Reactivity Testing on Self-Regulation and Psychological Well-Being in the Daily Life of Students – an Experience Sampling Study

B.Sc. Thesis

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Abstract

Background. Nowadays, applying biofeedback technology has been found to be an effective candidate to reduce stress and increase mental well-being in people. However, only few studies have tested whether such an effect could also be caused by alternative explanations other than the biofeedback device itself. Therefore, this study aims to investigate whether a so-called reactivity effect, meaning that participants are reactive towards being measured, could occur by measuring student´s self-regulation capacities and their psychological well-being within the approach of experience sampling without integrating a biofeedback device.

Methods. 36 participants were assigned to a 4-days experience sampling study that included responding to questions which measured their level of self-regulation and psychological well-being throughout the day. Their pre-and- post-measurement scores in self-regulation and psychological well-being were compared to a control group, consisting of 9 participants, who only filled out the pre-post measurement. Furthermore, it was also examined whether participants who adhered more strongly to the experience sampling method achieved a higher change in self-regulation.

Results. No reactivity effect could be confirmed within this study, as no change in self-regulation nor psychological well-being was found. Being exposed to think about and reflect on one's self-regulation and psychological well-being did not have a treatment-like effect on participants and, no higher change was detected in participants who adhered more strongly to the experiment.

Discussion. The results suggest to conduct follow up studies into biofeedback as a reactivity effect that might limit the effectiveness of biofeedback related to self-regulation and psychological well-being could be ruled out for the current study. However, future research should integrate more large-scale and longer studies to be able to draw valid conclusions and to provide more knowledge about biofeedback technologies with regard to self-regulation.

Keywords: experience sampling methodology, reactivity, self-regulation, psychological well-being, students, stress

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Reactivity Testing on Self-Regulation and Psychological Well-Being in the Daily Life of Students – an Experience Sampling Study

Experiencing stress can be considered as a global issue that affects individuals from all over the world regardless of their socio-economic status or origin. As reported by the American Psychological Association (2017) the amount of people experiencing chronic stress during their day is steadily increasing nowadays and, according to the World Health Organization (2017), over 50% of all medical treatments worldwide are related to illnesses and disorders induced by internal or external stress experiences. More specifically, university students often suffer from academic stress, resulting from studying for exams or thinking about future plans (Ramli, Hamizah, Alavi, Mehrinezhad & Ahmadi, 2018). This was also shown by a survey from the University of Twente that aimed at measuring the well-being of its students, as it revealed that a large number of students at this university experience high levels of stress, depression and/or anxiety (Kelders, Oberschmidt & Bohlmeijer, 2019).

These findings underline the importance and essentiality to come up with interventions and ways to achieve a decrease in the stress levels of students. One psychological construct that is associated with the occurrence of stress is self-regulation. Self-regulation can be defined as the ability to monitor and evaluate internal states to recognize discrepancies and to adapt thoughts, feelings and behaviours to achieve personal goals (Ramli et al., 2018). Therefore, finding methods to increase self-regulation in students might be seen as an important step to reduce stress and increase the level of psychological well-being in students (Durand-Bush, McNeill, Harding, & Dobransky, 2015).

When it comes to possible ways to counteract the issue of stress and heightening the ability of self-regulation, applying ambulatory biofeedback technology has been shown to be a potential candidate. (Yu, 2018). The usability of biofeedback techniques allows users to observe and monitor their physiological changes in real-time (Kennedy & Parker, 2019). Different studies have indicated that the use of ambulatory biofeedback, for example in the form of wearable devices, resulted in an increase of well-being and performance (De Witte, Buyck & Van Daele, 2019). However, it could be possible that those positive results of ambulatory biofeedback can also be explained by the fact that actively focusing and monitoring one's experiences might already have the effect of changing cognition and behaviour (Quinlan Cutler, Doherty & Carmichael, 2018). It can be criticized that only very few studies concerning ambulatory biofeedback have actually tested whether such an effect might have occurred within their studies, which represents a research gap that needs to be

filled in order to rule out plausible alternative explanations for the effectiveness of biofeedback (Meier, Miller, Lombardi & Leffingwell, 2017). Therefore, this research aims to investigate whether solely asking participants questions about their self-regulation ability and their psychological well-being throughout the day might already have a positive effect on their level of self-regulation and mental well-being without integrating an ambulatory biofeedback device.

Self-regulation and well-being

Different studies have suggested that the self-regulation capacity can have a positive influence on the level of well-being in people. For example, Hofer, Busch and Kärtner (2011) have discovered that students with higher self-regulation ability scored higher in well-being and reported lower levels of anxiety and stress. The theory underlying this finding suggests that self-regulation capacities allow "*individuals to effectively manage their thoughts, feelings, and actions to attain goals while mastering a demanding environment*" (Gagnon, Durand-Bush, & Young, 2016, p. 101) and thus, offers the possibility to develop healthy coping mechanisms to deal with stress and calm oneself down. This theory has also been supported by Simon and Durand-Bush (2014) who discovered within an experimental study that the ability of self-regulation was positively correlated with overall well-being in physicians. One way to measure the level of self-regulation and well-being in students is through applying the method of experience sampling.

Experience sampling methodology

The use of experience sampling methodology (ESM) can be defined as a diary method, in which users report their emotions, symptoms and the corresponding context as they appear throughout the day (van Os et al., 2017). ESM enables to examine how the actual experience of people and therefore their fluctuations in emotions, is related to their everyday environment and context (Myin-Germeys et al., 2018). This is highly advantageous when it comes to measuring stress as ESM provides various assessments over a specific time frame within one participant, which allows investigating the temporal dynamics of stress and its symptoms in daily life (Myin-Germeys et al., 2018). Through the use of ESM, participants will be encouraged and reminded to think about specific experiences and behaviours throughout the day (Van Berkel, Ferreira, & Kostakos, 2017). Due to the increasing use of mobile phones in today's society, the approach of ESM can easily be adopted by participants as they have the opportunity to respond to the measurement questions on various applications on their phones (Pejovic, Lathia, Mascolo, & Musolesi, 2016).

One aspect that influences the outcome and success of ESM studies includes the participants level of adherence to the mhealth interventions. According to Bender (2014), a higher level of adherence is coupled with an increased level of behavioural change. For example, a study by Sutton et al. (2014) showed that an intervention that included electronic self-reporting resulted in a small increase in adherence to medication. Thus, it can be assumed, that a higher level of adherence to an ESM study might result in a higher change in self-regulation as well.

Besides, ESM also holds different strengths concerning the reliability and validity of its measurement. For example, memory strains of the participants can be reduced as their state of mind and feelings are measured continuously over time and can therefore not be forgotten as when they have to recall their emotions at a later moment (Shiffman, Stone & Hufford, 2008). Furthermore, due to collecting information about the participants in different contexts since the measurements are repeated throughout the day, the researchers are able to get a grasp of how a psychological state can vary throughout the day in various daily life contexts (Bolger & Laurenceau, 2013). And, as already mentioned earlier, it might be possible that being repeatedly measured and assessed can already change the cognitions and behaviours of the participants, namely reactivity effect, which will be the focus of this research (Quinlan et al., 2018).

Reactivity effect

Different studies have shown that reactivity effects can occur when applying the method of ESM (Zimmerman, 2002). First of all, reactivity can be defined "*as changes that occur in an individual when she/he is aware of aspects of her/his behaviour due to metacognitive monitoring*" (Panadero, Klug & Järvelä, 2016, p.725). Most of the studies that have researched the so-called reactivity effect focused on the fact that a change in behaviour occurred through participants being assessed by others (Schrimsher & Filtz, 2011). An illustrative example of this phenomenon can be seen in the "*Hawthorne effect*" which stands for the alteration of participants behaviour while being observed, also referred to as the observer bias (Paradis & Sutkin, 2017).

However, less research has focused on whether a change in cognition and behaviour could also be reached by encouraging participants to engage in self-monitoring without giving them the feeling that they are steadily assessed and observed (Meier et al., 2017). Yet, a meta-analysis by Wood et al. (2015) shed light on the impact of asking different kinds of questions to people on their behaviour. Here, the term "attitude accessibility" serves as an explanation

of why a reactivity effect might occur. It holds the idea, that "*asking people to report their behavioural intentions or to predict their behaviour activates the attitude underlying that behaviour, making it more accessible in memory (. . .)"* (Wood et al., 2015, p.246). Consequently, being more aware of a certain attitude might increase the probability that individuals also engage in behavioural change. Wood et al. (2005) concluded that providing participants with intention/prediction questions may increase the likelihood of participants achieving the desired effect on behaviour. Furthermore, a few studies have already researched reactivity effects in ESM studies that required self-reporting on emotions: One example where the reactivity effect could be observed in a self-monitored way can be seen in a research conducted by Widdershoven et al. (2019): Within their study, the researcher used experience sampling to reach an enhancement in emotion regulation in depressed participants. In addition, the reactivity effect could also be found in a study by Meier et al. (2017) since the participants started to reflect on their alcohol consumption and initiated behavioural change when being engaged in self-monitoring by employing experience sampling methodology.

Building on the success of those studies, it might also be assumed that such a reactivity effect could occur when applying ESM on students, in order to increase their level of self-regulation and their psychological well-being. It could be hypothesized that letting students focus on their self-regulation skills might already encourage them to reflect on their abilities and to become aware of them. This could then, for example, influence what kind of self-regulation strategies the students would apply to handle daily stressors. And, as mentioned above, having higher self-regulation skills could then result in an increased level of psychological well-being, by using healthy coping skills and approaches to tackle problems efficiently (Gagnon et al., 2016). Even though some research has focused on whether such an effect can occur, no scientific data could be found concerning such an intervention aiming at enhancing self-regulation.

This study

Due to a lack of research in this field, this study will focus on applying the ESM approach by asking participants questions concerning their self-regulation abilities and psychological well-being throughout their day for a certain amount of time without utilizing a biofeedback technology. It is hypothesized that reporting on feelings with regard to self-regulation, by means of experience sampling, results in a higher level of self-regulation in students due to the reactivity effect. Also, it might be assumed that the capability of self-regulation and being asked to report one´s psychological well-being on a frequent basis might

increase the student's mental well-being itself. Therefore, this research paper aims at investigating whether self-regulation and psychological well-being are increased through self-reporting on emotions by means of experience sampling in students. Moreover, it is also of interest to research whether participants who completed more questions of the ESM survey would report a higher level of self-regulation in the post-measurement, compared to participants who completed fewer questions. This has been assumed based on findings confirming a positive correlation of an increase in adherence and behavioural change (Bender, 2014). Hence, the following hypotheses will be tested in this study:

1. In comparison to a control group, self-regulation increases for participants taking part in an experience sampling study on self-regulation.
2. In comparison to a control group, psychological well-being increases for participants taking part in an experience sampling study on self-regulation.
3. Participants who completed more ESM surveys report a higher difference score in self-regulation from the pre- to the post-measurement, compared to participants who completed fewer surveys.

Method

Participants

In total, 74 participants took part in this study, from which 23 were assigned to the control group and 51 participants were selected for the experimental group. However, the data of 28 participants could not be used as they did not complete the pre- and/or post-measurement, that was determined as exclusion criteria beforehand. Finally, 9 participants were assigned to the control group and 37 participated in the experimental group, hence the full cohort consisted of 46 people. University students have been chosen as a target group of this research. Participants were recruited through convenience sampling and via SONA systems of the University of Twente. SONA functions as an internet platform of the University of Twente where, on the one hand, Psychology and Communication Science students can sign up for research studies to receive course credit points. On the other hand, SONA provides students with a platform to recruit participants by publishing their studies. Besides being a student and having accessibility to a smartphone, no other requirements were needed to participate in the study. Finally, the study was approved by the Ethics committee of the University of Twente on the 25th of March, 2020 (request number: 200402).

Materials

SSRQ. The Short Form Self-Regulation Questionnaire (SSRQ) by Carey, Neal and Collins (2004), based on the Self-Regulation Questionnaire (SRQ; Brown, Miller & Lawendowski, 1999), was used to assess self-regulatory processes through self-report (see Appendix B). The questionnaire follows a 5-point Likert scale (1=strongly disagree to 5= strongly agree) and consists of 31 items. "*I have a hard time setting goals for myself*." and "*I am able to resist temptation"* represent two examples of the items of the questionnaire. The SSRQ has shown a high internal consistency (α = .92) and correlated strongly with the original 63-item SRQ (*r* = .96) (Carey et al., 2004). Those findings are in line with outcomes of similar studies, which also confirmed high validity (Šebeňa et al., 2018; Vosloo, Potgieter, Temane, Ellis & Khumalo, 2013). Thus, it can be concluded, that the SSRQ can provide valuable information about a person's self-regulation and can be used as a reliable measurement tool.

PWB. Psychological well-being was assessed with the Psychological well-being scale (PWB) by Ryff and Keyes (1995) (see Appendix C). In the 18-items version participants had to answer questions on a 7-point Likert scale (1=strongly agree to 7=strongly disagree). The questionnaire encompasses 6 different subtopics, namely "*autonomy*", "*environmental mastery*", "*personal growth*", "*positive relations with others*", "*purpose in life*" and "*self-acceptance",* for which individual scores can be calculated. *"I am good at managing the responsibilities of daily life."* represents an example item of the PWB. According to Clarke et al. (2001), the 18-items version was in accordance with the original 120-measure version and correlated strongly with it (*r* = .91) which indicates an acceptable content validity. Internal consistency was only modest for the subscales due to its short manner, with the highest value in personal growth (α = .62). In general, the scale was found to be a reliable and valid measurement tool to assess psychological well-being, especially in young adults and can, therefore, be used as a medium to detect possible changes in psychological well-being within this study (Henn, Hill & Jorgensen, 2016).

Trait Questionnaire. Both, the SSRQ as well as the PWB were included in the trait questionnaire that is used as a pre- and post-measurement for the control and experimental group. As this research was part of a larger study, the MAIA-2 with its 37 items, measuring interoceptive awareness, was also added to the trait questionnaire, but was irrelevant for this study. Therefore, the trait questionnaire consisted of 86 items for the post-test, whereas the

pre-questionnaire consisted of 89 items, as 3 demographic questions concerning age, gender and nationality were included as well.

State Questionnaire. The state questionnaire was used to test whether answering those items repeatedly in the daily life is associated with a reactivity effect. Such an effect can be operationalized as a significant change from the pre- to the post measurement of the trait questionnaire. 5 questions were obtained from the MAIA-2 questionnaire, from which 3 measured the level of interoceptive awareness and 2 the level of self-regulation. To also include an item that measures psychological well-being, a new item was created by combining different items from the PWB-scale. All items were adjusted by rewriting them to the present tense and by adding cue words such as "*at this moment*", to make sure, that the questions refer to a momentary feeling instead of a stable trait. A 6-point Likert scale (1 = strongly agree to 6 = strongly disagree) was chosen as response options, as this scale matched the adapted items the best. Finally, the state questionnaire consisted of the items: 1. *At this moment, I listen for information from my body about my emotional state*. (MAIA-2, Body Listening) 2. *At present, I can refocus my attention from thinking to sensing my body*. (MAIA-2, Attention Regulation) 3. *Right now, I feel my body is a safe place*. (MAIA-2, Trusting) 4. *Right now, I can bring awareness to my body and feel a sense of calm*. (MAIA-2, Self-Regulation) 5. *At this moment, I can reduce tension by focusing on my breathing*. (MAIA-2, Self-Regulation) 6. *I feel good about myself and enjoy what I am currently doing*. (psychological well-being).

Ethica Application. The Ethica application represents a digital platform on which technological research can be conducted. The setup of the study was completed on the website "www.ethicadata.com" and therefore, the Ethica application was also chosen as a research tool to conduct the study. The application can be downloaded on any Android or IOS device and for this research, Ethica version 230 has been used. As the control and experimental group received different questionnaires within this research, two different studies were created on Ethica. When publishing the two studies, a registration link and code was provided via the Ethica website, that has been used as a way to give participants access either to the control or the experimental part of the study. Through the application, participants in the experimental group were provided with a daily questionnaire as part of the experience sampling methodology**.** Through the category "*Participants*" on the Ethica website, the researchers were able to keep up with the number of people who signed up for each study and could follow the real-time progress of each participant. All survey responses

were saved on the website and could directly be downloaded via the website by clicking on "*survey responses*" and "*download*".

Design

The present study was a quantitative research that was based on gathering data through the use of self-reporting questionnaires by means of pre-and post-measurement. The research included a longitudinal experience sampling study with a within-subject design for participants being assigned to the experimental group. In addition to that, the control and experimental group was compared in this study and therefore a between-group design was also applied. The study aimed to investigate whether self-regulation and psychological well-being were increased through self-reporting on emotions by employing the approach of experience sampling in students. Moreover, it was also of interest to explore whether participants who completed more ESM surveys would report a higher difference score in self-regulation from the pre- to the post-measurement, compared to participants who completed fewer questionnaires. Concerning the first two hypotheses, being in the control or experimental group served as independent variable. Consequently, the level of self-regulation (hypothesis 1) and psychological well-being (hypothesis 2) functioned as dependent variable. With regard to the third hypothesis, the amount of ESM surveys filled out could be considered as the independent variable, whereas the self-regulation score in the post-measurement functioned as the dependent variable.

Procedure

The study duration constituted 6 days for both, the experimental and control group. All participants received general information via SONA systems or directly through the researchers before the start of the study. After agreeing to the provided consent form (see Appendix A), participants were able to sign up for the study by using an internet web link which led the participants to the app store where the application could be downloaded. After signing up into the app, the participants received further instructions on how to use the Ethica application. Especially the importance of answering the daily questions as soon as possible, since the ESM surveys vanished after 1 hour, was emphasized for participants who were assigned to the experimental group. Besides that, it was also stressed that participants should check whether notifications were allowed to be received from the app, as otherwise, the study would not have worked out. While Apple users received an automatic message where they could confirm the allowance of notifications from the app, Android users were asked to change the settings by themselves. To allow participants the opportunity to ask further or

concerns, the e-mail addresses of the researchers were also provided to them.

As the first step of the study, all participants had to fill out the above-mentioned trait questionnaire as part of the pre-test. Questions regarding demographic information (age, gender and nationality) were included as well. The test appeared directly after signing up to the study to ensure that participants would see the pre-test and fill it out immediately. As the pre-test expired after 24 hours, participants were asked to complete the survey within the day they signed up for the study. After 6 days, both groups received a notification to fill out the post-questionnaire which constituted of the same trait questionnaire. Again, participants had one day to fill out the post-test until the test would expire. While this represents the study structure of the control group, the experimental group additionally had to fill out the daily state questionnaires for 4 days. After filling out the pre-test of the study, the participants of the experimental group received notifications to fill out the state questionnaires 4 times a day (10 am, 1 pm, 4 pm and 7 pm) on day 2 till day 5 of the study. When the questionnaire was not completed 30 minutes after being published, the participants received a reminder to do so, as those questionnaires vanished after 1 hour. Identically to the control group, participants of the experimental group were asked to fill out the last questionnaire which encompasses the repetition of the trait questionnaire, lasting for 24 hours as well, on day 6 of the study. Drop-out of the study was possible by simply stop answering the questions on the Ethica application.

Data analysis

This study investigated the reactivity effect on self-regulation and psychological well-being. It was expected that the level of self-regulation and psychological well-being will increase over time due to repeated measurement of experience sampling questions. Thus, the scores of the SSRQ and PWB scale were used for the analysis of the control and experimental group. Moreover, the results of the five daily repetition questions were considered to make further analysis in the experimental group. The data analysis was done by using the statistical software SPSS (version 25) after downloading the data files from the Ethica website.

Data preparation. The final data set was determined by excluding cases that did not meet the inclusion criteria of filling out both the pre-and post-questionnaire. In addition, items with negative loadings in both the SSRQ and the PWB were reversed and recoded into new variables by reversing the numerical scoring for the Likert scales. With regard to the SSRQ, reversed scoring was done for items 2, 3, 4, 6, 7, 9, 10, 11, 16, 19, 22, 23, 27 and 31.

Furthermore, items 1, 2, 3, 8, 9, 11, 12, 13, 17, and 18 of the PWB needed to be reversed as well.

Descriptive statistics. With regard to the demographic information of the participants, for the variable "*age*", the mean (M) standard deviations (SDs) and minimum and maximum values were calculated. For the variables "*gender*" and "*nationality*" total scores have been determined and were also calculated in percentage. Moreover, frequency tables were computed to obtain an overall picture of the SSRQ and PWB mean-scores in the pre- and post-measurement for the control and experimental group. A difference score that measures the discrepancy between the pre- and post-measurement for both psychological constructs was also calculated.

Inferential statistics. Before starting with the data analysis, a randomization check was applied to test whether the control and experimental group were statistically different concerning gender, age and nationality. A chi-square test of independence was performed to check whether the two groups differ on gender and nationality while a t-test of independence was computed to explore whether they differed on age. Next, assumptions for the appropriateness of performing a paired sample t-tests were checked for the first two hypotheses. The first assumption (1) holds that the dependent variable needs to be continuous. Further (2), a linear relationship between the independent and dependent variable is required, that has been clarified by computing a scatterplot. The third assumption (3) suggests that no significant outliers should be detected, displayed in a boxplot. Lastly, the fourth assumption (4) requires that the difference between the pre-and post-measurement should be normally distributed that has been tested by performing a Shapiro-Wilk test. If those assumptions were not fulfilled, non-parametric tests, such as Spearman´s Rho and Wilcoxon signed-rank test are more suitable for statistical measurement.

With regard to the first and second hypothesis, Spearman´s Rho was computed to explore the relationship between the difference of the SSRQ and psychological well-being in the pre-and post-measurement for the control and experimental group. Cut-off scores used by Akoglu (2018) were applied to determine the strength of the correlation, ranging from weak ($\pm$0.1 - $\pm$0.3) to strong ($\pm$0.7 - $\pm$0.9), while $\pm$0 represents zero and $\pm$1 a perfect correlation. Moreover, either a paired sample t-test or the Wilcoxon signed-rank test, as a non-parametric alternative, will be performed to test whether there is a significant difference between the control and experimental group.

Concerning the third hypothesis, the assumption of linearity to run a linear regression

needed to be tested. Linearity between the independent variable "*number of completed ESM surveys*" and "*difference score-self-regulation*" as the dependent variable has been assessed by computing a scatterplot. When the assumption cannot be met, a Spearman´s rho test should be performed instead of a linear regression in order to test whether participants who completed more ESM surveys had a higher difference score in self-regulation (pre-post-measurement) than participants who completed less ESM surveys.

Results

Descriptive statistics

Participants. Regarding the participants characteristics, the majority of the participants were female in both the control and experimental group. Striking was, that the sample size of both groups was not equally spread as the experimental group had four times more participants than the control group. Moreover, the majority of participants was German in both groups, while the control group had a higher percentage of Dutch participants compared to the experimental group. Complete demographic information with exact values of the two groups separately as well of the full sample is demonstrated in Table 1.

Table 1.

Demographics: Experimental and Control Group

Characteristic	Experimental group		Control group		Full sample	
	N	%	N	%	N	%
Gender						
Female	29	78.4	6	66.7	35	76.1
Male	8	21.6	3	33.2	11	23.9
Others	0	0	0	0	0	0
Nationality						
German	35	94.6	6	66.7	41	89.1
Dutch	1	2.7	3	33.3	4	8.7
Others	1	2.7	0	0	1	2.2

	M	SD	M	SD	M	SD
Age	20.86	2.175	22.67	1.732	21.22	2.200

Self-regulation. Self-regulation mean-scores in the pre-and post-measurement together with minimum and maximum scores and standard deviations were calculated for the experimental- and control group to obtain a summary about the participants self-regulation capacity. Theoretically, a minimum score of 1 and a maximum score of 5 could be reached in this scale. In general, no meaningful differences between the scores in the pre-and post-measurements were detected when reporting the means. A slight difference can be detected between the mean scores of the experimental and control group as the mean scores of the control group were 0.3 points higher than the scores of the experimental group. All scores can be found in Table 2, as well as the mean difference scores between the pre-and post-measurement for self-regulation.

Table 2.

Descriptives of the SSRQ Questionnaire - Control and Experimental Group

Group	Scores	N	MIN	MAX	Mean	SD
Control						
	Pre-	9	2.58	4.13	3.51	0.49
	Post-	9	2.55	4.1	3,63	0.44
	Dif-	9	-0.19	0.81	0,12	0.28
Experimental						
	Pre-	37	2.84	3.55	3.24	0.19
	Post-	37	2.81	3.87	3.27	0.22
	Dif-	37	-0.55	0.52	0.02	0.21

Psychological Well-being. Descriptive statistics were also calculated for the PWB-Questionnaire to obtain a full picture of the differences in scores between the control and experimental group. In general, a theoretical minimum score of 1 and a maximum score of 7

were possible within this scale. When only comparing the mean scores psychological well-being of the pre- and post-measurement in the experimental group, no differences could be found. In contrast to that, the psychological well-being mean increased by 0.3 from the pre- to the post-measurement in the control group. Striking was also, that the experimental group mean score was much lower in the pre-and post-measurement compared to the average score of the control group. All mean values with its minimum and maximum scores as well as the standard deviations are reported in Table 3.

Table 3.

Descriptives of the PWB Questionnaire - Control and Experimental Group

Group	Scores	N	MIN	MAX	Mean	SD
Control						
	Pre-	9	3.11	5.78	4.98	0.94
	Post-	9	3.06	5.83	5.31	0.87
	Dif-	9	-0.17	2.06	0.33	0,67
Experimental						
	Pre-	37	2.56	4.67	3.57	0.38
	Post-	37	2.89	4.61	3.57	0.33
	Dif-	37	-0.72	0.67	0.001	0.33

Inferential statistics

Randomization check. A chi-square test of independence was performed to examine whether the two groups (experimental and control) differed on gender and nationality. First of all, no significant difference in gender could be found in the two groups [X^2 (1, N = 46) = 0.546, p = 0.462]. However, the two groups are meaningfully different on nationality [X^2 (2, N = 46) = 8.68, p = 0.013]. In addition, an independent t-test revealed that there was a significant difference between the two groups and the age of the participants, t (44) = 2.3, p = 0.026). Therefore, the control group and experimental group did differ significantly on nationality and age, which should be taken into account when discussing the results. But considering that the actual age difference of the two groups was only 1.8 years, with

participants in the control group being slightly older than participants of the experimental group and the majority of people were German in both groups, those effects might not be that substantial and meaningful for the outcome of this study.

Differences in self-regulation and psychological well-being. As the assumptions to perform a parametric test could not be fulfilled, non-parametric tests were chosen for the data analysis. The complete assumption check can be found in Appendix D. Spearman´s rho showed a moderately high relationship between the pre- and post- measurement of self-regulation (r (37) = 0.46, p = 0.004) and psychological well-being (r (37) = 0.45, p = 0.005) in the experimental group, as well as in self-regulation for the control group, r (9) = 0.68, p = 0.041). Yet, no significant correlation in psychological well-being has been found for the control group, r (9) = 0.553, p = 0.122. Next to that, a Wilcoxon signed-rank test showed no significant difference in self-regulation and psychological well-being for both, the control and experimental group. More detailed, the self-regulation pre-measurement (M = 3.24, SD = 0.19) and the post-measurement in the experimental group (M = 3.27, SD = 0.22) did not differ significantly, Z = -.543, p = 0.589. This result is equal to the outcome of the control group as the pre-measurement scores (M = 3.51, SD = 0.49) did not show a significant difference to the post-measurement scores (M = 3.63, SD = 0.44), Z = -1.011, p = 0.312. Moreover, same results were reported for psychological well-being as no difference between pre-measurement (M = 3.57, SD = 0.38) and the post-measurement (M =3.57, SD = 0.35), Z = -0.009, p = 0.993) in the experimental group and the control group were found (pre M = 4.98, SD = 0.93; post M = 5.31, SD = 0.87), Z = -1.689, p = 0.092).

Testing for reactivity. To test the third hypothesis, only the data of the experimental group (n = 37) has been used. Assumptions to perform a non-parametric test were not fulfilled and therefore, a non-parametric test was chosen to explore the relationship between the independent variable "*ESM surveys completed*" and the dependent variable "*pre-post difference score in self-regulation*". Spearman´s Rho showed a non-significant relationship between these two variables, r (37) = 0.031, p = 0.854. Even though the highest difference in self-regulation (0.52) was observed by a participant who filled out 15 ESM surveys, a negative difference score was accomplished by a participant who filled out 10 ESM surveys, hence, no consistent effect can be found here. A Scatterplot confirmed the non-linear relationship and the distribution of all values are illustrated in Figure 1.

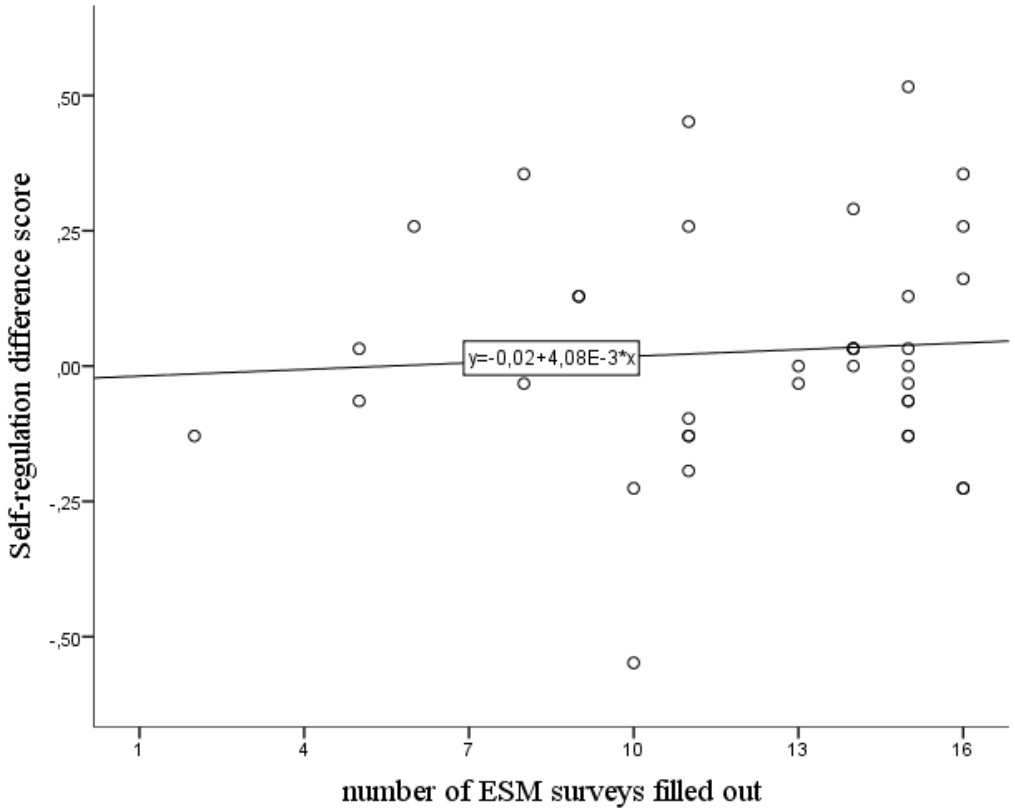

Figure 1. Self-regulation difference score by the number of completed ESM surveys.

Discussion

Conclusion

The aim of this study was to investigate whether self-regulation and psychological well-being are increased through a reactivity effect due to self-reporting on emotions within the approach of experience sampling. Due to a high number of students being confronted with stress and suffering from stress-related health issues, such research appeared to be relevant to find ways to counteract the trend and find ways to reduce stress in students (Ramli et al., 2018). A key finding of this research is, that neither self-regulation nor psychological well-being increased from the pre-to the post-measurement in the experimental group. Thus, the first two hypotheses, namely that self-regulation and psychological well-being increases when participants taking part in an experience sampling study, need to be rejected. The fact, that the control group did not report significant differences in self-regulation and psychological well-being scores as well, is in line with the hypothesis but this does not contribute to the exploration of a reactivity effect other than that no reactivity effect was found. With regard to the third hypothesis, that participants who completed more ESM surveys report a higher

difference score in self-regulation from the pre- to the post-measurement than participants who completed fewer surveys, could not be confirmed, as no positive correlation was found between those variables. Hence, it needs to be concluded that a reactivity effect could not be detected within this research.

Theoretical reflections

This research showed that no reactivity effect within an intervention-like effect concerning self-regulation and psychological well-being could be confirmed. Due to the fact that only a few studies have directly investigated whether a reactivity effect occurred within the approach of experience sampling, no clear trend towards reactivity could be determined in prior research about such effects. However, the outcomes of this research are contrary to studies that found such an effect within experience sampling. For example, Widdershoven et al. (2019) detected an increase in emotion regulation through the application of experience sampling in patients who suffered from depression. An explanation for such contrary findings might be the relatively short length of the current study. While the study by Widdershoven et al. (2019) lasted for 6 weeks, the ESM part of this study only had a duration of 4 days. Thus, participants may not had enough time to reflect on their self-regulation abilities nor psychological well-being, and a longer study duration could have led to a different study outcome.

Similar to this, Meier et al. (2017) detected a reactivity effect, in particular a behavioural change with regard to their alcohol consumption due to self-monitoring their behaviour within the approach of experience sampling. The author suggested that participants started to reflect and think about their alcohol consumption, triggered by the daily questions concerning their drinking behaviour. However, they found out that such a change only occurred for participants engaging in risky drinking behaviour, while overall alcohol consumption was not reduced in this study (Meier et al., 2017). This may lead to the conclusion that behaviour that is considered to be risky and dangerous is more inclined to achieve a change, which has also been confirmed within a study by Walters, Vader, Harris and Jouriles (2009). Taking into account that problematic drinking behaviour and a person's level of self-regulation are two very different constructs, namely that self-regulation per se does not affect one's physical or mental health and does not represent a risk behaviour, differences in study outcomes are not surprising.

Moreover, considering the type of questions that were asked within this experience sampling intervention, it can be stated that the questions regarding self-regulation and

psychological well-being focused on how a person experiences his/her ability to self-regulate at different times a day. However, a literature review by Wood et al. (2016) focused on the Question behaviour effect which "*refers to the impact of asking questions about a behaviour (vs. not asking such questions) on subsequent performance of that behaviour*" (p.245). Within their review, they found out that especially self-prediction questions promoted a behavioural or attitude change, and as those kinds of questions were not included in this study, this may serve for a possible explanation that no reactivity effect has been found.

The fact that self-regulation could rather be considered as a personality trait instead of a state of mind, could be seen as another explanation that no reactivity effect could be found within this research. According to Hampson et al. (2016), the degree to which individuals engage in self-regulation processes may originate early during childhood when personality traits are developed and shaped. He stated that "*individuals with higher levels of traits related to self-regulation, such as conscientiousness, are more likely to value their health and engage in actions (self-regulation processes) that support the goal of staying healthy"* (Hampson et al., 2016, p.152). Hence, self-regulation may depend on the degree to which certain personality traits are pronounced. In general, such traits are rather difficult to change, especially during an ESM intervention in which no exercise-based treatments were provided. For example, a study by Hudson and Fraley (2015) that focused on the process of changing certain personality traits, revealed that individuals were most likely to achieve an alteration of personality traits when the individual possesses the desire to change over a long period of time. Applying this to the current study, it needs to be stated that the participants were randomly selected and did not participate with the intention to achieve a change in behaviour. Hence it can be concluded, that self-regulation in general might be difficult to change by priming participants with experience sampling questions.

Another point that should be considered is, that the questions used for the state questionnaire had a high emphasis on the self-regulation abilities concerning the body. While those questions focused on whether participants were able to self-regulate by applying strategies to listen to the body, the trait questionnaire was focused on the cognitive elements of self-regulation. Thus, that no change was detected from the pre- to the post measurement in self-regulation, might be due to the cognitive nature of the SSRQ, as the trait and state questionnaire measured different aspects of self-regulation.

Strong points and limitations

The study displayed some strengths regarding the general set-up of the research. From most of the participants, we received positive feedback about the Ethica application as the usage was perceived to be handy and easy to understand. Through the daily questionnaires which were triggered four times a day, the real-life emotions of participants could be captured rather than them being influenced through an artificial and laboratory context. As part of this strength, memory strains could be reduced by using the approach of experience sampling methodology, as participants had to report their emotions within one hour and therefore reminiscence bias can be ruled out. Finally, as the phenomenon of reactivity has not been explored with regard to changes in self-regulation and psychological in prior research, this study fills a present research gap and adds valuable information for designing and implementing future studies.

However, there are also some potential limitations of this study that should be considered when interpreting the results of this research. One limitation that may arise when conducting experimental research encompasses the threat of differences between experimental and control group that may be responsible for the effect found in the study (Podsakoff & Podsakoff, 2019). In this study, the experimental and control group differed concerning the group size as well as with regard to their characteristics. While the final experimental group consisted of 36 participants, only one-quarter of the participants were assigned to the control group (9 participants). This was of part due to a high percentage of people in the control group who did not fill out the post-measurement of the study and therefore needed to be excluded from the final data set and partly because fewer people in general signed up for the control group. Effects found in the study could therefore also evolved due to an unequal distribution of participants in the experimental and control group. When running some tests to investigate whether those groups also differ on gender, age and nationality, a difference in age and nationality could be detected. However, it should be considered, that the nationality of a participant as well as their age (as everyone was above 18 and only students took part in the study, who should be familiar with technological means required in this research) probably does not affect how people react on an experience sampling study. Only if for example, both groups had significantly different scores in psychological well-being, this could have a tremendous effect on the outcome of a study.

Implications and directions for future research

Despite the mentioned limitations, these results suggest some theoretical and practical implications. Deepening the research in the effects of applying experience sampling methodology is very important as it can give suggestions and directions whether treatment-based interventions are effective itself or whether a reactivity effect contributed to a change. As no reactivity effect could be found in this research, the phenomenon reactivity as a plausible alternative explanation for the beneficial effects of biofeedback in relation to self-regulation could be ruled out for the current study. However, those results should be interpreted with caution, as the sample size and the duration of this study precludes from ruling out any effect. Still, the finding of this study emphasizes that, in the future, the focus should be put on applicable interventions, such as the use of biofeedback, to achieve a change in self-regulation and subsequently, in the level of psychological well-being, as solely priming students with ESM questionnaires did not show an effect. Only reflecting on one's self-regulation behaviour did not seem to be sufficient to already achieve an improvement in one's self-regulation capacity. Finding ways to increase people or especially student's self-regulation seems of high importance, as a positive correlation between self-regulation and reduced stress has been found in prior research (Hofer, Busch & Kärtner, 2011). Therefore, an implication would be to foster research on biofeedback which was found to be effective to achieve changes in self-regulation (Yu, 2018). Being able to perform self-regulation requires to be in a state of self-awareness which can be reached by using biofeedback devices that monitor physiological and emotional changes. Bringing thoughts, emotions and behaviours into consciousness may enable individuals to effectively manage one´s behaviour and impulses (Vago & David, 2012). As reported by Yu (2018), to enhance self-regulation skills through biofeedback, it is necessary to reach a stage of self-learning in which he or she makes sense of the information provided by the biofeedback device. As the current study has shown that a reactivity effect did not occur within the approach of experience sampling when focusing on increasing self-regulation and psychological well-being, it should now be tested whether the application of an ambulatory biofeedback device, could actually change participants self-regulation capacities.

For example, smartwatch applications such as the "Sense-IT" have shown promise as a technological aid for body awareness, as this technology informs the users about changes in the heart rate and aims at enhancing the user´s ability to recognize physiological changes, and thus their emotional awareness (Derks, Klaassen, Westerhof, Bohlmeijer & Noordzij,2019). If a change in self-regulation would be found when applying this technology in future research, it would be clear that the biofeedback device itself and not reactivity was the prime

contributor to that outcome. However, the mentioned limitations of this study should be taken into account when running future research, as a more equal sample size of both the control and experimental group as well as a longer duration of the study would be recommended to draw more accurate and valid conclusions. For future research, even though the use of experience sampling methodology can still be recommended, it may be suggested that treatment-oriented interventions such as ambulatory biofeedback technologies should be included in experience sampling approaches as solely priming participant with ESM questions did not lead to significant changes. Furthermore, it might be suggested that the ESM questions should be formulated in a more self-predicting style, as Wood et al. (2016) found out that those type of questions promoted the highest behavioural change. It is also advisable to use a more bodily focused self-regulation questionnaire for measuring the trait "self-regulation" as it might be assumed that an improvement in self-regulation works best through body awareness and attention training. Hence, integrating ambulatory biofeedback technologies, as they have shown to be effective to increase body awareness, could represent a good future approach to increase people´s self-regulation capacities.

Thus, even though no reactivity effect could be found when applying experience sampling on the level of self-regulation and psychological well-being in students, this outcome has enhanced our understanding that future interventions should largely rely on implementing exercises and treatments such as the use of ambulatory biofeedback, to achieve changes in self-regulation and psychological well-being. By all means, the generality of current results must be established by future research including more large-scale and longer studies, and until then, the effect of reactivity found in other studies should be considered as a positive side effect of an intervention but not be seen as a treatment option itself. In general, fostering the research on ways to effectively increase self-regulation in humans, seems to be very important, as such a change could ultimately also contribute to reduce the stress levels of people which represents one of the biggest challenges in our fast-paced society.

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Appendices

Appendix A: *Informed Consent Form*

10. 04.2020 University of Twente, Enschede, Netherlands

Consent Form

Informed Consent for the research 'Testing Reactivity of Interoceptive Awareness in the daily life of Students'

Your participation in this survey is completely voluntary and all your responses are treated anonymously. None of the responses will be connected to identifying information. Data will only be used for statistical analyses.

However, you can withdraw from the study at any time if you feel uncomfortable or stressed! By simply stopping answering the daily questions.

Appendix B: *Short Form Self-Regulation Questionnaire (SSRQ)*

Short Form Self-Regulation Questionnaire (SSRQ)

Please answer the following questions by circling the response that best describes how you are. Remember, there are no right or wrong answers.

	Strongly Disagree	Disagree	Uncertain or Unsure	Agree	Strongly Agree
1. I usually keep track of my progress towards my goals.	1	2	3	4	5
2. I have trouble making up my mind about things.	1	2	3	4	5
3. I get easily distracted from my plans.	1	2	3	4	5
4. I don't notice the effects of my actions until it is too late.	1	2	3	4	5
5. I am able to accomplish goals I set for myself.	1	2	3	4	5
6. I put off making decisions.	1	2	3	4	5
7. It's hard for me to notice when I've "had enough" (alcohol, food, sweets).	1	2	3	4	5
8. If I wanted to change, I am confident that I could do it.	1	2	3	4	5
9. When it comes to deciding about a change, I feel overwhelmed by the choices.	1	2	3	4	5
10. I have trouble following through with things once I've made up my mind to do something.	1	2	3	4	5
11. I don't seem to learn from my mistakes.	1	2	3	4	5
12. I can stick to a plan that's working well.	1	2	3	4	5
13. I usually only have to make a mistake one time in order to learn from it.	1	2	3	4	5
14. I have personal standards, and try to live up to them.	1	2	3	4	5
15. As soon as I see a problem or challenge, I start looking for all possible solutions.	1	2	3	4	5
16. I have a hard time setting goals for myself.	1	2	3	4	5
17. I have a lot of willpower.	1	2	3	4	5
18. When I'm trying to change something, I pay a lot of attention to how I'm doing.	1	2	3	4	5
19. I have trouble making plans to help me reach my goals.	1	2	3	4	5
20. I am able to resist temptation.	1	2	3	4	5
21. I set goals for myself and keep track of my progress.	1	2	3	4	5
22. Most of the time I don't pay attention to what I'm doing.	1	2	3	4	5
23. I tend to keep doing the same thing, even when it doesn't work.	1	2	3	4	5
24. I can usually find several different possibilities when I want to change something.	1	2	3	4	5
25. Once I have a goal, I can usually plan how to reach it.	1	2	3	4	5
26. If I make a resolution to change something, I pay a lot of attention to how I'm doing.	1	2	3	4	5
27. Often I don't notice what I'm doing until someone calls it to my attention.	1	2	3	4	5
28. I usually think before I act.	1	2	3	4	5
29. I learn from my mistakes.	1	2	3	4	5
30. I know how I want to be.	1	2	3	4	5
31. I give up quickly.	1	2	3	4	5

Appendix C: *Psychological Well-being scale (18 items)*

1. "I like most parts of my personality."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

2. "When I look at the story of my life, I am pleased with how things have turned out so far."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

3. "Some people wander aimlessly through life, but I am not one of them."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

4. "The demands of everyday life often get me down."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

5. "In many ways I feel disappointed about my achievements in life."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

6. "Maintaining close relationships has been difficult and frustrating for me."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

7. "I live life one day at a time and don't really think about the future."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

8. "In general, I feel I am in charge of the situation in which I live."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

9. "I am good at managing the responsibilities of daily life."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

10. "I sometimes feel as if I've done all there is to do in life."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

11. "For me, life has been a continuous process of learning, changing, and growth."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

12. "I think it is important to have new experiences that challenge how I think about myself and the world."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

13. "People would describe me as a giving person, willing to share my time with others."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

14. "I gave up trying to make big improvements or changes in my life a long time ago"

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

15. "I tend to be influenced by people with strong opinions"

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

16. "I have not experienced many warm and trusting relationships with others."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

17. "I have confidence in my own opinions, even if they are different from the way most other people think."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

18. "I judge myself by what I think is important, not by the values of what others think is important."

Strongly agree	Somewhat agree	A little agree	Neither agree nor disagree	A little disagree	Somewhat disagree	Strongly disagree

Appendix D: Testing assumptions for parametric tests

Testing the assumptions for using a parametric test showed that (1) could be met as the dependent variable is continuous. (2) Creating a scatterplot indicated a linear relationship between the pre- and post-scores in self-regulation and psychological wellbeing in both groups (3). However, (3) could not be met as significant outliers were found in the control as well as the experimental group for both psychological construct. Lastly, (4) a Shapiro-Wilk test showed that the data of the self-regulation scores is not normally distributed (W (46) =.943, p = 0.024) as well as no normality could be affirmed concerning the psychological wellbeing values, $W(46) = .839$, $p < 0$. Consequently, as the assumptions to perform a parametric test could not be fulfilled, a non-parametric test was chosen.