The Influence of Daily Monitoring on Stress: An Examination of the Experience Sampling Method Measurement Effect

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Abstract

The goal of the present study was to explore the potential measurement effect of the Experience Sampling Method on stress levels, in the general population, using a mixed-methods research approach. The research question was “To what extent do frequent reminders and daily monitoring of stress through the Experience Sampling Method (ESM) affect stress levels in adults, compared to those not using the ESM? ”, and it was hypothesized that “Participants using the ESM, exhibit statistically significant higher levels of stress post-study, when compared to those not using the ESM”.

A sample of 66 participants from various nationalities, with ages ranging from 18 to 57 was collected, and split into a control and an experimental group. The study lasted for 16 days, and both groups completed a pre- and post-questionnaire to measure their stress levels. In the 14 days in-between, the experimental group completed 3 short ESM questionnaires daily, measuring their stress, and in the post-questionnaire, they were asked to provide feedback on their experience.

For the analysis, a linear mixed model revealed a small but statistically significant reduction in stress for the experimental group post-study. Analyses examining relationships between response rates and pre- and post-study stress levels or stress change revealed no significant results. Thematic analysis of the feedback on the ESM supported the main results, with participants experiencing increased awareness, which for most was perceived positively.

Nevertheless, the change in stress levels was too slight to conclude that the ESM posed a measurement effect, but more research is necessary. If the conclusion that the ESM does not cause a measurement effect is replicated in future research, the tool can offer great value in achieving a more holistic understanding of stress, that moves beyond symptoms into a dynamic experience within a context, which is critical for both research and practice.

Introduction

With alarming levels of stress reported globally (Necho et al., 2021), understanding how stress is experienced has become a major focus of psychological research. The concept of stress has been defined in a variety of ways, however one conceptualization seems to be very central: stress as a disruption to homeostasis (Cannon, 1935; as cited in Lu et al., 2021). Homeostasis is a bodily process whose function is to maintain stability in the internal environment of the body, regardless of external changes (Modell et al., 2015). When there is a perceived threat to homeostasis, all bodily systems get activated to help the individual fight the threat or flee from it, a process known as the "fight-or-flight" response (Lu et al., 2021). This activation causes the common symptoms of stress, such as increased heart rate, quick and shallow breathing and heightened alertness (Chu et al., 2024). It was later found that emotional threats can cause the same effect as physical ones in terms of the fight-or-flight activation (Mason, 1975), and thus stress is often categorized as either physical or emotional.

Involving homeostasis in the conceptualization of stress allowed for stressors to be understood in terms of their level of threat. As explained by Lu et al. (2021), eustress is "positive" stress that mildly challenges homeostasis, and thus strengthens it, while distress poses a strong threat that impairs homeostasis and potentially harms health. Even in everyday life, mild, short-term stress may enhance mental and physical performance, thus helping the individual in the face of a challenge (Jamieson et al., 2011). However, severe or prolonged stress may have the opposite effect by impairing performance, and it has often been associated with significant health problems such as cardiovascular, metabolic and gastrointestinal issues, weakening of the immune system, cancer and psychiatric disorders (Chu et al., 2024; Dhabhar, 2018; Russell & Lightman, 2019). It is therefore a variety of variables that determine the potential consequences of stress on the individual.

While the negative effects of stress on health have been repeatedly demonstrated, research has shown that there are ways in which they could be mediated. The study of Brooks (2013), showed that people's perception of stress can influence their performance on a stressful task. In her paper, she presented that when people viewed the task as an opportunity or challenge, and changed their view of anxiety as excitement, their performance was enhanced, and their overall experience was perceived as more pleasant. Similarly, Jamieson et al. (2011), demonstrated how when participants waiting to take part in a stressful task were told that the arousal they feel increases performance, they ended up performing significantly better than those whom with this information was not shared. Additionally, the same study showed that reappraisal of stress does not only benefit the person cognitively, but physically, too. Specifically, while stress has been shown to raise blood pressure (Ayada et al., 2015), the study of Jamieson et al. (2011), showed that stress reappraisal led to a more adaptive cardiovascular response. This evidence suggests that while prolonged or severe stress can have significant implications for health and performance, the individual's perception of stress can have a strong mediating role in protecting against some of those negative effects or even reverting them into positive.

The evidence that the severity, perception, and duration of stress can affect its experience and consequences, point to a need to study stress in terms of individual experience within a context. The relationship between stress and psychological or physiological consequences is complex and involves multiple variables such as the level of exposure to stress, available resources, duration and frequency of stressful situations, or the individual's perceptions, as evident by the aforementioned literature. Collectively, those factors, in addition to the daily fluctuations of stress throughout the day (Adam et al., 2017), highlight the importance of studying not just the levels of stress, but the overall experience within

everyday life. To achieve that, researchers have often used self-report methods such as diary studies (Travers, 2010; Xia et al., 2021).

. However, diary studies present particular limitations, notably the delay between the experience and the diary entry, which can result in participants either forgetting important details or omitting experiences they deem insignificant at the time of recall (Van Berkel et al., 2017). Furthermore, participants' perception of the significance or intensity of an event or response may shift throughout their daily life, introducing fluctuations due to the retrospective nature of their reflection (De Vries et al., 2001).

A tool developed to measure experience within the context of daily life, as well as to overcome the limitations posed by other self-report measures such as diary studies, is the Experience Sampling Method (ESM). The ESM is a structured self-report technique in which participants record their environment, mood, emotions, and interpretations multiple times a day across a set timeframe (Myin-Germeys et al., 2018). This tool emphasizes that emotions and experiences ought to be understood in relation to their environment (Csikszentmihalyi & Larson, 1987), and aids in overcoming retrospective recall bias by capturing real-time information (Ellison et al., 2020). This allows for ecologically valid findings, which may have otherwise been altered due to the non-natural setting of traditional laboratory studies (Telford et al., 2011). In measuring stress, the in-the-moment measurement within a context is critical, to capture and understand the dynamic fluctuations of emotion (Kuppens et al., 2010), and allow for insight on the effects of context (Csikszentmihalyi & Larson, 1987). Overall, the ESM focuses on experiences as they happen, allowing for a more holistic and well-rounded measurement of stress.

While conducting research on the participants' everyday environment can aid in providing more valid results, there are multiple pathways through which their experience may

be affected. For example, it is not uncommon for measurements themselves to influence behavior, a phenomenon more commonly known as the "mere measurement effect" (Chapman, 2001). This concept expresses how the act of measuring may influence the results, and it is a critical point to consider as it may lead to unintentionally shaping a construct of interest, and therefore provide biased results (Feldman & Lynch, 1988). According to Chapman (2001), simply asking individuals about their attitudes, beliefs, or intentions alters their cognitive structures and subsequent behaviours. This may affect participants' responses and significantly impact the results of a study. He also presented how a common route through which this influence happens, is that of "construct accessibility", where the more available a piece of information is to the individual, the more likely it is to affect information-processing and behavior (Higgins, 1996; as cited in Chapman, 2001).

For measuring stress through the ESM, the phenomenon of construct accessibility becomes especially relevant. That is because through the constant notifications and reminders that the ESM utilizes, which may be overwhelming for some, the participant may become more aware of their stress levels or stressful stimuli, making them more accessible in their memory. Therefore, they may report higher stress levels than they would have otherwise, which may consequently affect their actual emotional experiences and responses. This is critical to examine, because while the ESM could be an invaluable tool for measuring the experience of stress in the natural environment and context of the individual, there is very limited evidence on the potential mere measurement effect of the tool.

The potential measurement effect of the ESM on stress is the central topic of this research. Specifically the research question of the study is: "To what extent do frequent reminders and daily monitoring of stress through the Experience Sampling Method (ESM) affect stress levels in adults, compared to those not using the ESM? ". Based on the literature review and the phenomenon of construct accessibility, it is hypothesized that "Participants

using the ESM, exhibit statistically significant higher levels of stress post-study, when compared to those not using the ESM".

Methods

Study Design

The current study utilized a mixed method pre-post study design with an experimental and a control group in order to determine the possible mere measurement effect of the ESM in measuring the experience of stress. The study lasted 16 days, and all participants completed the pre- and post-questionnaire, intended to measure their levels of stress, on the first and last day of the study. Participants in the control group only completed the pre- and post-questionnaires, whereas the experimental group also completed ESM questionnaires for the 14 days in-between. The study was reviewed and approved by the Ethics Committee HSS (BMS) of the University of Twente (Application nr. 240934).

Participants

The target population of this study was the general population, and participants were eligible as long as they fit the predetermined inclusion and exclusion criteria. Specifically, participants had to be 18 years old or over, to not have a diagnosis of any anxiety disorder, and to not currently receive treatment for any mental disorder. Furthermore, participants must own a mobile device with an Android or iOS operating system, able to connect to the internet, to ensure compatibility with the m-Path application (Mestdagh et al., 2023), which they had to download and use throughout this study. Participants were gathered through a convenience sampling strategy, and platforms such as social media, WhatsApp, and the University of Twente SONA system were used. Before deciding whether participants wish to take part in the study, they were given detailed information regarding the study, aim, and eligibility criteria, as well as the study link.

A total of 94 participants gave their informed consent and started the study, however 28 participants did not complete the post-questionnaire, resulting in a total sample of 66 participants. Before the beginning of the data collection, it was aimed to collect a sample of at least 90 participants. While this study was not an intervention, the goal was to examine whether there is an effect of the ESM on stress. Thus, samples of pre- and post-design intervention studies were researched, and the results varied significantly, ranging from 64 to 200 or more participants (Dolbier et al., 2009; Lane et al., 2007). Given the scope and timeframe of this study it was decided to attempt to gather at least 90 participants, as to control for some missing data and low response rates.

The mean age of the participants was 23.2 years old (M = 23.2, SD = 6.65). The age of the sample ranged from 18 to 57 years old. Out of the 66 participants, 63.6% identified as female, while 36.4% identified as male. Furthermore, the sample consisted of people with various nationalities, with 25.8% of the sample being German, 24.2% being Greek, 10.6% being Polish, and 39.4% constituting the category “Other” which included multiple other nationalities inside and outside of Europe, as well as those with a double nationality.

Materials

Pre- and Post-Questionnaires

For the pre- and post-questionnaires, the same set of validated questionnaires were used on the first and last day of the study. That is, the *Multidimensional Assessment of Interoceptive Awareness, Version 2* (*MAIA-2*; Mehling et al., 2018), the *Perceived Stress Questionnaire* (*PSQ*; Levenstein et al., 1993), and the *Multidimensional Self-Control Scale* (*MSCS*; Nilsen et al., 2020). The MAIA-2 and the MSCS were included for the aim of other studies and will not be discussed here, whereas the PSQ was chosen to measure the levels of perceived stress of the participant, as experienced for the past month.

The PSQ consists of 30 items describing stress-related feelings or situations, and participants are asked to indicate how often they experience them, on a scale ranging from 1 (Almost Never) to 4 (Usually) (Shahid et al., 2011). Scoring the PSQ, results in the PSQ Index which ranges from 0 to 1. There are two versions of scoring instructions, with the general one being how often they have experienced those feelings in the past year or two, and one pertaining to the last month, with the latter being used in this study. For the latter version, the mean PSQ Index of the general population has been shown to be approximately .41 (*SD* = 0.17) (Levenstein et al., 1993). The PSQ presents excellent internal consistency, good test-retest reliability, and construct validity (Levenstein et al., 1993). Cronbach's alpha and reliability have been reported at at least .85 and .80 respectively (Fliege et al., 2005). Due to its strong psychometric qualities and the variety of stress-related feelings and situations it presents, it was deemed suitable to measure perceived stress in this study. The complete questionnaire can be found in Appendix A.

ESM Questionnaire

For the first ESM item, participants were asked to indicate how they felt at that moment, using a slider ranging from 0 – 100, accompanied by an emote changing expressions based on the input value. The ESM items for stress were decided upon based on factor analysis of the PSQ in order to ensure that they capture the major dimensions of stress, as measured by the PSQ. Various factor analyses of the PSQ have yielded different dimensions, however, the study of Rönnlund et al. (2015) utilized a population-based Swedish sample, which bared the closest resemblance to the general population sample of the present study, and was thus deemed the most appropriate. Their study revealed five primary dimensions of the PSQ, namely: "Demands", "Worries/Tension", "Lack of joy", "Conflict", and "Fatigue".

The PSQ item most closely associated with each dimension, determined by its factor loading in the study of Rönnlund et al. (2015), was used and adjusted to yield an appropriate ESM item. For example, the PSQ item "You feel tense", had the highest factor loading for the "Worries/Tension" dimension, and was thus turned into the ESM item "How worried or tense do you feel at this moment?". All ESM items can be found in Appendix B. Despite the PSQ options ranging from 1 – Almost Never to 4– Usually, for the ESM items, participants could respond using a Likert scale ranging from 1 – Not at all, to 5 – Extremely. This change was decided upon because while the PSQ asked for an overall impression of the last month, the ESM referred to in-the-moment experience – thus making it harder to generalize –, so it was deemed more appropriate to provide participants with an extra, neutral option.

m-Path

The ESM part of the study was administered through the m-Path application. The m-Path, developed by KU Leuven, is a platform in which practitioners can connect with their clients outside of the therapy room (Mestdagh et al., 2023). It allows practitioners to set notifications and questionnaires that the clients receive on their mobile phones, to gather insight into their everyday life. The application is compatible with both iOS and Android operating systems. Notifications can be scheduled at specific times, and be available for a set duration, which can be adjusted by the researcher – practitioner. m-Path is frequently used in research to gather insight into participants' daily lives, and it has been shown to be an appropriate platform for ESM protocols (Weermeijer et al., 2023).

Procedure

Participants took part in the study for 16 days in total, of which 14 were used for the ESM measurements. The 2-week duration of the study was decided upon, in order to ensure that the use of the ESM had enough time to potentially show an effect. Participants were

provided with the link for the first part of the study either through University of Twente SONA system, if registered for the study, or through a direct link which was sent to them. This link took them to Qualtrics, where they could first read the consent form including the description of the study, inclusion and exclusion criteria, and information on the procedure, data handling and confidentiality, and contact details of the researchers. There, they could inform themselves about the study, and reach out for any questions they had.

Upon providing their consent, participants were asked some demographic questions and were then presented with the pre-questionnaire. Upon completion, they were given instructions on how to download the m-Path app, create an account using a nickname which did not include any personal information, and connect to the researcher as their "practitioner", who would be responsible to set up their notifications. They were then asked to input their m-Path nickname in the Qualtrics form, and, if they were students of the BMS Faculty of the University of Twente, also provide their participant ID to receive credits for participation through the SONA system. The m-Path nickname was necessary to be reported so that it was later possible to distinguish between the participants in the control or the experimental group, and link the data from the pre- and post-questionnaire to the same participant.

Upon successful completion of the first part of the study, participants would receive their first m-Path notification the next day at 12 p.m. This notification would either be the first short ESM questionnaire for the experimental group, or an m-Path text notification for the control group, informing them that they will receive their next and final questionnaire in 14 days. The control group did not do anything else for 14 days, whereas the experimental group received notifications daily at 12 p.m., 4 p.m., and 8 p.m., to fill in short questionnaires that lasted approximately 2 minutes each, and measured their levels and experience of stress in the current moment. Participants had 2 hours to respond to each questionnaire before it

became unavailable. On the 16th day, all participants received the same notification at 12 p.m. instructing them to complete the final questionnaire for this study via Qualtrics. For this notification, participants had 24 hours to respond, to accommodate for the higher time investment needed to complete this questionnaire.

At the start of the post-questionnaire they were asked to fill in their m-Path nickname once more, and were presented with the questions, which took approximately 30 minutes to complete. They were then thanked for their participation, and debriefed. Participants in the experimental group were asked to provide insight into their experience with using the ESM to measure those constructs, and whether it changed their view of them. Next, participants could provide their email address if they wished to receive a summary of the results upon completion of the study, and SONA participants were asked to provide their participant ID once more. Lastly, everyone was thanked and presented with the information of the researchers, in case they had questions or concerns. The data collection took place from November 2024 until December 2024.

Data Analysis

Quantitative Analysis

For the quantitative analysis of this study, RStudio of the R software environment (Version 4.4.2) was used. Since the primary interest of this study was in the pre- and post-questionnaires, the data from Qualtrics were used. The dataset was cleaned of missing entries and participants that responded to less than 60% of the ESM questionnaires. This percentage was based on the m-Path ESM study of researchers from KU Leuven, who found a mean response rate of 55% (Weermeijer et al., 2023). Due to the shorter duration of the present study, it was decided to raise this percentage slightly, to make sure that there was still enough compliance by the participant to potentially see a change in their stress levels.

When the data was cleaned, the baseline stress levels of all participants were calculated. Descriptive statistics of demographics and stress levels were analyzed for each group and for the whole dataset, which revealed distributions of age, gender, nationality and stress level. Then, a long-format dataset was created, containing the variables “Participant” for each participant, “Stress” for the PSQ Index, “Time” for pre- and post-, and “Group” to differentiate between the control and experimental group. The data was then checked for outliers, and relevant statistical assumptions were tested. Outliers were examined using the Interquartile Range and a boxplot, both of which showed two outliers at the lower end of the distribution, one from the control and one from the experimental group. Through further examination it was revealed that those were plausible values and not a result of entry errors and since they did not violate the statistical assumptions, they were retained as to preserve the integrity and variability of the sample.

The main analysis conducted was a Linear Mixed Model (LMM) with “Stress” as the dependent variable, “Time” and “Group” as the independent variables, “Time*Group” as the interaction term, and “Participant” as random effect. This method was chosen due to the nature of the study given both the repeated measures at the pre- and post-, but also to examine the expected interaction effects between time and group, specifically whether stress levels post-study would be significantly higher for the experimental group, when compared to the control group. The LMM allowed to assess the effect of “Time” (Pre-/Post-), “Group” (Control/Experimental), and their interaction on levels of stress.

Lastly, it was checked whether there was a relationship between response rates and pre- and post-study stress levels, as well as response rates and the magnitude of change in stress levels at both time-points. This was done to examine whether more extensive interaction with the ESM caused a larger effect on stress, and whether baseline stress levels could predict response rates. For this analysis, participants who completed the study but did

not meet the ESM response rate threshold were also included, to investigate whether higher stress levels pre-study could predict lower response rates. Three simple linear regressions were conducted: one with post-study stress levels as the dependent variable and response rate as the independent variable, another one with the change in stress levels as the dependent variable and response rate as the independent variable, and a last one with response rate as the dependent variable and pre-study stress levels as the independent variable.

Qualitative Analysis

For the qualitative analysis of this research, ATLAS.ti for Windows (Version 23.4.0.29360) was used (ATLAS.ti Scientific Software Development, 2023). The focus of this analysis was on the feedback participants from the experimental group provided in the post-questionnaire, regarding their experience with using the ESM. Thus, their comments were put in a new Microsoft Word (Version 2410) document, which was then imported into ATLAS.ti. There, thematic analysis was conducted to identify common themes and their frequencies within the feedback. Specifically, the data was extensively examined to gain an initial understanding of common patterns. Those were later divided into initial concepts, which were eventually refined into the final themes that adequately captured the essence of the participants' impression of and experience with using the ESM. The data of the participants who completed the study but did not have sufficient response rates were also imported separately, to check if any different themes would emerge.

Results

Quantitative Analysis

Descriptive Statistics

The first part of the analysis concerned the distribution of participants within the sample, particularly differences among the control and experimental group. Participants were

randomly allocated to each group, and while throughout the study the groups had equal amounts of participants, 9 participants from the experimental group did not meet the 60% response rates in the ESM questionnaires, and were thus excluded. This resulted in a final sample of 57 participants, with 34 participants in the control group, and 23 participants in the experimental group.

Next, the pre- and post-study stress levels of all participants, as well as means for all groups were calculated, as per the instructions of the Perceived Stress Questionnaire. For the pre-study assessment, the mean PSQ Index of the control group was 0.48 (M = 0.48, SD = 0.15), and for the experimental group was 0.49 (M = 0.49, SD = 0.16), making both of them just slightly above the population mean average of 0.41 (Levenstein et al., 1993). For the post-study assessment, the mean PSQ Index for the control group seem to increased slightly to 0.49 (M = 0.49, SD = 0.16), and for the experimental group seem to have decreased to 0.43 (M = 0.43, SD = 0.18). Therefore, there seemed to be a slight decreasing trend of stress levels in the experimental group.

Main Analysis

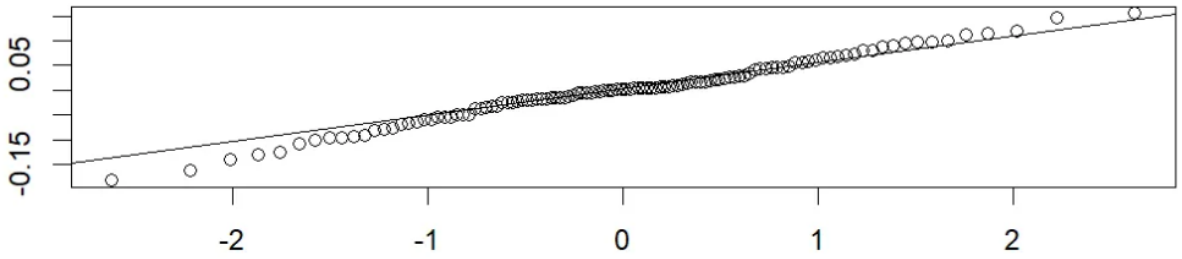
In order to address the research question of this paper, and test the chosen hypothesis, a Linear Mixed Model was used. “Stress” was the dependent variable to represent the participant’s PSQ Index, “Time” and “Group” were the fixed effects, and their interaction “Time*Group” was included to examine potential changes in stress levels at the different time points between the two groups. Lastly, due to the repeated measures of the study and to account for within-subject variability, the random intercept “Participant” was included.

Before proceeding to the main Linear Mixed Model analysis, the relevant statistical assumptions of Normality of Residuals, Linearity, Homoscedasticity and no Multicollinearity were tested. For the normality of residuals assumption, a Q-Q plot and the Shapiro-Wilk

normality test were used, both of which confirmed that the assumption is met. The Shapiro-Wilk test revealed the value $W = 0.99$, $p = .41$, and the Q-Q plot showed that the residuals followed a relatively normal distribution, as can be seen in Figure 1.

Figure 1

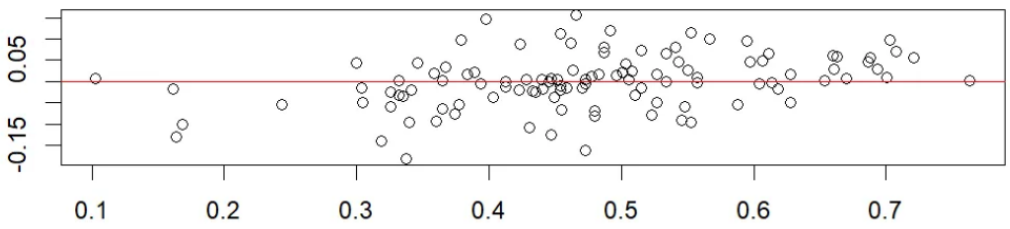
Normality of Residuals Q-Q Plot



For the assumptions of linearity and homoscedasticity, a residuals vs. fitted values plot was used, which revealed no discernible trends or systematic patterns, and the residuals appear relatively randomly scattered and evenly spread, as can be seen in Figure 2. The linearity and homoscedasticity assumptions were thus satisfied. Lastly, for the no multicollinearity assumption, the variance inflation factors (VIFs) were calculated for the predictor variables. The VIFs for Time (VIF = 1.68), Group (VIF = 1.16), and interaction Time × Group (VIF = 1.83) were all below the threshold of 5, thus indicating that the assumption is satisfied.

Figure 2

Residuals vs. Fitted Values Plot



With all the relevant statistical assumptions being satisfied, the next step was the main analysis. Based on the Linear Mixed Model, the results revealed that for the fixed effects there was no significant effect of "Time" on "Stress" ($\beta = 0.007$, $p = .74$), or of "Group" on "Stress" ($\beta = 0.01$, $p = .80$). There was however, a slight but significant effect of the interaction term between "Time" and "Group" on "Stress" ($\beta = -0.07$, $p = .04$). This result then indicates that the experimental group presented a slight reduction of stress levels post-study, as compared to the control group. For the random effects, the random intercept for "Participant" presented a variance of $\sigma^2 = 0.02$ ($SD = 0.14$), indicating very little variability in stress levels between participants, and the residual variance representing unexplained variability within each participant across the pre- and post- was $\sigma^2 = 0.007$ ($SD = 0.08$). The aforementioned results are presented in detail in Table 1.

Table 1

Summary of Linear Mixed Model: Effects of Time, Group, and Interaction on Stress Levels

Effect	Estimate	t-value	p-value
Intercept	0.481	17.372	<0.001
Time (Post)	0.007	0.336	.738
Group (Exper.)	0.011	0.258	.797
Time*Group (Exper.)	-0.067	-2.100	.040

Note. $p < .05$ (two-tailed).

Additional Analyses

It was also of interest to examine whether response rate was associated with pre- and post-study stress levels, and magnitude of change in the experimental group. For this, participants of the experimental group with response rates lower than 60% were also used, meaning that the sample for this analysis was 32 participants. The simple linear regression

with post-study stress as the dependent variable and response rate as the independent variable revealed that there is no noticeable or significant relationship between the two variables (β = 0.0002, p = .891, R^2 = 0.0006). Similarly, the simple linear regression with the change in stress as the dependent variable, and response rate as the independent variable revealed no results to suggest a significant relationship (β = -0.0008, p = .33, R^2 = 0.031). Lastly, the linear regression for the relationship between pre-study stress levels and response rates also revealed no significant results (β = 16.78, p = .570, R^2 = 0.0108). Scatterplots supported these results, and can be seen in Figure 3, Figure 4 and Figure 5.

Figure 3

Post-Study Stress vs. Response Rate Scatterplot

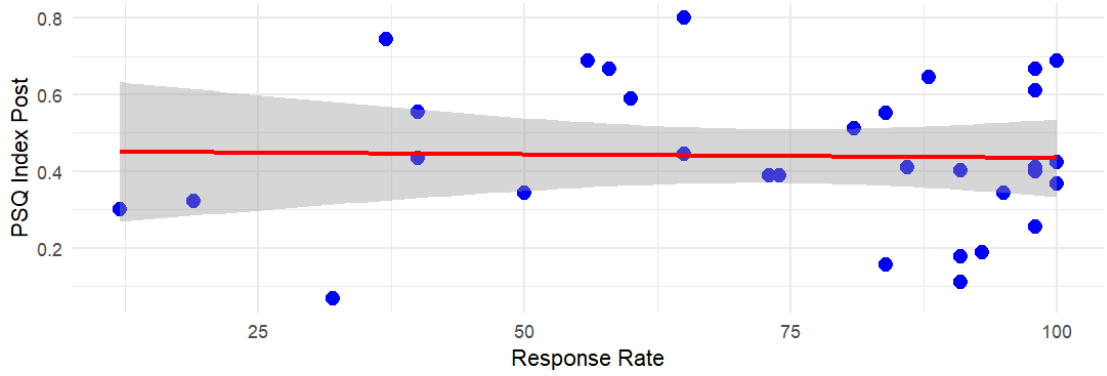


Figure 4

Stress Level Change vs. Response Rate Scatterplot

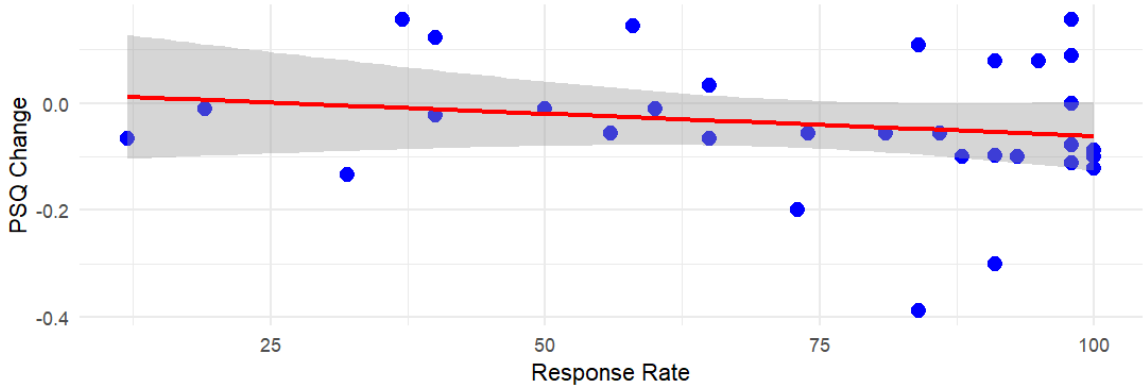
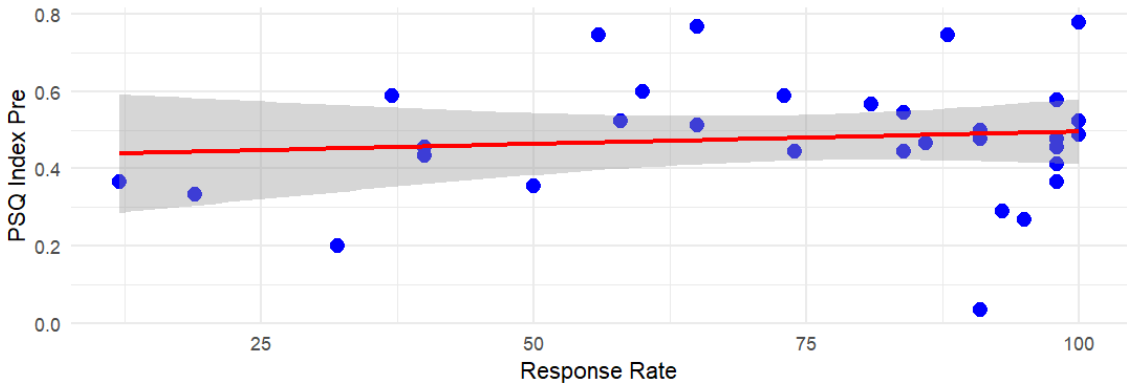


Figure 5

Pre-Study Stress vs. Response Rate Scatterplot



Qualitative Analysis

A thematic analysis was performed on the answers participants of the experimental group gave at the end of the study regarding their experience with using the ESM. Overall, the feedback was positive and four themes were identified, namely: “Awareness Boost”, “Positive Impact”, “Mood Tracking”, and “Repetitive Questions”. There was an extra theme which was derived only from a couple of the participants that filled in the post-questionnaire but did not have a sufficient response rate in the ESM notifications to be included, and that was “Negative Impact”.

The most common theme was “Awareness Boost”, which related to how participants felt like the questionnaires made them more aware of their body and emotions, for example: “Made me more aware of the connection between the way I feel and how it affects my body [...]”. There were a few participants that viewed the questionnaire as a way to track their mood throughout their everyday life, such as what a participant wrote: “It was a good experience to track my moods throughout the day, because I was able to compare them”, hence the theme “Mood Tracking”.

The theme of “Positive Impact” was often the consequence of “Awareness Boost” throughout the participants’ feedback. It related to how participants felt like the questionnaires, increasing their awareness, affected them positively throughout their everyday life. For instance, a participant wrote “I didn't notice how I was feeling until filling in the questionnaire, which then helped me to regain focus [...], which was really useful in my everyday life”, or another one stated that “Through the daily surveys, I was repeatedly reminded to focus on my sensations, which I found very helpful in various situations”.

There was a minority of participants that stated how the repetitive nature of the questions affected them, which gave rise to the theme “Repetitive Questions’. One participant criticized this, by writing “[...] the repetitive nature of the questions sometimes put me off”, but another one said that this repetition had the effect of the questions staying with them, which made it easier to remind themselves throughout their daily life: “Over time, the questions ‘stuck’ with me and kept running through my mind in between as well”.

Lastly, an additional theme emerged among 2 participants, that did not make the final dataset due to lower response rates (56% and 37%) in the ESM questionnaires, but still provided feedback after the study. This theme was named “Negative Impact” because they stated how the increased awareness of their emotions sometimes affected them negatively. For example, one stated: “[...] there were times when I had to answer it during working or studying when it made me realise how much in a hurry and anxiety I am most of the time during my day, which made me sad.”. Similarly, the other participant wrote: “ [...] made me continuously more aware about me having deadlines & thus kind of stressed me [...]”. A list with the theme definitions and specific number of instances can be found in Table 2.

Table 2

Thematic Analysis Experimental Group Feedback

Theme	Definition	Instances	Participants
Awareness Boost	Participant reported 'increased awareness' or 'increased attention' or 'being more in touch with their feelings or sensations' or equivalent.	15	13
Positive Impact	Participant found the questionnaires were helpful, pleasant, useful in their everyday life or in general.	7	6
Mood Tracking	Participant mentioned that it was a way to track and monitor their mood and/or notice how it fluctuates.	2	2
Repetitive Questions	Participant mentioned that they expected/remembered the questions they received, or criticized that they were always the same, or mentioned that they would have liked more/different questions daily.	2	2
Negative Impact	Participant reported that the questionnaires had a negative effect on them, or made them sad or stressed or feeling worse than before they completed the questionnaires.	2	2

Discussion

Main Findings

The aim of the present study was to examine the potential mere measurement effect of the Experience Sampling Method on stress. Specifically, the research question was “To what extent do frequent reminders and daily monitoring of stress through the Experience Sampling Method (ESM) affect stress levels in adults, compared to those not using the ESM?” and the proposed hypothesis was that “Participants using the ESM, exhibit statistically significant higher levels of stress post-study, when compared to those not using the ESM”. The quantitative analysis revealed that there was a small but significant decline in the stress levels of the experimental group, when compared to the control group post-study. The qualitative analysis supported those findings, with a large majority of participants in the experimental group indicating that while the study did increase their levels of awareness as expected, it was perceived as helpful and positive. While both quantitative and qualitative results point towards a reduction in stress levels, the change is too minor to suspect a mere measurement effect of the ESM in measuring stress.

Overall, the sample as a whole, as well as the control and experimental groups individually, presented relatively average stress levels both before and after the study, with both noting a mean reduction of stress levels post-study. The small but significant reduction in the experimental group’s stress level could be attributed to the daily self-monitoring of stress. Self-monitoring has been shown to have favorable outcomes in terms of identifying patterns and stressors, which allow the individual to adopt behavioral changes or coping strategies (Neupane et al., 2024). A pathway through which self-monitoring could help in reducing stress levels is that of increased awareness. This was supported by the qualitative

results of the present study, and by prior research which has reported the positive effects of increased awareness in overall well-being, depression and stress (Kauer et al., 2012).

There is a discrepancy between the hypothesis and the findings regarding the role of increased awareness in stress, which is also apparent in literature. Increased awareness of stress has been shown to lead to more adaptive responses and has been associated with greater self-efficacy (Donald et al., 2016). Self-efficacy in terms of stress is central, because it lead to milder stress responses and increased confidence in dealing with stressors overall (Liu et al., 2024). On the other hand, research has shown that for individuals prone to rumination, increased awareness of stress may be perceived as negative and contribute to feelings of overwhelm (Feolino et al., 2024). For those individuals, it has been shown that healthy distractions are more helpful in increasing their overall well-being and reducing stress levels (Hilt & Pollak, 2012). Thus, being put in the situation of the experimental group may have had a negative effect for some, as was the case for the two participants that reported that increased awareness stressed them further. Thus, self-awareness can generally yield positive results, but there may be a part of the population for which it can be experienced as negative.

While increased awareness could have contributed to the low responses of the two participants who stated that it stressed them further, no relationship was found between response rates and pre- and post-study stress levels or stress change. Even for the positive effects, based on the qualitative results it could have been expected that more engagement with the ESM would result in a larger increase in awareness and further decrease in stress, however no results supported this. The absence of this relationship, in addition to the minor reduction in stress for the experimental group post-study, support the conclusion that the ESM did not pose a mere measurement effect that drastically and directly affected stress.

Strengths and Limitations

The results of the present study should be interpreted with caution, due to a variety of limitations that need to be addressed. Firstly, most of the effects that were expected and those which were revealed were small or not significant, indicating that a larger sample is necessary. While a larger sample was initially gathered, approximately half of the experimental group dropped out or did not meet the response rate threshold. Furthermore, results of this study regard a general and non-clinical population. This means that the presented results regarding the measurement effect of the ESM on stress cannot be generalized to clinical populations.

Regarding the analyses, it is important to reiterate that only results of participants that completed the whole study including the post-questionnaire were used. This means that no conclusions can be drawn regarding correlations between stress and dropout, or reasons behind dropout, since participants were not asked to provide a reason for not continuing with the study. Therefore, it cannot be revealed whether participants dropped out due to the high study demands, potential increase in stress, or another reason. Lastly, it is critical to mention that this study, both on the pre- and post-questionnaires as well as the ESM items, involved measurements for the constructs of interoceptive awareness and self-control as part of the bigger project. Thus, particularly the concept of interoceptive awareness which may increase mindfulness, could have affected the results given the relationship between mindfulness and decreased stress levels (Kriakous et al., 2020).

The present study also demonstrated important strengths, especially regarding its qualitative analysis part, and including participants with low response rates on some analyses. Specifically, while the largest part of the analysis was quantitative, thematic analysis of the experimental group’s feedback provided very valuable insights into the effects of the ESM as

perceived by the individual. Furthermore, using participants that did not make the final sample due to low response rates allowed to analyze relationships between response rates and stress, which on a larger sample could yield more insight, but also examine qualitative feedback which allowed for another perspective on the effects of the ESM on stress.

Implications for future directions in research and practice

This study provided some preliminary findings regarding the measurement effect of the ESM, and results suggest that the ESM may cause a small but statistically significant reduction in stress levels, however this reduction is not substantial enough to suspect a mere measurement effect. Nevertheless, further research is critical in order to understand whether the current findings apply to a larger and even more diverse population, a clinical population, and if a change is found, to understand the direction and mechanisms through which this change comes about. Furthermore, it is critical to understand whether there are populations that are more sensitive to negative effects of frequent self-monitoring, in order to ensure a safe use of the tool. Lastly, it would be important to examine if the ESM duration has an effect on stress, and whether longer periods potentially cause a larger change in stress levels.

It is advised that future research utilizes a slightly different approach when it comes to the sample distribution of groups, the response rate threshold and the overall design. Specifically, given the high dropout rates of ESM studies (Van Berkel et al., 2017), it could be more appropriate to not split the participant pool in half to create groups. Perhaps a 35-65% split would be more appropriate, to account for dropouts in the experimental group. Furthermore, it would be advised to offer participants with some form of reward to keep them motivated to continue, such as a financial reward, or having the opportunity to receive personalized results, or another incentive. Lastly, it would be important to focus only on

stress and no other constructs, as to obtain a clearer understanding of the measurement effects, and perhaps the mechanisms through which changes in stress may be caused.

The current findings do not only offer new directions in research, but in the future could prove very important for practice. If it is confirmed that the ESM does not pose a mere measurement effect, the ESM could prove a very valuable tool for practitioners to understand the everyday life, experience, and fluctuations of emotions of clients without significantly influencing their perceptions and experiences. This could aid in identifying stressors and patterns in the client's life, allowing practitioners to develop more targeted, effective, and personalized treatment plans. Even though the ESM did not cause a substantial reduction in stress levels, majority of participants reported that it had a positive impact in their lives. This means that if more insight is obtained regarding populations that should perhaps avoid using the ESM, it could still be used selectively by individuals who could benefit from self-monitoring and increased awareness, thus utilizing its positive effects. Lastly, and of great importance, the ESM allows for a much more well-rounded understanding of stress, that moves beyond symptoms and individual measures, which is crucial for both research and practice.

Conclusion

Overall, based on the results of the present study, the ESM could potentially cause a small reduction in stress, but not substantial enough to suspect a mere measurement effect. However, more research is needed, to examine whether those findings still apply to a larger sample and different populations. If the conclusion of the present study, namely that the ESM only causes a minor reduction in stress and thus does not cause a mere measurement effect, is confirmed by future research, the ESM can provide new directions for research, practice, and the overall understanding of stress. Given the need for tools that enable professionals to

measure experience with psychological constructs including stress, the ESM could be an important step towards the right direction of a more holistic understanding that moves beyond just symptoms, into a dynamic experience within a context.

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Appendix A

Perceived Stress Questionnaire

For each sentence, circle the number that described how often it applied to you *during the last month* (1 – Almost Never, 2 – Sometimes, 3 – Often, 4 – Usually).

1. You feel rested
2. You feel that too many demands are being made on you
3. You are irritable or grouchy
4. You have too many things to do
5. You feel lonely or isolated
6. You find yourself in situations of conflict
7. You feel you're doing things you really like
8. You feel tired
9. You fear you may not manage to attain your goals
10. You feel calm
11. You have too many decisions to make
12. You feel frustrated
13. You are full of energy
14. You feel tense
15. Your problems seem to be piling up
16. You feel you're in a hurry
17. You feel safe and protected
18. You have many worries
19. You are under pressure from other people
20. You feel discouraged

21. You enjoy yourself
22. You are afraid for the future
23. You feel you're doing things because you have to not because you want to
24. You feel criticized or judged
25. You are lighthearted
26. You feel mentally exhausted
27. You have trouble relaxing
28. You feel loaded down with responsibility
29. You have enough time for yourself
30. You feel under pressure from deadlines

Appendix B

ESM Questionnaire

1. How do you feel in the current moment? (1-100)
2. To what extent do you feel overwhelmed due to multiple demands right now? (1-5)
3. How worried or tense do you feel at this moment? (1-5)
4. How much joy or satisfaction do you feel right now? (1-5)
5. To what extent do you feel pressured by expectations from others or from yourself right now (1-5)?
6. How tired or mentally exhausted do you feel right now? (1-5)