Effectiveness of Different Emotion Regulation Strategies on Stress Recovery of Students
An Experienced Sampling Study

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Abstract

Constant high stress levels can lead to severe impairments of physical and mental health of people. This holds especially true for people whose stress recovery is prolonged. Emotion regulation strategies can influence the recovery of stress positively or negatively. The strategy of reappraisal has a positive influence on recovery, whereas expressive suppression and rumination have a negative influence. As the effectiveness of these three emotion regulation strategies on affective recovery is still understudied, the current study investigated the effectiveness of reappraisal, expressive suppression, and rumination on the recovery of daily stressors. To test this, an ESM study was conducted with a sample of 26 students, who were between 18 and 27 (M = 21.3, SD = 1.8). The students completed ten questionnaires per day for six consecutive days. A multilevel analysis showed non-significant relationships between reappraisal and stress recovery, expressive suppression and stress recovery, and rumination and stress recovery. Further investigating the effect of the three emotion regulation strategies on stress reactivity, a post-hoc analysis showed a significant relationship between expressive suppression and stress reactivity B = -0.06, SE = 0.02, $t(643) = -2.27$, $p = .023$, and rumination and stress reactivity B = 0.10, SE = 0.02, $t(650) = 3.70$, $p < .001$. In conclusion the study suggests that none of the three emotion regulation strategies has an influence on the recovery from daily life stressors in students. This could be due to a low intensity daily stress which creates such a low negative affect that the strategies have no impact on the recovery, because there is not much to cope with or because of a too long recovery period.

Keywords: emotion regulation strategies, daily stress, negative affect, recovery, ESM

Stress in daily life is common and affects many people. According to the Techniker Krankenkasse in 2021, over 26 per cent of the population in Germany indicated that they often feel stressed. A study by Brougham and colleagues (2009) showed that students are especially affected by stress, as 52 per cent of them reported moderate to high amounts of stress. Having moderate to high levels of stress can lead to negative consequences. Particularly prolonged stress leads to severe problematic consequences for health (Rasheed, 2016). More precisely, it can cause cognitive deficits, illness, lower levels of well-being and higher levels of depression and anxiety. Moreover, stress can also lead to bad habits like eating unhealthy food, exercising less, and sleeping more (Brougham et al., 2009). To prevent such consequences of high and prolonged stress levels it is important to recover from these stressors. One important factor for stress recovery is how people deal with the stressful event. Various coping strategies are often used for the recovery of stress (Javed & Parveen, 2021). However, the effectiveness of these strategies in terms of recovery from daily stressful events is not yet clear.

Stress and stress recovery

According to Lazarus and Folkman (1984) psychological stress is defined as "a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being" (p.19). In other terms, an event or situation happens that cannot be dealt with the resources available and thus influences the well-being of that person. Especially students are more affected by stressors, because they are in the phase of growing from adolescents to adults, which makes them more vulnerable to stress. This is because they are becoming more independent, which is related to more responsibility (Brougham et al., 2009). Thereby the most common daily stressors according to Brougham et al. (2009) are academic undertakings, social, romantic, and family relationships, daily hassles like time-pressure or appointments, and finances.

These daily stressors or minor hassles can have a negative impact on health and emotions (An et al., 2019). Negative emotions produced by stress and associated with the stressful event will be especially triggered if the person is unable to cope with the situation. The direct feelings and the change of emotions in relation to the stressor are considered as emotional or affective stress responses, which could predict how affected the person was by the stressor (An et al., 2019). After the stressful event, the stress recovery period begins. Stress recovery implies the resting time after a stressful situation that gives information about how long it takes for the psychological or physiological symptoms of the body to return to the baseline after the occurrence of a stressor (Linden et al., 1997). Several studies showed that if the affective recovery is delayed because of continuous stress, it would have a negative impact on the mental

health and thus carries the risk of developing a mental illness. A study by de Calheiros Velozo et al. (2022) displayed that people who experience daily stress and are at risk of depression have a delayed affective recovery period. Moreover, the study also showed that additional stressors increased the affective recovery also in healthy people. To prevent such a delay in the recovery it is important to effectively deal with the daily stressors.

To measure the recovery of stress in daily life it is necessary to measure stress level and affect on stress several times a day. One method that aims at frequently collecting thoughts, behaviours, or emotions in their daily life's is the Experience Sampling Method (ESM) by Larson and Csikszentmihalyi (1983) (cited in van Berkel et al., 2017). ESM empathises to trigger the participants several times a day to give a self-report. The use of mobile phones and apps makes it easier to provide the participants with notifications and triggers, but also to collect all the data (van Berkel et al., 2017). This way it is possible to measure affective responses and the recovery of the stressful events on the person multiple times a day.

Dealing with stress

The recovery from the stressor depends on the severeness of the stressors but also on the coping and regulation strategies that a student adopts (Blanke et al., 2022; Hampel & Petermann, 2006). These strategies can be either adaptive or maladaptive for recovery. Adaptive coping strategies are strategies that benefit the people using them. In contrast, using maladaptive strategies implies harmful consequences for the people using them, like a lower well-being or higher risk for depression (Javed & Parveen, 2021). Overall, adaptive coping strategies have been shown to accelerate the recovery process, as opposed to maladaptive strategies (Hampel & Petermann, 2006). One way to cope with stress, which affects the recovery, are emotion regulation strategies.

Emotion regulation is a term that describes processes of influencing the timing and type of emotions one has but also the way of experiencing and expressing these emotions (Gross, 2008). Therefore, emotion regulation strategies are used to deal with the emotions and are also used to cope with stressful events (Gross, 2008). Using a particular emotion regulation strategy can have either a positive or negative effect on the response to or recovery from daily stress (Aldao et al., 2010).

Emotion regulation strategies also differ in the point at which they are applied in response to a daily stressor. Mainly, a distinction is made between antecedent-focused and response-focused emotion regulation strategies (Richardson, 2017). Antecedent-focused strategies are used before the emotional stress response. One example of a frequently applied emotion regulation strategy is reappraisal. Reappraisal is that the meaning of the situation is

changed in such a way that the situation gets viewed from different perspectives (Gross, 2008). This in turn changes the emotions that are associated with the event (Gross, 2008). Strategies that are applied after the emotional stress response are response-focused emotion regulation strategies. Examples of this are expressive suppression or rumination (Richardson, 2017). Expressive suppression describes the suppression to express emotions in a certain situation (Gross, 2008). Rumination is the constant thinking about negative emotions and the situation that caused them (LeMoult et al., 2013).

Reappraisal

Overall, reappraisal is an adaptive strategy, so performing reappraisal before, in or after a stressful situation has shown that it had a positive effect on stress (Gross, 2008). Performing trait reappraisal at a stressful event, changes the stress response and the associated negative emotions in such a way that they decrease. It increases the positive emotions in an individual through thinking of the event in another manner (Carlson et al., 2012). This could have the tendency that people performing it, recover faster and better from stressors.

Supporting this a study by Blanke et al. (2022) found that selecting reappraisal as a coping strategy in daily life was effective in reducing negative affect after a stressful event when it produced high levels of stress. Contributing to that, a laboratory study by Ray et al. (2008) provides evidence that reappraisal is helpful in the recovery of events that produce negative emotions, as they found that reappraisal assists in the recovery of anger-provoking situations. Another laboratory study showing the positive effect of reappraisal measured cortisol recovery in relation to stress (Lewis et al., 2018). Cortisol is a biological indicator of stress, which can be measured. It was found that reappraisal influences recovery from stress in healthy people, as it has a positive effect on cortisol recovery (Lewis et al., 2018). Based on these findings, it seems that the use of habitual reappraisal could have a positive effect on recovery of daily stressful events. The recent study by Blanke et al. (2022) is one of the few studies that has investigated the effect of momentary selection of reappraisal on stress in daily life. Therefore, this study contributes to gaining more insight into this topic.

Expressive suppression

There are two main theories that describe what happens when someone suppresses his emotions. The first theory is that through suppressing the emotions, the emotions go ‘muted’ and disappear, which supports regulating the emotions (Gross, 2008). The other theory is that emotions need to be expressed. When they are suppressed, they will find another channel to express like physiological responses of the body, which means that it has a negative influence on dealing with emotions (Gross, 2008). Looking at studies that have measured expressive

suppression in the context of stress and well-being, the second theory seems to be more valid. For example, it has been shown that people who suppress their emotions regularly have fewer close relationships and social support but also a worse well-being than people who do not often suppress their emotions (Gross, 2008). Adding to that, a laboratory study by Jentsch and Wolf (2020) showed high cortisol levels in the relation to habitual expressive suppression on stress, indicating high stress reactivity and thus a negative effect. It seems that the momentary use of expressive suppression on stress in daily life is under-researched. Therefore, based on previous research, it is assumed that also momentary use of expressive suppression has a negative effect on the recovery from daily stressors.

Rumination

Rumination is also considered as a response-focused emotion regulation strategy that seems to have a negative impact on stress recovery. It has been shown that repeatedly thinking about negative emotions increases the duration of the negative emotion, which can lead to higher depressive levels (Gross, 2008). In relation to stress response, state rumination is often used in contrast to trait-level rumination, as this can reflect the amount of rumination (LeMoult et al., 2013). It has been found that people who use state rumination recover less from stressors than people who do not ruminate (LeMoult et al., 2013). The momentary use of rumination during a stressful event in a daily life study has been shown to adversely reduce negative affect, especially the more intense the stressor was (Blanke et al., 2022). Whether the momentary use of rumination also has a negative effect on the recovery of stressors in daily life has not yet been fully investigated, but there are suggestions that it also has a negative effect.

Current study

The aim of this study is to investigate how effective different emotion regulation strategies are to recover from daily stress in students. As stated above, recovery could be dependent on the emotion regulation strategy that the students use. In this study the emphasis lies on the strategies reappraisal, expressive suppression, and rumination to have a mix between adaptive and maladaptive strategies and antecedent-focused and response-focused strategies. Therefore, the following research question will be investigated:

How effective are different emotion regulation strategies on the recovery of daily stressors in university students?

To answer the research question reappraisal, expressive suppression and rumination will be tested on the effectiveness of stress recovery. Thus, the following three hypotheses will be tested:

H1: The use of reappraisal to cope with a stressful event has a positive effect on recovery from daily stressors in students.

H2: The use of expressive suppression to cope with a stressful event has a negative effect on stress recovery in students.

H3: The use of rumination to cope with a stressful event has a negative effect on the recovery from daily stressors in students.

Methods

Participants

For people participating in this study, they had to be students at a university or HBO and between the age of 18 and 27. Additionally they should have sufficient English skills to complete the study, as the study was only provided in English. As the study was delivered via an app, the participants had to have a suitable smartphone with a stable internet connection. To have a reliable sample, a minimum of 19 participants had to fill out the questionnaires (van Berkel et al., 2017). Based on this number it was decided to have a minimum sample of 30 participants to have room to exclude participants due to dropouts or missing data.

Study design

This study was an empirical quantitative research and designed to measure stress recovery at several moments a day. For this purpose, ESM was chosen, as it aims to assess emotions, thoughts and behaviours several times a day (van Berkel et al., 2017). Ten measurements per day were scheduled, distributed between 7 am and 10 pm each day for six consecutive days (Habets et al., 2022). This was done to ensure that not too much time elapses between the measurements so that the stress recovery could be detected.

The intervals for the questionnaires were set at 1.5-hour intervals, in which the questionnaires appeared randomly, but with a minimum distance of 30 minutes. These 30 minutes intervals ensured the time period in which a new stressful event could happen for the next measurement. Each questionnaire took approximately one minute and expired after 40 minutes.

Procedure

After signing up for the study, the participants received a link to a website where they got their briefing for the study (see Appendix A). After reading the briefing, the participant had to provide their informed consent on the study, and they received an instruction to download the app ‘Ethica’ onto their mobile device (see Appendix B). Following this they had to set up an account in the app and enter the related code and register for the study. On the app, two

questionnaires were shown to the participant. First, they had to provide their informed consent a second time and fill out their demographics.

On the day after the registration, the participant had to complete ten short questionnaires for six consecutive days in the time between seven in the morning and ten in the evening (Habets et al., 2022). In the questionnaire, the participants were required to respond to questions about positive and negative affect, how stressful an event was since the last measurement, also called "beep", and questions about their emotional response (see Appendix C). Each questionnaire always contained the same set of questions in the same order and only took a participant approximately one minute to answer. After the last questionnaire on the sixth day, the study ended. To remind the participant to complete the questionnaires, they received notifications on their smartphones when it was time for a new one.

Measurements

Demographics

To know the demographics of the participants, items were created where they had to indicate their age, their gender, and their study programme.

Event-related stress

To measure how pleasant the stressful event was for the participants, the item "Think about the most important event since the last beep. This event was…" was created. This item was measured on a scale ranging from -3 (very unpleasant) to 3 (very pleasant).

To make sure that just stressful events were included for the stress recovery of the participants, the stress variable was dummy coded, indicating 0 = no stress (0 to3) and 1= stress (-1 to -3). The stress variable was also lagged (stress_t1), as only the measurements were included in the analysis where participants had a stressful event followed by another one.

Positive and negative affect recovery

The positive and negative affect was measured using the Positive Affect (PA) scale and the Negative Affect (NA) scale by Myin-Germeys et al. (2007). The PA consists of four items and has a good internal consistency (Cronbach's alpha = 0.86). The NA has six items and has also a good internal consistency (Cronbach's alpha = 0.76) (Myin-Germeys et al., 2007). In this study the items "cheerful", "satisfied" and "relaxed" were chosen to measure PA and for NA the items "down", "anxious" and "insecure" were selected. Both the PA and NA were measured on a 7-point Likert scale ranging from 1 (not at all) to 7 (very), on which the participants had to indicate to what extent the items apply to them.

The negative affect items were used to calculate the recovery of the participant between two following stressful events. To calculate the recovery of the participants after a stressful

event, the mean of the negative affect variables “down” “anxious” and “insecure” was calculated of each measurement, which resulted in a NA variable. With this variable the mean (NA_mean) and the centred mean (NA_centered) of the participants were calculated to see the differences within and between the participants. The “NA_centred” variable was lagged into “NA_centered_t1” to subtract these two variables to get the recovery. To be able to calculate the recovery only the values were taken that had a value in the subsequent measurement, i.e., a consequential value, in the “NA_centered” variable and where lagged stress was coded as 1.

Emotion Regulation

Reappraisal was measured by taking one item based on a subscale of the Emotion Regulation Questionnaire (ERQ) by Gross and John (2003). The original subscale consists of six items. For this study, the item “I looked at it from a different perspective” was created based on the six items of the subscale. To measure expressive suppression, one item based on a subscale of the Emotion Regulation Questionnaire (ERQ) by Gross and John (2003) was taken. The expressive suppression subscale consists of four items. In this study the item “I expressed my emotions” was created, which is based on this subscale. Rumination was measured with one item based on the Ruminative Response Scale (RRS) (Treynor et al., 2003). Overall, the scale consists of 22 items and based on them the item “I kept thinking about it” was created for this study.

To compare the three items, they were all measured on a 7-point Likert scale on which the participants must indicate how much they agree with the statement. The scale ranges from 1 (not at all) to 7 (very). Since with the item for expressive suppression high expressive suppression was indicated with a value of 1, but the items for reappraisal and rumination indicated high reappraisal and rumination with a value of 7, expressive suppression had to be recoded to 1(very) to 7 (not at all).

Data analysis

First descriptive statistics were done with the demographics of the participants to see how the sample looks according to age, gender, nationality, and study programme of the participants. Moreover, assumption checks were made for the negative affect variable, the dependent variable recovery and the independent variables reappraisal, expressive suppression, and rumination. Since only the values that had a subsequent measurement on the same day could be used when calculating the recovery, some values were omitted. Therefore, the compliance was calculated to see how many measurement points were available.

The data from the ESM study was analysed using a multilevel analysis, which has a hierarchical structure, consisting of two levels. The individual measured observations (level 1)

were nested within the participants (level 2). To answer all three hypotheses, a linear mixed model was run with recovery as the dependent variable and reappraisal, expressive suppression, and rumination as independent variables. To check for external influences, the variables gender, age, and stress_t1 were also included as independent variables. All independent variables were included as covariates in the model: recovery = B0 + B1 (reappraisal) + B2 (expressive suppression) + B3 (rumination) + B4 (stress) + B5 (gender) + B6 (age).

Results

Participants

Overall, a random convenient sample of 51 participants took part in the study. Because of a low response rate of the daily questionnaires and dropouts, the percentage of answered questionnaires in the study was set down to 30 % to have a more reliable sample of at least 19 participants (Habets et al., 2022; van Berkel et al., 2017). After excluding all participants below this rate, the study results in a final sample of 26 participants. The age range was between 18 and 27 years (M = 21.3, SD = 1.8). Further demographic characteristics are shown in Table 1.

Table 1

Frequencies of Gender, Nationality and Study Programme

	n	%
Gender		
Female	18	69.2
Male	8	30.8
Nationality		
German	20	76.9
Dutch	3	11.5
Other	3	11.5
Study programme		
Psychology	15	57.5
Communication science	2	7.7
Other	9	34.6

Note. N = 26

Descriptive of the variables in the analysis

First compliance was done on the beeps the participants filled out to see how many measurement points could be used. Overall, in this data set, 749 (52.5%) beeps were filled out of 1427.

To check the assumptions of the stress recovery, negative affect scale, the rumination scale, the reappraisal scale, and the expressive suppression scale were checked (see Table 2). The distribution of the negative affect scale is skewed to the right (see Figure 1). This indicates that more participants experienced less negative affect than the average. Because logging the data would not change the distribution no changes were made for this variable. Furthermore, stress recovery, the rumination scale, the reappraisal scale, and the expressive suppression scale all had a normal distribution.

Figure 1

Distribution of the Mean Negative Affect

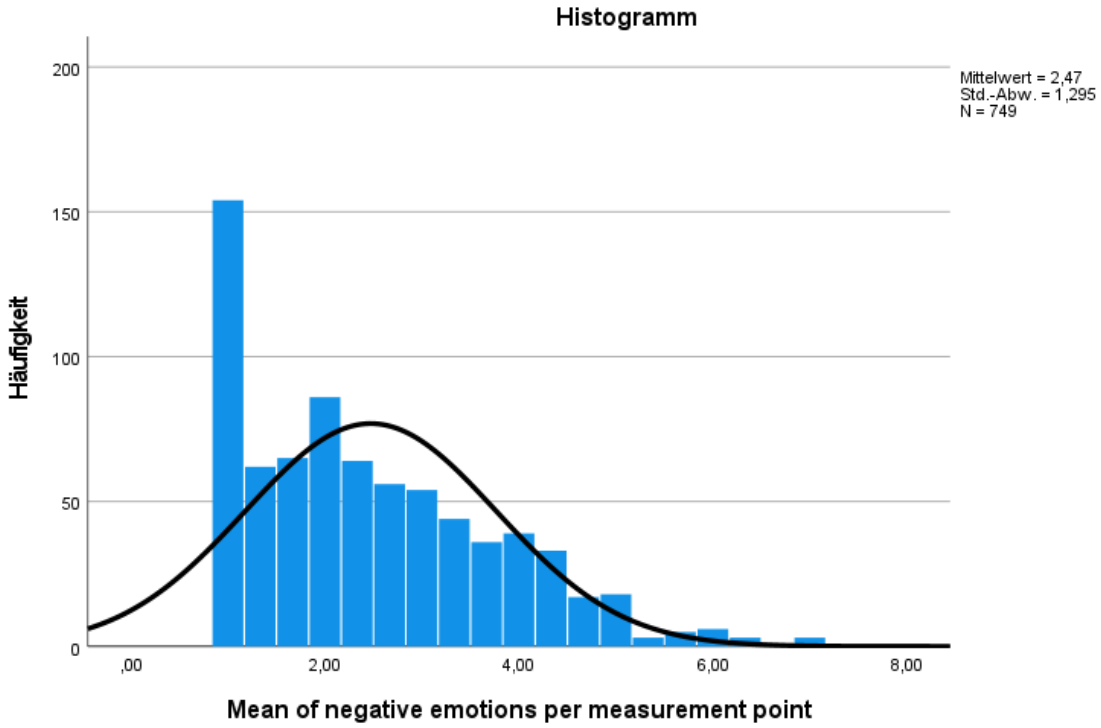

Table 2

Range, Mean and Standard Deviation of the Scales Included in the Analysis

Scale	Range		M	SD
	Min	Max		
Negative affect	1.0	7.0	2.47	1.29
Recovery	-3.67	4.33	.07	1.37
Reappraisal	1.0	7.0	3.37	1.68
Expressive suppression	1.0	7.0	4.27	1.82
Rumination	1.0	7.0	3.89	1.92

Since only values from recovery can be taken that have a consequential value and where a stressful event happened, only 164 (11.5%) out of 1427 can be analysed.

Effect of momentary use of emotion regulation strategies on stress recovery

For the first hypothesis, a non-significant relationship was found between reappraisal and stress recovery B = -0.01, SE = 0.07, $t(156)$ = -0.13, p = .894. This suggests that reappraisal at a stressful event cannot predict the recovery from daily stressors because it indicates that the use of reappraisal does not have a positive effect on recovery from daily stress.

To test whether expressive suppression has a negative impact on the recovery of daily stressors the second hypothesis was tested. Between expressive suppression and stress recovery a non-significant relationship was also identified B = -0.00, SE = 0.06, $t(156)$ = -0.07, p = .946. More concretely it appears that the coping strategy expressive suppression can also not predict if people recover faster from daily stressors when they use expressive suppression after a stressful event. This suggests that the use of expressive suppression in response to a stressful event is not associated with a negative effect on stress recovery.

Lastly for the third hypothesis, if the use of rumination has a negative influence on stress recovery in daily life, a non-significant relationship was found between rumination and stress recovery B = 0.05, SE = 0.06, $t(156)$ = 0.92, p = .361. In other words, it displays that if people use rumination as a coping strategy after a stressful event it cannot predict the recovery from daily stressors. Therefore, it suggests that the use of rumination in response to a stressful event is not related to negative stress recovery.

Exploratory research on stress reactivity

Because of the small number of data points that could be used in the study, additional research was done on stress reactivity. As stress reactivity is defined as “the increase in NA in

reaction to stress" (Lataster et al., 2010, p. 397), all filled out data points can be used, which increases the usable data points up to 746. Consequently, it makes the result more reliable.
First, the stressful event variable was recoded into "stress_experience", so that neutral and positive events (0-3) were coded as 0 and stressful events were recoded so that they received their same value only positively. Following this, a linear mixed model was run with negative affect as dependent variable and reappraisal and "stress_experience" as independent variables. As covariates reappraisal, "stress_experience" and an interaction effect between reappraisal and "stress_experience" was included. The interaction effect was included to analyse the effect of reappraisal together with stress on stress reactivity. Additionally, the model was controlled for age and gender. The same analysis that was done for reappraisal was also done for expressive suppression and rumination.

The results showed a non-significant relationship for the interaction effect of reappraisal and "stress_experience" on negative affect, B = -.02, SE = 0.03, $t(651)$ = -0.75, p = .455. For the interaction effect of expressive suppression and "stress_experience" on negative affect a significant relation was found B = -0.06, SE = 0.02, $t(643)$ = -2.27, p = .023. Another significant relationship was found for the interaction effect of rumination and "stress_experience" on negative effect B = 0.10, SE = 0.02, $t(650)$ = 3.70, p < .001. These results show that both expressive suppression and rumination influence stress reactivity when negative stress is experienced. More precisely it seems like that rumination in a stressful event increases the reactivity of stress whereas expressive suppression in a stressful event seems to decrease stress reactivity in students.

Discussion

The aim of this study was to gain better insights into the effectiveness of different coping strategies on the recovery of daily stress in students. Therefore, the three emotion regulation strategies of reappraisal, expressive suppression and rumination were selected to examine their effect on stress recovery. Due to a low number of values available for the analysis, the results should be considered with caution. The results of the present study showed that none of the three emotion regulation strategies has a significant impact on the recovery of daily stress. However, the post-hoc analysis on stress reactivity displayed that the use of rumination in combination with stress increases stress reactivity, whereas the use of expressive suppression in a stressful situation decreases stress reactivity. No significant results were found for reappraisal.

The negative effect of rumination on stress reactivity goes in line with previous studies, who found the adverse effect of rumination to reduce negative affect (Blanke et al., 2022). In

contrast, the positive effect of expressive suppression is contradictory to previous literature, which found that expressive suppression tends to increase stress reactivity (Jentsch &Wolf, 2020). Since expressive suppression aims to suppress the feelings associated with the situation, it could make sense that the reactivity to a stressor would not be high because the emotions are suppressed and not perceived. This would go in line with the first theory about habitual expressive suppression, which suggests that the emotions get muted and disappear (Gross, 2008).

The significant findings of expressive suppression and rumination on stress reactivity could also suggest a kind of stress recovery. Since in this study semi-randomised measurements were taken at 1.5-hour intervals, it is possible that there are almost 90 minutes between the stressful event of the students and its measurement. Since, for example, rumination significantly increases stress reactivity at a stressful event, it can be assumed that the recovery period had already begun between the event and the measurement. As the negative affect in relation to rumination was still high during the measurement, it can be assumed that rumination had a negative effect on the recovery from stress. This suggests that the stress recovery period was too long since there could be hours between the last event, the measurement, and the next event.

The assumption that the recovery period was too long in this study is supported by the fact that mentally healthy students participated in this study. In a previous ESM study by Lataster et al. (2010) the results indicated that people with psychotic symptoms showed a higher reactivity to stress. Additional to that, a laboratory study by Lewis et al. (2008) also showed differences in the recovery of stress in healthy participants and participants with social anxiety disorder. These studies shows that mental illnesses or symptoms of a mental illness seem to influence the affective recovery and reactivity, so these people need a longer time to recover from stressors. Since it is assumed that mainly only mentally healthy people participated in this study, it seems that they need a shorter time to recover from daily stressors. In addition, it also seems that they are better able to cope with stress because of a shorter recovery time and thus recovery is not strongly dependent on emotion regulation strategies.

These insights may also explain the non-significant findings of reappraisal. The momentary use of reappraisal in daily life showed to have a positive effect on stress recovery as previous studies have shown that reappraisal in stressful situations can reduce the negative affect and has a positive effect on stress recovery (Blanke et al., 2022). If the recovery already took place between the stressful event and its measurement, it may be that the students had already recovered from the stressor with the use of reappraisal and therefore no effect on reactivity and recovery could be measured and found.

A different interpretation for the non-significant findings of reappraisal could be found in the use of reappraisal as emotion regulation strategy. As reappraisal is considered as an antecedent-focused emotion regulation strategy, it implies that the participants should use it before or during the stressful event in order to reduce negative affect (Richardson, 2017). It might be that the participants failed to use reappraisal at the right time in the stressful moment. Support for this assumption can be found in a study by Raio et al. (2013), which showed that people might not be able to use adaptive coping strategies like reappraisal in stressful situations correctly, because of a cognitive overload caused by the stressful event. When the participants fail to use reappraisal in a stressful moment, it could be that it has no impact on the reactivity and recovery period.

Another explanation for the non-significant results of all three hypotheses could be that reappraisal, expressive suppression and rumination do not have a significant impact on the recovery of daily stressors. It might be that the intensity of the daily stressors was not high enough so that there were low stressors to cope with. This could also explain the low levels of negative affect in this study. Support for this could be found in a study by Blanke et al. (2022). In their study they found that the more intense the stress was, the more harmful rumination was for reducing negative affect. Additionally, reappraisal only had a positive influence on the reduction of negative affect when the stress intensity was high. No relation of reappraisal on reduction of negative effect was found for lower levels of stress. These findings indicate that emotion regulation strategies might not have significant influence on the recovery of stressors in daily life but rather only for intense stressors.

Study limitations and strengths

One limitation of this study is the low number of valid measurement points that can be used for the analysis. This is because the participants did not fill out the daily questionnaires regularly. Another reason is that only the measurement points are used where the participants experienced stress, which also reduced the points. Future research with ESM should therefore pay attention to that the participants fill out as many questionnaires as possible. Another limitation that also contributed to a lower response rate is that the app sometimes had some technical issues and did not work properly. Participants reported that they sometimes did not receive any notifications that a questionnaire was available. This could be, because the participants did not turn on their notifications but also because of the app itself. Therefore, in the future, it should be pointed out that the notifications should be turned on. However, it could also be due to a technical issue with the app itself, but because the app is provided by an external

company, this issue was outside of the control of this study. Having these limitations contributed to the questionable reliability of results of this study.

On the other hand, if the app would have worked properly, a strong point of conducting an ESM study is using an app. The app makes the accessibility and usability of the daily questionnaires for the participants easy. Supported by the fact that it has become common that a high percentage of participants have their smartphone with them all the time hence they can get a notification when a questionnaire is available. This supports participants to respond quickly. Without the support of modern digital media, it would be necessary for the participants to actively remember to complete a questionnaire on paper or in a diary (van Berkel et al., 2017). Another strength that can be identified is an ESM study itself for measuring daily stressors. Because of the regular and wide-ranging questionnaires, many daily stressors can be captured, as daily stressors are just minor events that can happen and change regularly. Also, the recovery can be measured properly.

Directions for future research

Apart from the limitations and the resulting suggestions for future research, the results of the study provide directions for future research. One starting point for future research is to make the recovery periods shorter than in this study, which could have an influence on the effect on all three emotion regulation strategies. It could be that there was 90 minutes between the stressful event and its measurement. In this time frame the recovery could have taken place and therefore could not be detected. If the measurements are closer to the stressful event, the affective response can be measured directly and the recovery until the next measurement of a stressful event can be measured.

In addition, it seems that the stress intensity was not high, so there was only a low level to cope with and therefore the emotion regulation strategies had no significant impact on the recovery. Resulting from this it might be a direction for further research to take the stress intensity into account in research about daily stress recovery and emotion regulation strategies.

As this study only considered the negative affect for the stress recovery, an additional suggestion for further research is to include positive affect in the research on stress recovery. For example, a study by Richardson (2017) has shown that expressive suppression had a negative and reappraisal had a positive influence on positive affect and on high levels of stress. As positive affect also has an influence on the recovery and well-being it might be insightful to include it into future research.

The final suggestion for future research is to add either additional stress measurements apart from self-reports or only look at differences between the effectiveness of emotion

regulation strategies on perceived stress recovery and actual stress recovery in daily lives. By adding biological measurements or additional others that are more objective in detecting stress and recovery than self-reports, a better picture of the actual stress level and recovery of the participants could be made.

Conclusion

Concluding the study did not display significant results of reappraisal, expressive suppression, and rumination on stress recovery. In the post-hoc analysis on stress reactivity, significant results were found for expressive suppression and rumination in stressful situations, showing that expressive suppression decreases stress reactivity and rumination increases stress reactivity. Since a lot of time could have passed between the stressful event and the measurement of this event, it is possible that some kind of recovery has already taken place, which, however, could not be measured properly. Even though the non-significant findings of the study are contrary to previous studies, they may also provide insights into how students cope with daily stress. It appears that emotion regulation strategies have low levels of impact on the recovery of daily stressors because the intensity of daily stressors seems too low for the strategies to be effective. Considering these findings and the study limitations they provide a basis for further research of emotion regulation strategies on daily stress recovery.

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Appendix A

Participant Information and Informed Consent

Welcome to our study. First of all, we would like to thank you for helping us with this project. We are three third-year Psychology students, currently doing our bachelor thesis and the purpose of this project is to understand how students perceive events of their daily life. We are interested in how you feel about and react to the many things that happen during the day, no matter if it is only a small event such as a spilled cup of coffee.

For your information, the study will take 6 days. As you already have read in the invitation to this study, it is a diary study and you will work with the app “Ethica”. You will be asked to fill in the same set of questions several times a day. In general the questions are about how you feel, what you think in relation to the last important event that you experienced during the day. You will get a notification every 1.5 hours because we really want to gain insight into your daily life. The app will send you a notification as a reminder to answer the questions. The reminders will allow us to get in-moment information without any recall bias. Also, it is important that you answer the questions right after you receive the notification. The procedure of this study looks like the following: On the day before the main study starts you will have to fill in a questionnaire about some general information about you and your current emotional state. This will already take place via the app. This questionnaire needs to be filled in only once. The day after, you will start with the main study, which means that you will have to fill out the same set of questions 10 times a day.

For your explanation, one of the questions says “Think about the most important event since the last hour. This was…”. With "important events" we mean any event that was meaningful for you. Even if nothing really important happened, please pick the most important event that happened since the last questionnaire/beep and answer the questions. After the last measurement of the sixth day, you successfully ended the study. We would like to stress that there are no right or wrong answers. Some questions may seem a bit strange or not applicable to you in that situation, but still try to answer them honestly. Also, if you have any questions during the conduction of the study or if you come across problems with the app feel free to contact us any time. Moreover, you can always contact us during the study, if any additional questions arise.

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Moreover, your data will be treated confidentially. This means that the answers and information you give will remain anonymous. Please read the information on the following page carefully before you agree.

After you gave consent, you will receive all the information how to download the app and create an account. Additionally, you will get an access code for the study.

Informed Consent

You are being invited to participate in a research study about your perception of events in daily life. This study is being conducted by students from the Faculty of Behavioural, Management and Social Sciences at the University of Twente as part of their bachelor thesis. The purpose of this research is to measure how you perceive daily life events throughout the day. This study will run for 6 days. On the first day we will ask for your informed consent and you will be presented with short questions about your demographics, a questionnaire about your well-being, and a questionnaire about your use of coping strategies. These questions just need to be filled out once. Ten times a day (7am-10pm), randomly in a time span of 1.5h, you will be asked to answer a very short questionnaire for 6 consecutive days. Completing one questionnaire will take approximately 1 minute of your time. After filling in the last questionnaire on the sixth day, the study will end. You will receive daily reminders to complete the questionnaires. We are aware that you might be quite occupied during the day, but still we want to ask you to fill in as many questionnaires as possible. For us, it is especially important that you do not adjust your daily routine to the study. Instead, please fill in the questionnaires directly after receiving the notification. Also, the questions will expire after 40 minutes.

Moreover, we would like to inform you that your participation in this study is entirely voluntary. You can withdraw from the study at any time, without having to give a reason. Your answers in this study are confidential. All data are collected anonymously as directly identifying information will not be obtained.

This study is approved by the BMS ethics committee. You can contact them if you want to file a complaint (ethicscommittee-bms@utwente.nl). If you have any questions about this study, please contact one of the involved students: c.bahlkow@student.utwente.nl h.rathmer@student.utwente.nl w.s.nipper@student.utwente.nl

Appendix B

Instructions to Download the App

Step 1: Download the App

You can download the App "Ethica" via the following links:

iOS : https://apps.apple.com/ca/app/ethica/id1137173052

Android: https://play.google.com/store/apps/details?id=com.ethica.logger

Step 2: Sign up as Participant

After you have installed the app you can sign up for a new account. By that, you enter your e-mail address and choose a password.

Step 3: Enroll in the study

You can access the study via the URL or by entering the registration code

URL: https://ethicadata.com/study/2433/

Study Registration code: 2433

By clicking on "Participate" you successfully have finished the enrollment process. We hope that setting up the app was easy. However, if you came across difficulties please contact us right away.

Appendix C

Screenshot of One Item of the Daily Questionnaire in the App