

**Resilience and Reappraisal as Coping Strategies for Stressful Events:  
An Experience Sampling Study**

Niklas Pollmann

Department of Psychology, Health, and Technology

Faculty of Behavioural, Management, and Social Sciences

Positive Clinical Psychology & Technology

First Supervisor: Dr. J. T. Kraiss

Second Supervisor: Dr. M. L. Noordzij

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## Abstract

**Background and aim:** Throughout daily life, people are frequently faced with stressful events which can cause the experience of negative affect. Being able to effectively manage these stressors to diminish the emotional impact is called being resilient. Resilience is supported by the application of emotion regulation strategies such as reappraisal. So far, these concepts have been studied through cross-sectional research, providing few insights into how they interact on the daily and within-subject level. This study set out to make use of the experience sampling method to get more insights into how these concepts interact on the state level.

**Method:** A sample of 70 participants ( $M_{age} = 22.93$ ) were asked to answer items three times a day for two weeks to study the relationship between resilience, stressful events and negative affect on the state level. In addition, they filled out a baseline questionnaire about their use of reappraisal before the study. 2,625 timepoints were analysed using linear mixed-effects models.

**Findings:** While an insignificant, negative association ( $\beta = -.18, p = .14$ ) was found between person mean scores of state negative affect and trait resilience, there was a significant, positive association ( $\beta = .49, p < .001$ ) between stressful events and momentary negative affect. A moderation analysis revealed that cognitive reappraisal had a significant moderation effect ( $p < .001$ ) on the relationship between stressful events and negative affect.

**Discussion and conclusion:** While no direct association between resilience and negative affect was established, the study identified cognitive reappraisal as an important buffer for the experience of negative affect during stressful events.

*Keywords:* resilience, negative affect, cognitive reappraisal, experience sampling, stressful events

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## **Resilience and Reappraisal as Coping Strategies for Stressful Events:**

### **An Experience Sampling Study**

The current study seeks to gain further insights into the relationship between the level of resilience a person displays and the degree to which they experience negative affect as a result of stressful events in daily life. So far, most of the literature has focused on resilience on a trait level. Self-report measurements on the trait level, however, measure semantic knowledge which is no longer connected to a specific time or place (Connor & Barrett, 2012). Therefore, these measurements are only able to capture more general tendencies in emotion regulation. In contrast, measurements on the state level like momentary self-report measures allow people to report their experiences in real-time at different times of the day (Connor & Barrett, 2012). These measurements are described as measuring episodic knowledge, which refers to event-specific information about an individual's experience at a specific point in time (Connor & Barrett, 2012). Therefore, measures on a state level are better able to give a more realistic representation of the dynamic, momentary regulation of emotion than measures on the trait level (Maxwell et al., 2018). Accordingly, even if the expected relation between two concepts was found at the trait level that does not necessarily hold for the state level (Nezlek, 2007). Accordingly, this study will use the experience sampling method to extend our understanding of the relationship between stressful events, negative affect, resilience and cognitive reappraisal at the state level.

### **Causes for stress**

Most people have probably encountered a situation in their lives that has made them feel uneasy or uncomfortable. Oftentimes, this feeling stems from the subjective experience of distress that was caused by the initial appraisal of a stimulus as being challenging, harmful or threatening (Garland et al., 2009). Subsequently, the situation is reassessed, and the available resources and coping options are weighed against the demands of the potential threat. The extent to which the demands can be dealt with determines the degree to which one experiences distress. If the resources are deemed inadequate to meet the demands, the stress response could maintain and cause further discomfort and distress (Garland et al., 2009). This does not only apply to major life challenges. The stresses of daily life such as financial difficulties or interpersonal conflict are also seen as causes of greater negative affect (Montpetit et al., 2010). Generally, there seems to be a

considerable correlation between daily stress and affect, regardless of the nature of the stress (Ong et al., 2006). This is supported by the research of Wu et al. (2013), which indicates that not only stressful life events and trauma can have a substantial impact on brain function and structure, but chronic adversity can also result in the development of post-traumatic stress disorder, depression, and other disorders. That is especially the case if individuals are unable to effectively manage their emotional response to these stress-eliciting events (Mennin et al., 2007). Thus, effectively managing one's emotional response to stressful events and everyday adversities plays a crucial role in maintaining mental health and overall well-being.

### **Resilience**

As every individual has probably faced a difficult or unpleasant situation at least once in their life, they would also have had to cope with it, be it in a more or a less effective manner. The different approaches to dealing with adversity are distinct across individuals (Bonanno et al., 2011). The ability to effectively negotiate, adapt to, and manage sources of stress or trauma is called resilience (Windle, 2011). A more resilient individual is expected to be more emotionally resistant to the detrimental effect of stress and to recover quickly (Montpetit et al., 2010). For acute events, resilience is defined by a rapid return to the baseline and the ability to sustain meaningful goal-directed activities (Zautra et al., 2010). A resilient response may be more or less likely depending on the recent history of an individual and the broader context of their lives (Bonanno et al., 2011). Moreover, resilient individuals are likely to differ on an even broader range of factors such as demographic profiles, personality, life history, social and economic resources, and possibly even more factors (Bonanno et al., 2011). To make a clearer distinction between all the different factors, one may differentiate between two categories of protective mechanisms: personal and community/social support factors (Bergeman & Wallace, 1999). Firstly, personal factors are dispositional attributes or personality characteristics which determine the individual way in which a person encounters and interprets stressful events (Bartone et al., 1989; Bergeman & Wallace, 1999). These factors linked to personality, such as emotion regulation strategies, are less likely to change over time, in contrast to external resources which can be different from time to time and may not always be available (Hobfoll, 2002). Emotion regulation, as defined by Gross (1998), is the process by which individuals alter their emotions, responses to emotions, or the situations in which

these emotions come up to better manage them. Importantly, the effectiveness of emotion regulation strategies is influenced by the context in which they are applied, with some strategies being adaptive or maladaptive depending on a specific situation (Brockman et al., 2017). While very impactful adverse events are more likely to call for the use of more social resources to bounce back, personal resources may be more important during situational adversity (Cowden et al., 2016). Hence, it may be sensible to take a closer look at how individuals employ certain emotion regulation strategies in certain moments to deal with stress.

### **Cognitive reappraisal**

Because of the threat stress can pose when it is not adequately dealt with, it is important to get a better understanding of what facilitates resilience. People who are high in resilience can also experience high levels of anxiety and frustration but seem to be able to experience positive emotions despite stressful circumstances (Tugade et al., 2004). The process in which one evaluates a stimulus as potentially harmful or threatening is dynamic and mutable (Garland et al., 2009). By inferring new information from the environment and novel information about one's reaction to the threat a reappraisal process may be initiated in which one's original appraisal is altered as a result of the feedback (Garland et al., 2009). This process of cognitive reappraisal has been shown to have a positive association with resilience (Polizzi & Lynn, 2021).

Cognitive reappraisal can be described as active meaning-based coping, an adaptive process through which stressful events receive new meaning as being benign, valuable, or beneficial (Folkman, 1997; Garland et al., 2009; Lazarus & Folkman, 1984). In his emotion regulation model, Gross (1998) posits that reappraisal can decrease the expression of both behavioural and subjective signs of emotions when confronted with adversity. Specifically, the meaning of the stressful event is reinterpreted in a more positive light, by which the individual comes to believe something valuable or beneficial has been gained from the situation, such as enhanced wisdom or personal growth (Folkman & Moskowitz, 2000; Gross, 1998). Consequently, the focus of this coping mechanism is on altering the emotion because only the cognitive appraisal is adjusted while the objective reality remains unchanged (Nowlan et al., 2015). Thus, reappraisal may be an effective coping strategy even in severe times of adversity with no benign solution such as the death of a loved one (Garland et al., 2009). The goal of reappraisal is not, however, to reframe adversity with unrealistic

optimism, but to recognise that some positive meaning can be found (Nowlan et al., 2015). Accordingly, reappraisal requires that the individual identifies the positive value themselves, perceives it as personally meaningful, acknowledges that the gain arose from having faced the negative experience, and acknowledges the negativity of the situation (Nowlan et al., 2015).

Oftentimes, reappraisal can be the first step towards re-engaging with the stress-eliciting event (Garland et al., 2009). For example, diabetes patients are often able to use their illness as a motivation to change their lifestyle. Overcoming adverse experiences such as fighting chronic illness may also facilitate survivors to help others who suffer from the same fate. This process of shifting the perspective may be enabled because of reappraisal which lets an individual disengage from a self-immersed vantage point and see the bigger picture (Wallace-Hadrill & Kamboj, 2016). Furthermore, reappraisal has been shown to lead to a greater decrease in negative affect compared to other coping styles such as distraction and showed greater activation of parts of the brain that are associated with processing affective meaning (McRae et al., 2009). Likewise, reappraisal has been found to have a negative relation to psychopathology and a positive relation to well-being (Hu et al., 2014). In addition, reappraisal is also recognised as a key component of cognitive behavioural therapy, one of the most successful interventions for the treatment of mood and anxiety disorders which are thought to be related to maladaptive appraisal processes (Beck et al., 1979).

Most of the studies mentioned so far only studied the relationship between cognitive reappraisal and negative affect in traditional lab settings over a short period of time. Some of them found that there was either no significant relationship between the two concepts (Nezlek & Kuppens, 2008) or showed mixed results for different groups, where it resulted in decreased negative affect in some and increased negative affect in others (Brockman et al, 2017). A possible explanation for the latter may be that reappraisal can have an adaptive effect when a person has control over a given situation while it may have a maladaptive effect in uncontrollable situations (Troy et al., 2013). Overall, the relationship between cognitive reappraisal and negative affect may not be as stringent as commonly expected and its success in effectively mediating negative affect as a response may be dependent on other factors. A limited amount of research exists examining this

relationship, and even fewer studies have been conducted in an ecological manner, which calls for further examination to fill exactly those gaps.

### **Experience sampling**

Understanding how emotions are managed at specific moments during the day provides the possibility to understand more about the well-being and functioning of individuals (Brockman et al., 2017). By measuring daily processes over time, one can examine personality as a dynamic process and get better insights into how individuals shape their experience (Davis et al., 2006). A research methodology that aims to look at such daily processes is Experience Sampling Methods (ESM) which use self-report measures to track experiences in the real world (Myin-Germeys & Kuppens, 2021). With the application of ESM, it is possible to retrieve a more reliable and accurate impression of daily processes instead of having to rely on retrospective reports (Bolger et al., 2003). Thereby, memory recall bias is significantly reduced (Scollon et al., 2009). Moreover, the use of technological devices in ESM studies enables researchers to measure concepts of interest in a real-life setting and outside of the laboratory (Myin-Germeys & Kuppens, 2021). ESM also allows for better inferences about the individual as data collection is not solely restricted to between-person observations, but also within-person observations (Curran & Bauer, 2011). Therefore, ESM may be seen as very suitable to capture the dynamic nature of emotion regulation processes and the frequent fluctuations from day to day.

### **The present study**

This study seeks to add to previous research by assessing negative affect and stressful events in an ecological setting over an extended period of time. Furthermore, the current study aims to gain new insights into the relationship between cognitive reappraisal and how negative affect is constituting itself within subjects in a natural environment. As cognitive reappraisal occurs as an emotion regulation strategy in daily life it should also be investigated at the state level (Tugade & Fredrickson, 2007). Therefore, the following research questions were formulated: RQ1: *Do people who have more trait resilience experience less momentary negative affect?*, RQ2: *How is the experience of stressful events associated with more negative affect?* and RQ3: *Does trait reappraisal moderate the relationship between the experience of stressful events and momentary negative affect?* Due to the notion that more resilient individuals are being described as more



emotionally resistant to the experience of stressful events and quicker to recover from them (Montpetit et al., 2010) the following hypothesis was formulated: *H1: There is a negative correlation between trait resilience and momentary negative affect*. Another hypothesis was formulated based on the previous findings that not only major life events can be causes for increased negative affect, but also day-to-day challenges and irritations (Montpetit et al., 2010; Ong et al, 2006): *H2: There is a strong positive correlation between experiencing stressful events and momentary negative affect*. Last, the goal of gaining insights into the relationship between reappraisal and negative affect using experience sampling methods is addressed in a third hypothesis. In this hypothesis, the previously established positive relationship between cognitive reappraisal and resilience is considered, as well as its ability to diminish emotional responding in the face of adversity (Gross, 1998, Polizzi & Lynn, 2021): *H3: Reappraisal moderates the relationship between stressful events and negative affect by reducing the impact of the stressful event and the intensity of negative affect experienced in response*.

## **Methods**

### **Participants**

This is a secondary analysis of data that was previously collected in a study by Wallner (2022). For the original study, a total of 114 participants were recruited to participate in the study through convenience sampling. This non-probability sampling method was deemed the most practical in the given situation as it is common for ESM studies and warrants that participants are motivated and easily accessible to the researcher (Etikan et al., 2016). Thus, participants were recruited through the personal contacts of the researchers and the test subject recruitment tool SONA Systems of the University of Twente. For participants who enrolled for the study through this recruitment system, an incentive was provided. They received 3.5 credit points, which are needed for the completion of one's study program.

To be eligible for participation, participants had to be at least 18 years old, have sufficient skills in the English language and availability of a smartphone, as this was needed to fill out the daily questionnaires. Participants with a response rate of less than 33% were omitted from the initial dataset. According to Van Berkel et al. (2018), ESM studies commonly have an average of 53 participants, which was surpassed by the final number of participants ( $N = 70$ ).

## **Materials**

### ***Trait measures***

**Resilience.** Trait resilience was measured on a 5-point Likert scale using the Brief Resilience Scale (BRS) with 6 items. The scale ascribes higher trait resilience to a higher mean score on the scale, while a lower mean score indicates lower trait resilience. With a small number of items, the BRS is very suitable for studies using the experience sampling method. The psychometric properties of the scale are characterised by good internal consistency ( $\alpha = >0.70$  to  $<0.95$ ) and good construct validity (Windle et al., 2011). The reliability of the scale for this study was moderate and acceptable with a Cronbach's  $\alpha = 0.79$ .

**Cognitive Reappraisal.** The sub-scale for trait reappraisal of the Emotion Regulation Questionnaire (ERQ) with 6 items was used to measure trait cognitive reappraisal. It measures the usage of cognitive reappraisal on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree), with higher scores indicating more frequent use and lower scores indicating less frequent use. The scale shows excellent internal consistency ( $\alpha = 0.89$  to  $0.90$ ) and good construct validity (Preece et al., 2019). The reliability of this scale for this study was very good with a Cronbach's  $\alpha = 0.90$ .

### ***State measures***

**Negative affect.** Momentary negative affect was measured using 4 items which were created by Helmich et al. (2021) for use in studies employing the experience sampling method and can, thus, be found in the ESM Item Repository (ESM Item Repository, n.d.). The four items ask participants how anxious, irritable, down, and sad they feel at the given moment by indicating this on a 7-point Likert scale from 1 (not at all) to 7 (very much). A higher mean score for all four items indicates higher momentary negative affect and a lower mean score indicates lower momentary negative affect. Helmich et al. (2021) did not provide any information about the reliability or validity of these items. A correlation matrix, with the MHC-SF as an indicator for symptoms of depression, showed a significant correlation ( $r = -.35, p < .01$ ) between the two measurements, affirming the convergent validity of the selected items.

**Stressful events.** To measure how stressed participants were at a particular moment they were asked to indicate how stressful they would rate the most striking event or activity in the last

hour. Therefore, participants had to answer the item “*Think of the most striking event or activity in the last hour. How stressful was this activity?*” on a 7-point Likert scale ranging from 1 (not at all) to 7 (very much). The item was also taken from the ESM Item Repository (ESM Item Repository, n.d.) and has been used in studies before (Schleich, 2022).

**Cognitive Reappraisal.** For the measurement of momentary cognitive reappraisal, two items from the Emotion Regulation Questionnaire (ERQ) were included in the daily questionnaires. The two items were “*In the last hour, I controlled negative feelings by changing the way I think about the situation I am in*” and “*In the last hour, I tried to look at the cause of my negative feelings from a different perspective*”. These questions were also answered on a 7-point Likert scale ranging from 1 (not at all) to 7 (very much) with a higher score indicating the use of cognitive reappraisal in the given moment.

### **Design and Procedure**

The original study received ethical approval from the Ethics Committee of Behavioural, Management and Social Sciences of the University of Twente (220285). For data collection, the application Ethica was used. It allows researchers to create a questionnaire which is suitable for experience sampling as its corresponding smartphone application lets participants answer the timed questionnaires from their phone at any time (Ethica Data, n.d.). Before a code to sign up for the study within the smartphone application was sent to participants, the study was pilot tested for three days by the researchers to check for any technical issues which may occur. As soon as participants enrolled for the study, they were able to give informed consent (Appendix A). At 9:00 on the first day of the study, participants were asked to fill out the baseline questionnaire which did not expire until the last day of the study (Appendix B). If they did not immediately fill out the questionnaire, reminders were sent 8, 24, and 72 hours later. The state measurement questionnaires were triggered in semi-structured time intervals four times on each day of the 14-day study. Sampling schemes that use random intervals have higher ecological validity compared to fixed sampling schemes, which tend to be limited due to their predictability (Dejonckheere & Erbas, 2021). However, fixed interval schemes tend to have higher compliance rates compared to schemes that use random intervals because questionnaires are triggered at predictable times rather than at unpredictable times (Dejonckheere & Erbas, 2021). The daily schedule comprised one time

frame in the morning (10:00 - 11:00), at noon (13:30 - 14:30), in the afternoon (17:00 - 18:00), and in the evening (20:30 - 21:30) respectively. Within each time frame, participants were reminded to fill out the questionnaire if they had not done so already. If participants did not respond within the given time frame of 60 minutes the questionnaire expired. In addition to the mentioned scales, more were included as part of a collaborative effort of multiple researchers in the original study.

### **Data analysis**

The dataset was analysed with the help of the statistical analysis software IBM SPSS Statistics 28. To establish the convergent validity of the measurements, the extent to which the trait and average state measurements were interrelated was examined. Thereby, their shared variance of a latent construct was reflected. For this reason, mean scores for state measures of cognitive reappraisal and negative affect were calculated for each participant. The means of the state measures were then correlated with the corresponding trait measures of the construct using a bivariate correlation function.

Multilevel data, such as ESM data, can be challenging to analyse due to its nested structure. ESM data consists of multiple assessments within days, which are nested within individual participants. Traditional fixed effects models are not sufficient for analysing this type of data. Instead, multilevel models such as Linear Mixed-Effects (LMM) models are necessary to properly account for the subject-level variability in the measured construct (Viechtbauer, 2021). LMM models are able to take random errors and missing data into account, allowing for a more accurate analysis of the data (Viechtbauer, 2021). In this way, LMMs can account for the fact that the strength of a relationship may differ across subjects. Subsequently, using the Linear Mixed Effect analysis in SPSS, the variable ID (indication for individual subjects) was assigned to the *subjects* field and the variable time was assigned to the *repeated* field, thus indicating repeated measures within subjects. Moreover, a first-order autoregressive structure (AR1) was applied as it assumes measurements to be less correlated the bigger the time difference between them.

To address the first research question, it was analysed whether the average momentary negative affect was negatively associated with higher average levels of trait resilience. Hence, mean scores for momentary negative affect were calculated for each participant. Then, a linear regression model was used to analyse the association with trait resilience as the predictor variable and the

average score of momentary negative affect as the outcome variable. In this case, a linear mixed model was not needed as there was no variation within participants that had to be accounted for. To get a better understanding of the effect sizes, z-scores were calculated for the two variables and the analysis was repeated using these standardised scores.

The aim of the second research question was to assess whether the level of momentary negative affect was higher when participants experienced a stressful event. Consequently, the variables of the linear mixed effect analysis were replaced with event stress as the independent variable and the state measurement of negative affect as the dependent variable.

The last research question aimed at finding out whether trait reappraisal moderates the relationship between the experience of stressful events and negative affect. For this reason, a dichotomous variable was created for trait reappraisal. This was done by calculating the median for trait reappraisal and separating the subjects according to high use of reappraisal (scores >29 being recoded to 1) and low use of reappraisal (scores <29 being recoded to 2). Next, the aforementioned linear mixed effects analysis was run, again with event stress as the independent variable and momentary negative affect as the dependent variable. However, to assess the moderation effect of cognitive reappraisal, both event stress and trait cognitive reappraisal were classified as fixed covariates. They were both selected as multifactorial variables and the interaction effect for the two was also selected to be included in the output. To get a better understanding of the effect sizes, z-scores were calculated for all variables and the analyses were repeated using these standardised scores.

At last, certain subjects with varying resilience scores and a moderately high compliance rate were examined further. In this exploratory analysis, mean scores for state cognitive reappraisal, state negative affect and stressful events for each time point were plotted using the ggplot2 package (Kassambara, 2020) in R Studio (v4.2.2; R Core Team, 2022).

## **Results**

### **Descriptive statistics**

The mean age of the sample was 22.93 ( $SD_{age} = 7.52$ ). 34 (57%) of the participants identified as female and 26 (43%) identified as male. The majority of the sample was German with 41 (68%) participants, followed by Dutch with 10 (17%) participants and the remaining 15% being

from other nations. Most of the subjects indicated having a high school degree or similar (89%) as their educational level, while 6 (4%) had a bachelor's degree, 4 (3%) a master's degree and one participant had an HBO-associate degree. An overview of the characteristics of the sample can be found in Table 1.

**Table 1**

*Sample characteristics (N=70)*

<i>Variable</i>	<i>Category</i>	<i>%</i>	<i>N</i>
Age	Range: 18 to 65	-	70
	( $M=22.93$ , $SD=7.52$ )		
Gender	Male	37	26
	Female	61	43
	Non-binary	1	1
Nationality	Dutch	17	12
	German	69	48
	Other	14	10
Educational Level	Bachelor	6	4
	Master	4	3
	High School	89	62
	Other	1	1

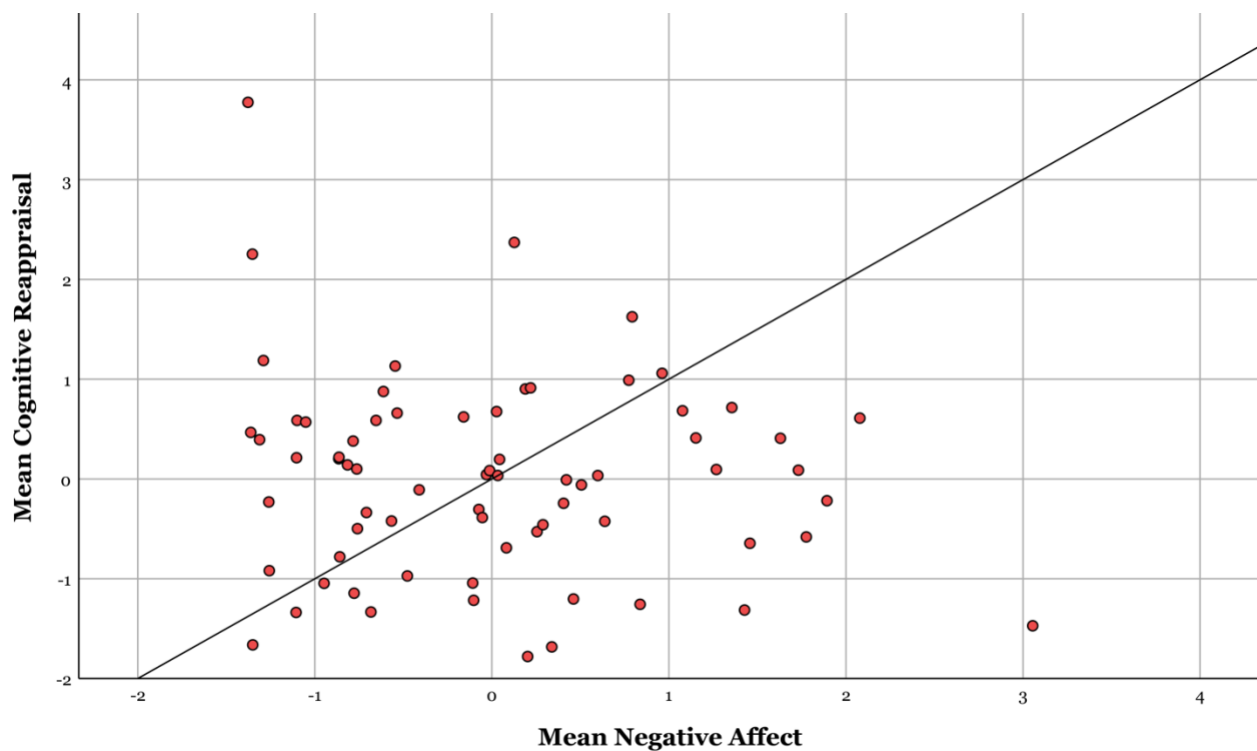
The mean score of the Brief Resilience Scale assessing trait resilience in the current sample ( $M=3.1$ ,  $SD=0.7$ ). The mean score for the current sample for the cognitive reappraisal subscale of the Emotion Regulation Questionnaire ( $M=4.45$ ,  $SD=1.07$ ) was comparable to the scores measured by Gross & John (2003;  $M=4.6$  [ $SD=.94$ ] for men;  $M=4.62$  [ $SD=1.02$ ] for women).

### Association among state variables

When examining the relationship between person mean scores for standardised cognitive reappraisal and person mean scores for standardised negative affect, the pattern is inconsistent (see Figure 1). While for some participants a higher score on one scale coincides with a lower score on the other scale, the opposite can be observed for other participants. A correlation analysis between standardised state negative affect and standardised cognitive reappraisal yields a significant, weak, negative association ( $r=-.119, p <.001$ ).

### Figure 1

Scatter plot with standardised person mean scores for state cognitive reappraisal and state negative affect for each participant ( $N=70$ )



Convergent validity between state and trait measures was assessed by running a correlation analysis between them. Correlations that are supposedly measuring the same constructs were shown to head in the expected directions (see Table 2).

**Table 2**

*Mean, standard deviations, and inter-correlations among trait measurements*

	Mean	SD	1	2	3	4
1 ERQ	4.45	1.07				
2 BRS	3.05	.70	.39**			
3 MHC-SF	2.64	.92	.49**	.42**		
4 State Cog. Reappraisal	3.09	1.04	.26*	.22	.45**	
5 State Negative Affect	2.16	.75	-.45**	-.18	-.35**	.29

*Note.* Person-mean scores were used for State Cognitive Reappraisal and State Negative Affect.

\*\* . Correlation is significant on the level of 0.01 (2-tailed)

\* . Correlation is significant on the level of 0.05 (2-tailed)

### **Correlation of trait resilience and momentary negative affect between subjects**

A linear model for person mean scores of state negative affect as a function of mean trait resilience revealed an insignificant, negative association ( $\beta = -.18$ ,  $p = .14$ ) on the between-subjects level. This means that it cannot be inferred that trait resilience predicts negative affect at a population level (see Table 3). According to Cohen (1988), this effect size can be classified as small.

**Table 3**

*Coefficients for the fixed linear effects model of momentary negative affect as a function of trait resilience*

<i>Parameter</i>	<i>B</i>	$\beta$	<i>SE</i>	<i>df</i>	<i>t</i>	<i>p</i>	<i>95% CI</i>	
							<i>LL</i>	<i>UL</i>
Intercept	2.75		.4	70	6.85	<.001	1.95	3.54
Resilience	-.19	-.18	.13	68	-1.5	.139	-.45	.06

*Note:* SE = Standard Error; CI = Confidence Interval; LL = Lower Limit; UL = Upper Limit



### Correlation of stressful events and momentary negative affect within subjects

A linear-mixed model for momentary negative affect as a function of the dichotomous variable of stressful events revealed a significant, positive association ( $\beta = .49, p < .001$ ). This indicates that experiencing stressful events increases the experience of negative affect (see Table 4). According to Cohen (1988), this effect size can be classified as moderate.

**Table 4**

*Estimates for fixed effects of stressful events on state negative affect as the dependent variable*

<i>Parameter</i>	<i>B</i>	$\beta$	<i>SE</i>	<i>df</i>	<i>t</i>	<i>p</i>	<i>95% CI</i>	
							<i>LL</i>	<i>UL</i>
Intercept	2.09	-.05	.09	69.6	24.24	<.001	1.92	2.26
Stressful Event	.55	.49	.05	2379.25	11.45	<.001	.46	.65

*Note: SE = Standard Error; CI = Confidence Interval; LL = Lower Limit; UL = Upper Limit*

### Trait reappraisal as moderator on stressful events and momentary negative affect

A linear-mixed model for momentary negative affect as a function of the dichotomous variable of stressful events with trait cognitive reappraisal as the moderating variable revealed a significant, negative moderation effect ( $b = -.41, p < .001$ ) (see Table 5). This signifies that cognitive reappraisal has a significant moderating effect on the relationship between stressful events and momentary negative affect. Thus, individuals who score higher in trait reappraisal display a weaker relationship between the experience of a stressful event and momentary negative affect. In other words, an individual who uses cognitive reappraisal to cope may experience less negative affect after experiencing a stressful event. There was a significant small correlation between negative affect and the experience of stressful events for the group who had a higher score in trait cognitive reappraisal ( $r = .2, p < .001$ ). For the group who had a lower trait reappraisal score the same correlation was moderate ( $r = .34, p < .001$ ).

**Table 5**

*Estimates for fixed effects of stressful events and cognitive reappraisal on state negative affect as the dependent variable*

<i>Parameter</i>	<i>B</i>	$\beta$	<i>SE</i>	<i>df</i>	<i>t</i>	<i>p</i>	<i>95% CI</i>	
							<i>LL</i>	<i>UL</i>
Intercept	2.426	.244	.14	69.75	17.72	<0.001	2.15	2.7
Reappraisal	-.52	-.46	.17	69.31	-3.06	.003	-.85	-.18
Stressful event	.77	.68	.07	2392.57	10.95	<.001	.63	.9
Reappraisal * Stressful Event	-.41	-.36	.1	2382.17	-4.24	<.001	-.6	-.22

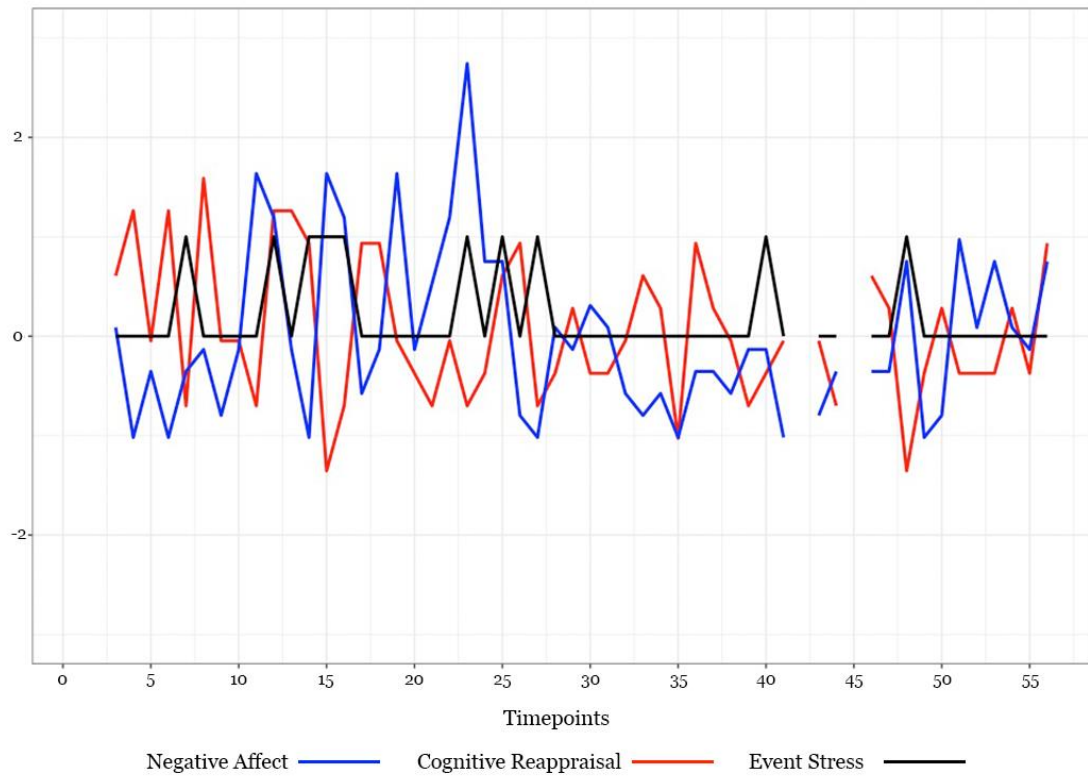
*Note: SE = Standard Error; CI = Confidence Interval; LL = Lower Limit; UL = Upper Limit*

### **Explorative analysis of subjects with different resilience scores**

Participant 52712, who had a mean trait resilience score of 2 (lower than average), demonstrated an inconsistent pattern between stressful events and momentary negative affect (see Figure 2). The two variables were moderately negatively correlated,  $r(51) = -.32, p < .05$ . At some timepoints, such as 10, 35, and 49, stressful events were correlated with state negative affect. During this time, the participant's score for both variables was below average, indicating that their level of negative affect did not call for the need to regulate their emotions. Furthermore, at times when the participant indicated stressful events (e.g., 7, 15, 48), their score for cognitive reappraisal was below average. This indicates that they were less likely to make use of cognitive appraisal when they experienced stress.

**Figure 2**

*Line plot for standardised state cognitive reappraisal, state negative affect, and stressful event for each time point for participant 52712*

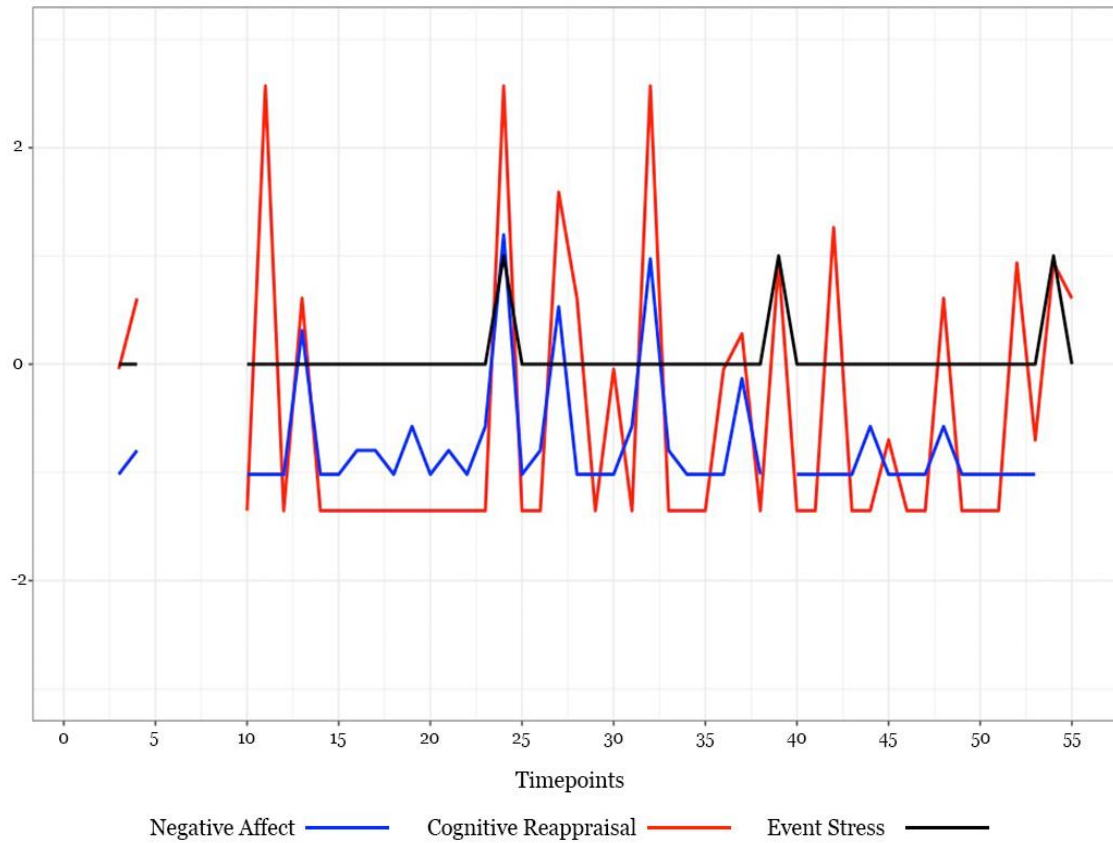


*Note.* Stressful events were coded as 0 = no stressful event and 1 = stressful event

In contrast, participant 52829 displayed a more consistent pattern between the two variables (see Figure 3). In line with that, there was a positive moderate correlation between state negative affect and state cognitive reappraisal,  $r(49) = .47, p < .01$ . Their mean score for trait resilience of 4 was above average for the sample. It is notable that while they are relatively low on cognitive reappraisal most of the time, their score was remarkably high when they scored above average, such as at time points 13, 24, and 32. Moreover, they were consistently low in negative affect and only report a few stressful events which all coincide with a spike in cognitive reappraisal. Even in the absence of stressful events, cognitive reappraisal was effectively used to alleviate rising levels of negative affect. This indicates that while they may have generally been less prone to experiencing stress, they may not only have known how to effectively cope with stressful events but also other causes for an increase in negative affect.

### Figure 3

*Line plot for standardised state cognitive reappraisal, state negative affect, and stressful event for each time point for participant 52712*

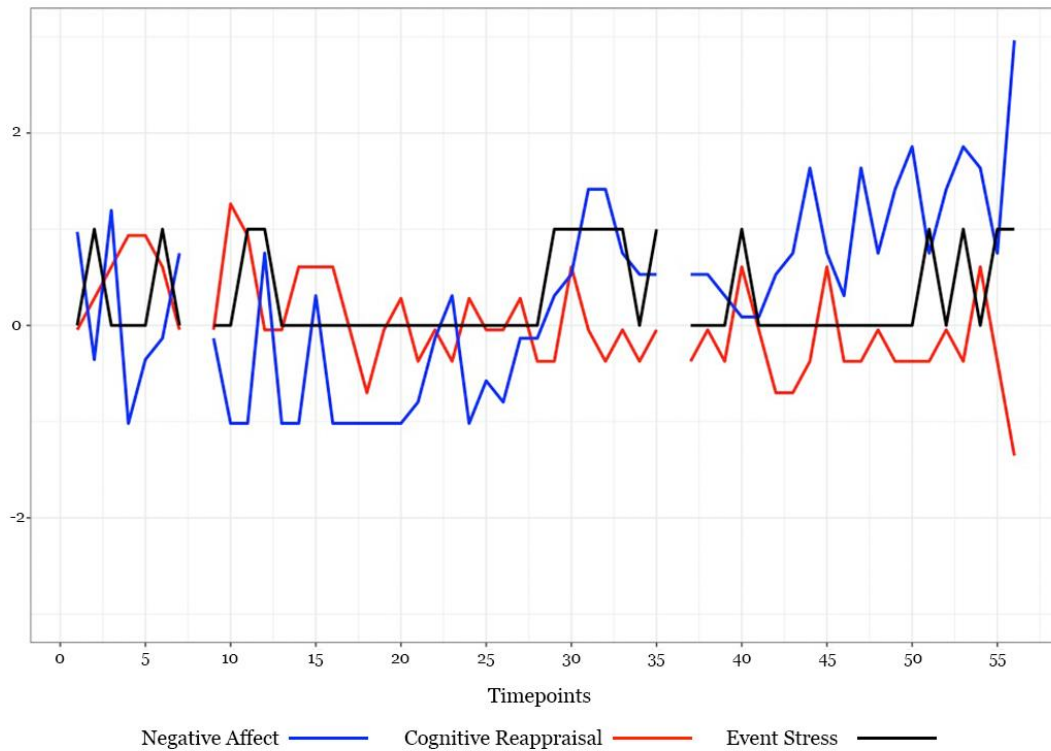


*Note.* Stressful events were coded as 0 = no stressful event and 1 = stressful event

Last, participant 38382 displayed an inconsistent pattern for scores in momentary negative affect and the use of cognitive reappraisal (see Figure 4). There was a negative moderate correlation between the two variables,  $r(52) = -.47, p < .01$ . With a mean trait resilience score of 3.33 they scored comparatively high to the rest of the sample and experienced a relatively high number of stressful events. Until time point 27, they almost consistently score higher in cognitive reappraisal in comparison to negative affect, with only a few exceptions. From that point onwards, their score in negative affect is consistently above average, while they score lower in negative affect than before. This pattern indicates that their less frequent use of cognitive reappraisal may correlate to the rise in negative affect.

**Figure 4**

*Line plot for standardised state cognitive reappraisal, state negative affect, and stressful event for each time point for participant 52712*



*Note.* Stressful events were coded as 0 = no stressful event and 1 = stressful event

## **Discussion**

The purpose of this study was to extend previous research by examining the relationship between negative affect, stressful events, and cognitive reappraisal in a natural setting over an extended period. Furthermore, the study aimed to use the experience sampling method to better understand the association of stressful events with negative affect. Lastly, the current study sought to gain new insights into how the relationship between cognitive reappraisal and negative affect is constituted within subjects in a natural environment.

As stated in the first hypothesis, it was expected that there would be a negative correlation between trait resilience and momentary negative affect. This was based on the notion that more resilient individuals would be more emotionally resistant to stressful events and have a better ability to quickly recover from the negative effects of those events (Montpetit et al., 2010). The

current research only provides a non-significant moderate effect size for this relationship. While the relationship is still negative and, thus, in line with the hypothesis, it is not enough to support the findings from previous research. Nevertheless, it is important to keep in mind that even highly resilient individuals experience negative affect (Tugade et al., 2004). The difference to individuals who are lower in resilience is rather that they are better at recovering from stress and are quicker to return to baseline levels (Montpetit et al., 2010; Zautra et al., 2010). Experiencing negative affect should not be considered inherently bad. Depending on the context, the experience of negative affect can even have adaptive and beneficial effects on cognition, judgement, motivation and social behaviour (Forgas, 2013). Thus, the experience of positive and negative affect can be considered valuable. In line with this, reduced emotional reactivity, i.e., the extent to which one experiences emotional responses to both negatively and positively valenced stimuli, was found in subjects who were diagnosed with a major depressive disorder (Bylsma et al., 2008). After all, negative affect may not be the most appropriate assessment to capture the dynamic nature of resilience and the ability to recover from stress. Another variable that provides a more accurate reflection of an individual's resilience may be the speed of recovery from small perturbations (Kuranova et al., 2020). The complex system theory views resilience as a dynamic process and considers factors like critical slowing down and changes in mental health states (Kuranova et al., 2020). It is recommended that future research looks at the speed of recovery from daily unpleasant events and changes over time to gain a more comprehensive understanding of the relationship between resilience and emotional experiences.

According to the second hypothesis, it was anticipated that there would be a strong association between stressful events and negative emotions. The assumption behind this hypothesis was that both major life events and daily challenges and irritations can contribute to increased negative affect (Montpetit et al., 2010). The current study shows a moderate, statistically significant positive relationship between stressful events and negative affect. Hence, the hypothesis can be accepted, and the notion supported that the source of stress can be multifaceted, and daily stressors may alongside major life events be counted as a potential cause for increased negative affect (Ong et al, 2006). This points out the importance of considering various sources of stress when studying the impact on an individual's well-being. Additionally, it highlights how important it

is to develop coping strategies that help individuals better handle day-to-day challenges and irritations and mitigate the impact they can have on emotional well-being.

The last hypothesis predicted that the use of cognitive reappraisal, or the process of reframing one's thoughts about a situation, would moderate the relationship between stressful events and negative affect. This hypothesis was based on the observation that cognitive reappraisal and resilience are positively associated, and that reappraisal may be an effective coping strategy for managing stress (Polizzi & Lynn, 2021). As anticipated, the results demonstrated a significant moderating effect of cognitive reappraisal on the relationship between stressful events and momentary negative affect, resulting in a decrease in negative affect. This indicates that individuals who make use of cognitive reappraisal are less likely to experience negative affect after a stressful event. This observation aligns with previous findings that demonstrated a correlation between the use of cognitive reappraisal and reduced negative affect on the trait level (Gross & John, 2003). The overall tendency of the given sample to effectively employ cognitive reappraisal in coping with stressful events may also be related to their age. Brockman et al. (2017) hypothesised that the use of cognitive approval could improve with age. They observed cognitive reappraisal to be associated with improved well-being outcomes in individuals over the age of 20, while it was associated with more negative affect in younger individuals (Brockman et al., 2017). As most participants in the current sample were over the age of 20, age may have also been a factor contributing to the observed association. It may also be considered that the use of cognitive reappraisal as a coping strategy can be more effective in situations where an individual has some control but may be less effective when control is lacking (Troy et al., 2013). Had these factors been considered in the present study, the observed effect could have been more evident. Future studies could take this into account.

The analysis of the data at the individual level revealed that the relationship between stressful events, negative affect, and cognitive reappraisal was not consistent across all participants. Particularly for one participant with a low resilience score (Figure 2), there was a negative association between state reappraisal and negative affect. A more consistent pattern was observed in one highly resilient participant (#52829) where a positive correlation was found. For this specific participant, it was interesting to see that when there was an increase in negative affect,

there was also an increase in cognitive reappraisal. In contrast, another participant with relatively high resilience (see Figure 5) did not exhibit this pattern. This may suggest that while the benefits of cognitive reappraisal can be seen at the group level, they may not hold for all individuals (Curran & Bauer, 2011). Nevertheless, as seen in the highly resilient participant, some individuals consistently make use of cognitive reappraisal, potentially as a reaction to negative affect. Likewise, Brockman et al. (2017) examined cognitive reappraisal on the state level and discovered that, for some individuals, there was an increase in negative affect, while for others, it was associated with a decrease in negative affect. This is in line with the notion that the adaptiveness of emotion regulation strategies is dependent on the person who is applying it and the context it is applied (Aldao, 2013). Thus, it would be beneficial to conduct more idiographic research on individuals who also show high levels of resilience. This way, we can further understand if a high score in resilience is directly associated with a more consistent use of cognitive reappraisal or if other factors play a role. Furthermore, such studies could take a closer look at how effective cognitive reappraisal is in these situations. The line plots further indicated that reappraisal may not only function as an emotion regulation strategy in the face of stressful events but may also facilitate the maintenance of mental health in the face of other, possibly more internal, causes for distress.

### **Strengths and Limitations**

The current study demonstrated strengths in its employment of the experience sampling method. As participants were assessed several times a day with the help of an app on their smartphone the study was essentially conducted in a very naturalistic environment, leading to a high ecological validity compared to studies conducted in a lab. The high frequency of measurements may also have led to higher accuracy in the measured variables and provided a more nuanced picture of how these variables vary for each of the participants during their daily life (Csikszentmihalyi et al., 2014). Another benefit of the study design was the mitigation of recall bias, as the time between stressful events and measurement was significantly reduced (Palmier-Claus et al., 2019). The ecological validity that was afforded through the employment of the experience sampling method stands in contrast to previous studies which employed cross-sectional, retrospective designs in studying resilience and cognitive reappraisal (Polizzi & Lynn, 2021).



Despite the strengths this study has to offer, several limitations must be discussed. As the present sample was mainly recruited by the researchers through convenience sampling, mostly friends and close contacts of the researchers were able to participate in the study. Thus, the studied sample was very homogeneous and as such not representative of the larger, more diverse population. This is evidenced by the great number of German participants in the study who due to the sampling method presumably also have a high degree of social overlap.

It should also be considered that the original study which provided the data for the current study was a collaboration of multiple researchers with differing objectives. As they did not all set out to measure the same concepts, a large number of items had to be answered by the participants at each of the three daily measurement points. This may have put a higher strain on participants than it would have, were they to only answer items about the concepts analysed in the present study. Consequently, participants may have been less motivated to fill out the questionnaires at every timepoint, especially when they were short on time or stressed at the given moment.

Another limitation may have resulted from the phrasing of the item which assessed whether participants experienced a stressful event. The item asked participants to recall the most “striking” event or activity they experienced in the last hour. The term “striking” may refer to something that is “very unusual or easily noticed, therefore attracting a lot of attention” or something “obvious, interesting, and often attractive” (Cambridge Dictionary, n.d.). Hence, participants may not have interpreted this item in reference to the last stressful event they had experienced. As a result, the item may not have measured the intended concept.

Furthermore, the use of only self-report measures may have interfered with an objective assessment of the measured concepts (Polizzi & Lynn, 2021). As a result, participants were able to only report on emotion regulation mechanisms they experienced consciously. A measurement that can indicate the use of emotion regulation strategies and does not solely rely on self-report is heart rate variability (HRV) (Appelhaus & Luecken, 2006). For example, increased HRV during cognitive reappraisal was shown to be associated with decreased negative affect (Denson et al., 2011). In addition, the measurement of cognitive reappraisal neglected the quality to which it was applied. This may, however, be an important factor in how effective cognitive reappraisal is as an emotion regulation strategy. Highly resilient individuals, for example, may just be more skilled in

the way they make use of cognitive reappraisal or know how to effectively use it (Southward et al., 2021). Similarly, the context in which cognitive reappraisal is employed can affect its effectiveness, as emotion regulation strategies can have either positive or negative outcomes depending on the context in which they are applied (Brockman et al., 2017).

### **Implications and future research**

In his model of emotion regulation, Gross (1998) posits that the strategy of cognitive reappraisal can not only elicit positive emotional responses but may also be noticeable in physiological reactions individuals have as a reaction to a stimulus. While the experience sampling method already offers advancements in the way emotional regulation is looked at, current technological developments may allow taking such physiological reactions into account. As such, future research into emotion regulation strategies like cognitive reappraisal could incorporate wearables to measure physiological data, such as HRV for emotion regulation or galvanic skin response (GSR) for stress (Appelhaus & Luecken, 2006; Yang et al., 2021). The collection of data using ESM at various timepoints throughout the day with the corresponding physiological data collected by the wearables may reveal patterns and associations between self-reported emotions and physiological responses. This combined approach can help find out more about the effectiveness of emotion regulation strategies and offers a more objective assessment by complementing the self-report measures of ESM.

A more nuanced impression of the relationship between cognitive reappraisal and negative affect may also be achieved by applying a lagged analysis in future research. In this way, the relationship of the application of cognitive reappraisal at one timepoint can be analysed in relation to levels of negative affect at later timepoints (Viechtbauer, 2021). This would allow drawing inferences about the directionality of this relationship. This was not the case in the present study where it was analysed whether higher levels of negative affect and the application of reappraisal coincide at the same timepoints.

The explorative analysis of cognitive reappraisal and negative affect in one participant who scored high on the resilience scale revealed a relatively stable pattern in which the two constructs coincided quite frequently. Future research could focus more on such individuals who score high in resilience. Idiographic research on these individuals may reveal more about the ways in which they

make use of emotion regulation strategies and if their use is effective. Moreover, if the application does show to be effective, such research may provide information about other factors that could contribute to the effectiveness and could help in the teaching of emotion regulation strategies to promote resilience. Ideally, the sample for such research should also be more diverse than was given in the sample analysed in this study.

### **Conclusion**

The present study examined the relationship between resilience and negative affect and found no significant negative correlation. This supports the notion that while resilient individuals may be better at buffering the effect of stressful events, negative affect is still experienced. Furthermore, the study provided insights into how daily stressors can be a significant predictor of momentary negative affect. In this relationship, cognitive reappraisal can work as an effective emotion regulation strategy to alleviate the emotional impact of a stressful event. However, future research is needed to better understand how cognitive reappraisal works as a buffer against negative affect throughout the day. This research may incorporate the use of wearables to investigate the physiological changes as a measurement for the effectiveness of emotion regulation strategies and use lagged analysis to gain insights into the directionality of this relationship.

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## Appendices

### Appendix A: Informed Consent

Dear participant,

Thank you for your participation in this study. Before you participate, it is important that you understand the goal of this research and what the study will ask from you. The purpose of this study is to find out mental health is related to the way you deal with feelings in daily life. To explore this relationship, we want to measure fluctuations in emotions in daily life.

For this study, we will ask you to fill in several questionnaires on your mobile phone. All questionnaires will be completed in the Ethica app. The study will start with a questionnaire concerning your demographics and general mental health. This initial questionnaire will take about 20 minutes to complete. Afterwards, you will receive four questionnaires per day for a period of two weeks. Notifications will remind you about the next questionnaire. One daily questionnaire takes approximately 3 minutes to complete. It is important that you answer the questionnaires as soon as possible. Please make sure that you turn on the notifications for the Ethica app on your mobile device.

The information that we collect from this research project will be kept confidential. This means that only the researchers have insight into your answers. All personal data (such as age, gender etc.) will be anonymized and will not be published and/or given to a third party. Your participation in this study is voluntary. You are free to withdraw from this study at any time and without giving a reason.

### Contact information

If you have any questions regarding this study, you can contact the researchers of this research project Jasmin Wallner (j.wallner@student.utwente.nl), Paula Oberle (p.v.oberle@student.utwente.nl), Natalie Koop (n.koop@student.utwente.nl), Caroline Dauer (v.c.dauer@student.utwente.nl), Kia Lemmen (k.r.lemmen@student.utwente.nl) and Jenny Schwabe (j.schwabe@student.utwente.nl).

**Consent**

I have read and understood the information provided and had the opportunity to ask questions. I understand that my participation is voluntary and that I am able to withdraw at any time, without a reason or cost. I hereby voluntarily agree to take part in this study.

**Appendix B: Baseline questionnaire***Demographics*

- Age: How old are you?
- Gender: What gender do you identify as? Female, Male, Other, If you prefer to not specify, you can skip this question
- Nationality: What is your nationality? Dutch, German, Other
- Occupation: What is your current occupation? Working, Self-employed, Student, Studying and Working, Not working, Other
- Highest degree obtained: What is the highest degree or level of school that you have completed? If currently enrolled, mark the highest degree already received. Middle school (such as MBO, MTS, MEAO or Haupt- or Realschule), High school (such as HAVO, VWO, HBS or Gymnasium/Berufsschule/Berufskolleg), Bachelor, Master, PhD, Other
- SONA ID

*Brief Resilience Scale (BRS)*

Could be answered on a 5-point Likert scale from: Strongly disagree (1) to Strongly agree (5)

Item	Description
1	I tend to bounce back quickly after hard times.
2	I have a hard time making it through stressful events.
3	It does not take me long to recover from a stressful event.
4	It is hard for me to snap back when something bad happens.
5	I usually come through difficult times with little trouble.
6	I tend to take a long time to get over setbacks in my life.

*Emotion Regulation Questionnaire (ERQ)*

Could be answered on a 7-point Likert scale from: Strongly disagree (1) to Strongly agree (7)

Item	Description
1	When I want to feel a more positive emotion (such as joy or amusement) I change what I am thinking about.
2	When I want to feel less negative emotion (such as sadness or anger) I change what I am thinking about.
3	When I am faced with a stressful situation, I make myself think about it in a way that helps me stay calm.
4	When I want to feel more positive emotion, I change the way I am thinking about the situation.
5	I control my emotions by changing the way I think about the situation I am in.
6	When I want to feel less negative emotion, I change the way I am thinking about the situation.

## Appendix C: Daily questionnaire

### *Negative affect*

Could be answered on a 7-point Likert scale from: Not at all (1) to Very much (7)

Below you can find several questions about your current feelings.

Please try to indicate how you felt right before you started to answer the questionnaire.

Item	Description
1	How anxious do you feel right now?
2	How irritable do you feel right now?
3	How down do you feel right now?
4	How sad do you feel right now?

### *Cognitive reappraisal*

Could be answered on a 7-point Likert scale from: Not at all (1) to Very much (7)

Item	Description
1	In the last hour, I controlled negative feelings by changing the way I think about the situation I am in.
2	In the last hour, I tried to look at the cause of my negative feelings from a different perspective.