descriptive statistics of the study variables are displayed in table 2. To be noted is that the sample in the present study can be classified as a healthy community sample according to the GSI mean values, as no elevated scores of subclinical psychopathology were observed.

Table 1

Demographic characteristics of the participants (N=53).

Variable	Category	Frequency	Percent
Sex	Male	7	13.2
	Female	46	86.8
Nationality	Belgian	46	86.8
	Dutch	3	5.7
	Other	4	7.6
Marital Status	Single	12	22.6
	In a Relationship	31	58.5
	Married or domestic partnership	9	17.0
Work	Working	21	39.6
	Student	32	58.5

Table 2

Descriptive Statistics Study Variables.

Variable	*n*	*M*	*SD*	*Min.*	*Max.*
GSI	53	.63	.43	.10	1.96
State Rumination	53	4.15	1.34	1	7
Affective Recovery	53	1.7	1.27	-.60	5.40

Assumption Testing

An analysis of the standard residuals showed that the data contained no outliers (Std. Residual Min = -1.69, Std. Residual Max = 2.94). Tests to check the absence of multicollinearity indicated that multicollinearity was not a concern. The assumption of independent errors was met (Durbin-Watson value = 1.79). The results of a Kolmogorov Smirnov test and Shapiro-Wilk test indicated a normal distribution of the dependent variable. The normal P-P plot of standardised residuals, as well as the histogram of standardised residuals, demonstrated that the data had approximately normally distributed errors. Lastly, the scatterplot of standardised residuals showed that the data met the assumptions of homogeneity of variance and linearity.

Manipulation Check

A paired-samples t-test was conducted to compare the mean values of negative affect (NA) during the control and stress condition. Pairwise comparisons showed a significant NA difference between the control (M = 2.13, SD = .92) and stress condition (M = 3.71, SD = 1.48), $t(52) = -9.87$, $p < .001$. A second pairwise comparison demonstrated a significant NA difference in the stress (M = 3.71, SD = 1.48) and recovery condition (M = 1.94, SD = 1.14), $t(52) = 10.15$, $p < .001$.

Hypothesis Testing

Hypothesis one claimed that "*Individuals with higher levels of subclinical psychopathology show a slower affective stress recovery within 15 minutes after the stress task*". A multiple regression was calculated to predict affective stress recovery based on subclinical psychopathology. The results revealed no significant effect of subclinical psychopathology on affective stress recovery ($R^2 = .07$, $F(3,49) = 1.28$, $p = .297$). Thus, the first hypothesis needed to be rejected. The results are displayed in table 3.

Table 3

Multiple Regression Analysis of Affective Stress Recovery, Subclinical Psychopathology (GSI), and Covariates (N=53).

			95% CI		
Effect	Estimate	SE	Lower	Upper	p
Constant	-.94	1.42	-3.80	1.93	.51

GSI	-.06	.42	-.91	.79	.88
Age	.11	.06	-.00	.23	.06
Gender	.00	.53	-1.05	1.07	.99

Note. Model Significance: R^2 = .07, F(3,49) = 1.28, p = .291

In order to test hypothesis two, *"Individuals with higher levels of subclinical psychopathology who ruminate in response to the stress task show a slower affective stress recovery within 15 minutes after the task than individuals with higher levels of subclinical psychopathology who do not ruminate*" an interaction effect was added to a multiple regression analysis. The results showed that momentary engagement in rumination did not moderate the effect of subclinical psychopathology on affective recovery (R^2 = .10, F(5,47) = 1.03, p = .409). Hence, hypothesis two needed to be rejected. The results are displayed in table 4.

Table 4

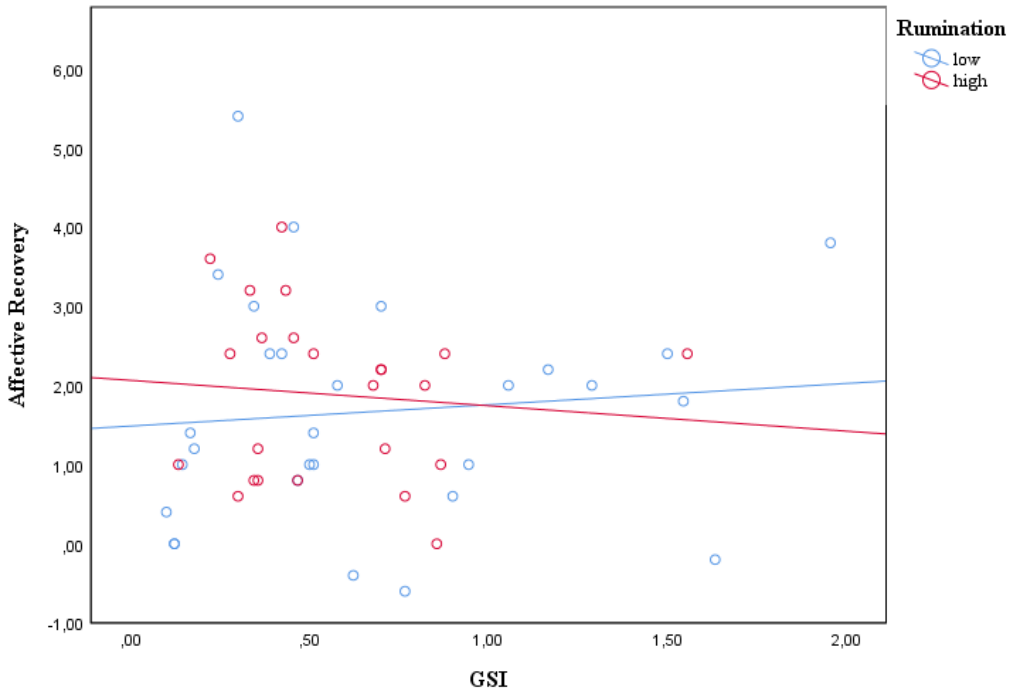
Moderation Analysis of Affective Recovery, Subclinical Psychopathology (GSI), Interaction Effect, and Covariates (N=53).

			95% CI		
Effect	Estimate	SE	Lower	Upper	p
Constant	-1.52	1.52	-4.57	1.54	.32
GSI	-.03	.46	-.96	.90	.95
Rumination	.15	.14	-.13	.42	.29
Interaction Effect	-.07	.22	-.52	.38	.74
Age	.11	.06	-.01	.23	.08
Gender	.04	.53	-1.03	1.11	.95

Note. Model Significance: R^2 = .10 , F(5, 47) = 1.03, p = .409

Figure 1

Scatterplot of GSI and affective recovery in participants varying in low and high state rumination.



Discussion

The purpose of the present study was to investigate the between-person association between subclinical psychopathology and affective stress recovery following a laboratory task and whether state rumination plays a moderating role in this association. According to the results of the present study, subclinical psychopathology did not predict slower affective stress recovery. Furthermore, state rumination was not found to significantly moderate the relationship between subclinical psychopathology and affective stress recovery.

Subclinical Psychopathology and Affective Stress Recovery

Previous daily-life research demonstrated delayed stress recovery in individuals with early psychosis (Vaessen et al., 2019), at risk for depression (De Calheiros Velozo et al., 2022), and general psychopathology (Kuranova et al., 2020). It was proposed that delayed affective stress recovery may signal an emerging mental disorder, highlighting a potential effect of subclinical psychopathology. Yet, laboratory studies investigating the association between subclinical psychopathology and affective stress recovery are lacking. Contrary to the expectation, the results of the current study revealed no significant effect of subclinical

psychopathology on affective stress recovery. Thus, subclinical psychopathology was not found to predict delayed affective stress recovery.

This discrepancy in results may be due to differences in methodology. Prior studies examining this association mostly relied on daily-life research and experience sampling. Thus, previous studies have examined recovery from everyday stressors, whereas the present study examined recovery from an acute laboratory-induced stressor. The use of a laboratory stressor allows for the manipulation of context effects and physiological, cognitive, and affective responses to understand how they develop under stress (Epel et al., 2018). It should be noted, however, that despite the high reliability of a laboratory study in terms of standardizing stressors, its ecological validity is limited because acute responses to short-term behavioural stimuli in a controlled environment that rarely occur in normal life are studied (Kidd et al., 2014). Accordingly, it is important to consider differences between acute laboratory-induced stressors and daily stressors, as these may lead to differences in research findings. Generally, acute stress is defined by the occurrence of a specific triggering event. This event may be an identifiable, punctual situation (Epel et al., 2018). In a laboratory setting, acute stressors include reaction time tasks, spontaneous speech, or mental arithmetic tasks. Acute stressors in the real world include events such as job interviews, public speaking, or examinations. In contrast, ESM studies mostly examine responses to daily events. Daily events are minor incidents that occur frequently, such as rushing, arguing, or deadlines (Epel et al., 2018). Because of the different characteristics of laboratory-induced acute stressors and daily life events, discrepancies in results are possible. It might be that laboratory-induced stressors are too brief or insufficiently personally relevant in terms of content and intensity for each participant (Lincoln et al., 2015). Therefore, it is likely that an individual's stress response following a laboratory stressor differs from responses to everyday stressors. This could explain why an association between (subclinical) psychopathology and affective stress recovery was found in ESM studies but not in the present laboratory study.

Furthermore, the measurement frame of the present laboratory study and the measurement frame of ESM studies differ. The results of the present study suggest that subclinical psychopathology has no effect on affective stress recovery within 15 minutes after the stress task. It should be considered that the observation size in ESM studies is usually larger than in the present study. Commonly, there is an average interval of 90 minutes between assessments, such as in the previous ESM studies by Vaessen et al. (2019) and De Calheiros Velozo et al. (2022). In contrast, in the present study, stress recovery was measured

only within a 15-minute period after the stress task. Therefore, it could be that the time period was too short to detect an effect.

Furthermore, it has to be noted that the present study deviates from most other studies by relying on the level of subclinical psychopathology in a general population. In contrast, previous studies relied on data from individuals at higher risk for psychopathology (Kuranova et al., 2020), at different risk for depression (De Calheiros Velozo et al., 2022), and Vaessen et al. (2017) included both healthy participants and participants with early and chronic psychosis. Examining the mean values of the level of subclinical psychopathology of the participants in the present study, low values can be observed. The mean GSI score of this study (M = .63, Sd = .43) is similar to the GSI mean of a healthy Finnish community sample (M = .60, SD = .44) (Holi, 2003). To better classify this value, it is important to know that, for example, a Finnish clinical sample displayed a significantly higher GSI mean (M = 1.56, SD = .61) (Holi, 2003). Comparing the mean values of the present study with the mean values of other studies, it can be concluded that the present sample can be classified as a healthy community sample. Accordingly, there are no elevated levels of subclinical psychopathology. Consequently, the magnitude of subclinical symptoms may have been too low to detect significant effects. Future studies in a sample with higher levels of subclinical psychopathology could more accurately determine whether subclinical psychopathology determines changes in an individual's affective stress recovery.

The Role of Rumination

With respect to the second hypothesis, state rumination was not found to significantly moderate the relationship between subclinical psychopathology and affective stress recovery. Previous research identified an association between rumination and prolonged periods of negative affect following stressors (e.g., Nolen-Hoeksema et al., 2008). Hence, it was hypothesized that engagement in rumination in response to the laboratory stress task (i.e., state rumination) moderates the relationship between subclinical psychopathology and affective stress recovery. However, the results of the current study did not confirm this hypothesis. In other words, individuals with higher levels of subclinical psychopathology who ruminated in response to the stress task did not show slower affective recovery than individuals with higher subclinical psychopathology who did not ruminate.

One possible explanation for the absent effect of state rumination may be that rumination can be regarded as a form of negative automatic thinking. Because automatic thoughts are typically repetitive and rapid, one may be more aware of the feeling than the

thought (Beck 1995). Consequently, practice may be required to consciously perceive automatic thoughts (Beck 1995). In addition, there is the possibility that individuals with a heightened tendency to ruminate (i.e., trait rumination) may not reliably provide information about state rumination (Key et al., 2008). This assumption is in line with the idea that rumination becomes a habitual tendency for these individuals and therefore it may be difficult for them to recognize when they are engaging in rumination. Individuals low in trait rumination, on the other hand, may find it simpler to recognize the unusual and occasional situations when they ruminate (Key et al., 2018). Conclusively, to assess a potential relationship between state rumination and recovery, more sophisticated methods of assessing state rumination may be needed than the simple one-item self-report scale used in the present study. Furthermore, it may be beneficial to control for trait rumination.

Another explanation could be that rumination may not be a moderator but a mediator. Since rumination is a transdiagnostic pathological process (Ehring & Watkins, 2008; Nolen-Hoeksema & Watkins, 2011), higher levels of subclinical psychopathology might be associated with an increased propensity to rumination following a stressor. Accordingly, the independent variable subclinical psychopathology could elicit an increased likelihood of rumination. Moreover, rumination is also likely to influence the dependent variable affective stress recovery as it is associated with a prolonged experience of negative affect following stressful events (Morrow & Nolen-Hoeksema, 1990; Nolen-Hoeksema & Morrow, 1993; Nolen-Hoeksema et al., 1993). In summary, rumination may be a manifestation of subclinical psychopathology as well as an antecedent of delayed affective stress recovery, thus mediating the relationship between subclinical psychopathology and affective stress recovery.

Although the results did not confirm the expectations, it can be noted that a study by Capobianco et al. (2018) obtained similar findings. Results showed that rumination caused delayed stress recovery; however, this effect was only evident for physiological, but not self-reported, negative affect indices (Capobianco et al., 2018). This may be related to the functional dimension of rumination. Rumination is past-oriented and is associated with little motivation to recognize, avoid, or cope with dangers in the present or future (Capobianco et al., 2018). Accordingly, rumination is more likely to be a reflective, memory-based activity that could delay later phases of stress recovery that rely more heavily on memory-based processes (Capobianco et al., 2018). Thus, the possibility that the effect of rumination on affective stress recovery may become apparent at a later time cannot be ruled out. It may be advisable to examine the recovery phase in more detail and broaden the scope of observation to investigate and determine longer-term effects. In addition, it would be useful to examine

worry as a potential moderator in the relationship between subclinical psychopathology and affective stress recovery. Typically, worry serves to anticipate danger and prepare for action, and consequences unfold rapidly once the internal anxiety program of avoidance and vigilance is activated (Capobianco et al., 2018). Thus, worry might be associated with early effects on affective stress recovery and potentially moderates the relationship between subclinical psychopathology and affective stress recovery. Similarly, the study by Capobianco et al. (2018) showed that worry was found to have earlier effects on self-reported affect.

Strengths, Limitations, and Future Recommendations

A particular strength of the present study is its novel focus. To the researcher's knowledge, this was the first study to address the effects of subclinical psychopathology on affective stress recovery as well as a potential moderating effect of state rumination in a laboratory setting. Furthermore, the use of a laboratory-based stress task provides several methodological advantages, including the precise definition of the reactions to a standardised stimuli under controlled settings as well as the elimination of confounding effects of contemporaneous activities and exposures (Steptoe, 2007). In addition, the rMIST was found to be effective in eliciting a significant self-reported as well as cardiovascular stress response (De Calheiros Velozo et al., 2021).

Despite the strengths, several limitations of the present study are necessary to consider. First, examining affective recovery in response to a laboratory stressor is subject to some general limitations since only acute responses to short-term behavioural stimuli under artificial conditions, which rarely occur in everyday life can be studied (Kidd et al., 2014). Thus, generalizability is limited. Second, although the rMIST employs a computer-based stressor and is simple to standardize, there are still elements that are difficult to control, such as the researcher-participant interaction. For instance, subtle changes in tone or body language may affect how the participant experiences the rMIST (De Calheiros Velozo et al., 2021). A third limitation relates to the number of assessment time points examining affective stress recovery. In fact, measurements of negative affect during the recovery phase first occurred 15 minutes after the stress task. Future research should consider including measurements at shorter time intervals and for an extended time period. Hence, a more detailed insight into the recovery rate of the participants could be gathered. Fourth, state rumination was measured by a single and a rather broad item (“Right now, I keep thinking about my feelings and problems”). The first critique of single-item measures is that estimation of measurement error cannot follow the recommended approach, which uses intercorrelations of scale components

to estimate reliability (i.e., internal consistency) (Allen et al., 2022). Single-item measurements cannot be submitted to statistical analyses of internal consistency since different components of measurement are non-existent (Allen et al., 2022). Furthermore, it is difficult to capture complex psychological constructs with a single item. One could argue that the present study used a relatively unspecific statement to measure state rumination, therefore future studies should consider using more explicit and validated items or scales. For example, the State Rumination Questionnaire (SRQ) could be used to measure state rumination in response to a stressor (LeMoult et al., 2013). Alternatively, the Brief State Rumination Inventory (BSRI) could be utilized (Marchetti et al. 2018). Fifth, the sample was relatively small and consisted of healthy individuals. The latter resulted in a rather low symptom level, which might have been too low to detect significant effects. Therefore, it is recommended that future studies use data from individuals at higher risk for psychopathology to examine higher levels of subclinical psychopathology. Future research in samples with a higher level of subclinical psychopathology may be better able to determine whether subclinical psychopathology influences affective stress recovery. Lastly, the generalizability of the findings is limited due to the young age, high educational level, and high proportion of female participants. Consequently, the results of the present research require replication in studies with a more representative sample. Especially because females are more likely than males to report higher levels of negative affect in response to social stress demands, putative gender differences in a heterogeneous group need further investigation (Kelly et al., 2008).

Conclusion

The present study contributed to the existing body of research by being the first to examine the effects of subclinical psychopathology on affective stress recovery as well as a potential moderating role of state rumination in a laboratory environment. Nevertheless, the results contradicted initial expectations. The findings of the present study demonstrated no evidence that subclinical psychopathology predicts delayed affective stress recovery within 15 minutes following the stress task. Furthermore, in this association, state rumination was not proven to be a moderator. It is important to emphasize that the results and interpretations of the current study should be treated with caution, as this was the first study to examine subclinical psychopathology related to affective stress recovery in a laboratory setting. Therefore, few comparable data are available, and further studies, preferably in a more representative sample with a higher degree of subclinical psychopathology, are needed to

confirm the results. In addition, future research is advised to consider rumination as a potential mediator and to expand the scope of observation to determine longer-term effects.

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