The Association of Momentary Mental Resilience with Positive and Negative Affect in the Subsequent Moment, Depending on the Level of Momentary Perceived Social Support

Department of Behaviour Management and Social Sciences, University of Twente
Module 12: BSc Thesis Psy
Kilian Pötter (2531712)
First Supervisor: Dr. T.R. Vaessen
Second Supervisor: Dr. J.T. Kraiss
June 28th, 2023

Abstract

Background: Research on evaluating mental resilience in daily life is limited. However, some Experience Sampling Method (ESM) studies indicate positive effects on affect. Further research shows that perceived social support is believed to be a moderating variable, enhancing the influence of resilience.

Objective: This study aimed to build on this research and investigate mental resilience on a moment-to-moment basis, evaluate how it is associated with negative affect (NA) and positive affect (PA), and how it interacts with momentary perceived social support (MPSS). A temporal effect was expected, namely, that momentary mental resilience (MMR) in one moment is 1a) negatively associated with NA in the subsequent moment and 1b) that the relationship is moderated by MPSS. Further, MMR was presumed to be 2a) positively associated with PA in the subsequent moment and 2b) that the association is stronger when MPSS is higher.

Methods: This study utilised the ESM, providing a baseline questionnaire once and ten ESM questionnaires daily to participants over one week. The sample (n = 90) contained people from Germany, the Netherlands, and other countries, with participants' age ranging from 19 to 81.

Results: Significant direct effects of MMR on NA and PA in the next moment were found with MPSS significantly moderating both relationships. Further analyses revealed that the effect of MMR was significant only if individuals had moderate levels of MPSS.

Conclusion: The study's results are mainly in line with previous research, showing a negative association between MMR and NA and a positive one with PA. MMR also interacted with MPSS, strengthening the negative association with NA and positive with PA. Future research should apply probability sampling and examine why MMR is only significant if MPSS levels are at least moderate. Creating interventions aiming to improve MMR and MPSS could be valuable.

Keywords: momentary mental resilience, momentary perceived social support, negative affect, positive affect, experience sampling method

1. Introduction

Daily hassles, including a problem at work, at home, or an argument, strongly predict immediate negative outcomes in affect (Charles et al., 2013). However, researchers mention that adaptational responses to an event are more crucial in influencing affective states than the event itself (Charles et al., 2013). The adaptational ability to influence one's affect in daily life leads to many positive consequences. Among them are lower risks of developing depression and gaining better mental well-being (Nezlek & Kuppens, 2008). In this regard, research underpins the utility of mental resilience since it protects individuals facing risk factors from declining mental well-being (Collishaw et al., 2007; Davydov et al., 2010). Perceived social support can also enhance the positive effect of resilience (Öksüz et al., 2019). However, research on mental resilience and perceived social support and its impact on affect in daily life is limited.

1.1 Mental Resilience Experienced in Daily Life

Resilience is defined as a dynamic ability that can enable people to deal with adversities, given suitable social and personal conditions (Howe et al., 2012). This definition encapsulates the view that within a single person, resilience may be dynamic, varying with time. Howe et al. (2012) also outlined that in practice, the ability is viewed as an individual's belief and personal control to handle challenging situations. This ability depends on the personal context of actually being confident in controlling potential problematic settings. It further relies on social conditions, namely that support from others can enhance or undermine mental resilience (Howe et al., 2012).

Momentary mental resilience (MMR) can be studied using the *Experience Sampling Method* (ESM), which collects data from participants in the context of their daily lives over a specific time period ranging from days to months (Conner et al., 2009). One research by Blanke et al. (2022) showed that an increase in MMR leads to lower levels of distress. Another ESM study utilised a two-week schedule of participants reporting on MMR and mood (Nahum et al., 2022). The results demonstrate that higher levels of MMR predict more positive outcomes in mood. Bai et al. (2020) used daily diaries among school students, operationalising resilience as the impact of dampened reactivity facing daily adversities. Children in the study indicated individual differences in same-day and next-day mood following problems at school, depending on their levels of dampened reactivity. The more resilient children used dampened reactivity as a means to achieve equilibrium. In line with the definition of resilience by Howe et al. (2012), the notion that resilience is not an isolated construct and considers more than only the personal

condition is essential. From a broader perspective, the social support system can either strengthen or weaken a person's capacity for resilience.

1.2 Momentary Perceived Social Support and Momentary Mental Resilience

Previous literature adds to this perspective by revealing that perceived social support is a central protective and promotive aspect of resilience (Dawson & Pooley, 2013; Wilks & Croom, 2008). *Perceived social support* is defined as one's perception of the sufficiency and availability of social support (Eagle et al., 2019). Khan and Husain (2010) indicated a moderating effect of social support on the association between resilience and well-being. Moreover, research aimed to explain the relationship between mental resilience and perceived social support. According to Dawson & Pooley (2013), the perception of having a social network to access may support individuals in adapting to stressful events. Indeed, in their study, they found that for first-year university students, perceived social support was a crucial factor for being resilient. Researchers such as Vostanis (2016) and Öksüz et al. (2019) outlined how perceived social support can impact resilience by, for instance, diminishing the perception of being isolated (Öksüz et al., 2019). Significant others may also enhance the sense of belonging and being understood (Vostanis, 2016). Perceived social support further minimises the appraised importance of a stressor and increases the feeling of confidence or control of the situations at hand (Vostanis, 2016).

Despite studies showing that perceived social support enhances resilience, the available literature does not focus on their relationship experienced in daily life. The effects of MMR and *momentary perceived social support* (MPSS) have yet to be explored together in ESM studies. It can be theorised that MPSS enhances or undermines MMR in daily life. For example, having the perception of no immediate access to a social support network might diminish the feeling of being capable of dealing with adversities, as in line with Vostanis (2016). Consequently, the need emerges to explore how perceived social support unfolds from moment to moment in relation to MMR. In the context of daily life, immediate affective reactions are analysed moment-to-moment by investigating positive and negative affect.

1.3 The Influence of Momentary Mental Resilience and Momentary Perceived Social Support on Negative and Positive Affect

Negative affect (NA) is seen by Tiro et al. (2013) as the experience of unpleasant moods, while *positive affect* (PA) is defined as the occurrence of subjective pleasurable moods (Miller,

2011). Research in investigating the effect of MMR on NA and PA is limited. One ESM study analysed the effect of resilience on NA and PA among undergraduate students over 14 days (Tung et al., 2022). The results revealed higher NA levels and lower PA levels for students scoring low on resilience. The researchers explained these results by positing that having resilience capability helps one manage everyday obligations and reduces negative affect. Furthermore, another ESM study operationalising resilience as recovering from negative experiences shows that NA and PA fluctuated differently between individuals over time (Kuranova et al., 2020). For many participants, NA was pertaining over the 90 minutes measurement intervals, following a daily unpleasurable event. The more resilient participants were able to bounce back to their individual mean levels of NA and PA faster. This result indicates a temporal effect of resilience and NA and PA, namely that it takes time to reach baseline levels of affect again.

Research is also limited regarding the impact of MPSS on NA and PA. Smyth et al. (2014) reported a significant effect of MPSS on NA in asthma and arthritis patients. The study's researchers argued that subjective access to social support acts as a buffer against the impact of daily stressors. Another ESM study by Fang et al. (2022) supports this notion as they discovered that the impact of momentary stressors was significantly buffered by perceived social support. It is theorised that functional features (e.g., perceived support) wield their positive effect through buffering by increasing confidence in handling the situation (Kawachi & Berkman, 2001). Furthermore, MPSS might positively affect PA as social support provides stability for the individual (Cohen & Wills, 1985). Since the field of research into the effect of MMR and MPSS on NA and PA is scarce, research in that direction is needed.

1.4 The Current Study

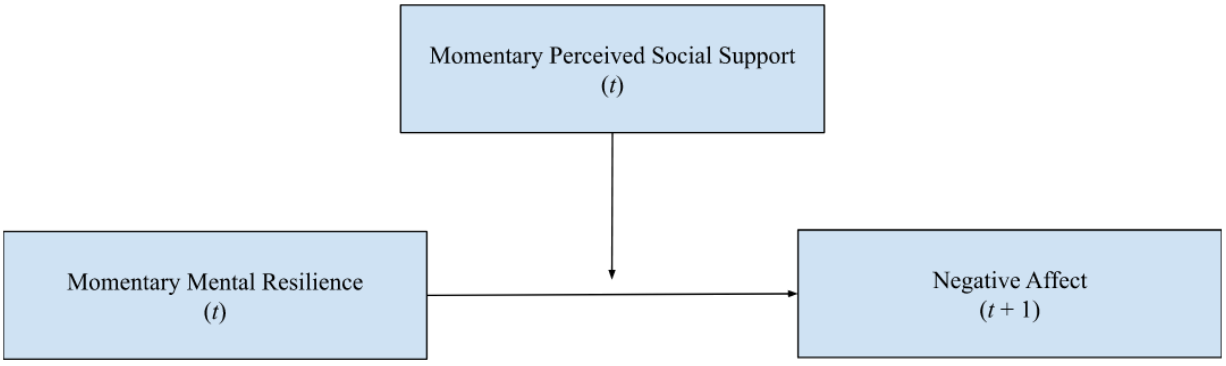
This study aims to provide insight into MMR and considers the effect of MPSS. The goal is to understand the nature of their relationship and their influence on individuals' levels of NA and PA. This information can help to combat negative affective states in daily life which in turn enhance mental well-being (Nezlek & Kuppens, 2008). Therefore, the research question of this study is "What is the association of mental resilience at one moment with positive and negative affect in the subsequent moment, and in how far is this relationship moderated by momentary perceived social support"? The research question will be answered utilising the ESM, in which

data will be collected by participants submitting self-reports repeatedly at various intervals throughout the day.

Specifically, it is hypothesised that 1a) higher scores on mental resilience in one moment are associated with lower scores on negative affect in the subsequent moment and that 1b) this association is stronger in moments where perceived social support is higher. It is further hypothesised that 2a) higher scores on mental resilience in one moment are associated with higher scores on positive affect in the subsequent moment and 2b) this association is stronger in moments where perceived social support is higher. Visualisations of the hypotheses can be found in Figure 1 and Figure 2.

Figure 1

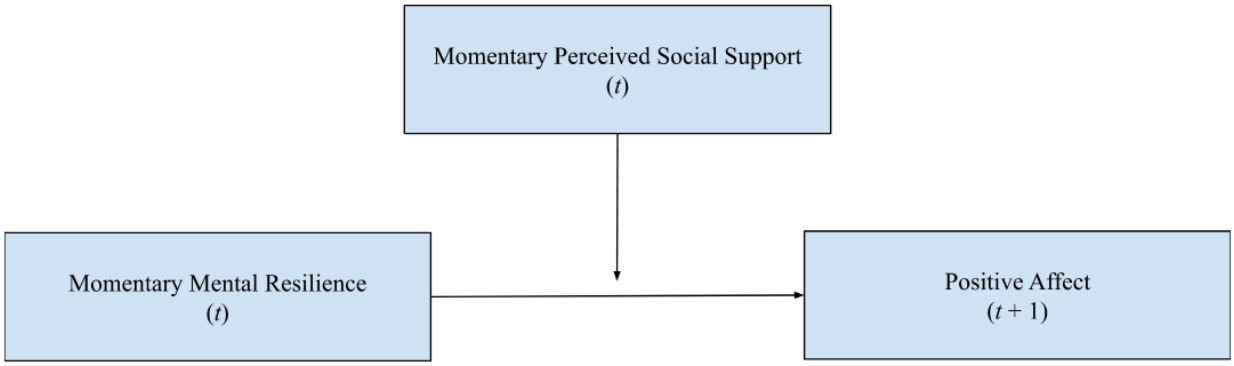
Visualisation of Hypotheses 1a and 1b Including the Times of Measurement



Note. Time point *t* represents a time point of measurement while *t* + 1 refers to the subsequent time point of measurement following *t*.

Figure 2

Visualisation of Hypotheses 2a and 2b Including the Times of Measurement



Note. Time point *t* represents a time point of measurement while *t* + 1 refers to the subsequent time point of measurement following *t*.

2. Methods

2.1 Participants

The current study used convenience sampling to recruit participants through the researchers' social networks. They were asked to participate, and their email addresses were collected in case of interest. The ESM study was conducted primarily with German and Dutch participants but also with people from other countries. Before completing the questionnaire, all participants provided written consent in compliance with the regulations established by the BMS Ethics Committee and with their approval (see Appendix A). An incentive for participants to receive a personalised report from the individual results was offered (see Appendix B).

2.2 Procedure

Every participant in the study was supposed to own a smartphone with a stable internet connection. Before participating in the study, people were sent a link to their email addresses to download the app Ethica. Then, a participation information sheet and an informed consent form were provided within the app environment. If participants agreed to the informed consent form, they started with a baseline questionnaire only to be answered once (see Table 1). Then, the ESM questionnaires were distributed over seven days, and every day each participant had to fill out the same questionnaire ten times. This accumulated to 70 questionnaires in total per person. These elements align with the ESM handbook provided by Myin-Germeys & Kuppens (2021). Starting at 8:00 o'clock in the morning, the participants were informed by phone notifications to answer

the questionnaire items until 23:00 o'clock. The exact time participants received the push notification varied since a semi-random scheme was applied. This scheme created patterns that appeared random and were difficult to predict for the participant to ensure they could not structure their days around them. However, they had a certain regularity. The ten questionnaires were provided approximately every 90 minutes but differed in the exact delivery time. Each questionnaire expired 15 minutes after delivery to ensure participants answered them timely.

Table 1

Data Collection Schedule

Day	Questionnaire	Variables	Time of Delivery	Expiration
1	Baseline Questionnaire	Demographics	8:00	After seven days
1-7	Experience Sampling Questionnaire	MMR MPSS NA and PA	8:00 - 9:30 9:30 - 11:00 11:00 - 12:30 12:30 - 14:00 14:00 - 15:30 15:30 - 17:00 17:00 - 18:30 18:30 - 20:00 20:00 - 21:30 21:30 - 23:00	After 15 minutes

Note. MMR = Momentary Mental Resilience. MPSS = Momentary Perceived Social Support. NA = Negative Affect. PA = Positive Affect.

2.3 Measures

2.3.1 Demographic and Baseline Questionnaire

Prior to the start of the ESM study, participants had to indicate their gender, age, occupation, highest degree obtained, and nationality in a baseline questionnaire.

2.3.2 Momentary Mental Resilience

MMR was measured using the items "Right now, I feel like I can handle unpleasant situations" and "Right now, I feel like I can deal with whatever comes". The items were derived and adapted from the Connor-Davidson Resilience Scale (Connor & Davidson, 2003). Participants could respond to the items on a seven-point Likert scale, ranging from 'strongly disagree' (1) to 'strongly agree' (7). Further, the two items were averaged and combined into a scale. In terms of internal reliability, the person-mean-centred MMR value was computed to consider within-person scores. The value for Cronbach's alpha was .94 and interpreted as an excellent outcome for internal reliability (*Cronbach's Alpha: Definition, Interpretation, SPSS - Statistics How To*, 2023). Computing the split-half reliability was carried out using the Spearman-Brown formula and resulted in a good internal consistency score of .76.

2.3.3 Momentary Perceived Social Support

MPSS was measured using the item "Right now, I feel like there are people who are there for me if I need them". This item was obtained and adapted from the Social Support Scale (Santiago et al., 2023). In the ESM questionnaire, possible answers ranged from 'strongly disagree' (1) to 'strongly agree' (7) on the same seven-point Likert scale as for MMR. Applying the Spearman-Brown formula, the split-half reliability score was .59 and therefore rated as acceptable in terms of internal consistency.

2.3.4 Momentary Affect

Data on momentary affect was collected using ten items, among which five covered negative and five positive affect (see Table 2). Most items were based on a previous ESM study conducted by Matcham et al. (2019). The item "Right now, I feel enthusiastic" was retrieved from Bennik (2015), while "Right now, I feel good about myself" was derived from Eddington et al. (2017). On the seven-point Likert scale, responses ranged from "strongly disagree" (1) to "strongly agree" (7). Scores for NA and PA were all averaged and combined into their respective scales. The person-mean centred values resulted in an acceptable Cronbach's alpha for NA of .77

and for PA with good internal reliability of .85. Split-half reliability of .54 for NA and .59 for PA were calculated with the Spearman-Brown formula and can both be interpreted as acceptable.

Table 2

Positive and Negative Affect Items

Item Number	Item	Valence
1.	Right now, I feel stressed.	Negative
2.	Right now, I feel anxious.	Negative
3.	Right now, I feel irritable.	Negative
4.	Right now, I feel lonely.	Negative
5.	Right now, I feel down.	Negative
6.	Right now, I feel cheerful.	Positive
7.	Right now, I feel enthusiastic.	Positive
8.	Right now, I feel good about myself.	Positive
9.	Right now, I feel satisfied.	Positive
10.	Right now, I feel relaxed.	Positive

2.4 Analysis Plan

The data was analysed using R-Studio version 2023.03.0+386. The whole script for R-Studio can be found in Appendix C. Before the analysis, participants were removed who filled out less than 30% of the ESM questionnaires.

After the data set was prepared, the assumption of linearity was tested by creating a scatterplot of the residuals. Further assumption checks were not carried out. Many researchers agree that a sample size of about 80 is typically sufficient, even in the presence of substantial model violations (Sainani, 2012). Van den Berg (2021) outlined that the standard errors are

usually correct even if the distribution is skewed. The estimates in examining within-subject variability also tend to be unbiased even if there is a skewed distribution (Schielzeth et al., 2020). In regard to the assumption of no multicollinearity, the model included a moderation effect and thus, MMR and MPSS were associated. This automatically led to multicollinearity. Schielzeth et al. (2020) additionally described that the implications of collinearity are far more minor than is typically believed. Due to these two factors, it was not needed to test for multicollinearity. Homoscedasticity was not checked since a robust significance test using the *Heteroskedasticity-Consistent Standard Errors version 3* (HC3) approach was applied in all analyses. The HC3 approach was used in the robust analysis to estimate heteroscedasticity-consistent standard errors (Hayes & Cai, 2007). This technique computes the coefficient covariance matrix assuming that individual differences in residual variances exist. Hence, the data could not be heteroscedastic which eliminated the necessity to check for homoscedasticity.

All hypothesis tests for these four models used a robust significance test with the HC3 method. Additionally, each model had a random intercept for the participants, accounting for the variation between individuals. To produce a temporal effect, models were created where NA and PA were analysed at the subsequent time point (time point $t + 1$) than mental resilience and perceived social support (t). To create the linear-mixed-effects models, the lme4 package was used. The random effects were modelled with unstructured a priori covariance matrices. The estimation method used was restricted maximum likelihood. For the significance tests, an alpha of .05 was applied. Hypothesis 1a) assumed that higher scores on mental resilience in one moment are associated with lower scores on NA in the subsequent moment while 1b) constituted that the association is stronger when MPSS is higher. To test hypothesis 1a, a linear mixed-effects model was created with the *independent variable* (IV) MMR (t) and the *dependent variable* (DV) NA ($t + 1$). Hypothesis 1b was tested using a linear mixed-effects model with the IV MMR (t), its interaction with MPSS (t), and the DV NA ($t + 1$). Hypothesis 2a) presumed that higher scores of MMR are associated with higher scores on PA in the subsequent moment while 2b) predicted that the relationship becomes stronger with higher levels of MPSS. A linear mixed-effects model with the IV MMR (t) and the DV PA ($t + 1$) was created to test hypothesis 2a. For hypothesis 2b, the linear mixed-effects model included the IV MMR (t), its interaction with MPSS (t), and the DV PA ($t + 1$). Moreover, marginal R2 and conditional R2 were calculated for each model. Marginal R-squared measured the variance that can be accounted for by fixed

factors alone without considering random effects (Nakagawa & Schielzeth, 2012). The conditional R-squared estimated the variance explained by both the fixed effects and the random effects (Nakagawa & Schielzeth, 2012).

To further explore the nature of the relationship between MMR and MPSS with NA and PA, a median split was plotted. A median split visualised the association between MMR, NA, and PA, depending on the values of the interaction effect MPSS (DeCoster et al., 2011). The results of the moderator MPSS were divided into two groups, one above the median and one below. While the median split depicted the relationship between MMR, NA and PA, splitting MPSS into two groups, it did not state the statistical significance of MMR. The Johnson-Neyman technique was employed as it could precisely identify the region of significance for the predictor variable on the dependent variable based on the level of the interaction effect (Potthoff, 1964). The exact threshold value of MPSS where the relationship of MMR with NA and PA changes from non-significant to significant (or vice versa) was therefore computed.

3. Results

Overall, 103 people participated in the study. 13 were removed from the data set since they filled out less than 30% of the ESM questionnaires. 90 participants met the criteria for the data analysis. The ages ranged from 19 to 81, with a mean age of 29.97 (*SD* = 13.59). Additional demographics can be seen in Table 3.

Table 3

Demographics

		n	%
Gender	Female	51	56.67
	Male	38	42.22
	Non-binary	1	1.11
Nationality	German	46	51.11
	Dutch	29	32.22
	Other	15	16.67

Highest degree obtained	Middle School	16	17.78
	High School	46	51.11
	Bachelor's degree	15	16.67
	Master's degree	7	7.77
	Other	6	6.67
Occupation	Employed	26	28.89
	Self-employed	4	4.44
	Student	31	34.44
	Studying and working	23	25.56
	Unemployed	5	5.56
	Other	1	1.11

First, the assumption of linearity was tested by creating a scatterplot of the residuals (see Appendix D, Figure D1). The residuals were found close to the linear regression and therefore, it could be concluded that the assumption of linearity was met.

In Table 4, the direct effect model shows the results for hypotheses 1a and the interaction effect model for hypothesis 1b. The outcome of hypothesis 1a was in line with the assumption that MMR is negatively associated with levels of NA in the subsequent moment (b = -.18, p < .001). 6% of the variance in the model testing hypothesis 1a was explained by fixed factors (marginal R^2 = .06). 44% of the variance was explained by fixed and random factors (conditional R^2 = .44).

Turning to hypothesis 1b, the expectation aligned with the result that MPSS had a negative moderation effect on the relationship between MMR and NA in the next moment (b = -.03, p = .04) (see Table 4). Thus, higher levels of MMR were more strongly associated with lower levels of NA when MPSS levels were higher. In the model, 7% of the variance was explained by fixed factors (marginal R^2 = .07), and 44% by fixed and random factors (conditional R^2 = .44).

Table 4

Linear Mixed-Effects Model Using a Robust Significance Test According to the HC3 Method to test the Association of Momentary Mental Resilience with Negative Affect and the Interaction of Momentary Mental Resilience with Momentary Perceived Social Support on Negative Affect

						95% CI	
Model	Parameter	*b*	SE	*t*	*p*	Lower	Upper
Direct Effect Model	MMR	-.18	.017	-10.61	< .001	-.21	-.15
Interaction Effect Model	MMR	.01	.09	.11	.91	-.17	.19
	MPSS	.07	.07	.91	.37	-.08	.21
	MMR*MPSS	-.03	.02	-1.99	.04	-.06	.01

Note. N = 90. The model included a random intercept. MMR = Momentary Mental Resilience. MPSS = Momentary Perceived Social Support.

The results for hypothesis 2a can be found in the direct effect model and for 2b in the interaction effect model (see Table 5). The outcome of hypothesis 2a aligned with the assumption that MMR is positively correlated with levels of PA in the subsequent moment (b = .23, p < .001). In the model, 7% of the variance was explained by fixed factors (marginal R^2 = .07). Meanwhile, 48% of the variance was explained by fixed and random factors (conditional R^2 = .48).

Concerning hypothesis 2b, the expectation aligned with the result that MPSS had a positive moderation effect on the association between MMR and PA in the subsequent moment (b = .05, p < .001) (see Table 5). Consequently, MMR more strongly correlated positively with PA when MPSS levels were increased. Fixed factors explained 10% of the variance (marginal R^2 = .10), while 48% of the variance was explained by fixed and random factors (conditional R^2 = .48).

Table 5

Linear Mixed-Effects Model Using a Robust Significance Test According to the HC3 Method to test the Association of Momentary Mental Resilience with Positive Affect and the Interaction of Momentary Mental Resilience with Momentary Perceived Social Support on Positive Affect

						95% CI	
Model	Parameter	*b*	SE	*t*	*p*	Lower	Upper
Direct Effect Model	MMR	.23	.017	13.42	< .001	.20	.27
Interaction Effect Model	MMR	-.08	.08	-1.05	.30	-.24	.07
	MPSS	-.15	.07	-2.18	.03	-.28	-.02
	MMR*MPSS	.05	.01	3.80	< .001	.26	.08

Note. N = 90. The model included a random intercept. MMR = Momentary Mental Resilience. MPSS = Momentary Perceived Social Support.

In regard to the median split, Figure 3a visualises the interaction of the correlation between MMR and NA, depending on MPSS. Figure 3b depicts the same relationship but with the DV PA. The results of both median splits were very similar. The median split in Figure 3a shows that for people scoring higher on MPSS, the slope for the effect of MMR on NA decreases faster than for the group of lower MPSS. Figure 3b visualises the effect of PA. The slope for MMR increases faster when participants score above the median for MPSS.

Figure 3

Median Split of the Relationship of Momentary Mental Resilience and Momentary Perceived Social Support with Negative Affect and Positive Affect

Figure 3a

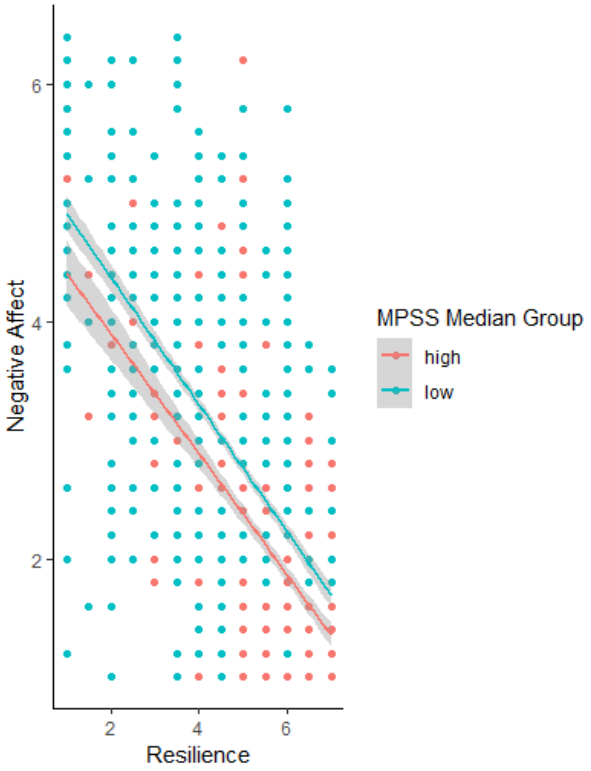
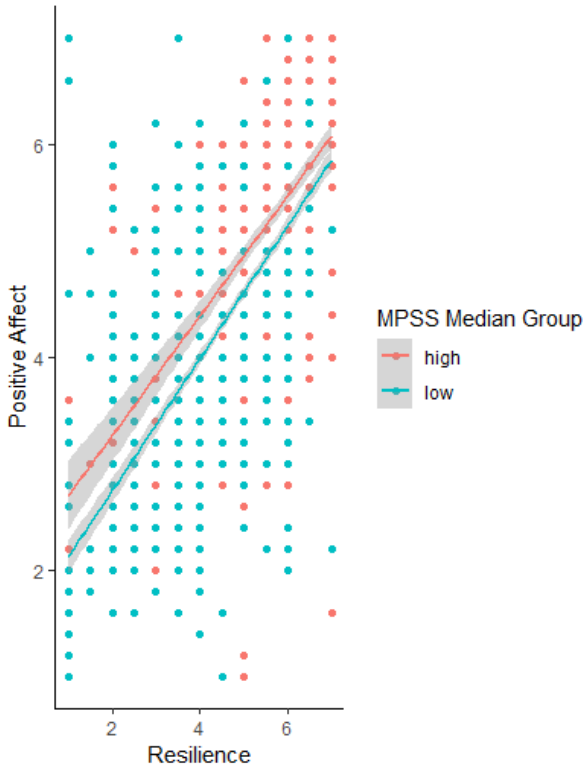


Figure 3b



Inspecting the area of significance for MMR, Figure 4a shows the Johnson-Neyman Plot for the model with the association of MMR with NA, moderated by MPSS, while Figure 4b visualises the same model but with the DV PA. Both plots draw similar pictures. If MPSS was low, there was neither a significant correlation between MMR and NA nor PA (see Figure 4a; see Figure 4b). Only if there was a certain amount of MPSS did the predictor variable MMR become significant. In more detail, the plot indicates that if participants scored higher than 3.15 on MPSS, the negative association of MMR with NA became significant (see Figure 4a). For PA, if participants scored above 3.28, the positive correlation with MMR became significant (see Figure 4b). Thus, it can be seen that MMR to a certain degree depends on MPSS. Only if people have a moderate score of MPSS, is MMR negatively associated with NA and positively with PA.

Figure 4

Johnson-Neyman Plots of the Significant Interaction Effect of Momentary Mental Resilience and Momentary Perceived Social Support on Negative Affect and Positive Affect

Figure 4a

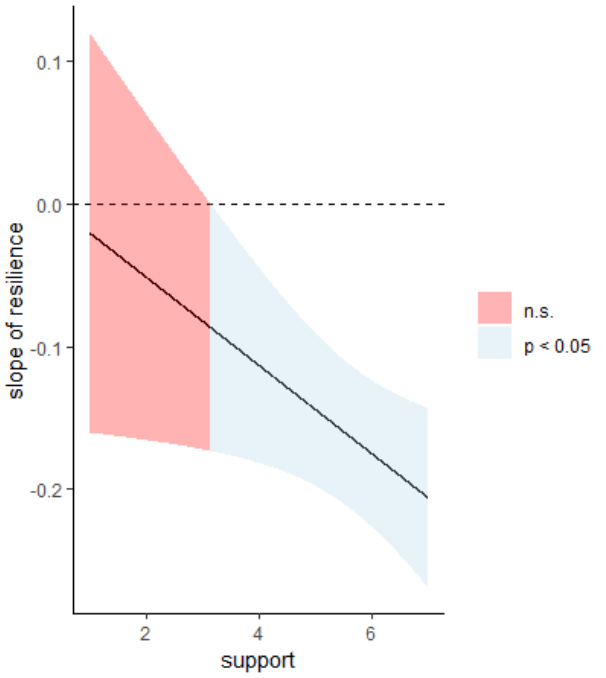
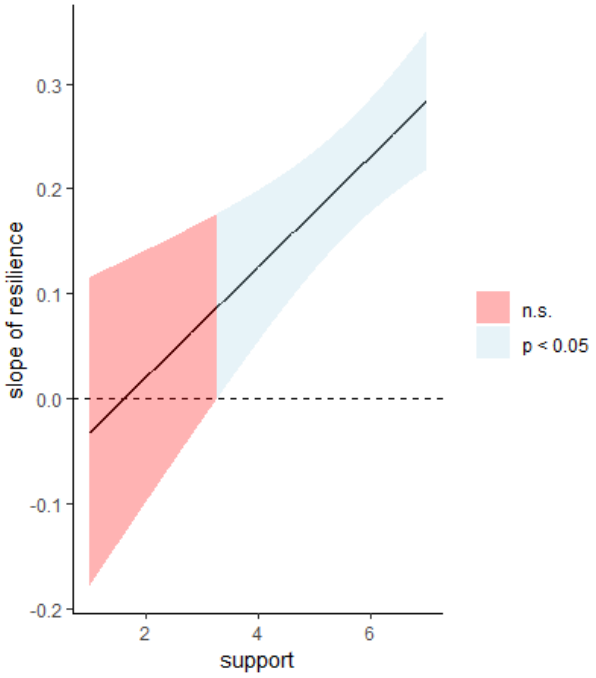


Figure 4b



4. Discussion

This study aimed to examine the association of mental resilience with NA and PA in daily life, and whether MPSS moderates the relationship. First, a negative significant association of MMR with NA and a positive with PA in the subsequent moment was found. MPSS significantly moderated both associations. It was moreover shown that if an individual scored above the mean, the MMR slope decreased faster, while PA increased more rapidly. MMR was only significantly associated with NA and PA if the individual had moderate levels of MPSS.

4.1 The Role of Momentary Mental Resilience

4.1.1 The Association of Momentary Mental Resilience with Negative and Positive Affect

This study's findings of the significant correlations of MMR with NA and PA align with the previous literature. Tung et al. (2022) found that MMR helps to decrease NA levels and enhance PA. These results may be due to the assumption that resilience is a resource to help

handle everyday situations and, in turn, mitigates negative affect (Tung et al., 2022). Resilience might elicit its effect by providing an initial sense of inner readiness to deal with unpleasant events. The preparedness might positively impact NA and PA regardless of a stressor occurrence. Additionally, Charles et al. (2013) described that assessing a stressor is important over and above an adverse event. Daily unpleasurable events might be interpreted as challenges to overcome and grow from rather than having detrimental consequences. Changing one's perspective on daily life is not only used in assessing a stressor differently but also in optimism. Optimism involves positive outlooks into the future which are based on the belief in one's abilities, but also stem from outside factors such as luck (Gallagher et al., 2020). Both resilience and optimism can further be a cyclical process, reinforcing each other (Maheshwari & Jutta, 2020). Optimism can nurture resilience, and when resisting daily hassles, this positive reinforcement cultivates an optimistic outlook in return.

It is worth bearing in mind that NA and PA are not emotional states that are the exact opposites (Russell & Carroll, 1999). Just because a person does not feel down, they may not automatically be relaxed. Therefore, although overlapping, strategies might slightly differ when improving PA compared to reducing NA. Disentangling NA and PA is difficult since both effects yielded almost congruent results. A possible explanation is a link between resilience and the positive effects of using distraction (Phillips et al., 2019) or practising gratitude (Wilson, 2016). In a study by Layous et al. (2023), distracting from unpleasant events significantly reduced NA but did not impact PA. Therefore, alleviating NA demands primarily to impede the influence of unpleasurable experiences. In contrast, centring around the positive aspects of life by utilising gratitude can reduce NA and improve PA (Layous et al., 2023).

4.1.2 The Temporal Effect of Momentary Mental Resilience

Temporal effects were found as higher scores of MMR were significantly associated with next-moment NA and PA. These outcomes align with the ESM study by Kuranova et al. (2020). Resilience was tested as the time of recovery, measured in 90-minute intervals. Detecting NA levels revealed that resilient people recover faster from negative events (Kuranova et al., 2020). This temporal effect might be attributed to the dynamic and fluctuating characteristic of resilience (Rutter, 2012) and affect (Kuppens & Verduyn, 2017). Both can vary throughout the day. However, MMR might manifest as emotional stability that equips a person to deal with hassles faster and better (Flynn et al., 2021). Thus, when MMR is high, the negative association

with NA and positive with PA in the subsequent moment becomes stronger. The temporal effect also may occur as adaptational processes need time to develop and influence NA and PA. For instance, practising gratitude can take more or less time depending on the situation, and its effect fluctuates as well (Redwine et al., 2016). The appraisal of an event also depends on the complexity or familiarity of the situation. When encountering new situations, reappraisal takes longer than when having experienced it before (Zeier et al., 2023). Hence, for resilience to combat NA and PA, time and effort are needed, creating a temporal effect.

4.2 The Role of Momentary Perceived Social Support

Turning to the moderation effect of MPSS, the results of this study are in line with the preceding research. Similar to Khan and Husain (2010), MPSS interacted with MMR, strengthening the association with NA and PA. These results can be explained by the functional utility of perceived social support, as according to Kawachi and Berkman (2001). They described how the moderator operates through a buffering effect. Individuals perceive social support in their minds as a shield against unpleasant affect. This buffering effect might have been found because MPSS can prevent feelings of isolation and make them feel to be part of a larger network they can turn to (Öksüz et al., 2019). This view aligns with Vostanis (2016) who pointed out that MPSS can increase the perception of belonging to others and feeling understood.

Additional results of the study expand on previous studies stating the importance of perceived social support for resilience (Dawson & Pooley, 2013; Wilks & Croom, 2008). This study found out that NA decreases and PA increases more rapidly the more resilient a person is when scoring high on MPSS. Moreover, MMR even depends on MPSS to a certain degree. Only if participants had at least moderate levels of MPSS, the predictor MMR was significant. This underpins the importance of MPSS for MMR to be associated with NA and PA. People need a moderate level of perceived social support to be resilient, which follows the definition by Howe et al. (2012) that resilience depends on the context of social support. Possibly, access to social support provides a sense of security which is the conviction that one is part of a more extensive and more lasting existence (Krause, 2007). This network is supportive and ensures that efforts will not be unnoticed. Likewise, when a person perceives no social support, dealing with adversities might feel trivial as sacrifices and endeavours will not be recognised.

4.3 Strengths and Limitations

In retrospect, there are various strengths that need to be enumerated. This study was the first to apply experience sampling in investigating the association of mental resilience and perceived social support with NA and PA. The study's results confirmed a large proportion of available literature, showing the significance of MMR and MPSS for NA and PA in the subsequent moment. The study further expanded on the results of previous studies, investigating the exact nature of the relationship between MMR and MPSS.

Although several strengths were identified, multiple limitations need to be considered. The compliance rate of 64.29% was below the typical range of 66% to 86% in other ESM studies (Rintala et al., 2019). This might have occurred due to factors such as low response rates in the morning, a tendency for younger people to respond less compared to older people, or missed notifications (Rintala et al., 2019). The convenience sampling method might limit the external validity of the results as participants were recruited from the social networks of the researchers. The validity might also be reduced concerning the items used to measure MMR and MPSS. First, these items were derived and adapted from other questionnaires but not extensively tested in ESM research. Second, the low number of items might be problematic. For MMR, only two items were part of the ESM questionnaire; for MPSS, only one was used. These items might not be able to capture all facets of their constructs. In regard to MPSS, it is not possible to fully explain why MMR is only occurring while at least having moderate levels of MPSS. Also, it was not measured from whom participants perceived to receive the most support. It could be the case for participants to gain more support from their parents, friends, or partner. If they actually received support is also unknown.

4.4 Directions for Future Research

These limitations indicate directions future research should consider. Probability sampling should be employed to ensure that results can be generalised. Steps to improve the compliance rate should be taken, such as delivering questionnaires after 9:00 o'clock (Rintala et al., 2019). The usefulness of the items for MMR and MPSS from this research should be tested again, and if additional ones have to be derived. Regarding MMR, its negative association with NA and positive with PA should be further investigated. Reducing NA and enhancing PA might be different processes as theorised in this study. Testing possible explanations, such as whether distraction primarily impacts NA, could be useful. Furthermore, the temporal characteristics of

MMR should be investigated. The analysis could go beyond this study by including more measurement times. For example, by not only investigating the subsequent moment but all notifications throughout the day. This could provide more insights into how stable resilience and its impact on NA and PA is.

Concerning MPSS, multiple directions are possible considering the interaction effect of MPSS on the relationship between MMR, NA, and PA. The identification of persons from whom it is most important to receive help and the assessment of differences between perceived social support and received support could be interesting. Since MMR depends on MPSS to a certain extent, the reason should be investigated. One example is the possibility of relying on acknowledgements from others for putting in effort (Krause, 2007).

4.5 Practical Contributions

This study bears practical implications that can be used for future interventions supporting students and employees dealing with daily hassles. Research has shown that students' distress is primarily caused by daily hassles, leading to higher risks of depression and lower mental well-being in the student population (Shankland et al., 2018). Many employees also experience daily hassles at work, leading to symptoms of burnout (Klusmann et al., 2020). Future interventions can profit from the strength of this ESM study, namely the investigation of individuals' daily lives. MMR can be improved by, for instance, practising coping strategies or stress-reducing techniques (Pallavicini et al., 2016). As at least moderate levels of MPSS are needed to be resilient, accounting for MPSS in interventions is crucial. Increasing self-esteem and teaching people social and cognitive skills can enhance levels of MPSS (Brand et al., 1995).

4.6 Conclusion

This study succeeded to provide insights into daily life MMR and MPSS. MMR was significantly associated with NA and PA in the subsequent moment. MPSS moderated the relationship between MMR and NA and PA. Further, it was demonstrated that MMR only exerts influence when moderate levels of MPSS are experienced. Future research should explore the temporal aspects of resilience and how MMR depends on MPSS to a certain degree. Practical implications are mainly for interventions aimed at improving affect in daily life by enhancing MMR and MPSS.

References

Bai, S., Robles, T. F., Reynolds, B. M., & Repetti, R. L. (2020). Daily Mood Reactivity to Stress during Childhood Predicts Internalizing Problems Three Years Later. *Journal of Abnormal Child Psychology*, *48*(8), 1063–1075. https://doi.org/10.1007/s10802-020 00650-7

Bennik, E. C. (2015). Every dark cloud has a colored lining. *University of Groningen*. https://www.rug.nl/research/portal/files/24107863/Title_and_contents.pdf

Blanke, E. S., Schmiedek, F., Siebert, S., Richter, D., & Brose, A. (2022). Perspectives on resilience: Trait resilience, correlates of resilience in daily life, and longer-term change in affective distress. *Stress and Health*, *39*(1), 59–73. https://doi.org/10.1002/smi.3164

Brand, E. F., Lakey, B., & Berman, S. (1995). A preventive, psychoeducational approach to increase perceived social support. *American Journal of Community Psychology*, *23*(1), 117–135. https://doi.org/10.1007/bf02506925

Charles, S. T., Piazza, J. R., Mogle, J., Sliwinski, M. J., & Almeida, D. M. (2013). The Wear and Tear of Daily Stressors on Mental Health. *Psychological Science*, *24*(5), 733–741. https://doi.org/10.1177/0956797612462222

Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin*, *98*(2), 310–357. https://doi.org/10.1037/0033-2909.98.2.310

Collishaw, S., Pickles, A., Messer, J., Rutter, M., Shearer, C., & Maughan, B. (2007). Resilience to adult psychopathology following childhood maltreatment: Evidence from a community sample. *Child Abuse & Neglect*, *31*(3), 211–229. https://doi.org/10.1016/j.chiabu.2007.02.004

Conner, T. S., Tennen, H., Fleeson, W., & Barrett, L. F. (2009). Experience Sampling Methods: A Modern Idiographic Approach to Personality Research. *Social and Personality*

Psychology Compass, *3*(3), 292–313. https://doi.org/10.1111/j.1751-9004.2009.00170.x

Connor, K. M. & Davidson, J. R. T. (2003). Development of a new resilience scale: The Connor-Davidson Resilience Scale (CD-RISC). *Depression and Anxiety*, *18*(2), 76–82. https://doi.org/10.1002/da.10113

Cronbach's Alpha: Definition, Interpretation, SPSS - Statistics How To. (2023, March 3). Statistics How To. https://www.statisticshowto.com/probability-and-statistics/statistics-definitions/cronbachs-alpha-spss/

Davydov, D. M., Stewart, R., Ritchie, K., & Chaudieu, I. (2010). Resilience and mental health. *Clinical Psychology Review*, *30*(5), 479–495. https://doi.org/10.1016/j.cpr.2010.03.003

Dawson, M. R., & Pooley, J. A. (2013). Resilience: The Role of Optimism, Perceived Parental Autonomy Support and Perceived Social Support in First Year University Students. *Journal of Education and Training Studies*, *1*(2). https://doi.org/10.11114/jets.v1i2.137

DeCoster, J., Gallucci, M., & Iselin, A. R. (2011). Best Practices for Using Median Splits, Artificial Categorization, and their Continuous Alternatives. *Journal of Experimental Psychopathology*, *2*(2), 197–209. https://doi.org/10.5127/jep.008310

Eagle, D. E., Hybels, C. F., & Proeschold-Bell, R. J. (2019). Perceived social support, received social support, and depression among clergy. *Journal of Social and Personal Relationships*, *36*(7), 2055–2073. https://doi.org/10.1177/0265407518776134

Eddington, K. M., Burgin, C. J., Silvia, P. J., Fallah, N., Majestic, C. & Kwapil, T. R. (2017). The Effects of Psychotherapy for Major Depressive Disorder on Daily Mood and Functioning: A Longitudinal Experience Sampling Study. *Cognitive Therapy and Research*, *41*(2), 266–277. https://doi.org/10.1007/s10608-016-9816-7

Fang, B., Li, D., Chen, B., Huang, J., Hou, Y., & Lou, V. W. Q. (2022). Perceived Support

Protects Against Negative Affective Experiences of Momentary Solitude: An Ecological Momentary Assessment Study. *The Journals of Gerontology: Series B*, *77*(12), 2170 2181. https://doi.org/10.1093/geronb/gbac081

Flynn, P. J., Bliese, P. D., Korsgaard, M. A., & Cannon, C. (2021). Tracking the Process of Resilience: How Emotional Stability and Experience Influence Exhaustion and Commitment Trajectories. *Group & Organization Management*, *46*(4), 692–736. https://doi.org/10.1177/10596011211027676

Gallagher, M. W., Long, L. J., & Phillips, C. (2020). Hope, optimism, self-efficacy, and posttraumatic stress disorder: A meta-analytic review of the protective effects of positive expectancies. *Journal of Clinical Psychology*, *76*(3), 329–355. https://doi.org/10.1002/jclp.22882

Hayes, A. F., & Cai, L. (2007). Using heteroskedasticity-consistent standard error estimators in OLS regression: An introduction and software implementation. *Behavior Research Methods*, *39*(4), 709–722. https://doi.org/10.3758/bf03192961

Howe, A., Smajdor, A., & Stöckl, A. (2012). Towards an understanding of resilience and its relevance to medical training. *Medical Education*, *46*(4), 349–356. https://doi.org/10.1111/j.1365-2923.2011.04188.x

Kawachi, I., & Berkman, L. F. (2001). Social Ties and Mental Health. *Journal of Urban Health bulletin of the New York Academy of Medicine*, *78*(3), 458–467. https://doi.org/10.1093/jurban/78.3.458

Khan, A., & Husain, A. (2010). Social Support as a Moderator of Positive Psychological Strengths and Subjective Well-Being. *Psychological Reports*, *106*(2), 534–538. https://doi.org/10.2466/pr0.106.2.534-538

Klusmann, U., Aldrup, K., Schmidt, J., & Lüdtke, O. (2020). Is emotional exhaustion only the result of work experiences? A diary study on daily hassles and uplifts in different life domains. *Anxiety Stress and Coping*, *34*(2), 173–190. https://doi.org/10.1080/10615806.2020.1845430

Krause, N. (2007). Longitudinal study of social support and meaning in life. *Psychology and Aging*, *22*(3), 456–469. https://doi.org/10.1037/0882-7974.22.3.456

Kuppens, P., & Verduyn, P. (2017). Emotion dynamics. *Current Opinion in Psychology*, *17*, 22–26. https://doi.org/10.1016/j.copsyc.2017.06.004

Kuranova, A., Booij, S. H., Menne-Lothmann, C., Decoster, J., Van Winkel, R., Delespaul, P., De Hert, M., Derom, C., Thiery, E., Rutten, B. P. F., Jacobs, N., Van Os, J., Wigman, J. T. W., & Wichers, M. (2020). Measuring resilience prospectively as the speed of affect recovery in daily life: a complex systems perspective on mental health. *BMC Medicine*, *18*(1). https://doi.org/10.1186/s12916-020-1500-9

Layous, K., Kumar, S. A., Arendtson, M., & Najera, A. (2023). The effects of rumination, distraction, and gratitude on positive and negative affect. *Journal of Personality and Social Psychology*, *124*(5), 1053–1078. https://doi.org/10.1037/pspp0000440

Maheshwari, A., & Jutta, V. (2020). Study of relationship between optimism and resilience in the times of COVID-19 among university students. *International Journal of Indian Psychology*, *8*(3). https://doi.org/10.25215/0803.157

Matcham, F., Di San Pietro, C. B., Bulgari, V., De Girolamo, G., Dobson, R., Eriksson, H., Folarin, A., Haro, J. M., Kerz, M., Lamers, F., Li, Q. J., Manyakov, N. V., Mohr, D. C.,

Miller, D. (2011). Positive Affect. In *Springer eBooks* (pp. 1121–1122). https://doi.org/10.1007/978-0-387-79061-9_2193

Myin-Germeys, I., & Kuppens, P. (2021). *The Open Handbook of Experience Sampling Methodology: A Step-by-step Guide to Designing, Conducting, and Analyzing ESM Studies*.

Nahum, M., Sinvani, R., Afek, A., Avraham, R. B., Jordan, J. T., Yehuda, A. B., Cohen, N. B., Davidov, A., & Gilboa, Y. (2022). Cognitive control and Mood in relation to Psychological Resilience: An Ecological Momentary Assessment Study. *Research Square (Research Square)*. https://doi.org/10.21203/rs.3.rs-2217160/v1

Nakagawa, S. & Schielzeth, H. (2012). A general and simple method for obtaining$R^2$from generalized linear mixed-effects models. *Methods in Ecology and Evolution*, *4*(2), 133–142. https://doi.org/10.1111/j.2041-210x.2012.00261.x

Nezlek, J. B., & Kuppens, P. (2008). Regulating Positive and Negative Emotions in Daily Life. *Journal of Personality*, *76*(3), 561–580. https://doi.org/10.1111/j.1467 6494.2008.00496.x

Öksüz, E., Demiralp, M., Mersin, S., Tüzer, H., Aksu, M., & Sarıkoç, G. (2019). Resilience in nurses in terms of perceived social support, job satisfaction and certain variables. *Journal of Nursing Management*, *27*(2), 423–432. https://doi.org/10.1111/jonm.12703

Pallavicini, F., Argenton, L., Toniazzi, N., Aceti, L., & Mantovani, F. (2016). Virtual Reality Applications for Stress Management Training in the Military. *Aerospace Medicine and Human Performance*, *87*(12), 1021–1030. https://doi.org/10.3357/amhp.4596.2016

Phillips, S. P., Reipas, K., & Zelek, B. (2019). Stresses, Strengths and Resilience in Adolescents: A Qualitative Study. *The Journal of Primary Prevention*, *40*(6), 631–642. https://doi.org/10.1007/s10935-019-00570-3

Potthoff, R. F. (1964). On the Johnson-Neyman technique and some extensions thereof. *Psychometrika*, *29*(3), 241–256. https://doi.org/10.1007/bf02289721

Redwine, L., Henry, B. L., Pung, M. A., Wilson, K. S., Chinh, K., Knight, B., Jain, S., Rutledge, T., Greenberg, B. H., Maisel, A. S., & Mills, P. J. (2016). Pilot Randomized Study of a Gratitude Journaling Intervention on Heart Rate Variability and Inflammatory Biomarkers in Patients With Stage B Heart Failure. *Psychosomatic Medicine*, *78*(6), 667 676. https://doi.org/10.1097/psy.0000000000000316

Rintala, A., Wampers, M., Myin-Germeys, I., & Viechtbauer, W. (2019). Response compliance and predictors thereof in studies using the experience sampling method. *Psychological Assessment*, *31*(2), 226–235. https://doi.org/10.1037/pas0000662

Russell, J. A., & Carroll, J. D. (1999). On the bipolarity of positive and negative affect. *Psychological Bulletin*, *125*(1), 3–30. https://doi.org/10.1037/0033-2909.125.1.3

Rutter, M. (2012). Resilience as a dynamic concept. *Development and Psychopathology*, *24*(2), 335–344. https://doi.org/10.1017/s0954579412000028

Santiago, P. H. R., Smithers, L. G., Roberts, R. M., & Jamieson, L. (2023). Psychometric properties of the Social Support Scale (SSS) in two Aboriginal samples. *PLOS ONE*, *18*(1), e0279954. https://doi.org/10.1371/journal.pone.0279954

Schielzeth, H., Dingemanse, N. J., Nakagawa, S., Westneat, D. F., Allegue, H., Teplitsky, C., Réale, D., Dochtermann, N. A., Garamszegi, L. Z. & Araya-Ajoy, Y. G. (2020). Robustness of linear mixed-effects models to violations of distributional assumptions. *Methods in Ecology and Evolution*, *11*(9), 1141–1152. https://doi.org/10.1111/2041-210x.13434

Smyth, J. M., Zawadzki, M. J., Santuzzi, A. M., & Filipkowski, K. B. (2014). Examining the

effects of perceived social support on momentary mood and symptom reports in asthma and arthritis patients. *Psychology & Health*, *29*(7), 813–831. https://doi.org/10.1080/08870446.2014.889139

Tiro, J. A., Lee, S. M., Lipshultz, S. E., Miller, T. L., Wilkinson, J. S., Mestre, M. A., Resnick, B., Miller, D. R., Fernández, C., Lee, D. J., Hall, M. H., Young-Hyman, D., Young Hyman, D., Pellowski, J. A., Resnick, B., Bustillo, N. E., Pellowski, J. A., Bryant, V. M., Frankel, A., . . . Gambert, S. R. (2013). Negative Affect. In *Springer eBooks* (pp. 1303 1304). https://doi.org/10.1007/978-1-4419-1005-9_606

Tung, N. Y. C., Yap, Y., Bei, B., Luecken, L. J., & Wiley, J. F. (2022). Resilience to early family risk moderates stress-affect associations: A 14-day ecological momentary assessment study. *Journal of Affective Disorders*, *311*, 134–142. https://doi.org/10.1016/j.jad.2022.05.075

Van den Berg, S. M. (2021). *Analysing data using linear models* (Fifth edition). University of Twente.

Vostanis, P. (2016). New approaches to interventions for refugee children. *World Psychiatry*, *15*(1), 75–77. https://doi.org/10.1002/wps.20280

Wilks, S., & Croom, B. (2008). Perceived stress and resilience in Alzheimer's disease caregivers: Testing moderation and mediation models of social support. *Aging & Mental Health*, *12*(3), 357–365. https://doi.org/10.1080/13607860801933323

Wilson, J. (2016). Brightening the Mind: The Impact of Practicing Gratitude on Focus and Resilience in Learning. *Journal of the Scholarship of Teaching and Learning*, *16*(4), 1–13. https://doi.org/10.14434/josotl.v16i4.19998

Zeier, P., Sandner, M., & Wessa, M. (2023). Regulating emotions with experience – the effectiveness of reappraisal inventiveness depends on situational familiarity. *Anxiety*

Stress and Coping, 1–9. https://doi.org/10.1080/10615806.2023.2200999

Appendix A

Informed Consent

Dear participant,

Thank you for agreeing to be part of this research project conducted by students of the University of Twente. This project aims at investigating momentary resilience in relation to other factors by gaining insight into your normal, day-to-day life. To get a thorough insight, it is of great importance that you fill out as many of the questionnaires as possible for our research.

Participation in this research requires active involvement for a duration of one week. You will receive 10 notifications at random moments throughout the day via this Ethic App. It is required that you complete the questionnaires as soon as possible following the notification, but at least within a timeframe of 15 minutes after receiving the notification.

Keep in mind that there are no right or wrong answers since the research solely relies on your feelings and experiences. Therefore, we kindly ask you to honestly answer all questions to get accurate information for further conclusions.

After submitting the questionnaire and finalising the measurements via the application, your responses will be pseudonymized, meaning that any information that could be used to directly identify a person will be replaced with a pseudonym. Also, all information will be handled with confidentiality. This ensures that the data cannot be traced back to you as a participant. Furthermore, when agreeing to participate in this study, you agree to contribute your responses to this research.

We would like to warn you that a few questions could be sensitive and could possibly evoke negative feelings. For this reason, a link to a website where help will be offered is placed at the bottom of this page if needed. Additionally, you have the right to withdraw from the research at any time without giving any reason for your withdrawal.

The study was approved by the BMS Ethics Committee.

If you have any questions after participating, please feel free to contact one of the researchers:
j.libosan@student.utwente.nl
v.barbaros@student.utwente.nl
l.sorgenfrei@student.utwente.nl
m.mertens@student.utwente.nl
h.unger@student.utwente.nl
k.potter@student.utwente.nl
s.eltohamiahmed@student.utwente.nl

If you want to file a complaint, please contact the BMS Ethics Committee: ethicscommittee-bms@utwente.nl

Link to websites:
https://findahelpline.com/nl
https://www.betterhelp.com

Consent Form

Demographic Information Participant

Age:
Gender: □ Male
□ Female
□ Other
Nationality: □ Dutch
□ German
□ Other: _____

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study		
I have read the study information dated 24/04/2023, or it has been read to me. I gained understanding of the information provided. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	□	□
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	□	□
Risks associated with participating in the study		

I understand that taking part in the study might result in mild discomfort related to filling out questionnaires.	□	□
Use of the information in the study		
I understand that information I provide will be used for a quantitative research report focusing on mental resilience in the general public.	□	□
I understand that all shared information will be stored pseudonymized, and will not be shared beyond the research team.	□	□
I agree that my pseudonymized information can be used in research outputs.	□	□
Future use and reuse of the information by others I give permission for the information that I provide to be archived in a Microsoft Word file so it can be used for future research and learning.	□	□
I agree that my information may be shared with other researchers working on the same study for future research studies that may be similar to this study or may be completely different. The information shared with other researchers will not include any information that can directly identify me. Researchers will not contact me for additional permission to use this information.	□	□
Signatures		

Name of participant	Signature	Date

For participants unable to sign their name, mark the box instead of sign

Study contact details for further information:

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee of the Faculty of Behavioural, Management and Social Sciences at the University of Twente by ethicscommittee-bms@utwente.nl

Appendix B

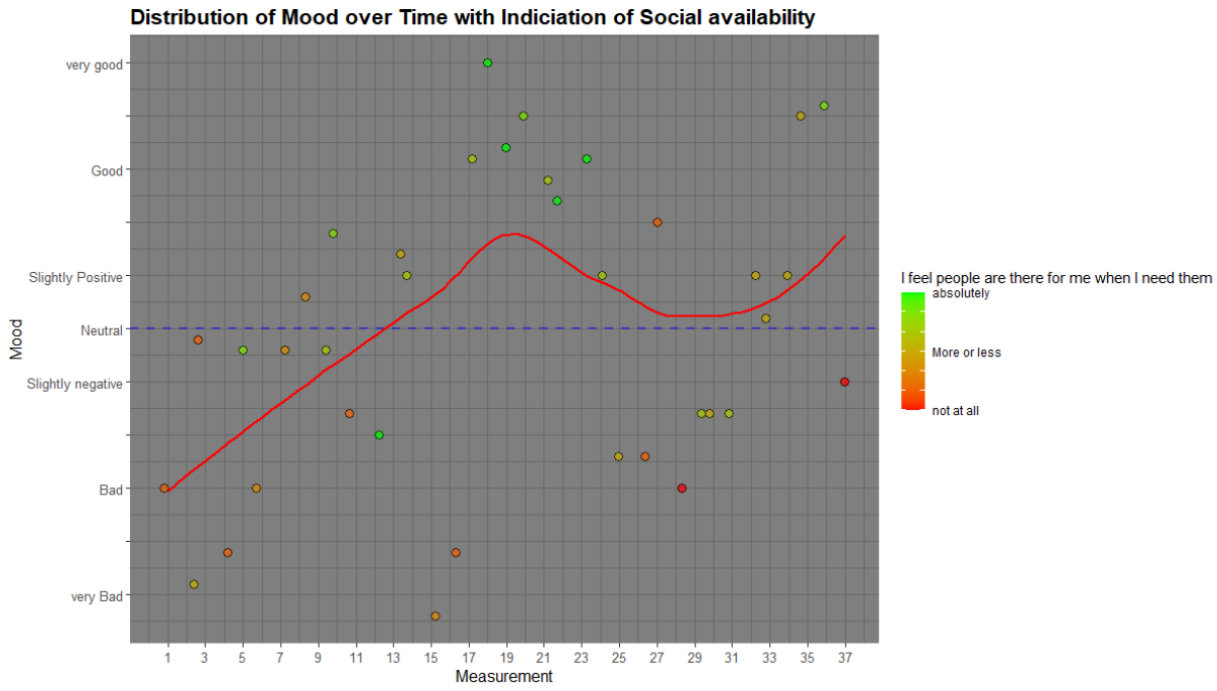
Example of a Personal Report

Personalized Overview: Mental Resilience Study

23.04.23 – 29.04.23

You filled out the regular questionnaire: 37 times

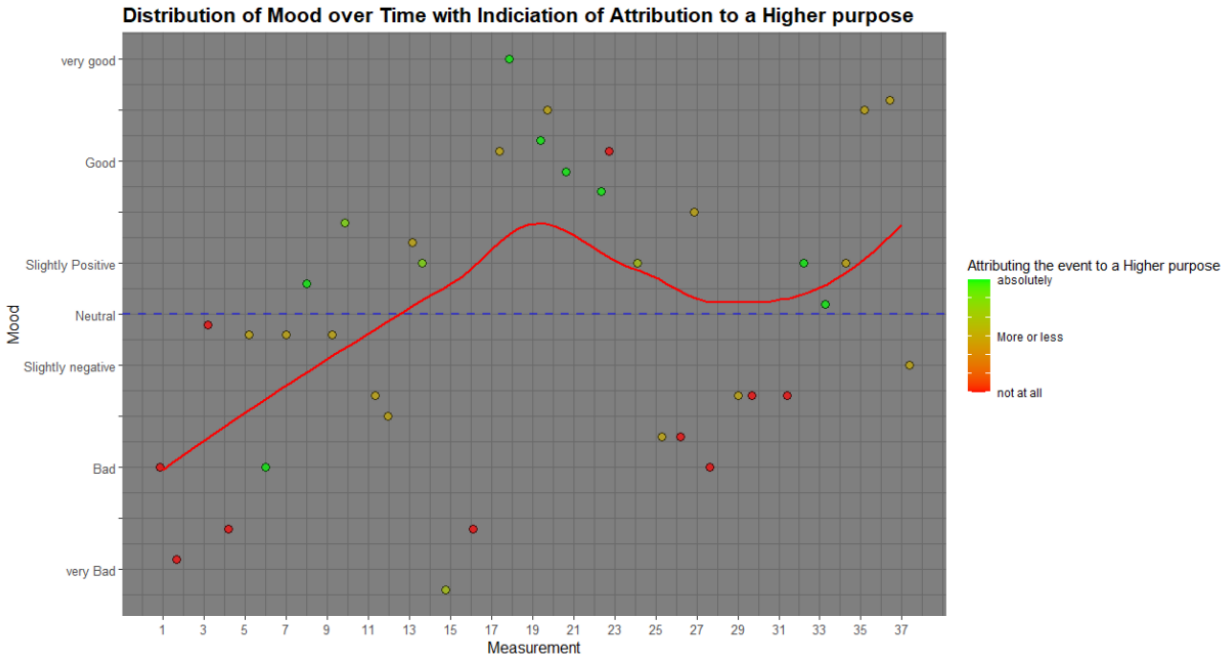
1. The following graph shows how your **mood** was over the course of the whole study (indicated by how high or low the point is displayed in the graph). The **red** line shows how your mood was on average during the course of the study. The colour of the measurement-point shows you how much you thought that people are there for you if you would need them in this moment.



Interpretation: You tend to think that people are more available to you (to speak with them for example) when your mood is high. The higher your mood, the more you think that others have

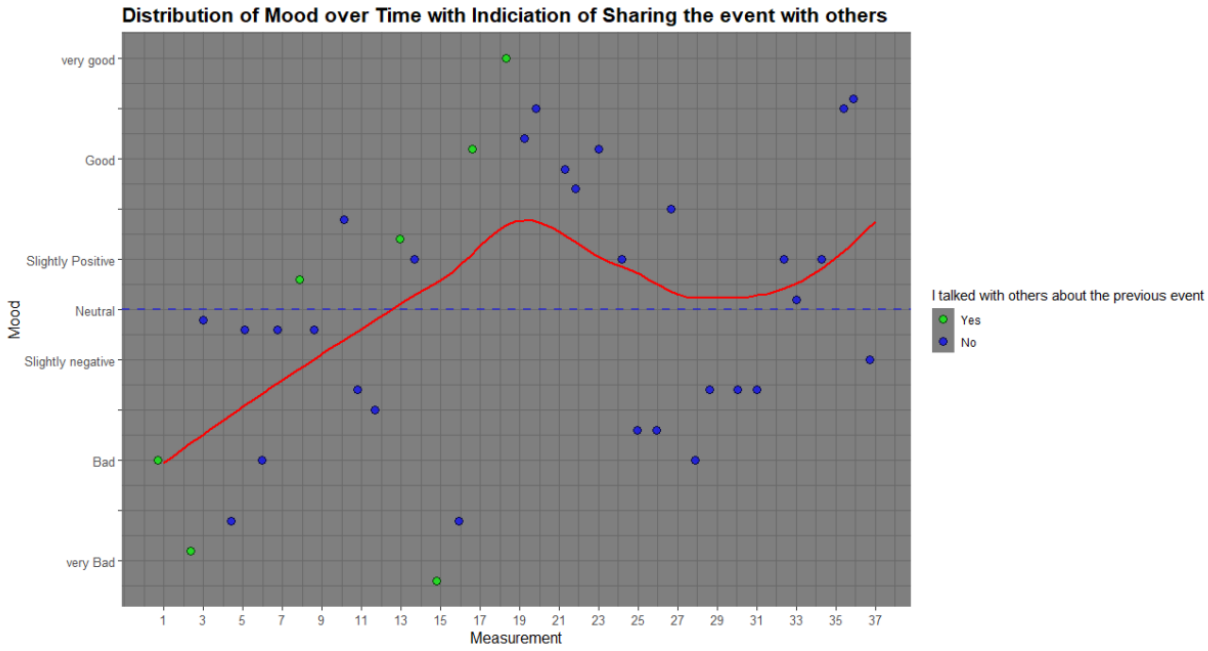
time for you. When believing the report of this study, Your mood therefore strongly influences you how much you think others would be there for you.

2. The following graph shows (again) how your **mood** was over the course of the whole study (indicated by how high or low the point is displayed in the graph). The **red** line shows how your mood was on average during the course of the study. The colour of the measurement-point shows you how much attributed the past event you experienced to having a *higher purpose*.



Interpretation: The better your mood, the more you attribute events to having a higher purpose. If your mood is low, you tend to rather not attribute the event to a higher purpose.

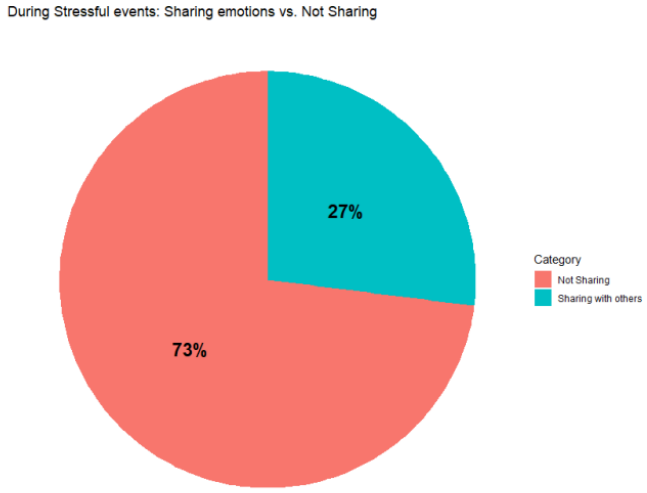
3. The following graph shows (again) how your **mood** was over the course of the whole study (indicated by how high or low the point is displayed in the graph). The **red** line shows how your mood was on average during the course of the study. The colour of the measurement-point shows you whether you talked with others about the previous event or not.



Interpretation: In both extremes (the absolute minimum and maximum mood) you tend to share your event and feelings with others. Besides that, you share your experience of the last event rather randomly, independent of the mood. There is no indication for a tendency here. Lastly, you only shared experiences of a previous event in the first half of the experiment. The second half is not shared.

---

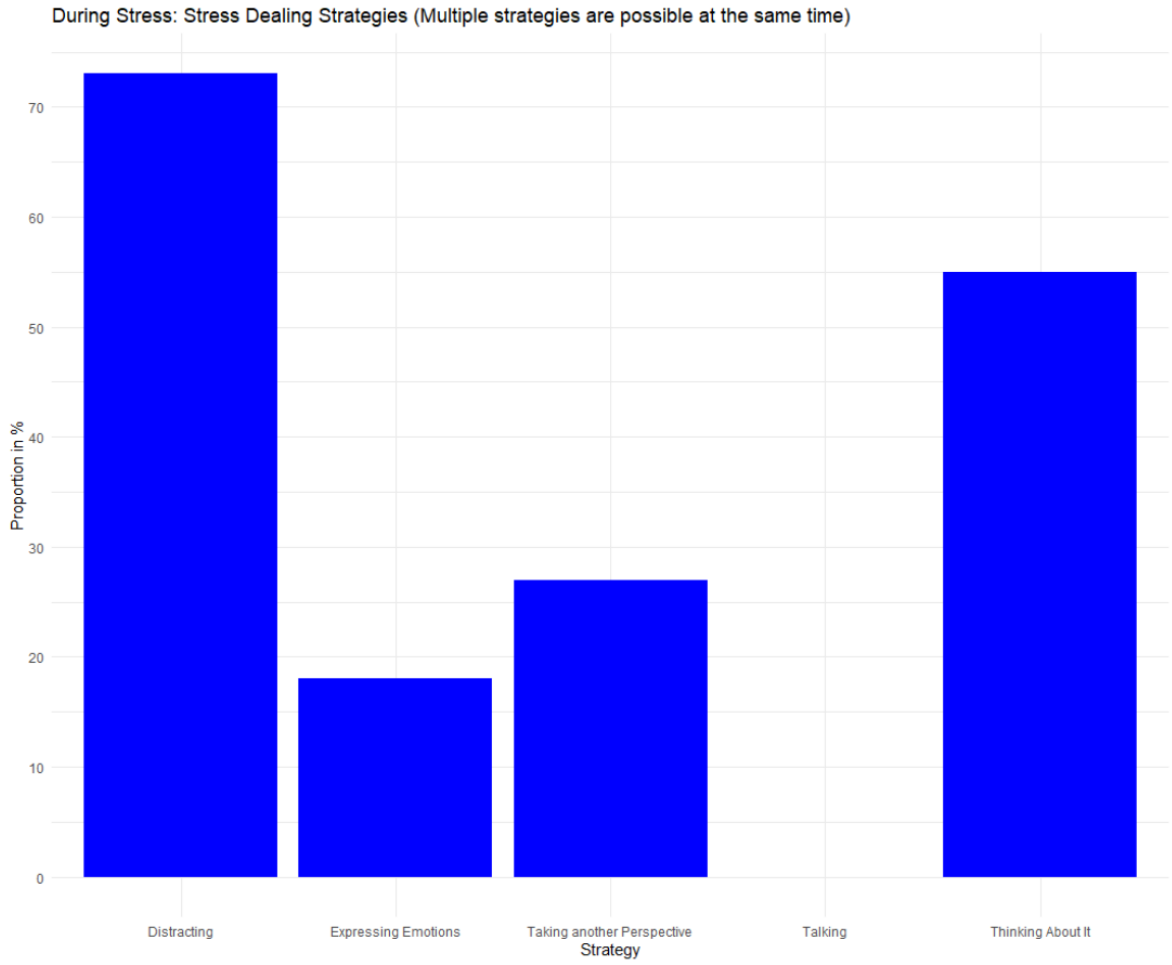
4. The following graph shows how often you **shared your emotions** with others after a *Stressful event*. Note that we look here only at events which you rated as stressful, not at those you found pleasant.



Interpretation: -

---

5. The following graph shows **how you dealt with stressful events**. Note again, that we do only look at stressful events, not at pleasant ones. The higher the stripe, the more often you used this strategy. On the left, it is shown to you how much in % you used the strategy. In total, you rated **11** of the 37 events as *stressful*.



Interpretation: More than 2/3 of the time you distracted yourself from stressful events. Directly after that (little more than 50% of the time) you thought about the event. You indicated that you did not talk with others to deal with stressful events, but rather try to solve them on your own.

One could (tentatively) conclude, this could maybe correlate with your tendency to perceive others as unavailable to you when you are in a bad mood?

_____

Thank you a lot for your participation in the study. You gave valuable input for academic research into resilience and how people deal with small stressful events during their live. You contributed with 37 of possible 70 measurement points over the week. This is a big contribution!!!

Your input increased knowledge about mental health psychology and well-being in general.

If you have any questions about the personalized overview or the study in general, feel free to contact me via m.mertens@student.utwente.nl

Thank you very much!

Appendix C

R-Script

```
closing <- read.csv("survey_responses_18962.csv")

baseline <- read.csv("survey_responses_18694.csv")

esm <- read.csv("survey_responses_18695.csv")

#install.packages("tidyverse")
library(tidyverse)

#install.packages("lmmadd")
library(lmmadd)

baseline_sub <- baseline %>% select(c("Name", "age", "gender", "nationality", "occupation",
"degree", "base_religion"))
print(nrow(baseline_sub))

baseline_sub <- baseline_sub[!is.na(baseline_sub$gender),]
print(nrow(baseline_sub))

baseline_sub <- baseline_sub[!duplicated(baseline_sub$Name),]
print(nrow(baseline_sub))

esm_sub <- esm[,c("Name","Response.Time",colnames(esm)[9:21])]

joined <- esm_sub %>% left_join(baseline_sub, by="Name")

#Check how many surveys werde filled out per person
filled_surveys <- joined %>% group_by(Name) %>%
  summarize(n = sum(is.na(ESM_M_1)))
```

```
print(length(unique(filled_surveys$Name)))
g21_ids <- filled_surveys$Name[filled_surveys$n >= 21]
print(length(unique(g21_ids)))

joined <- joined[joined$Name %in% g21_ids,]

#Compute day time
library(lubridate)

time <- hour(as_datetime(joined$Response.Time))*60 +
minute(as_datetime(joined$Response.Time))

joined$daytime <- time

#Drop missing ESMs
joined <- joined[!is.na(joined$ESM_M_1),]
#103 filled ESM
#less than 30%
#13 deleted because incomplete ESM

#person-mean centering
mean_nona <- function(x){
  return(mean(x,na.rm=T))
}

pmcs <- joined[,c(1,3:15)] %>%
  group_by(Name) %>%
  summarize(across(everything(), list(mean_nona)))

joined_pmc <- joined
```

```
for(i in 3:15){
  joined_pmc[,i] <- joined[,i] - pmcs[match(joined$Name, pmcs$Name), i-1]
}


#Alpha

#negative affect
psych::alpha(joined_pmc[,c(3,9,10,11,12)])

#positive affect
psych::alpha(joined_pmc[,c(4,5,6,7,8)])

#resilience
psych::alpha(joined[,13:14])

#joined$mood <- rowMeans(joined[,3:12])

#Resilience
#Alpha:
psych::alpha(joined_pmc[,13:14])

joined$resilience <- rowMeans(joined[,13:14])

#Social support
joined$support <- joined$ESM_S_1

#Format dataset
data <- joined[,c("Name","Response.Time","age","gender","daytime","negative_affect",
"positive_affect","resilience","support")]
data <- data[order(data$Response.Time),]
```

```
data$na_shifted <- data$negative_affect
data$pa_shifted <- data$positive_affect
for(id in unique(data$Name)){
  person_nas <- data$negative_affect[data$Name == id]
  person_pas <- data$positive_affect[data$Name == id]
  if(length(person_nas) == 1){
          data$na_shifted[data$Name == id] <- c(NA)
          data$pa_shifted[data$Name == id] <- c(NA)
  }
  else{
          data$na_shifted[data$Name == id] <- c(person_nas[2:length(person_nas)],NA)
          data$pa_shifted[data$Name == id] <- c(person_pas[2:length(person_pas)],NA)
  }
}

#Check how many participants are left
length(unique(data$Name))
#90

#Model
install.packages("lmerTest")
library(lmerTest)
library(lme4)

devtools::install_github("AlexHartmann00/lmmadd")
#Base model

basemodel_pa <- lmer(pa_shifted ~ resilience + (1|Name),data=data)
basemodel_na <- lmer(na_shifted ~ resilience + (1|Name),data=data)
```

```
#robust model NA
sigtest_bmna <- lmmadd::robust_sig_test(basemodel_na,"HC3") %>%  as.data.frame
sigtest_bmna$llci <- sigtest_bmna$coef - 1.96 * sigtest_bmna$se
sigtest_bmna$ulci <- sigtest_bmna$coef + 1.96 * sigtest_bmna$se
sigtest_bmna

#robust model PA
sigtest_bmna <- lmmadd::robust_sig_test(basemodel_pa,"HC3") %>%  as.data.frame
sigtest_bmna$llci <- sigtest_bmna$coef - 1.96 * sigtest_bmna$se
sigtest_bmna$ulci <- sigtest_bmna$coef + 1.96 * sigtest_bmna$se
sigtest_bmna

#normal robust model
lmmadd::robust_sig_test(basemodel_pa,"HC3")
lmmadd::robust_sig_test(basemodel_na,"HC3")



#Moderation
model_pa <- lmer(pa_shifted ~ resilience * support + (1|Name),data=data)
model_na <- lmer(na_shifted ~ resilience * support + (1|Name),data=data)

lmmadd::robust_sig_test(model_pa)

#robust moderation with CI
#PA
sigtest_bmna <- lmmadd::robust_sig_test(model_pa,"HC3") %>%  as.data.frame
sigtest_bmna$llci <- sigtest_bmna$coef - 1.96 * sigtest_bmna$se
sigtest_bmna$ulci <- sigtest_bmna$coef + 1.96 * sigtest_bmna$se
sigtest_bmna

#NA
```

```
sigtest_bmna <- lmmadd::robust_sig_test(model_na,"HC3") %>%  as.data.frame
sigtest_bmna$llci <- sigtest_bmna$coef - 1.96 * sigtest_bmna$se
sigtest_bmna$ulci <- sigtest_bmna$coef + 1.96 * sigtest_bmna$se
sigtest_bmna

#R Squared
# install the MuMIn package if needed

install.packages("MuMIn")

# load the MuMIn package
library(MuMIn)

# calculate R-squared using r.squaredGLMM()
r.squaredGLMM(model_na)
r.squaredGLMM(model)

#Assumptions:

#normality
# Conduct Shapiro-Wilk test
shapiro.test(resid(model))

hist(resid(model))

#Multicollinearity: VIF > 5 bad, VIF > 10 horrible
car::vif(model)

#Residuals:
qqnorm(scale(resid(model)))
abline(0,1)
```

```
#Heteroskedasticity:
plot(predict(model),resid(model))

#To ignore Heteroskedasticity:

library(ggplot2)

#Johnson-Neyman-Plot; if low social support -> no effect of resilience
lmmadd::johnson_neyman(model_pa,"resilience", "support")
lmmadd::johnson_neyman(model_na,"resilience", "support")

#MEDIAN SPLIT
#Positive Affect
plot_data <- data[,c("resilience","support","negative_affect","positive_affect")]
plot_data$half <- ifelse(plot_data$support > median(plot_data$support,na.rm=T),"high","low")

support_median <- median(plot_data$support,na.rm=T)

ggplot(plot_data[!is.na(plot_data$half),], aes(x=resilience, y=positive_affect, color=half))+
  geom_point()+
  geom_smooth(method = "lm")+
  labs(x="Resilience",y="Positive Affect",color="MPSS Median Group")+
  theme_classic()

ggplot(plot_data[!is.na(plot_data$half),], aes(x=resilience, y=negative_affect, color=half))+
  geom_point()+
  geom_smooth(method = "lm")+
  labs(x="Resilience",y="Negative Affect",color="MPSS Median Group")+
  theme_classic()
```

```
ggplot(data, aes(x=Response.Time,y=positive_affect,group=Name,alpha=0.5))+
  geom_line()+
  geom_point()



# view the summary of the model, which includes R-squared
summary(basemodel)$r.squared

summary(model)$r.squared



#for how many participants is the effect significant -> Johnson-Neyman Plot
# Calculate the Johnson-Neyman region of significance
# Load necessary packages
library(lme4)

# Fit the model
modelneyman <- lmer(mood_shifted ~ resilience * support + (1|Name), data = data)

# Define the range of values for the moderator variable (support)
support_range <- seq(min(data$support), max(data$support), length.out = 100)

# Calculate the predicted values of the dependent variable (mood_shifted) for each value of
support
pred_values <- predict(modelneyman, newdata = data.frame(resilience = mean(data$resilience),
support = support_range), allow.new.levels = TRUE)

# Calculate the residuals
resid_values <- residuals(modelneyman)
```

```
# Find the index of the row corresponding to the participant's data
part_index <- match(data$Name, rownames(modelneyman@frame))

# Calculate the leverage statistic for each observation
leverage <- hatvalues(modelneyman)

# Calculate the Cook's distance for each observation
cooksd <- cooks.distance(modelneyman)

# Calculate the critical value of F for alpha = .05 and the degrees of freedom of the residual error and the interaction term
crit_val <- qf(0.95, modelneyman$df.residual, modelneyman$df.residual)

# Find the indices of the observations that have a significant effect
sig_obs <- which(cooksd > crit_val & leverage >= 0.5)

# Create the plot
plot(support_range, pred_values, type = "l", xlab = "Support", ylab = "Mood Shifted")
abline(h = 0, lty = 2)

# Add vertical lines to indicate the range of values of support where the effect is significant for each participant
for (i in sig_obs) {
  mod_range <- (resid_values[i] - crit_val * sqrt(1 - leverage[i])) /
modelneyman@beta["support"]
  abline(v = mod_range, lty = 2)
}

# Add a legend indicating the number of significant participants
legend("topright", legend = paste(length(sig_obs), "participants with significant effects"), lty = 2,
bty = "n")
```

```
#descriptive statistics:
# Count number of unique individuals in each gender category
library(dplyr)

# gender
data %>%
  distinct(Name, .keep_all = TRUE) %>% # keep only first row for each ID
  count(gender)

#gender percentage
data %>%
  distinct(Name, .keep_all = TRUE) %>%
  count(gender) %>%
  mutate(percentage = n / sum(n) * 100)

#degree
joined %>%
  distinct(Name, .keep_all = TRUE) %>% # keep only first row for each ID
  count(degree)

#degree percentage
joined %>%
  distinct(Name, .keep_all = TRUE) %>%
  count(degree) %>%
  mutate(percentage = n / sum(n) * 100)

#occupation
joined %>%
  distinct(Name, .keep_all = TRUE) %>% # keep only first row for each ID
  count(occupation)
```

```
#occupation percentage
joined %>%
  distinct(Name, .keep_all = TRUE) %>%
  count(occupation) %>%
  mutate(percentage = n / sum(n) * 100)

#age range
# Calculate age range while ignoring missing values
range(data$age, na.rm = TRUE)

# Count number of individuals from each country while ignoring missing values
table(baseline$nationality, useNA = "ifany")

#nationality percentage
joined %>%
  distinct(Name, .keep_all = TRUE) %>%
  count(nationality) %>%
  mutate(percentage = n / sum(n) * 100)

#mean and sd age
mean_age <- mean(joined$age, na.rm = TRUE)
sd_age <- sd(joined$age, na.rm = TRUE)

mean_age
sd_age
```

```
#plot interaction
# Load required packages
install.packages("ggpubr")
library(ggplot2)
library(ggpubr)

# data frame named 'data' with the variables 'mental_resilience', 'social_support', and 'mood'



# Plot the interaction
ggplot(data, aes(x = resilience, y = mood, color = factor(support))) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE, aes(group = support)) +
  labs(x = "Mental Resilience", y = "Mood", color = "Social Support") +
  theme_minimal()
```

Appendix D

Parametric Assumptions

Figure D1

Scatterplot of Residuals