

**The Effects of Ecological Momentary Interventions on Emotion Regulation Strategies of
People in Psychological Distress: A Mixed Design Pilot Study**

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Bachelor Thesis, Psychology

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June 30, 2024

APA 7th Edition

Abstract

Background: Emotion Regulation (ER) strategies are highly relevant to people's mental health. Practicing adaptive ER strategies could help to cope with the psychological stressors in one's daily life. The current study implemented four different Ecological Momentary Interventions (EMIs) with Acceptance and Commitment Therapy (ACT), Cognitive Behavioural Therapy (CBT), and Positive Psychology (PP) derived exercises to investigate their effects on ER. It aimed to answer a quantitative research question: "*How do Ecological Momentary Interventions affect people's emotion regulation strategies?*", and a qualitative research question: "*How do people perceive the effects of Ecological Momentary Interventions on their emotion regulation in real life?*".

Methods: The first sample ($N = 52$, $M_{\text{age}} = 22.46$) who were experiencing at least mild psychological distress took part in the 16-day EMI period of 32 EMI exercises on their mobile phones, distal pre-post measurements were taken. Using the first sample as the population, a second sample of 16 interviewees took part in semi-structured interviews after the EMIs.

Results: The quantitative results indicated that only ER Acceptance significantly increased after the interventions ($p = .015$), whereas Positive Reappraisal and Rumination did not significantly change as hypothesised. Further, the completed EMI exercises did not significantly correlate to their corresponding ER strategies as hypothesised. The qualitative interviews yielded three themes: i) Gaining more from PP; ii) ACT and CBT's counterproductivity; and iii) Unsustainable positive changes.

Discussion: The quantitative results and qualitative results did not align. Interviewees perceived PP to be more useful than the mainstream ACT or CBT. Alternative common-factor model was considered in explaining the inconsistency. Nevertheless, the current pilot study provided valuable insights into ER changes from both perspectives, the discrepancy between the statistical improvements in ER and their applicability in real-life, and conditions for future research in designing higher-level Just-In-Time-Adaptive-Interventions.

Key words: Emotion Regulation (ER), mental health, mixed-design, Ecological Momentary Intervention (EMI).

Introduction

Emotions are an essential part of us. In the field of psychology, there are many different theories of emotions on how they are formed, their functions and working mechanisms (Moors, 2009). Regardless of the various theories, psychologists could agree on the importance of regulating one's own emotions in relation to one's mental health (Berking & Wupperman, 2012). Emotion Regulation (ER) could be defined as: "How a person manages and responds to an emotional experience" (Thomson et al., 2024). ER is a fundamental skill that a person should possess, and practicing it inappropriately is often associated with psychopathologies (Berking & Wupperman, 2012; Thomson et al., 2024). This is due to the fact that many psychopathologies are characterised an inappropriate amount or control of (negative) emotions, such as mood disorders or anxiety disorders (Thomson et al., 2024).

Therefore, psychotherapies based on different theoretical frameworks generally included elements of that would either directly or indirectly influence the client's ER (Gratz et al., 2015). These psychotherapies suggest that they would help the clients learn diverse ER strategies to cope with daily stress or diminish the clients' old strategies that deteriorated their mental health. The prior is referred as adaptive ER strategy and the latter is referred as maladaptive ER strategies (Thomson et al., 2024). Clinical evidence suggests that a significant improvement of ER and decrease of maladaptive ER strategies could be obtained from psychological interventions derived from the most prevalent psychotherapies (Gratz et al., 2015). However, the problem is the lack of sufficient empirical data that the ER could be improved similarly by psychological interventions that are beyond the clinical context, which are not administered as a treatment by the psychologist (Gratz et al., 2015; Thomson et al., 2024).

Ecological Momentary Interventions

In correspondence to that, Ecological Momentary Interventions (EMI) are psychological interventions that aim to provide support and intervention in real-time, naturalistic settings (Balaskas et al., 2021). EMIs are designed to deliver therapeutic content to change participants behaviors and experiences in response to daily stressors as they occur in their everyday environments (Heron & Smyth, 2010). The delivery of EMIs is primarily done through smartphone apps (Balaskas et al., 2021). EMIs are grounded in the principles of Ecological Momentary Assessment (EMA), which captures data on individuals' thoughts,

feelings, and behaviors in the moment, thus offering high ecological validity and reducing recall bias compared to traditional self-reports (Shiffman et al., 2008). EMAs are still self-administered but prompted by the electronic devices at random moments or predetermined intervals (Shiffman et al., 2008). EMAs are particularly effective for studying phenomena that vary over short periods such as one's emotional state or ER, thus providing detailed insights into the temporal and contextual dynamics of those psychological processes (Shiffman et al., 2008). Overall, self-delivered digital interventions and digital assessments like EMIs and EMAs could overcome the difficulties of traditional psychotherapies, which are financial burden, restricted access to visit psychotherapists and social stigmas (World Health Organization, 2022).

EMI Exercises

As mentioned, the mainstream psychotherapies are effective in improving ER (Gratz et al., 2015). These psychotherapies' derivatives could be implemented in EMIs. Two examples are from Acceptance and Commitment Therapy (ACT) and Cognitive Behavioural Therapy (CBT). In addition, the fast-growing field of Positive Psychology (PP) also has yielded preliminary results that it may help with people's emotions as well. For instance, Positive Psychotherapy (PPT) was found to increase positive emotions such as happiness in patients with Major Depressive Disorder (MDD) more effectively than group CBT (Asgharipoor et al., 2012). Such finding suggests that PPT may also have the potential in improving people's ER, thus, two exercises are also derived from PP that could be implemented in EMIs. In total, four EMI exercises are devised, and they are targeting different ER strategies (see Appendix A).

The Gratitude exercise is a reflective activity that encourages individuals to identify and contemplate three aspects of their life they are grateful for, ranging from simple pleasures to significant life events. Research has shown that deliberately expressing gratitude significantly boost well-being (Emmons & McCullough, 2003).

The Savouring exercise involves recalling a joyful memory in great detail and focusing on the positive emotions felt during that moment. This exercise is linked to emotion regulation as it encourages the experience of positive emotions and reduces negative affect. In the context of Broaden-and-Build Theory of positive emotions, it could be interpreted that experiencing positive emotions broaden one's awareness and capabilities of ER, subsequently building new adaptive ER strategies to experience more positive emotions (Fredrickson,

2001).

The ACT exercise encourages individuals to accept and embrace negative thoughts and emotions rather than resisting them. This exercise aligns with the James-Lange theory of emotion, which posits that our emotional experiences as a result of physiological reactions to events (Northoff, 2012). By acknowledging and accepting their physiological responses, individuals can better manage their emotional state. This promotes the adaptive ER strategy of Acceptance, which involves acknowledging and experiencing emotions, thoughts, and feelings without trying to change or eliminate them (Hayes et al., 1999).

The CBT exercise involves identifying, challenging, and replacing unhelpful thoughts. This exercise aligns with the Cognitive Appraisal theory of emotion, suggesting that our emotional response to an event is determined by our interpretation of that event (Kemper & Lazarus, 1992). By challenging and changing their negative interpretations, individuals can alter their emotional responses. This CBT exercise especially promotes the adaptive ER strategy of Positive Reappraisal, which is a form of Cognitive Reappraisal that involves identifying and modifying maladaptive thoughts more positively (Koles, 2012). It also discourages the maladaptive ER of Rumination, which involves dwelling on negative thoughts or feelings (Nolen-Hoeksema et al., 2008)

Current Study

The current study aims to bridge the gap of insufficient empirical data on the effectiveness of the mainstream psychotherapies on ER in real life setting. The mainstream ACT and CBT derived exercises have clearer mechanisms and target ER strategies compared to PP exercises, thus being the focus of the study. The study uses Experience Sampling Methodology (ESM) to gather the data, which is a synonym of the EMA. ESM is a broader term that incorporates EMA, while EMA specifies the self-delivery and the momentary data collection (Myin-Germeys & Kuppens, 2022). The EMAs in the current study are in the form of daily questionnaires that contain various questions regarding the participants' momentary affect, surroundings, and a few ER strategies. However, considering the feasibility, this report will not analyse the momentary ER data. The current study will deliver four EMIs based on each exercise, and measure the changes in ER by comparing the measurements before and after intervention. Its target population is the adults in the Netherlands who are in psychological distress, whose potential improvements in ER may prevent them from developing mental health problems. The first research question: "*How do Ecological*

Momentary Interventions affect people's emotion regulation strategies?" will be answered quantitatively. Specifically, it hypothesises i) After the intervention period, the participants will report more Acceptance and Positive Reappraisal, and less Rumination; ii) The improvements in Acceptance are positively associated with the number of completed ACT exercises; and iii) The improvements in Positive Reappraisal are positively associated with the number of completed CBT exercises. Moreover, a second research question: "*How do people perceive the effects of Ecological Momentary Interventions on their emotion regulation in real life?"* will be answered qualitatively.

Methods

The current research was approved by the BMS ethics committee of University of Twente (No. 240007 and No.240440).

Participants

The sampling methodologies used in this study were volunteer sampling and convenience sampling. The study was posted on the SONA system of University of Twente for students to join voluntarily in exchange for 5 SONA credits. Flyers were left across the University of Twente and Saxion University's campuses in Enschede (see Appendix B). Furthermore, the study was posted on various online platforms for university students in the Netherlands such as Facebook, WhatsApp, and WeChat. In addition, the researchers asked their close contacts to participate. The participants were incentivised by Amazon vouchers when they did not need SONA credits: Five euros for the pre-intervention questionnaires, 10 to 30 euros for different participation rates of daily EMAs, and 15 euros for the post-intervention questionnaires. The inclusion criteria were a) above 18 years old; b) score above or equal to 20 on K10 scale. This sample will be referred as the first sample for the quantitative results.

Out of the first sample, a random list of participants was created. They were invited to participate in the interview by email. Notably, the only inclusion criterion was participating in the quantitative measurements, and their participation rates of daily EMAs or EMI exercises were not considered. They were incentivised by another 10 euros Amazon voucher. This sample will be referred as the second sample for qualitative results.

Materials

Psychological Distress

The psychological distress was measured by the Kessler Psychological Distress Scale (K10), developed by Kessler and Mroczek (Kessler & Mroczek, 1994, as cited in Andrews & Slade, 2001). It contained 10 items regarding the respondent's anxiety and depression symptoms in the past month. Participants rated each item on a five-point Likert scale, ranging from "None of the time" (1) to "All of the time" (5). An example item was "During the last 30 days, how often did you feel worthless" (see Appendix C for the whole scale). As the total score ranged from 10 to 50, a higher score indicated more psychological distress. The K10 was used as a screening material for selection participants in the study, as the participants should be at least in moderate psychological distress with score 20 or higher (Andrews & Slade, 2001). The psychometric properties of K10 have been tested in many populations and cultures. Fassaert and colleagues (2009) found excellent internal consistency of K10 in a multi-ethnic sample in the Netherlands, with a Cronbach's alpha value of 0.93. In addition, the authors found good criterion validity in matching K10 scores to DSM diagnoses (Fassaert et al., 2009).

Acceptance

The ER strategy Acceptance was measured by Acceptance and Action Questionnaire, Version 2 (AAQ.II). AAQ.II contained seven items to measure respondent's psychological (in)flexibility (Bond et al., 2011). Participants rated each item on a seven-point Likert scale, ranging from "Never true" (1) to "Always true" (7). An example item was "I am afraid of my feelings" (see Appendix C for the whole questionnaire). As the items were phrased to measure Experiential Avoidance and psychological inflexibility, Acceptance was reversely measured. The total score ranged from seven to 49, a higher score indicated less Acceptance. AAQ.II has improved internal consistency than AAQ.I, Cronbach's alpha value was 0.84 (Bond et al., 2011). AAQ.II's reliability was also shown in test-retest reliabilities of 0.81 and 0.79, for three and 12 months respectively (Bond et al., 2011). Further study has also shown that AAQ.II measured Experiential Avoidance unidimensionally, thus indicated construct validity (Fledderus et al., 2012).

Rumination

The ER strategy Rumination was measured by a refined version of Ruminative Response Scale (RRS-10). RRS-10 contained 10 items to measure respondent's Rumination by two underlying constructs: Reflecting pondering and brooding (Treynor et al., 2003). Participants rated each item on a four-point Likert scale, ranging from "Almost never" (1) to

“Almost always” (4). An example item was “Analyse recent events to try to understand why you are depressed” (see Appendix C for the whole scale). The total score ranged from four to 40, a higher score indicated more Rumination. The refined 10 items had acceptable reliability, Cronbach’s alpha was 0.75 and test-retest correlation was 0.61. The content validity of RRS-10 was improved after removing the items confounded with depression, while the construct validity was demonstrated by the two distinct factors of reflection and brooding (Treyner et al., 2003).

Positive Reappraisal

The ER strategy Positive Reappraisal was measured by a subscale of Cognitive Emotion Regulation Questionnaire (CERQ-PR). CERQ-PR contained four items to measure respondent’s Positive Reappraisal (Garnefski & Kraaij, 2006). Participants rated each item on a five-point Likert scale, ranging from “Almost never” (1) to “Almost always” (5). An example item was “I think that the situation also has its positive sides” (see Appendix C for the whole scale). The total score ranged from five to 20, a higher score indicated more Positive Reappraisal. The CERQ-PR had a high Cronbach’s alpha of 0.85, and the CERQ overall had factorial and discriminative validities (Garnefski & Kraaij, 2006).

Interview Scheme

A semi-structured interview scheme was created by the researchers (see Appendix D). The semi-structured form was chosen due to its flexibility and the explorative nature of the qualitative part of the study (Harrison & Rentzelas, 2011). This interview scheme had three parts due to researchers’ different interests: a) Effects on psychological well-being; b) Effects on Emotion Regulation; c) User experience. The second part regarding the ER was developed by the author of this paper. It contained two questions: “Do you have a feeling that these exercises changed the way you look at or deal with unpleasant thoughts or emotions?” and “Do you have the feeling that these exercises helped you with managing your emotions?”. The first question was asked after a reminder that ACT and CBT exercises served the purpose to improve their ER, and the second question was asked after a reminder that the PP exercises served the purpose to experience more positive emotions (see Appendix D). Nevertheless, both of questions aimed to examine the changes in interviewee’s ER. Follow-up questions such as “In what way?”, “How is that different from what you would do before?” were used to probe real-life examples and to determine whether the changes in ER were caused by the EMI exercises.

Design and Procedure

As mentioned, the current study was mixed in quantitative and qualitative data. It was also within-subject and fully online. Firstly, the participants registered for the study filled in the K10 and their ages on Qualtrics for screening. The qualified participants were briefed online and asked to download the m-Path app on their phones for receiving daily EMA questionnaires and EMI exercises. The participants were also informed about the possibility of an additional online interview in the briefing. Then, the participants filled in the pre-measurement of the three questionnaires (AAQ-II; RRS-10; CERQ-PR) before continuing to the intervention.

In the EMI period of 16 days, participants received eight EMA questionnaires and two EMI exercises per day. The relatively high number of questionnaires and exercises per day were aimed at investigating the appropriate moments of providing the exercises. Moreover, it was implemented in a Microrandomised Trials (MRT) design which is getting increasingly more prevalent in digital EMIs (Qian et al., 2022). More specifically, each daytime was equally divided into four blocks. In two of these four blocks, a daily EMA questionnaire would appear at a random time on m-Path. After 30 minutes of completing it, a follow-up EMA would appear. In the other two blocks, a daily EMA questionnaire would also appear at a random time. The difference was that an EMI exercise would follow by it immediately. After 30 minutes of completing the EMI exercise, then the follow-up EMA would appear.

The EMI period of 16 days was also divided into four conditions based on the EMI exercise. Each condition lasted for four days, only one type of EMI exercise would appear during those four days. In other words, every participant had four days of Gratitude, Savouring, ACT, and CBT exercises. There were two possible orders of the conditions that the participants were arbitrarily assigned into: a) Gratitude exercise, ACT exercise, Savouring exercise, and CBT exercise; b) CBT exercise, Savouring exercise, ACT exercise, and Gratitude exercise. Therefore, potential biases by order and learning effects were eliminated (Harrison & Rentzelas, 2011).

After the EMI period, participants filled in the post-measurement of the same three questionnaires (AAQ-II; RRS-10; CERQ-PR) again. Approximately half of the participants who completed all quantitative measurements were invited to join the qualitative interview. Only interviewees who agreed to participate received an additional informed consent form (see Appendix E) besides the one collected as a part of the larger study. In addition, an

information sheet was sent to the interviewees to read before the interview, which contained the EMI exercises' content as a reminder (see Appendix A). At the start of the interview, the researchers asked if the interviewees had any questions, had read the information sheet, and signed the ICF. The interviewees were reminded by the researchers that audio recording was taken, and they had the right to not share anything personal and withdraw at any time. The interview sessions lasted between 20 to 30 minutes on Microsoft Teams. After the interview, the participants completed the study entirely. The whole data collection lasted from March 18th to May 17th, 2024.

Data Analyses

Quantitative Data Analysis

The raw data gathered from the screening (K10), pre and post questionnaires (AAQ.II; RRS-10; CERQ-PR) and daily EMA questionnaires were first cleansed, transformed into numeric values and merged into one dataset in R. Participants who did not complete any of these three measurements were not included in the quantitative data analysis. From the daily EMA questionnaires, only answers to one item in the follow-up questionnaires "Did you complete the exercise that you received in the last hour?" was analysed.

Firstly, the demographic information filled in the pre and post questionnaires were summed. Secondly, the questionnaire' scores at the pre and post measurements were calculated and compared. Descriptive statistics were also provided on each EMI exercises' participation. The four different EMI exercises' participation was compared altogether using a one-way repeated ANOVA. Thirdly, to test the first hypothesis, paired-sample t-tests were performed. The parametric assumption of normal distribution of the residuals must be checked. A non-significant Shapiro-Wilk test would indicate the normal distribution was not skewed or with abnormal kurtosis (Harrison & Rentzelas, 2011). Notably, the parametric assumption of homogeneity of variances between the samples did not need to be checked due to the within-subject design (Harrison & Rentzelas, 2011). Left-tailed t-tests were performed on AAQ.II and RRS-10, and right-tailed t-test was performed on CERQ-PR. Lastly, Pearson's correlation coefficients and tests were calculated between the change in pre-post questionnaire scores and their corresponding EMI exercise participation rates for the second and third hypotheses. The significance level was set to .05 in all analyses (see Appendix F for R script).

Qualitative Data Analysis

The raw data, i.e., interview transcripts generated by Microsoft Teams automatically was fixed manually by listening to the recordings. Therefore, verbatim transcripts were obtained, and the recordings were deleted. The cleaned data was analysed by Thematic Analysis in summarising similar patterns. Thematic analysis has six iterative phases: a)Familiarising with the data; b) Generating initial codes; c)Searching for themes; d)Reviewing themes; e)Defining and naming themes; f)Producing the report (Braun & Clarke, 2006). In the first step of familiarising with the data, the researcher found that interviewees addressed their ER to a great extent in answering the questions from the first part of the interview. Consequently, interviewees' answers to both first and second part of the interview were coded.

The current study coded inductively in ATLAS.ti without pre-conceived codes and developed a hierarchical coding scheme. None of the main codes or subcodes were mutually exclusive. Therefore, one quotation could have multiple subcodes applied to it across different main codes. After the coding was completed, the researchers who took part in the qualitative interview exchanged coding schemes and coded three transcripts for each other. Multiple group discussions were organised to discuss codes' working definitions. This measure was taken to ensure inter-coder reliability (Harrison & Rentzelas, 2011). The transcripts were repeated coded using the established coding scheme without checking the previous results, thus intra-coder reliability was enhanced by self-revisions. Lastly, themes were gathered from the main codes and the interviewees' quotes were used under pseudonyms.

Results

Quantitative Results

First Sample Characteristics

Starting with 174 participants that registered for the study and completed the screening, 100 participants fit the inclusion criteria and were invited to take part in the EMIs. In the end, 52 participants completed the pre, post questionnaires and EMIs. These 52 participants constitute the first sample for the quantitative analysis.

In the first sample, participants ranged from 18 to 34 years old ($M_{age} = 22.46$, $SD_{age} = 3.25$). Most participants were female, German, unemployed undergraduate students (see Table 1).

Table 1*Demographic Information of the First Sample (N = 52)*

Variable and Categories	<i>n</i>	%
Gender		
Female	32	61.5
Male	18	34.6
Non-binary	1	1.9
Other	1	1.9
Nationality		
German	20	38.5
Dutch	12	23.1
Other European	12	23.1
Non-European	8	15.4
Completed education		
High school	31	59.6
Bachelor's degree	16	30.8
Master's degree	4	7.7
Doctoral degree	1	1.9
Occupation status		
Unemployed student	29	55.8
Working student	16	30.8
Part-time employed	5	9.6
Full-time employed	1	1.9
Unemployed	1	1.9

Descriptive Statistics

The first sample's K10 mean score was 27.46 ($SD = 6.11$). In comparison to its population mean of 14.2 (cf. 10641 Australian adults), it corresponds to a Z-score of 1.84 (Andrews & Slade, 2001). This indicated moderate to high psychological distress.

Participants scored a mean of 25.52 points ($SD = 9.08$) on the pre AAQ.II, and 23.54

points ($SD = 8.59$) on the post AAQ-II. In comparison to their population mean of 18.00 (cf. 2816 American university students and British working adults), their respective Z-scores were 1.18 and 0.87 (Bond et al., 2021). This indicated low level of ER Acceptance, despite improvements after EMIs.

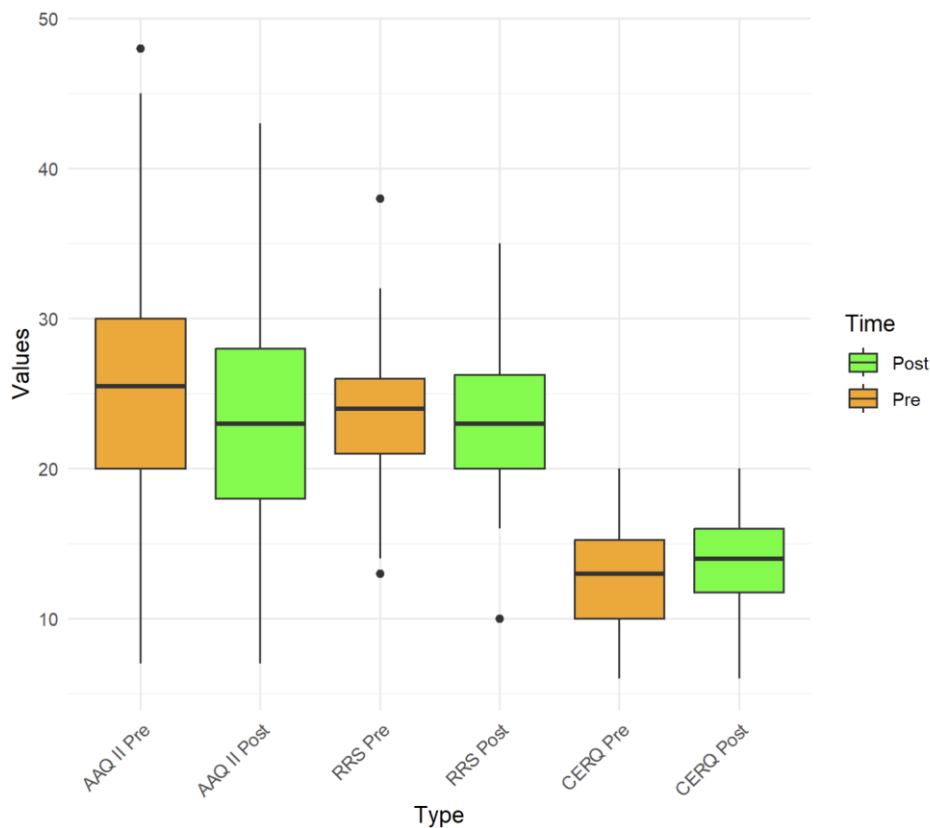
The mean score of pre RRS-10 was 23.38 points ($SD = 4.58$), and 23.37 points ($SD = 4.79$) on the post RRS-10. In comparison to their population mean of 21.26 (cf. 5236 Chinese university students), their respective Z-scores were 0.47 and 0.46 (Lei et al., 2017). This indicated above-average level of ER Rumination that was negligibly affected by the EMIs.

The mean score of pre CERQ-PR was 13.00 points ($SD = 3.45$), and 13.73 points ($SD = 3.53$) on the post CERQ-PR. In comparison to their population mean of 12.46 (cf. 611 Dutch adults), their respective Z-scores were 0.13 and 0.31 (Garnefski & Kraaij, 2006). This indicated above-average level of ER Cognitive Reappraisal that was positively affected by the EMIs. The dispersions of all questionnaires' scores could be seen below (see Figure 1).

Out of the eight moments for each exercise, Gratitude exercises were completed on a mean of 5.25 times ($SD = 2.12$). Savouring exercises were completed on a mean of 5.06 times ($SD = 1.84$). ACT exercises were completed on a mean of 4.88 times ($SD = 2.18$). CBT exercises were completed on a mean of 5.06 times ($SD = 2.01$). These means were not significantly different from each other, $F(3, 153) = 0.635, p = .594$. This indicated that participants practiced each EMI exercise roughly to the same extent.

Figure 1

Boxplots of Pre and Post Questionnaires' Scores



Note. AAQ.II = Acceptance and Action Questionnaire, Version 2. RRS(-10) = Ruminative Response Scale, 10-item. CERQ(-PR) = Cognitive Emotion Regulation Questionnaire, Positive Reappraisal Subscale.

First Hypothesis

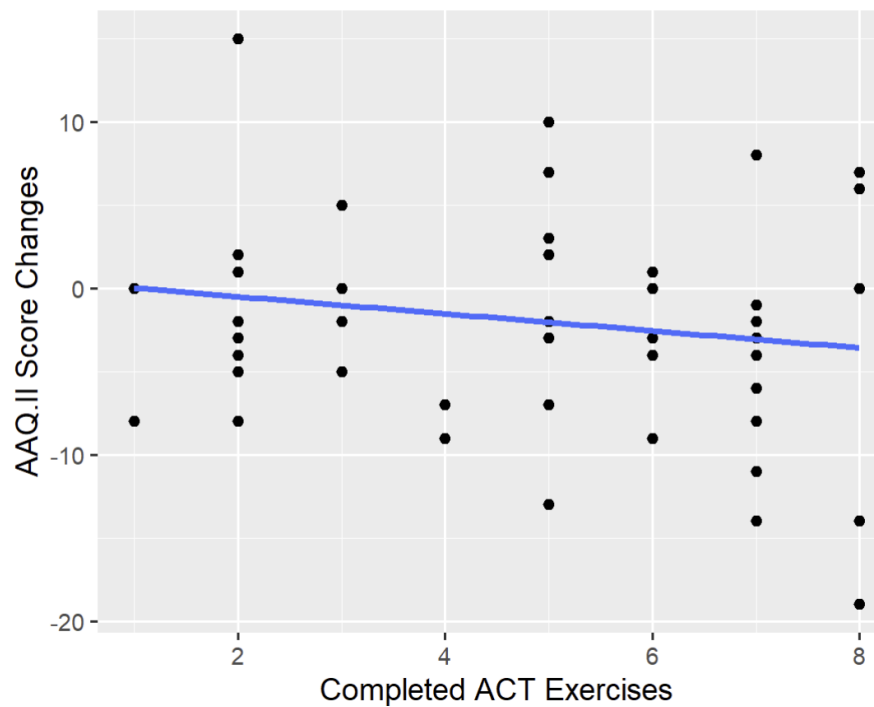
As none of the Shapiro-Wilk test results were significant, the parametric assumption of normal distribution was not violated. Therefore, one-tail paired-sample t-tests were continued. In line with this hypothesis, the study found the decrease in AAQ.II scores to be statistically significant, $t(51) = -2.225, p = .015$. In contrary to the hypothesis, the increase in CERQ-PR scores was not significant, $t(51) = 1.663, p = .051$. Further against the hypothesis, the decrease in RRS-10 scores was not significant, $t(51) = -0.031, p = .488$. In sum, the first hypothesis' results were mixed, it was partly rejected.

Second Hypothesis

Pearson's correlation between the number of completed ACT exercises and changes in AAQ.II scores was weak and negative, $r(50) = -0.174, p = .217$. As the participants did more ACT exercises, their AAQ.II scores did not significantly decrease (see Figure 2). Therefore, the second hypothesis was rejected.

Figure 2

Scatterplot between Completed ACT Exercises and AAQ.II Score Changes



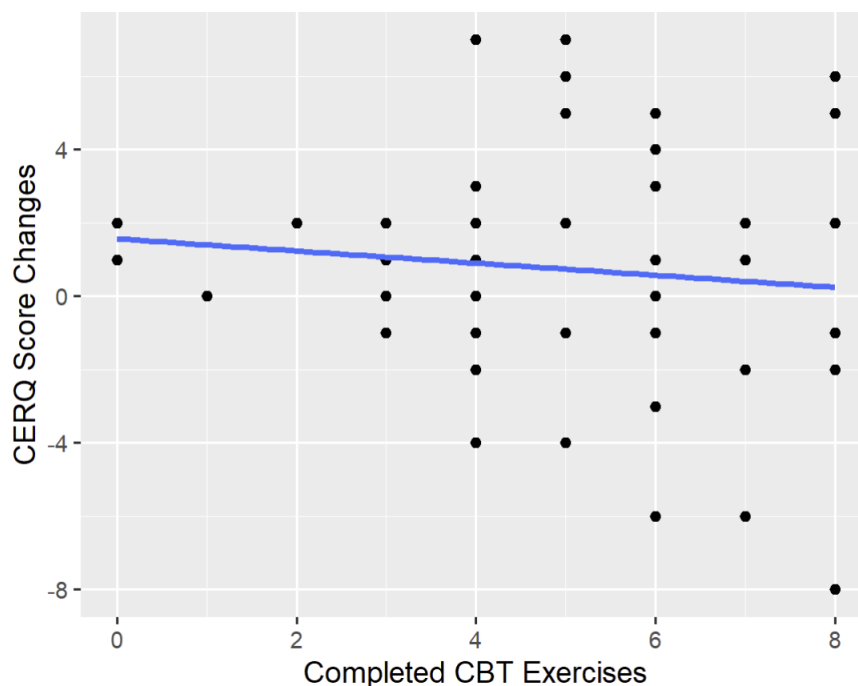
Note. ACT = Acceptance and Commitment Therapy. AAQ.II = Acceptance and Action Questionnaire, Version 2.

Third Hypothesis

Pearson's correlation between the number of completed CBT exercises and changes in CERQ-PR scores was weak and negative, $r(50) = -0.105, p = .459$. As the participants did more CBT exercises, their CERQ-PR scores did not significantly increase (see Figure 3). Therefore, the third hypothesis was rejected.

Figure 3

Scatterplot between Completed CBT Exercises and CERQ-PR Score Changes



Note. CBT = Cognitive and Behavioural Therapy. CERQ(-PR) = Cognitive Emotion Regulation Questionnaire, Positive Reappraisal Subscale.

Qualitative Results

Second Sample Characteristics

The second sample gathered 16 interviewees which were representative of the first sample, both in terms of the demographic information and initial psychological stress level (see Table 2).

Table 2

Demographic Information of the Second Sample ordered by Initial K-10 Scores

Alias	Age	Gender	Nationality	K-10
Nirved	32	Male	Sri Lanka	46
Alice	19	Female	France	46
Theresa	22	Female	Germany	37
Eva	23	Female	Germany	35

Amrik	34	Male	India	33
Luisa	20	Female	Germany	31
Sofija	23	Female	Latvia	31
Adhi	24	Male	Indonesia	29
Camilla	23	Female	Germany	27
Dirk	23	Male	Germany	25
Aylin	23	Female	Netherlands	25
Xuan	23	Non-binary	Vietnam	25
Lisa	21	Female	Luxembourg	24
Meta	21	Female	Germany	22
Aksana	20	Female	Belarus	22
Yuk	21	Male	Netherlands	20

Six main codes and 28 subcodes were created (see Appendix G for a complete overview), and three themes emerged which were a) Gaining more from PP; b) ACT and CBT's counterproductivity; and c) Unsustainable positive changes. While there was certain overlap between the themes, this only indicates the coherence between the themes and could be seen later by cross-referencing codes in support of a theme.

Theme 1: Gaining more from PP

The first theme was created based on a clear preference of the two PP EMIs by the vast majority of interviewees. Interviewees gained more adaptive ER strategies and experienced more positive emotions from PP EMIs. It included main codes "Preference on EMI", "Adaptive ER strategy", and part of the main code "Self-perceived effects" (see Table 3 for a summary).

Table 3*Summary of Codes under Theme 1*

Main Codes and Example Subcode	Working Definition	Number of Quotations	Number of Interviewees
Preference on EMI			
PP2: Savouring	State preference on Savouring exercise on one occasion	55	12
Adaptive ER strategy			
Mindfulness	Pay attention one's own present feelings, emotions and surroundings	28	10
Self-perceived effects			
Helpful	Perceive the exercise to be useful in one occasion	118	16

Note. The column “Number of Quotations” refers to the sum frequency of the quotations of that (sub)code across all 16 interview transcripts, the values are unlimited. The column “Number of Interviewees” refers to the number of people which the subcode has been applied to at least once, i.e., one quotation, the values have a maximum of 16. The example subcode was the most used subcode of that main code, an exhaustive list of subcodes can be found in Appendix G.

The first theme indicated a pattern that the interviewees' most often practiced adaptive ER strategy was Mindfulness, which was mostly brought out by the PP EMIs. Other adaptive ER strategies such as Positive Refocusing, Positive Reappraisal, Downward Comparison, and Social Interaction were also preferably brought out by the PP EMIs. The following quotes can help illustrate this pattern.

Sofija: ... *positive memory one, it doesn't take you much to actually remember that. So, for example, I did this exercise a few times when I was walking, so I was just walking, I was looking at nature and I was just then remembering: "OK, what happened during this positive memory?". So, I think especially combined with like effects of nature and this exercise, it just felt great. But with other exercises you actually have to sit down and kind of focus on the thinking a lot, but with this one it just naturally for me.*

Dirk: *Yeah, it [Note: Refers to Gratitude exercise] helps me to focus more on things that are positive in stressful situations, that are not as stressful as I think they are, if you know what I mean. So sometimes, in my situations are a lot worse than they are in reality. And focus positive things helps me to, as I said, calm down a bit and rely on more positive feelings in that situation, yeah.*

In the first quote, Sofija paid attention to her present feelings during walks in the nature. Sofija distinctly complemented the compatibility between the Savouring EMI and Mindfulness. Although Sofija did not specify the causes, she perceived the Savouring exercise to not require as much cognitive effort as the other exercises, i.e., “sit down and focus on thinking a lot”. In the second quote, Dirk demonstrated other adaptive ER strategies Positive Refocusing and Positive Reappraisal because of the PP EMIs. Dirk first refocused to positive aspects of stressful situations. Subsequently, Dirk also positively re-evaluated his stressful situation. After Positive Reappraisal, Dirk had a more positive interpretation of the stressful situation, experienced calmness and positive emotions.

There was also evidence that was not in line with the Theme 1. For instance, Aksana had a opinion that Mindfulness could be brought out by any EMI regardless the content. Her intriguing view was supported by another interviewee Adhi who disliked all EMIs, yet he showed elements of Mindfulness by reflecting on his internal feelings. In addition, not all adaptive ER strategies were favourably brought out by PP EMIs. Perspective Taking was equally likely to manifest after CBT as PP EMIs, Self-compassion was solely elicited by CBT EMI, and Acceptance was favourably elicited by ACT EMI. Nevertheless, Theme 1 “Gaining more from PP” was named accurately as it summarises most interviewees’ positive ER changes. The theme was not named “Gaining exclusively from PP” due to the consideration of some unfitting evidence, and a proper recognition of ACT and CBT EMIs’ helpfulness as well.

Theme 2: ACT and CBT's Counterproductivity

The second theme was also affected based on the clear preference of the PP EMIs by the majority of interviewees. Although ACT and CBT EMIs positively affected some interviewees, many interviewees also thought they were unhelpful and even counterproductive in some situations. This theme included main code “Maladaptive ER strategy” and part of the main code “Self-perceived effects” (see Table 4 for a summary).

Table 4

Summary of Codes under Theme 2

Main Codes and Example Subcode	Working Definition	Number of Quotations	Number of Interviewees
Maladaptive ER strategy			
Avoidance	Deliberately avoid stressor to not experience the negative emotion	9	5
Self-perceived effects			
Unhelpful	Perceive the exercise to be not useful in one occasion	48	14

Note. The column “Number of Quotations” refers to the sum frequency of the quotations of that (sub)code across all 16 interview transcripts, the values are unlimited. The column “Number of Interviewees” refers to the number of people which the subcode has been applied to at least once, i.e., one quotation, the values have a maximum of 16. The example subcode was the most used subcode of that main code, an exhaustive list of subcodes can be found in Appendix G.

Many interviewees experienced negative emotions due to the content of the ACT and CBT EMIs, and the majority of interviewees who preferred PP EMIs would also perceive ACT and CBT EMIs to be unhelpful on some occasions. The following quotes from Theresa

and Camilla can clarify this theme.

Theresa: Umm, I think exactly those exercises [Note: Refers to ACT and CBT exercises] were kind of hard to digest, I think. Because if you were sad, then focused on those feelings. It made me more sad or stressed so I don't know.

Camilla: The other one which was about opening up [Note: Refers to the ACT exercise]. [...] I didn't really like that and I didn't feel like it helped me. [...] The most important reason was that a lot of the times when the exercise was prompted, I didn't have a negative thought right then in my mind. And then it kind of forced me to think of a negative thought, which I didn't want. For example, I was out with friends and I was like kind of in a good mood and I didn't want to drag myself down with the negative thought.

Both Theresa and Camilla's examples illustrated how the ACT and CBT EMIs could be unhelpful and even counterproductive to their ER. Theresa explained that overly focusing on her negative emotions would intensify those emotions, and she expressed the same opinion four times in her interview to emphasise her point. Camilla was against the ACT EMI from a different angle than deteriorating one's ongoing negative mood, she thought it would create the negative emotions when she was in a positive mood socialising with her friends.

However, some evidence was not in line with this theme. ACT and CBT EMIs were not the only EMIs that could be counterproductive: a) Savouring EMI could lead to Avoidance, albeit hardly occurred; b) A strong opposing view by Xuan that PP EMIs were the counterproductive ones, which were offering temporary distractions from the stressors.

Theme 3: Unsustainable Positive Changes

The third theme was characterised by a reported short-term positive change on emotions or ER strategies by the majority of the interviewees, regardless of the type of EMI. This theme included main codes "Changes in ER strategy" and "Condition for changes" (see Table 5 for a summary).

Table 5

Summary of Codes under Theme 3

Main Codes and Example Subcode	Working Definition	Number of Quotations	Number of Interviewees
Changes in ER strategy			
New ER strategy	Learn a new ER strategy from the exercises	20	10
Condition of effects			
When keep doing EMIs	When the self-perceived effects or changes in ER strategy occur but only last during the exercises or shortly after	19	9

Note. The column “Number of Quotations” refers to the sum frequency of the quotations of that (sub)code across all 16 interview transcripts, the values are unlimited. The column “Number of Interviewees” refers to the number of people which the subcode has been applied to at least once, i.e., one quotation, the values have a maximum of 16. The example subcode was the most used subcode of that main code, an exhaustive list of subcodes can be found in Appendix G.

The most common pattern was that an interviewee experienced positive effects or gained adaptive ER strategies, but they were not sustainable. In other words, the positive changes were frequently limited by a concurrent subcode of “When keep doing EMIs”. The following quote from Luisa and Nirved can clarify this theme.

Luisa: *I feel like they [Note: Refers to ACT and CBT exercises] did as a preventative matter. I feel like when I was starting to feel very stressed out or very anxious or something, it did help. But sometimes I was feeling already very anxious and, in those days, I felt like it was more difficult for me to see if it helped or not. So, I feel like as a preventative matter it does, but when you are already in kind of like an anxiety state, it's kind of difficult to help.*

Nirved: *...since I'm not using the app anymore, nothing, notification doesn't come. So I had*

to force to my memory: "Now I should relax a bit more and remember some good things" [Note: Refers to Savouring exercise]. Uh, yeah, that's how it's now. So, it's not easy. So, it's not as good as when I was in the second week of the program.

In the first quote, Luisa claimed that CBT EMI could help her at the initial phase of a stressful event, but not when she was already under severe stress. This quote was coded "Preventative" as a subcode of "Self-perceived effects" from Theme 1 (see Appendix G). As Nirved explained, he had difficulty in keep practicing Mindfulness after the study and the perceived positive changes were not sustainable without the EMIs.

Lastly, in supporting of this theme, positive effects were often perceived with subcode "When moderately stressed" instead of subcode "When highly stressed" under the main code "Condition of effects" (see Appendix G). This coincides with Luisa's quote and subcode "Preventative" from Theme 1. Luisa's quote could support that the EMIs were preventatively helpful when she sensed signs of great amount stress, but not during the stressful event, therefore confirming the unsustainability.

Discussion

The current study investigated the EMIs' effect on ER in a mixed design approach. The first quantitative research question was: "*How do Ecological Momentary Interventions affect people's emotion regulation strategies?*". The second qualitative research question was: "*How do people perceive the effects of Ecological Momentary Interventions on their emotion regulation in real life?*" Three hypotheses were made for the quantitative research question.

The quantitative results rejected most parts of the hypotheses. The first hypothesis expected more practices of Acceptance (decrease in AAQ.II) and Positive Reappraisal (increase in CERQ-PR), and less Rumination (decrease in RRS-10) after the intervention. However, only the adaptive ER strategy of Acceptance had a statistically significant improvement after the EMIs. And this could not be solely attributed to the ACT EMI because the post measurement of Acceptance was taken after all four EMIs took place. The improvements in Positive Reappraisal and less Rumination did occur in the direction of the first hypothesis, but they were not statistically significant. The second hypothesis stated that the improvements in Acceptance should be significantly correlated to the number of completed ACT exercises. The second hypothesis was rejected, thus further suggesting that the improvement in Acceptance could not be plainly attributed to ACT EMI. The third hypothesis stated that the improvements in Positive Reappraisal should be significantly

correlated to the number of completed CBT exercises. The third hypothesis was rejected due to the insignificant correlation. This was supplemented by the fact that improvements in Positive Reappraisal was not significant either, as shown in the first hypothesis.

One explanation of the mostly insignificant results could be relatively short period of each type of EMI. Other similar longitudinal study provided only one type of EMI for two months (Castilla et al., 2022). In the current study, each EMI only lasted four days. Therefore, the value of a significant increase in Acceptance is still substantial. Since the ACT EMI cannot solely account for the significant increase in Acceptance, it may be that other EMIs also contributed, or the interaction between them led to the improvement. Cuijpers and colleagues (2019) mentioned the possibility that different practices of psychotherapies have the same underlying factors for their therapeutic effects. In which case, the psychotherapy-derived EMI exercises may have the same elements that aided the improvement in Acceptance.

The qualitative results were more positive, but not entirely in line with the quantitative results. Three themes were identified: a) Gaining more from PP; b) ACT and CBT's counterproductivity; and c) Unsustainable positive changes. These patterns revealed that the participants perceived the PP EMIs to be more effective and helpful on their ER than the ACT and CBT EMIs. This was unexpected, because the theories suggested that ACT and CBT had clearer mechanisms and targeted ER strategies. The three themes disclosed that most of the interviewees exhibited various adaptive ER strategies and experienced positive emotions from the PP EMIs. Moreover, for those who are in severe psychological distress ((Nirved, Alice), the PP EMIs remained helpful. The most common adaptive ER strategies reported were not Acceptance or Positive Reappraisal which the report focused at first. Instead, it was Mindfulness and Positive Refocusing by the PP EMIs. Other forms of Cognitive Reappraisal such as Perspective Taking was also more frequently perceived than the Positive Reappraisal. Many interviewees described that ACT and CBT EMIs could also be counterproductive in some daily scenarios. Nevertheless, ACT and CBT EMIs were also helpful in other occasions. Overall, the four EMIs were perceived to be more positive than negative despite its limits in long-term changes.

The qualitative results revealed the shortcoming of the quantitative results: Not all forms of ER strategies were measured at the pre and post measurements. Therefore, it provided valuable insights into which ER strategies were most personal and applicable for the

participants in naturalistic settings. Other qualitative studies also highlighted the importance of the learning adaptive ER strategies like Positive Reappraisal to maintain mental health in young adults (Chang et al., 2023). Through the quotes of the interviewees, it was shown that some perceive explicit forms of ER strategies to be more important, and other interviewees thought the unconscious impact on their immediate emotions by the EMIs alter their ER more. This is in line with the Dual-process model of ER, which argues that both forms of ER are highly relevant for one's mental health (Gyurak et al., 2011).

Limitations

Firstly, the biggest limitation of the current study was not collecting quantitative data on ER strategies other than Acceptance, Positive Reappraisal and Rumination. The qualitative results seem to indicate that adaptive ER strategy Mindfulness was more wide-spread than the Acceptance, which was statistically significant. This would seemingly suggest that if Mindfulness was measured quantitatively, it would also likely to be statistically significant, yet this was not confirmed. Secondly, some interviewees indicated that they were familiar with some of the EMI exercises before the study, which was neither controlled for nor measured. Thirdly, the study aimed to use the EMIs preventatively for individuals from general population who were in psychological distress. However, it was not confirmed by the screening that they did not have any psychological disorders already. Lastly, the convenience and volunteer sampling methodology resulted in the samples of young university students, which may not be the ideal representative sample for all adults in psychological distress in the Netherlands.

Future Research

Firstly, a secondary analysis could be made from the current research. A meta-review can be made between EMIs' effects on ER, on mental health, and user motivation to continue EMI exercises to sustain positive changes on ER. The future study should review and incorporate the momentary data on ER, it could investigate the participants' patterns use different of ER strategies in under different contexts. Just-In-Time-Adaptive-Intervention (JITAI) may be achieved, which is a form of EMI that is on a higher interactive level with the users (Myin-Germeys & Kuppens, 2022). The current study provided the EMI exercise in MRT design, but the EMIs exercises were fixed to be delivered after two random EMAs. When incorporate in JITAIs, the participants may receive an unfixed number and type of EMI exercises that is suitable for the user's preference and emotional state (Nahum-Shani et al.,

2018). The current pilot study has discovered preliminary results that ACT and CBT EMIs should not be delivered to participants who are already in high psychological distress and inclined to PP EMIs.

Conclusion

In conclusion, this pilot study has found mixed results in people's ER after four EMIs. Acceptance was significantly increased, whereas Positive Appraisal and Rumination did not significant change according to the existing theories. On the other hand, the qualitative interview revealed many other ER strategies that the participants perceived from the EMIs, which were not quantitatively measured. There have been obstacles in sustaining the positive effects on ER and accommodating individual preferences. Nonetheless, it has practical implications towards a future which people in psychological stress could utilise the EMI exercises, modify ER, and self-improve their mental health.

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Appendices

Appendix A

Ecological Momentary Intervention (EMI) Exercises

Gratitude Exercise

This activity, the Gratitude Journal, is designed to focus on things in your life you're thankful for. This practice can be about anything from simple pleasures (like enjoying a delightful lunch) to major life events (such as the birth of a healthy niece).

Viewing positive experiences as gifts helps prevent taking them for granted. Research indicates that regularly engaging in this exercise can significantly boost well-being.

Instructions

1. List down three things currently in your life – events, experiences, people, or any other aspect – that you feel grateful for. You can write them down in the textbox below or on paper.
2. Reflect on why you are grateful for these particular things. You can write these reflections down in the textbox below, use pen and paper, or simply ponder them without writing.
3. Pay attention to the feelings that arise during your reflection on them. You can ask yourself the following questions:

Which emotions do you notice as you reflect on what makes you grateful right now?

How does your body react to these feelings of gratitude? (Do you feel warmer,

more relaxed, or perhaps a smile forming on your face?)

What changes do you observe in your mood as you focus on these grateful feelings?

Savouring Exercise

Experiencing positive emotions can often be achieved by revisiting joyful memories.

The Positive Memory exercise is an effective way to do just that. This exercise involves recalling a happy memory in as much detail as possible and focus

on how you felt during that moment. Good example memories for this exercise are

those where you felt significant positive emotions such as joy, love, or inspiration, but

it can also be any other memory you experienced as pleasant.

Instructions

1. Think of a memory where you experienced strong positive emotions.
2. Aim to reconstruct the memory in as much detail as possible. If you like, you can write your thoughts in this textbox or use pen and paper. Consider these questions to guide your writing:

What exactly happened in the memory you selected?

What were your feelings at the moment it occurred?

How do you feel now as you revisit this memory?

What changes do you observe in your mood as you focus on this positive memory?

Try to include many details to vividly recall the experience, but remember to keep the

writing process enjoyable.

ACT Exercise

The goal of this exercise is to accept and embrace negative thoughts and emotions instead of trying to get rid of them. Resisting unpleasant feelings may actually cause them to become stronger and more frequent. By embracing our thoughts and feelings and accepting that they are there, we don't need to suffer from our struggles in trying to control them.

Instructions

1. What have you been struggling with lately (e.g., stress, anger, sadness, insecurity, guilt, shame, pain, worries...)? You can write it down in the text box below

.....
2. See if you can open up to these unpleasant thoughts and feelings, allowing them to just be there.
3. Explore what there is to experience—Are the feelings getting heavier, lighter, do they remain the same, or do they fluctuate?
4. Can you stay present with these difficult thoughts and feelings and keep in touch with them?
5. See if you can continue giving some space to these unpleasant feelings for a while, instead of trying to control them or trying to get rid of them.

CBT Exercise

With this exercise, we will have a good look at unpleasant thoughts you may have and help you to investigate if they are really helpful and true, or if there are more positive alternative thoughts that are more realistic. The unpleasant thoughts you may have, such as worries about the future, negative thoughts about yourself or others, or memories about an unpleasant situation in the past, are often unrealistically negative and not helpful. With this exercise, we will see if we can replace these unpleasant thoughts with more positive, more realistic thoughts.

Instructions

1. Think of an unpleasant thought that is causing you stress or negative emotions lately.

Take a moment so you have the unpleasant thought clear in your mind, and write it down in the text box below

.....

2. Now try to challenge this unpleasant thought a little: Is it really true? What evidence do you have for it? Is this unpleasant thought helping you?

3. What would you tell a close friend if they were having these thoughts?

4. Now try to come up with another, more positive interpretation, and write it in the text box below. What evidence do you have for this more positive thought? Is this thought more helpful to you?

.....

5. Take a moment to think about both thoughts. Is it possible that your unpleasant thoughts are not the most realistic or helpful ones? See if you can challenge your unpleasant thoughts this way for a while, and replace them with more helpful, more positive thoughts.

Appendix B

Figure 1

Flyer of the Study

GET

**50€ / 5 SONA
POINTS**

Participate in a 23 day Mobile-Based Intervention Study "ALERT" and get 50€ Amazon Gift Card or 5 SONA Points upon completion*

SCAN THE QR CODE BELOW TO LEARN MORE AND SIGN UP FOR THE STUDY



*Conditions Apply.
Check the full description of the study.

Appendix C

Psychometric Tests

Kessler Psychological Distress Scale (K10)

1. During the last 30 days, about how often did you feel tired out for no good reason?
2. During the last 30 days, about how often did you feel nervous?
3. During the last 30 days, about how often did you feel so nervous that nothing could calm you down?
4. During the last 30 days, about how often did you feel hopeless?
5. During the last 30 days, about how often did you feel restless or fidgety?
6. During the last 30 days, about how often did you feel so restless you could not sit still?
7. During the last 30 days, about how often did you feel depressed?
8. During the last 30 days, about how often did you feel that everything was an effort?
9. During the last 30 days, about how often did you feel so sad that nothing could cheer you up?
10. During the last 30 days, about how often did you feel worthless?

Acceptance and Action Questionnaire, Version 2 (AAQ-II)

1. My painful experiences and memories make it difficult for me to live a life that I would value.
2. I'm afraid of my feelings.
3. I worry about not being able to control my worries and feelings.
4. My painful memories prevent me from having a fulfilling life.
5. Emotions cause problems in my life.

6. It seems like most people are handling their lives better than I am.
7. Worries get in the way of my success.

Ruminative Response Scale, 10 Items (RRS-10)

1. Think “What am I doing to deserve this?”.
2. Analyse recent events to try to understand why you are depressed.
3. Think “Why do I always react this way?”.
4. Go away by yourself and think about why you feel this way.
5. Write down what you are thinking and analyse it.
6. Think about a recent situation, wishing it had gone better.
7. Think “Why do I have problems other people don’t have?”.
8. Think “Why can’t I handle things better?”.
9. Analyse your personality to try to understand why you are depressed.
10. Go someplace alone to think about your feelings.

Cognitive Emotion Regulation Questionnaire, Positive Reappraisal Scale (CERQ-PR)

1. I think I can learn something from the situation.
2. I think that I can become a stronger person as a result of what has happened.
3. I think that the situation also has its positive sides.
4. I look for the positive sides to the matter.

Appendix D

Interview Scheme

Interview Part 1

1. How would you describe the impact of the 16 days of exercises on your well-being? Can you describe what exactly changed? How do you notice these changes in your daily life?
2. Has there been an exercise in the period of these interventions that has been particularly helpful regarding the improvement of your well-being? Why do you think that is and how did it help you to improve your well-being?
3. Do you think you will be maintaining the changes initiated during the exercises? Why?
4. Do you think you will be applying some of the exercises further in your daily life? Which ones and why? And how will you do that?

Interview Part 2

1: Some of these exercises were aimed to help you in handling unpleasant thoughts or emotions, or support you in the way you deal with stressful situations. Do you have the feeling that these exercises changed the way you look at or deal with unpleasant thoughts or emotions?

In what way? And how is that different from what you would do before?

Why not, do you think? What would have helped you better with unpleasant thoughts or emotions?

Were there specific exercises that helped you more with this? Or less?

2: Other exercises were aimed at letting you experience more positive emotions. Do you have

the feeling that these exercises helped you with managing your emotions?

In what way? And how is that different from what you would do before?

Why not, do you think? What would have helped you better to experience more positive emotions?

Were there specific exercises that helped you more with this? Or less?

Interview Part 3

1: Did you find the exercises clear?

Was it clear for you how to do them?

What made them clear?

What could have made them clearer?

2: How doable was it for you to do the exercises?

What things made it easier to do an exercise? What things made it more difficult to do an exercise?

Were there any moments where you did find the exercises particularly helpful, or unhelpful?

What would have made it easier for you to do an exercise?

3: How motivated were you to do the exercises?

What motivated you?

Did your motivation change over time?

How could you have been more motivated?

What factors influenced your motivation to do the exercises?

Can you recall any instances where you felt tempted to stop doing the exercises?

What motivated you to continue?

What would the exercises need in order for you to stay motivated over prolonged periods?

General follow-up Questions

1. I'm unsure I understood ...Could you tell me more about that?
2. I'm not certain what you mean by... Could you give me some examples?
3. Could you tell me more about your thinking on that?
4. You mentioned.... Could you tell me more about that? What stands out in your mind about that?
5. This is what I thought I heard...Did I understand you correctly?
6. So what I hear you saying is..."
7. Can you give me an example of...
8. What makes you feel that way?
9. What are some of your reasons for liking it?
10. You just told me about.... I'd also like to know about...

Appendix E

Informed Consent Form for Interview

Figure 1

ICF Page 1

Consent Form for Ecological Momentary Interventions Interview
YOU WILL BE GIVEN A COPY OF THIS INFORMED CONSENT FORM

	Yes	No
<i>Please tick the appropriate boxes</i>		
Taking part in the study		
I have read and understood the study information or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	<input type="radio"/>	<input type="radio"/>
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.	<input type="radio"/>	<input type="radio"/>
I understand that taking part in the interview study involves the transcription and use of the information provided by you in the interview for data collection of the study.	<input type="radio"/>	<input type="radio"/>
Risks associated with participating in the study		
I understand that taking part in the study potentially involves the following minor risks for example: minor mental discomfort or short-term stress as personal questions about the past weeks which can include stressful events will be asked.	<input type="radio"/>	<input type="radio"/>
Use of the information in the study		
I understand that information I provide will be used for a written report, which may be shared with the academic community, including academic supervisors and will possibly be presented in a thesis defense.	<input type="radio"/>	<input type="radio"/>
I understand that regarding personal information collected about me anonymization is guaranteed but researchers might use quotes that will be anonymized by assigning a number to a participant X rather than mentioning his or her name which means that confidentiality and anonymity will be maintained to the fullest extent possible, and no identifying information will be included in the final report or any subsequent presentations or publications.	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>

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Figure 2

ICF Page 2

○ ○

○ ○

○ ○

Signatures

Name of participant [printed]
Signature

Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Researcher name [printed]

Signature

Date

Study contact details for further information: [Shujie Wu, s.wu-3@student.utwente.nl]

[Lukas Kindhäuser,

l.kindhauser@student.utwente.nl]

[Marieke Meyer, [m.meyer-](mailto:m.meyer-4@student.utwente.nl)

4@student.utwente.nl]

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/domain Humanities & Social Sciences of the Faculty of Behavioural, Management and Social Sciences at the University of Twente by ethicscommittee-hss@utwente.nl

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Appendix F

R Codes

```
library(tidyverse)
library(dplyr)
library(janitor)
library(broom)
library(modelr)
library(ggpubr)
library(afex)

#load (raw) dataset
getwd()
setwd("C:/Users/shuji/Documents")
data_pre <- read.csv("Thesis_pre.csv", sep = ",")
data_post <- read.csv("Thesis_post.csv", sep = ",")
data_k10_age <- read.csv("K10_and_age.csv", sep = ",")
number_EMI_useful <- read.csv("EMI_completed_cleaned.csv", sep = ",")

#Data cleansing
#Select the relevant variables
pre_useful <- data_pre %>% select(ID, sex, nationality, education, AAQ.II._1:CERQ_4)
post_useful <- data_post %>% select(ID, occupation, AAQ.II._1:CERQ_4)
k10_age_useful <- data_k10_age %>% select(ID, age, K10_sum)

#Delete participants who did not participate in both pre and post

#ALERT 017 is deleted among the steps, because she did only post, not pre
#Her K-10 score & age should be checked here already

#these participant did pre but did not do post
pre_useful <- pre_useful[-c(66, 50, 63, 62, 64, 67, 69, 65, 70, 68, 71), ]
```

```
#this participant did post but did not do pre
```

```
post_useful <- post_useful[-c(53), ]
```

```
#these participants did not do either pre or post, or both
```

```
k10_age_useful <- k10_age_useful[-c(94, 11, 12, 13, 27, 2, 3, 5, 6, 22, 4, 26, 7, 23, 16, 15, 8,
21, 32, 66, 46, 61, 78, 65, 63, 76, 81, 85, 96, 86, 89, 91, 92, 93, 95, 97, 99, 98, 100, 18), ]
```

```
#Replace the words with their corresponding numerical values in the answers to the scales
```

```
#AAQ.II in pre
```

```
pre_useful <- pre_useful %>%
```

```
  mutate(across(AAQ.II._1:AAQ.II._7, ~recode(., 'Never true' = 1, 'Very seldom true' = 2,
'Seldom true' = 3, 'Sometimes true' = 4, 'Frequently true' = 5,
```

```
          'Almost always true' = 6, 'Always true' = 7)))
```

```
#AAQ.II in post
```

```
post_useful <- post_useful %>%
```

```
  mutate(across(AAQ.II._1:AAQ.II._7, ~recode(., 'Never true' = 1, 'Very seldom true' = 2,
'Seldom true' = 3, 'Sometimes true' = 4, 'Frequently true' = 5,
```

```
          'Almost always true' = 6, 'Always true' = 7)))
```

```
#RRS in pre
```

```
pre_useful <- pre_useful %>%
```

```
  mutate(across(RRS_1:RRS_10, ~recode(., 'Almost never' = 1, 'Sometimes' = 2, 'Often' = 3,
'Almost always' = 4)))
```

```
#RRS in post
```

```
post_useful <- post_useful %>%
```

```
  mutate(across(RRS_1:RRS_10, ~recode(., 'Almost never' = 1, 'Sometimes' = 2, 'Often' = 3,
'Almost always' = 4)))
```

```
#CERQ in pre
```

```
pre_useful <- pre_useful %>%
```

```
  mutate(across(CERQ_1:CERQ_4, ~recode(., 'Almost never' = 1, 'Rarely' = 2, 'Occasionally'
```

```
= 3, 'Frequently' = 4, 'Almost always' = 5,)))
```

```
#CERQ in post
```

```
post_useful <- post_useful %>%
```

```
  mutate(across(CERQ_1:CERQ_4, ~recode(., 'Almost never' = 1, 'Rarely' = 2, 'Occasionally'
= 3, 'Frequently' = 4, 'Almost always' = 5,)))
```

```
#Calculate total scores for each scale
```

```
#AAQ.II in pre
```

```
pre_useful <- pre_useful %>%
```

```
  mutate(AAQ.II_pre_total = rowSums(.[5:11]))
```

```
#AAQ.II in post
```

```
post_useful <- post_useful %>%
```

```
  mutate(AAQ.II_post_total = rowSums(.[3:9]))
```

```
#RRS in pre
```

```
pre_useful <- pre_useful %>%
```

```
  mutate(RRS_pre_total = rowSums(.[12:21]))
```

```
#RRS in post
```

```
post_useful <- post_useful %>%
```

```
  mutate(RRS_post_total = rowSums(.[10:19]))
```

```
#CERQ in pre
```

```
pre_useful <- pre_useful %>%
```

```
  mutate(CERQ_pre_total = rowSums(.[22:25]))
```

```
#CERQ in post
```

```
post_useful <- post_useful %>%
```

```
  mutate(CERQ_post_total = rowSums(.[20:23]))
```



```
#Only keep the useful columns again, since total scores are created
```

```
pre_useful <- pre_useful %>% select(ID, sex, nationality, education,
AAQ.II_pre_total:CERQ_pre_total)
```

```
post_useful <- post_useful %>% select(ID, occupation, AAQ.II_post_total:CERQ_post_total)
```

```
# Convert ID column to consistent case format (lowercase)
```

```
k10_age_useful$ID <- tolower(k10_age_useful$ID)
```

```
pre_useful$ID <- tolower(pre_useful$ID)
```

```
post_useful$ID <- tolower(post_useful$ID)
```

```
#Merge the four datasets by ID
```

```
final_data <- merge(k10_age_useful, pre_useful, by = "ID")
```

```
final_data <- merge(final_data, post_useful, by = "ID")
```

```
final_data <- merge(final_data, number_EMI_useful, by = "ID")
```

```
#Two participants are lost somehow (they had EMA data, but did not do either pre or post)
```

```
#Be careful again that Alert 017 was deleted and not included in the quantitative results, but in
the interview (because she did have EMA data)
```

```
#Create more variables which are the differences between pre-post total scores
```

```
final_data$AAQ.II_change <- final_data$AAQ.II_post_total - final_data$AAQ.II_pre_total
```

```
final_data$RRS_change <- final_data$RRS_post_total - final_data$RRS_pre_total
```

```
final_data$CERQ_change <- final_data$CERQ_post_total - final_data$CERQ_pre_total
```

```
#Actual Data Analysis begins here
```

```
#Demographics
```

```
#Age
```

```
final_data %>%
```

```
  summarise(mean = mean(age), sd = sd(age), var = var(age), minimum = min(age),
            maximum = max(age))
```

```
#Gender, nationality, education, occupation
```

```
final_data %>%
  map(tabyl)

#Univariate analyses / descriptive statistics

final_data %>%
  summary()

#K-10
final_data %>%
  summarise(mean = mean(K10_sum), sd = sd(K10_sum), var = var(K10_sum), minimum =
min(K10_sum),
            maximum = max(K10_sum))

#Participation in each EMI
#PP1
final_data %>%
  summarise(mean = mean(PP1), sd = sd(PP1), var = var(PP1), minimum = min(PP1),
            maximum = max(PP1))

#PP2
final_data %>%
  summarise(mean = mean(PP2), sd = sd(PP2), var = var(PP2), minimum = min(PP2),
            maximum = max(PP2))

#ACT
final_data %>%
  summarise(mean = mean(ACT), sd = sd(ACT), var = var(ACT), minimum = min(ACT),
            maximum = max(ACT))

#CBT
final_data %>%
```

```

summarise(mean = mean(CBT), sd = sd(CBT), var = var(CBT), minimum = min(CBT),
           maximum = max(CBT))

#Repeated measures ANOVA to test if the participation in four EMIs' exercises were the same

# Reshape the data to long format for repeated measures ANOVA
final_data_long <- final_data %>%
  pivot_longer(cols = c(PP1, PP2, ACT, CBT), names_to = "variable", values_to = "value")

# Perform repeated measures ANOVA
modell <- aov_ez("ID", "value", final_data_long, within = "variable")

# Summary of the model
summary(modell)

#Questionnaires
#AAQ.II
final_data %>%
  summarise(mean = mean(AAQ.II_pre_total), sd = sd(AAQ.II_pre_total), var =
var(AAQ.II_pre_total), minimum = min(AAQ.II_pre_total),
           maximum = max(AAQ.II_pre_total))

final_data %>%
  summarise(mean = mean(AAQ.II_post_total), sd = sd(AAQ.II_post_total), var =
var(AAQ.II_post_total), minimum = min(AAQ.II_post_total),
           maximum = max(AAQ.II_post_total))

#RRS
final_data %>%
  summarise(mean = mean(RRS_pre_total), sd = sd(RRS_pre_total), var = var(RRS_pre_total),
           minimum = min(RRS_pre_total),
           maximum = max(RRS_pre_total))

```

```

final_data %>%
  summarise(mean = mean(RRS_post_total), sd = sd(RRS_post_total), var =
var(RRS_post_total), minimum = min(RRS_post_total),
            maximum = max(RRS_post_total))

#CERQ
final_data %>%
  summarise(mean = mean(CERQ_pre_total), sd = sd(CERQ_pre_total), var =
var(CERQ_pre_total), minimum = min(CERQ_pre_total),
            maximum = max(CERQ_pre_total))

final_data %>%
  summarise(mean = mean(CERQ_post_total), sd = sd(CERQ_post_total), var =
var(CERQ_post_total), minimum = min(CERQ_post_total),
            maximum = max(CERQ_post_total))

#Boxplots for the 6 total scores at the same time
# Combine the data for plotting
combined_data <- rbind(
  data.frame(Type = "AAQ II Pre", Value = final_data$AAQ.II_pre_total, Time = "Pre"),
  data.frame(Type = "AAQ II Post", Value = final_data$AAQ.II_post_total, Time = "Post"),
  data.frame(Type = "RRS Pre", Value = final_data$RRS_pre_total, Time = "Pre"),
  data.frame(Type = "RRS Post", Value = final_data$RRS_post_total, Time = "Post"),
  data.frame(Type = "CERQ Pre", Value = final_data$CERQ_pre_total, Time = "Pre"),
  data.frame(Type = "CERQ Post", Value = final_data$CERQ_post_total, Time = "Post")
)

# Reordering the levels of Type to ensure "pre" is always before "post"
combined_data$Type <- factor(combined_data$Type, levels = c("AAQ II Pre", "AAQ II Post",
"RRS Pre", "RRS Post", "CERQ Pre", "CERQ Post"))

# Plotting all box plots together with "pre" always on the left and "post" in green
ggplot(combined_data, aes(x = Type, y = Value, fill = Time)) +

```

```
geom_boxplot() +
scale_fill_manual(values = c("Pre" = "orange", "Post" = "green")) +
labs(y = "Values", fill = "Time") +
theme_minimal() +
theme(axis.text.x = element_text(angle = 45, hjust = 1))

#Hypothesis 1
#Check parametric assumption of normality (on the residuals)
# Normality tests using Shapiro-Wilk test
# AAQ.II
shapiro_test_AAQ <- shapiro.test(final_data$AAQ.II_change)

# RRS
shapiro_test_RRS <- shapiro.test(final_data$RRS_change)

# CERQ
shapiro_test_CERQ <- shapiro.test(final_data$CERQ_change)

# Print Shapiro-Wilk test results
print(shapiro_test_AAQ)

print(shapiro_test_RRS)

print(shapiro_test_CERQ)

#One-tailed paired-sample t-tests
# Left-tailed paired-sample t-test for AAQ.II
t_test_1 <- t.test(final_data$AAQ.II_post_total, final_data$AAQ.II_pre_total, paired = TRUE,
alternative = "less")

# Print the result
print(t_test_1)
```

```
# Left-tailed paired-sample t-test for RRS
t_test_2 <- t.test(final_data$RRS_post_total, final_data$RRS_pre_total, paired = TRUE,
alternative = "less")

# Print the result
print(t_test_2)

# Right-tailed paired-sample t-test for CERQ
t_test_3 <- t.test(final_data$CERQ_post_total, final_data$CERQ_pre_total, paired = TRUE,
alternative = "greater")

# Print the result
print(t_test_3)

#Bivariate analyses

#Hypothesis 2
#Pearson's correlation coefficient
correlation1 <- cor(final_data$ACT, final_data$AAQ.II_change, method = "pearson")

print(correlation1)

#Peason correlation test
cor_test_result1 <- cor.test(final_data$ACT, final_data$AAQ.II_change, method = "pearson")

p_value1 <- cor_test_result1$p.value
print(p_value1)

#Scatterplot
final_data %>%
  ggplot(aes(x = ACT, y = AAQ.II_change)) +
  geom_point() +
```

```
geom_smooth(method = "lm", se = FALSE) +
labs(
  x = "Completed ACT Exercises",
  y = "AAQ.II Score Changes"
)

#Hypothesis 3
#Pearson's correlation coefficient
correlation2 <- cor(final_data$CBT, final_data$CERQ_change, method = "pearson")

print(correlation2)

#Pearson correlation test
cor_test_result2 <- cor.test(final_data$CBT, final_data$CERQ_change, method = "pearson")

p_value2 <- cor_test_result2$p.value
print(p_value2)

#Scatterplot
final_data %>%
  ggplot(aes(x = CBT, y = CERQ_change)) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE) +
  labs(
    x = "Completed CBT Exercises",
    y = "CERQ Score Changes"
  )
```

Appendix G
Complete Overview of Coding Scheme and Working Definitions

Table 1*Overview of Codes under Theme 1*

Main Codes and Subcodes	Working Definition	Number of Quotations	Number of Interviewees
Preference on EMI			
ACT	State preference on ACT exercise on one occasion	10	4
CBT	State preference on CBT exercise on one occasion	7	4
PP1: Gratitude	State preference on Gratitude exercise on one occasion	30	12
PP2: Savouring	State preference on Savouring exercise on one occasion	55	12
Adaptive ER strategy			
Acceptance	Acknowledge and embrace the emotion without change, judgement, or avoidance	7	5
Downward comparison	Re-evaluate one's own situation by social comparison to the worse	4	2
Mindfulness	Pay attention one's own present feelings, emotions and surroundings	28	10

Perspective taking	Neutrally re-evaluate the situation from another person's view	15	9
Positive reappraisal	Positively re-evaluate the situation or item	11	7
Positive refocusing	Deliberately shift attention to more positive aspects of the situation or item	21	10
Self-compassion	Treat oneself with kindness upon setbacks	2	2
Social interaction	Actively communicate with others	1	1
<hr/>			
Self-perceived effects			
Calming	Perceive the exercise to be relaxing	15	10
Helpful	Perceive the exercise to be useful in one occasion	118	16
Positive emotion	Experience positive emotion	39	14
Preventative	Believe the exercise prevents negative emotion that may appear later	3	2

Note. The column “Number of Quotations” refers to the sum frequency of the quotations of that (sub)code across all 16 interview transcripts, the values are unlimited. The column “Number of Interviewees” refers to the number of people which the (sub)code has been applied to at least once, i.e., one quotation, the values have a maximum of 16.

Table 2*Overview of Codes under Theme 2*

Main Codes and Subcodes	Working Definition	Number of Quotations	Number of Interviewees
Maladaptive ER			
strategy			
Avoidance	Deliberately avoid stressor to not experience the negative emotion	9	5
Rumination	Repeatedly focus on the negative emotion without seeking solutions or alternatives	2	2
Suppression	Consciously inhibit an emotion internally or externally	3	2
Self-perceived			
effects			
Negative emotion	Experience negative emotion	8	5
Unhelpful	Perceive the exercise to be not useful in one occasion	48	14

Note. The column “Number of Quotations” refers to the sum frequency of the quotations of that (sub)code across all 16 interview transcripts, the values are unlimited. The column “Number of Interviewees” refers to the number of people which the (sub)code has been applied to at least once, i.e., one quotation, the values have a maximum of 16.

Table 3*Overview of Codes under Theme 3*

Main Codes and Subcodes	Working Definition	Number of Quotations	Number of Interviewees
Changes in ER strategy			
Enhanced old ER strategy	Positively reinforce an existing ER strategy	16	9
New ER strategy	Learn a new ER strategy from the exercises	20	10
None	Did not affect any ER strategy beside recalling it	10	6
Condition of effects			
Unconditioned	Any of the self-perceived effects or changes in ER strategy could persist, or exercises are practised after the study	10	6
When highly stressed	When the self-perceived effects or changes in ER strategy occur under high stress	12	7
When keep doing EMIs	When the self-perceived effects or changes in ER strategy occur but only last during the exercises or shortly after	19	9

When moderately stressed	When the self-perceived effects or changes in ER strategy occur under moderate stress	3	2
--------------------------	---------------------------------------------------------------------------------------	---	---

Note. The column “Number of Quotations” refers to the sum frequency of the quotations of that (sub)code across all 16 interview transcripts, the values are unlimited. The column “Number of Interviewees” refers to the number of people which the (sub)code has been applied to at least once, i.e., one quotation, the values have a maximum of 16.