The influence of a Self-Control Training App on Students' Levels of Self-Control and Bedtime Procrastination : A Single Case Experimental Design

R.S.M. van den Brink

Faculty of Behavioural, Management and Social Sciences, University of Twente

Positive Clinical Psychology and Technology

1st Supervisor: Dr. Tessa Dekkers

2nd Supervisor: Dr. Selin Ayas

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Abstract

Bedtime procrastination is an increasingly common societal problem, with detrimental consequences for one's well-being and mental health. Because of the behavioural component of bedtime procrastination, current theories suggest that it is a form of self-control failure. Prior research has found that self-control training (SCT) is effective in increasing self-control, but it has not yet been examined if and how changes in self-control affect bedtime procrastination. This study aimed to evaluate to what extent the SCT-app SCIPP affects students' level of self-control as well as bedtime procrastination. An introduction-withdrawal single-case experimental design (SCED) was during which participants were asked to use SCIPP as well as fill in daily questionnaires on self-control and bedtime procrastination. Data was analysed using visual and statistical analyses. Intervention effects for all participants turned out to be non-significant. Bedtime procrastination and self-control do not seem to co-vary over time. A negative autocorrelation pattern seems present for half of the participants regarding bedtime procrastination. Results of this study suggest that the current version of SCIPP might not be effective for users aged 22-34 who do not have a mental illness. Next to that, bedtime procrastination might be dependent on factors other than self-control.

Introduction

Sleep is deemed one of the most important biological requirements for human life (Buysse, 2014; Grandner, 2017). Getting sufficient sleep, between 7 and 8 hours, is seen as vital for maintaining good physiological and mental health (Kitamura et al., 2016). Yet over the past decades, a trend has emerged in which the general population gradually spends less hours asleep (National Sleep Foundation, 2005, as cited in Kroese et al., 2016a). A recent study even shows that up to 74 percent of a sample representative of the entire Dutch adult population unnecessarily pushes back their bedtime at least once a week (Kroese et al., 2016a).

This phenomenon of unnecessarily delaying the time one goes to bed is called bedtime procrastination, which is more clearly defined by Kroese et al. (2014) as "going to bed later than intended while no external circumstances are accountable for doing so". In such scenarios, a gap between intention and actual behaviour can be observed. People have the intention of going to bed at a certain time but end up postponing actually going to bed. This can result in less hours of sleep. Research confirms this mechanism and shows that bedtime procrastination in general tends to lead to shorter durations of sleep, sometimes even reaching insufficient levels (Kroese et al., 2014; Kadzikowska-Wrzosek, 2020).

Several negative psychological outcomes have been identified of the shorter durations of sleep associated with bedtime procrastination. First, a shorter duration of sleep is associated with lower levels of happiness in general, as well as a higher risk of developing mood disorders such as anxiety and depression (Zhao et al., 2019). Second, it is associated with higher levels of despair and rumination, and lower levels of self-esteem, life satisfaction, and overall measures on well-being (Lee & Sibley, 2019). Thus, people who often procrastinate going to sleep run a

higher risk of experiencing these negative psychological outcomes than people who do not unnecessarily postpone their bedtime.

Because of the behavioural component of bedtime procrastination, it can be seen as a problem with self-control (Kroese et al., 2016b). As explained by Tangney et al. (2004, p.274), self-control refers to "the ability to override or change one's inner responses, as well as to interrupt undesired behavioural tendencies (such as impulses) and refrain from acting on them". When applying the concept of self-control to bedtime procrastination, an explanation can be offered which states that people unnecessarily postpone their bedtime because they fail to disregard inner responses, temptations, or impulses that tempt them to stay up for longer. Next to that, task aversion regarding bedtime-related tasks such as brushing one's teeth could play a role. In all these cases, a lack of self-control could explain why one fails to go to bed at the intended time. Multiple studies have confirmed this dynamic by showing that lower levels of self-control are related to higher levels of bedtime procrastination, and vice versa (Kroese et al., 2014; see also Digdon & Howell, 2008; Exelmans & Van den Bulck, 2021; Kadzikowska-Wrzosek, 2018).

Kroese and colleagues (2014) conducted research on the association between self-control and bedtime procrastination. In their study, self-control is viewed as a stable trait which is unlikely to change significantly over time. However, according to a study on self-control by Na and Paternoster (2012), self-control can also be viewed as an ability. Their study showed that people's ability to control themselves differed over time, and that their level of self-control could be improved by efforts to train it. So, according to this perspective on self-control, it is possible that people can score differently on their level of self-control each day. Na and Paternoster's (2012) results are in line with the strength model of self-control as explained by Baumeister et al. (2003; 2017). The strength model of self-control proposes that every individual possesses a pool

of resources, from which they draw to resist temptations or impulses. Successful resistance of impulses draws from this pool of resources, which temporarily leaves less resources available for another attempt. Baumeister et al. (2003) compare this mechanism to the working of a muscle. A muscle will become temporarily exhausted when used, but training can improve its strength. This is also the case with self-control, and the strength model suggests that repeatedly practising to resist or overrule impulses can enlarge one's pool of resources. In accordance with the strength model of self-control by Baumeister (2003; 2017), this study will view self-control as an ability, and examines if and how bedtime procrastination is affected by possible changes in one's level of self-control.

Based on the strength model of self-control, self-control training (SCT) has been developed. SCT incorporates tasks such as opening doors with one's non-dominant hand, avoiding use of slang, or bettering one's posture (Berkman, 2016). These tasks then have to be completed over a pre-specified time. This helps increase participants' self-control by learning how to resist an impulse, as well as to replace it with a desired response (Friese et al., 2017; Finkel et al., 2009). A meta-analysis of 33 studies on the overall effectiveness of SCT found small to medium positive effects on self-control (Friese et al., 2017).

SCTs are now also being offered digitally, due to the advantages of and the growing interest in eMentalHealth interventions (Cranwell et al., 2014; Dekkers et al., 2021; Kip et al., 2021). These digital applications of SCT are more easily accessible, time-efficient, and cost efficient than traditional in-person therapy forms (Lal & Adair., 2014). An example of a digital SCT application is SCIPP (Dekkers et al., 2021). In this app, 14 different self-control tasks are included, and each user has to execute one self-control challenge every day over a two week

period (Kip et al., 2021). The results of the study showed a positive effect on self-control for university students (Kip et al., 2021) and adults with a mental illness (Dekkers et al., 2021).

While the effect of SCIPP on self-control has been investigated in both a student (Kip et al., 2021) as well as a mentally-ill adult sample (Dekkers et al., 2021), no prior research on SCIPP or other SCT has been conducted yet in the context of bedtime procrastination. Especially the student population could benefit greatly from the possible effect of digital SCTs on bedtime procrastination, since bedtime procrastination has proven to negatively affect academic performance (Ghafoor et al., 2022). Additionally, improvements in students' self-control are also linked to higher academic attainment, course grades, and achievement test scores (Duckworth & Carlson, 2013). Therefore, it is interesting to examine if and how usage of SCIPP will affect self-control and bedtime procrastination in a student population.

Thus, this study aims to assess the effectiveness of SCIPP in increasing self-control as well as decreasing bedtime procrastination. Based on previous research on the association between self-control and bedtime procrastination, and the effectiveness of SCIPP, it is expected that SCIPP will have a positive effect on both self-control and bedtime procrastination.

Methods

Study design

For this study, a Single Case Experimental Design (SCED) was chosen. SCED is an experimental research method that tests the efficacy of an intervention, using only a small number of participants who simultaneously serve as their own control (Krasny-Pacini & Evans, 2018). This is typically done by repeatedly measuring a behaviour, mood, or context both in the absence and presence of an intervention. The type of SCED that was chosen for this study is an introduction-withdrawal design (also known as reversal design) (Smith, 2012). This design is suitable when manipulation is expected to lead to changes in the dependent variable that are

expected to reverse or disappear when the manipulation is not there (Smith, 2012). In the context of this study, engaging in SCT is expected to lead to an increase in self-control and a decrease in bedtime procrastination, but these effects are expected to reverse or disappear when participants do not engage in SCT. An introduction-withdrawal design typically consists of four phases (ABAB). After a first baseline period (A_1), the intervention (B_1) is temporarily stopped (A_2) to assess whether the intervention during period B_1 (and later on B_2) led to a change in participants' level of self-control and the extent to which they engaged in bedtime procrastination. For this study, the duration of each phase is 7 days, resulting in a 14-day total for both the actual intervention as well as the control period. When including the day on which the baseline measures are established, the total study duration is 29 days (see Table 1).

Moreover, Experience Sampling Methodology (ESM) was chosen to track possible fluctuations or changes regarding participants levels of self-control and bedtime procrastination. ESM is a structured self-report diary technique that can be used to examine subjective experiences as they occur in daily life (Myin-Germeys et al., 2018). In the context of this study, it means that participants received daily questionnaires regarding self-control and bedtime procrastination for the entire duration of the study. The ethical committee of the University of Twente approved this study (request number 230104).

Participants

For this study, 6 participants were gathered through convenience sampling. The participants were all existing contacts of the researcher, either derived from their network at the University of Twente, or their social network. To take part in the study the following inclusion criteria applied. First, participants needed to have access to an Android smartphone, in order to be able to use SCIPP. Second, they had to be either left- or right-handed, so not ambidextrous.

Third, they needed to be able to use their hands for the daily self-control exercises. Fourth, they needed to possess a sufficient understanding of the Dutch language. Fifth, they currently had to be a student at an university. The demographic information of the participants can be found in table 2.

Table 1

Overview of study design

Time	Day 1 (Baseline assessment)	Day 2-8 (Control phase 1)	Day 9-15 (Intervention phase 1)	Day 16-22 (Control phase 2)	Day 23-29 (Intervention phase 2)
11:00-13:00		SC BP	SC BP	SC BP	SC BP
19:00-21:00		SC	SC	SC	SC
12:00-15:00	Demographics BPS BSCS	BPS[a] BSCS[a]	BPS[a] BSCS[a]	BPS[a] BSCS[a]	BPS[a] BSCS[a]

Note. This table provides an overview of each phase of the study, as well as which measurements are taken at which days/times. SC refers to self-control items. BP refers to bedtime procrastination items. BPS refers to the Bedtime Procrastination Scale. BSCS refers to the Brief Self-Control Scale.

[a] These measures only take place once on the last day of every phase, in the indicated timeframe.

Table 2

Participant demographic information

Participant	Age, Sex, Nationality	Handedness	Mental Illness	Trait self-control at A1	Bedtime Procrastination at A1
1. Koen	22, Male, Dutch	Right	No	45	23
2. Max	34, Male, Dutch	Right	No	28	20
3. Sophie	23, Female, Dutch	Right	No	37	27
4. Stijn	22, Male, Dutch	Right	No	35	40
5. Jutta	22, Female, German	Right	No	44	26
6. Esmee	23, Female, Dutch	Right	No	34	21

Note. Participant names in this table have been changed with regard to anonymity. Self-control refers to participants' level of self-control prior to starting the study (scale 13-65, higher score indicates high self-control). Bedtime procrastination refers to participants' level of bedtime procrastination prior to starting the study (scale 9-45, higher score indicates high bedtime procrastination).

Materials & Measures

Ethica

Ethica was used to obtain informed consent from the participants (see Appendix B), as well as gather data on participants' levels of self-control and bedtime procrastination. Ethica is a digital platform which allows researchers to gather data by using participants' own smartphones (ethicadata.com). By installing the Ethica app on participants' smartphones, questionnaires can be sent directly to participants, which enables participants to answer them in a more natural setting. For this reason, using ESM in combination with participants' own mobile devices results in high ecological validity (Van Berkel et al., 2017; Verhagen et al., 2016). Moreover, the

questionnaires can be presented to participants at the desired times. To remind participants of when the questionnaires should be completed, pop-up notifications are used.

Intervention

SCIPP is a self-control training app developed by Kip et al. (2021). Each participant receives their own account and login code, and the app will then present them with 14 daily challenges (see Table 3). Each day, participants will receive a new challenge to encourage them to use their non-dominant hand for daily tasks. In the app, participants can track on what day they currently are, how many days of the training are still left, which days they succeeded or failed their challenge, and what the challenge for a specific day is (see Figure 1).

According to the Fogg Behaviour Model (FBM) of persuasive design, three factors are responsible for influencing human behaviour: motivation, ability, and triggers (Fogg, 2009). In order for a target behaviour to happen, individuals must posses sufficient motivation and ability, as well as exposure to a trigger. When all three factors are present at the same time, it is likely that the target behaviour occurs. SCIPP has been designed to incorporate all three factors. Usability tests on the current version of the app show that users were motivated to work on self-control due to coaching of the mascot, could successfully navigate the app on their own, and found the reminders to execute the challenges helpful (Dekkers et al., 2021).

Figure 1

Screenshots of SCIPP

Note. This figure shows screenshots of the start screen, a daily task, and the task overview

Table 3

SCIPP tasks

Day of the study	Task number	Description
8	8	Pour drinks with your non dominant hand
9	9	Push or pull up your chair with your non-dominant hand
10	10	Throw things in the trash with your non-dominant hand
11	11	Grab food with your non-dominant hand
12	12	Close/open your zipper or buttons with your non-dominant hand
13	13	Clean with your non-dominant hand
14	14	Open cabinets with your non-dominant hand
22	1	Open doors with your non-dominant hand
23	2	Hold a fork with your non-dominant hand
24	3	Hold your mobile phone with your non-dominant hand
25	4	Drink from a cup, mug, or bottle using your non-dominant hand
26	5	Switch lights on/off with your non-dominant hand
27	6	Turn the tap on/off with your non-dominant hand
28	7	Cover your mouth when you yawn with your non-dominant hand

Measures

Weekly measures. A baseline assessment, as well as weekly scores, on self-control and bedtime procrastination were gathered. To assess self-control, the Brief Self-Control Scale (BSCS) was chosen (Tangney et al., 2004) (see Appendix A). The BSCS consists of 13 items, of which 4 items portray a high level of self-control and 9 items portray a low level of self-control. An

example of an item which portrays a high level is “I refuse things that are bad for me”. An example of an item which portrays a low level is “I find it difficult to quit with bad habits”. The scoring was done on a 5 point Likert scale, ranging from ‘not at all’ (1) to ‘very much’ (5). After reverse-coding the 9 low self-control items, participants’ final scores were calculated by adding the scores of all items together, leaving them with a score between 13 and 65. A higher final score indicates a higher level of self-control. The BSCS shows good reliability as well as good discriminant and convergent validity among college students (Tangney et al., 2014).

To assess bedtime procrastination, the Bedtime Procrastination Scale (BPS) by Kroese et al. (2014) was chosen (see Appendix A). The BPS consists of 9 items, of which 5 items portray a high level of bedtime procrastination and 4 items portray a low level of bedtime procrastination. An example of an item which portrays a high level is “I go to bed later than I had intended”. An example of an item which portrays a low level is “I have a regular bedtime that I keep to”. Participants had to answer across a 5 point Likert scale, ranging from ‘(almost) never’ (1) to ‘(almost) always’ (5). After reverse-coding the 4 low bedtime-procrastination items, participants’ final scores were calculated by adding the scores of all items together, leaving them with a score between 9 and 45. A higher final score indicates more bedtime procrastination behaviours. The BPS has proven to have good validity, as well as good test-retest reliability (Kroese et al., 2014; Kroese et al., 2016). Moreover, the BPS has good discriminant validity since it successfully distinguishes between general procrastination and bedtime procrastination (Kroese et al., 2014).

Daily measures. For the daily assessment of self-control and bedtime procrastination, 7 items were selected, of which 4 items measured participants’ level of self-control and 3 items measured participants’ level of bedtime procrastination (see Appendix A). An example of one of the self-control items is “Did you find it difficult to make decisions during the last few hours,

even about simple things?". The self-control items were scored on a 5-point Likert scale, ranging from '(almost) never' (1) to '(almost) always' (5). A pilot study on the daily self-control items showed high face validity (Schankweiler, 2022). To assess whether participants engaged in bedtime procrastination on a certain day, no prior validated scale could be found. Therefore, the items "At what time do you plan to go to bed today?" and "What time did you actually go to bed last night?" were created. Participants had to answer the items by filling in a specific time, e.g. 22:00. These answers were then compared to see whether participants went to bed at the time they originally planned. One more open-answer item was added for bedtime procrastination in which participants could offer an explanation for a (possible) deviation in bedtime. This way, it could be checked whether there was an external factor responsible for the delayed bedtime or whether an internal factor (e.g. self-control) was at play. This procedure of measuring daily bedtime procrastination is new, but offers the possibility to (relatively) objectively assess whether participants procrastinated their bedtime by comparing the reported bedtimes in combination with evaluation of given reasons for missing their planned bedtime.

Procedure

Before the start of the data collection, participants received an email in which they were briefed about the procedure of the study (see Appendix C). The email contained instructions which informed participants how to download SCIPP and Ethica on their mobile phone, and how to create and access their accounts. Moreover, information was provided on how the apps worked and how they could use them. Lastly, it was explained that Ethica had to be used for the entire duration of the study, but that participants only had to use SCIPP during the two 7-day intervention phases. So, it was emphasised that even though SCIPP would be accessible on their

phone for the entire duration of the study, they were only expected to use it during the actual intervention phases.

The data was collected over 29 days during March and April 2023 using Ethica (see Table 1). Written consent was given by all participants via email before the start of the data collection. Before the first phase of the study started, participants were asked to establish a baseline measure on self-control and bedtime procrastination in Ethica by answering 5 demographic items, as well as the BPS and BSCS. Over the 29-day period in which the study took place, participants received daily and weekly notifications from Ethica that asked them to fill in the items. Each day, they had to fill in one questionnaire between 11 a.m. and 1 p.m. and one between 7 p.m. and 9 p.m. Reminders were sent after 30 minutes and 1 hour in case a participant failed to fill in a questionnaire. If the items were not filled in after 2 hours, participants were not able to do so anymore. The allowed response delay was kept relatively short, since larger response delays can negatively affect the reliability of the data, through increasing self-selection bias as well as recall bias (Myin-Germeys & Kuppens, 2021). At the end of each phase, participants were asked to fill in two additional questionnaires: the BPS and the BSCS. This was always on the seventh day of a phase, between 12 and 3 p.m. (see Table 1). For these questionnaires, reminders were sent after 30 minutes and 1 hour in case a participant had failed to fill them in. After 5 hours, participants were not able to answer them anymore. The scores of the BPS and BSCS that were answered by the participants on the last day of the study were seen as final post-test scores.

Analysis

After extracting the data from Ethica, suitable files were created for running the analyses in R using the Shiny SCDA plug-in-package (Bulté & Onghena, 2013). There will be both individual and group components to the analyses.

Analyses of daily measures

First of all, the most dominant evaluation method used for SCEDs is Single-Case Visual Analysis (SCVA), which provides graphical presentations of the data between phases and between participants (Kazdin, 2021). Within SCVA, attention is paid to the measure of central tendency, variation, and possible trends in the data. The measure of central tendency helps understand the overall magnitude of participants' scores in each phase. The variability provides insight into the stability or inconsistency of participants' scores in each phase. Trendlines help identify the overall direction and consistency of participants' scores in each phase. The daily scores for both self-control and bedtime procrastination of each participant will be visualized in two figures. Each figure contains three different plots, to visualize the measure of central tendency, variability, and possible trends. For the figures regarding self-control, measurement times are represented on the x-axis and self-control scores on the y-axis. For the figures regarding bedtime procrastination, measurement times are represented on the x-axis and the y-axis shows how many minutes after their planned bedtime participants actually went to bed.

Second, for each participant, Single-Case Randomization Tests (SCRT) were run to determine whether random variations in self-control and bedtime procrastination had occurred, which would suggest that any observed differences in the data are due to the effect of SCIPP (Bulté & Onghena, 2013). Lastly, a Single-Case Meta-Analysis (SCMA) was run to be able to determine the effect size measures for each participant, as well as to see whether there was an

overall significant effect of SCIPP on self-control and bedtime procrastination on a group level (Bulté & Onghena, 2013).

Analyses of weekly measures

For both self-control and bedtime procrastination, participants' weekly scores were examined to see how their scores changed during the study period. More specifically, comparisons were made between their scores on day 0 and day 28 (i.e. at the first and last day of the study), and between day 7 and day 14 (i.e. before and after receiving the first 7 days of SCT). Here, the focus was not on the exact changes for each individual participant, but more on changes in scores on a group level.

Comparison daily and weekly measures

For both self-control and bedtime procrastination, the daily measures were compared to the weekly measures. This was to examine to what extent the daily and weekly measures actually seemed to measure the same underlying construct.

Results

Daily self-control

Individual participant results

Koen, 22-year old Dutch male student. The self-control scores of participant 1 show great stability across all four phases (see Figure 2). Few differences can be found between the baseline period (range: 3.5-4.75, $M = 4.09$), first intervention phase (range: 3.75-4, $M = 3.91$), control period (range: 3.88-4.25, $M = 4.05$), and second intervention phase (range: 3.88-4.13, $M = 4.02$). The observed test statistic and p-value show that the differences in participant 1's level of self-control across phases were statistically non-significant ($p = .514$), which means that SCIPP was not effective in improving daily self-control for this participant (see Table 4).

Figure 2

Koen - Daily scores on self-control across each study phase

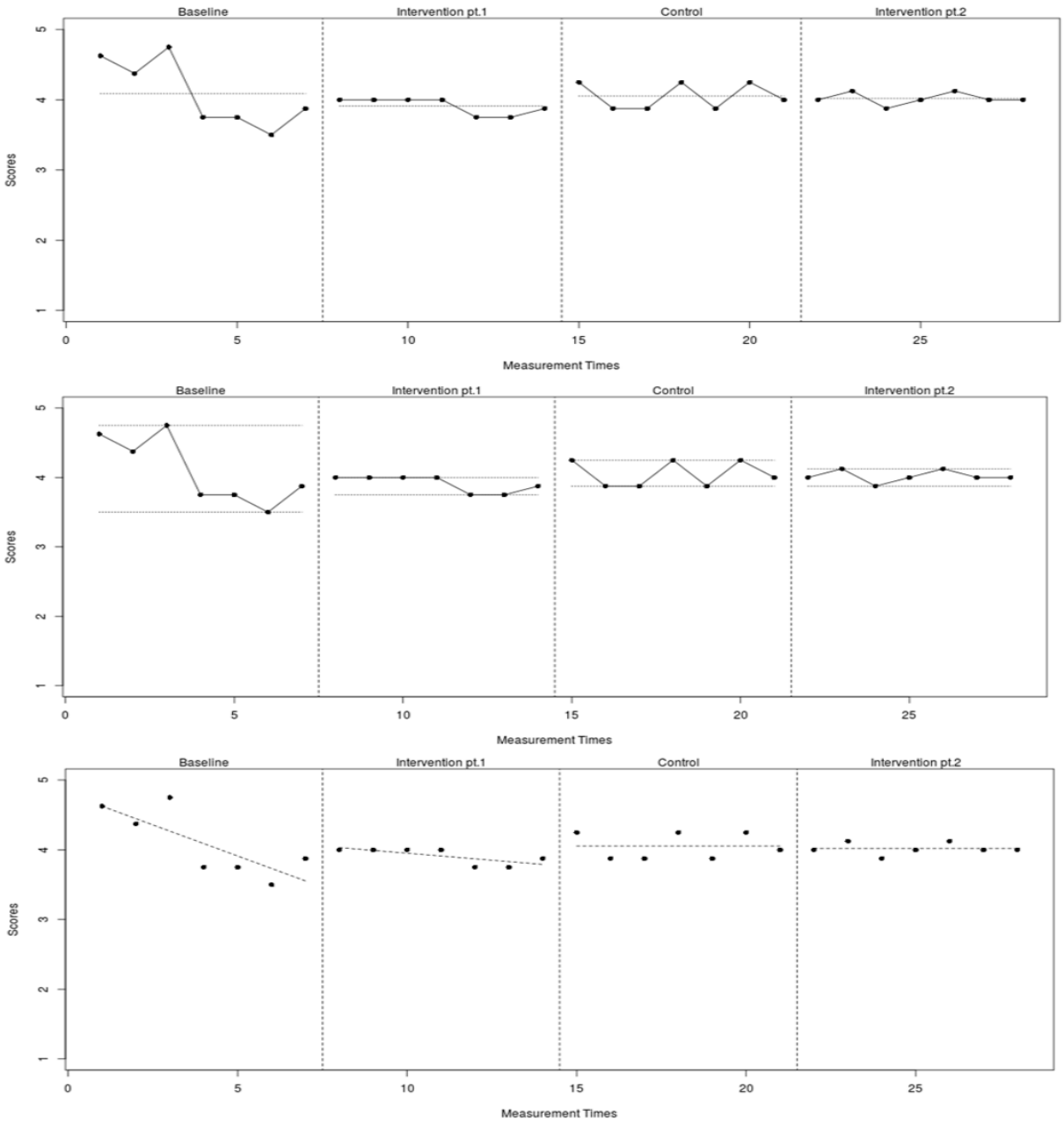


Table 4

SCRT and SCMA on participants' daily scores on self-control

Participant	Observed test statistic	P-value	Effect size measure
1. Koen	-0.11	.514	-0.28
2. Max	-0.03	.815	0.08
3. Sophie	-0.12	.815	-0.31
4. Stijn	-0.23	.879	-0.59
5. Jutta	0.10	.679	0.19
6. Esmee	-0.24	.457	-0.21

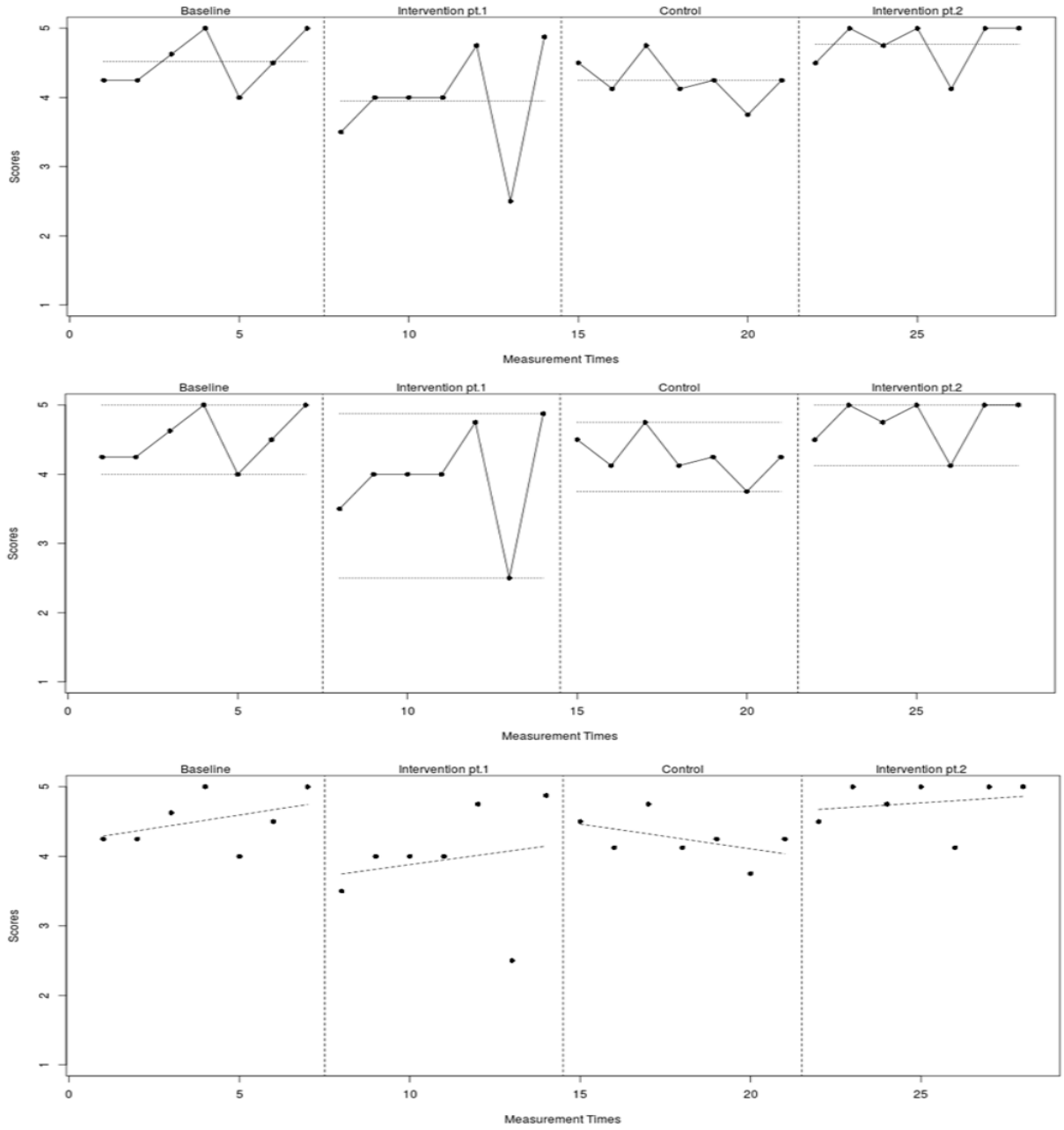
Note. SCRT refers to Single-Case Randomization Tests. SCMA refers to Single-Case Meta-Analysis.

Max, 34-year old Dutch male student. Participant 2 reported high levels of self-control throughout the study period, with occasional days of low self-control and no clear differences between baseline period (range: 4-5, $M = 4.52$), first intervention phase (range: 2.5-4.88, $M = 3.95$), control period (range: 3.75-4.75, $M = 4.25$), and second intervention phase (range: 4.13-5, $M = 4.77$) (see Figure 3). The observed test statistic and p-value show that the differences in participant 2's level of self-control across the different phases were statistically non-significant ($p = .815$), which means that SCIPP was not effective in improving daily self-control for this participant (see Table 4).

Sophie, 23-year old Dutch female student. Participant 3 reported overall high levels of self-control throughout the study period, with no clear differences between baseline period (range: 3.5-4.38, $M = 3.91$), first intervention phase (range: 3.25-4.13, $M = 3.80$), control period (range: 3.75-5, $M = 4.31$), and second intervention phase (range: 3.75-4.75, $M = 4.19$) (see Figure 4). The observed test statistic and p-value show that the differences in participant 3's level of self-

Figure 3

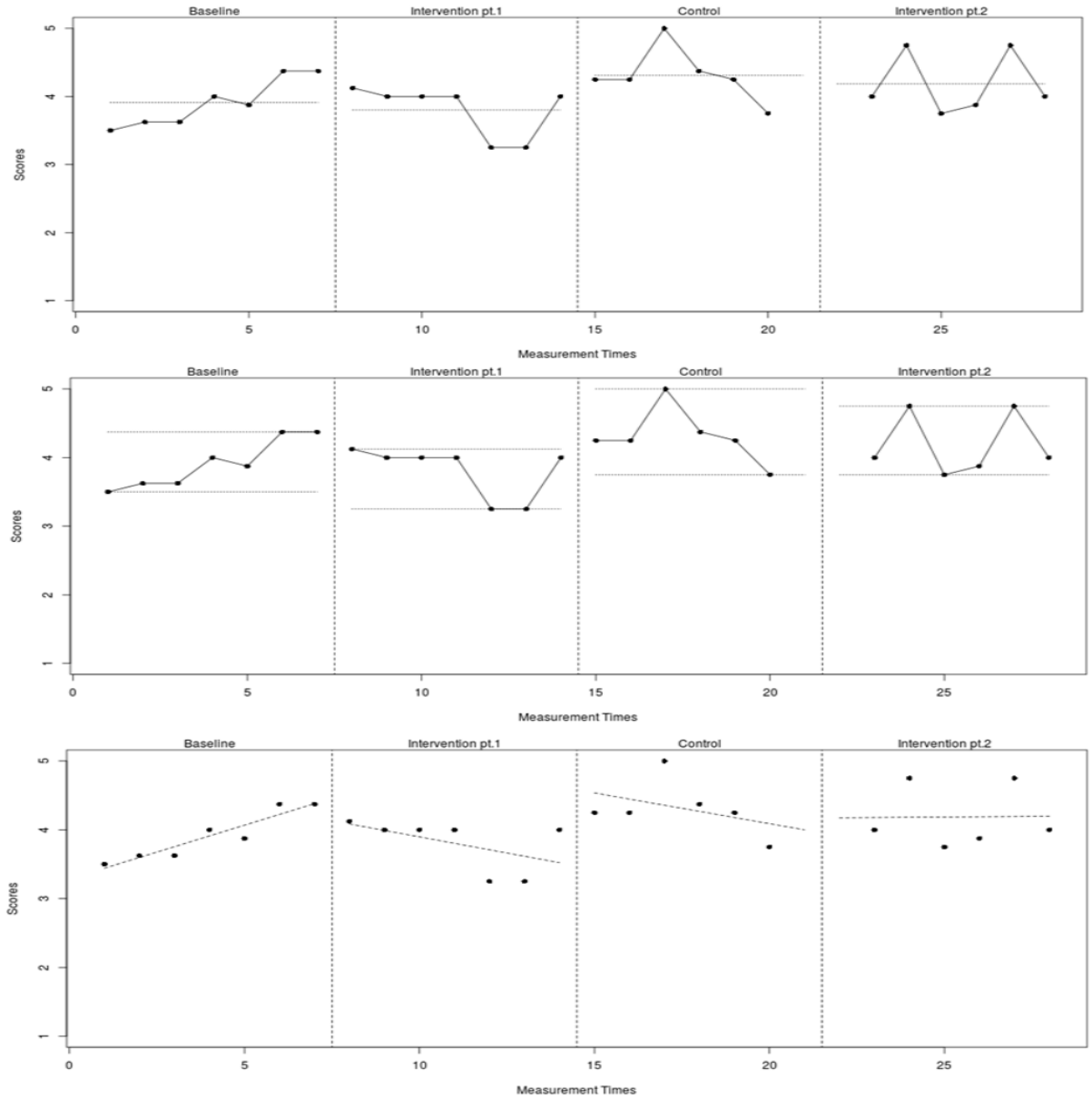
Max - Daily scores on self-control across each study phase



control across phases were statistically non-significant (p = .815), which means that SCIPP was not effective in improving daily self-control for this participant (see Table 4).

Figure 4

Sophie - Daily scores on self-control across each study phase

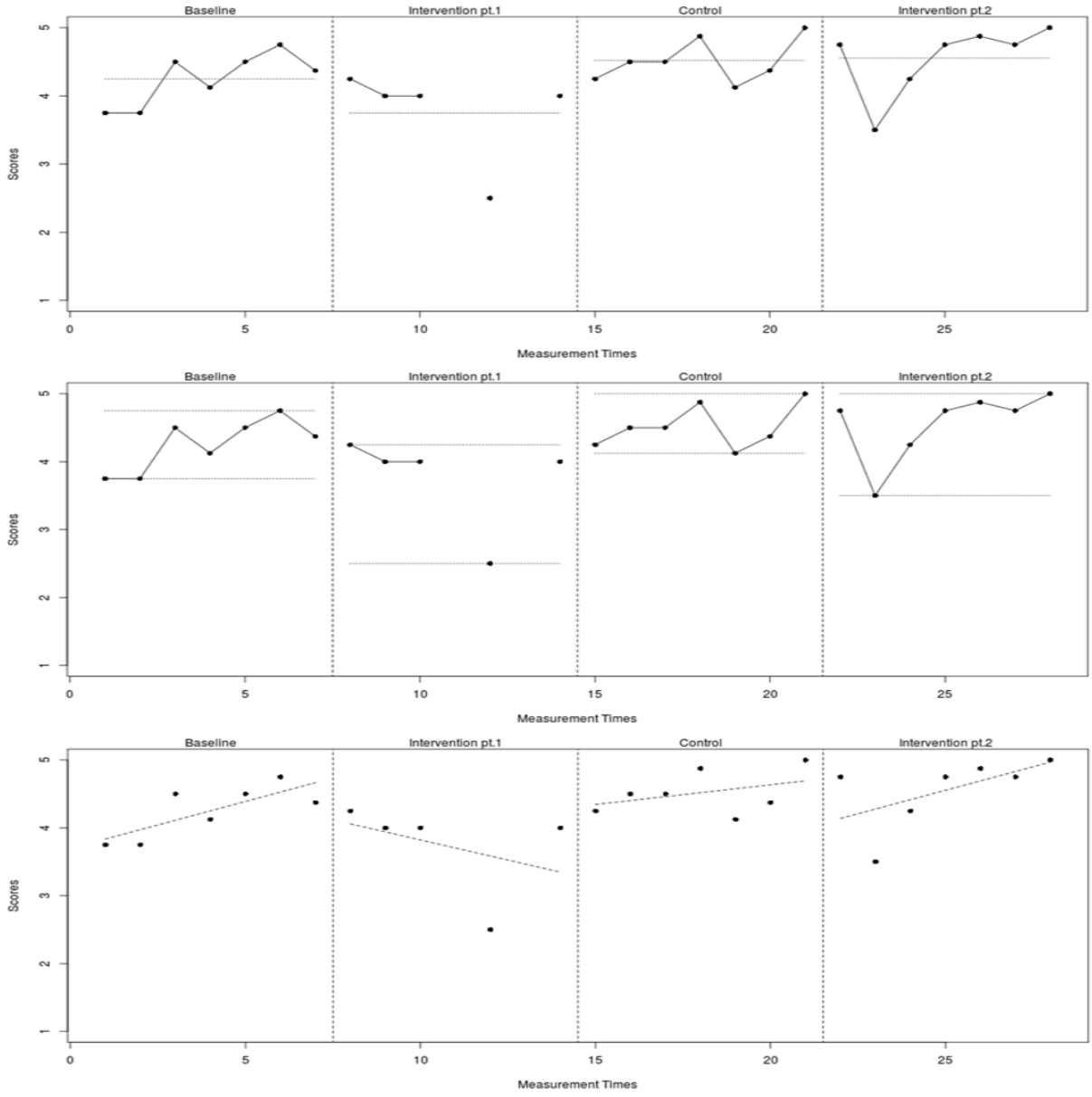


Stijn, 22-year old Dutch male student. Participant 4 reported high levels of self-control throughout the study period, with occasional days of low self-control and no clear differences between baseline period (range: 3.75-4.75, *M* = 4.25), first intervention phase (range: 2.5-4.25, *M* = 3.75), control period (range: 4.13-5, *M* = 4.52), and second intervention phase (range: 3.5-5,

M = 4.55) (see Figure 5). The observed test statistic and p-value show that the differences in participant 4's level of self-control across phases were statistically non-significant ($p = .879$), which means that SCIPP was not effective in improving daily self-control for this participant (see Table 4).

Figure 5

Stijn - Daily scores on self-control across each study phase



Jutta, 22-year old German female student. Participant 5 reported relatively high levels of self-control throughout the baseline period (range: 3.75-4.75, *M* = 4.25), first intervention phase (range: 2.5-4.25, *M* = 3.75), and second intervention phase (range: 3.5-5, *M* = 4.55) (see Figure 6). During the control period a large decreasing trend is present, with scores ranging from 4.88 to 2.25. The observed test statistic and p-value show that the differences in participant 5's level of self-control across phases were statistically non-significant ($p = .679$), which means that SCIPP was not effective in improving daily self-control for this participant (see Table 4).

Esmee, 23-year old Dutch female student. Participant 6 reports extremely varying scores on self-control across all phases (see Figure 7). The variation in scores appears to be slightly smaller during the first (range: 1.5-3.38, *M* = 2.77) and second (range: 2.75-3.75, *M* = 3.36) intervention phase, as compared to the baseline (range: 2.25-4.63, *M* = 3.39) and control (range: 2.5-4.25, *M* = 3.21) period. The observed test statistic and p-value show that the differences in participant 6's level of self-control across phases were statistically non-significant ($p = .457$), which means that SCIPP was not effective in improving daily self-control for this participant (see Table 4).

Comparison of daily and weekly self-control

Participants' daily self-control scores (see Figure 8) were compared to their weekly scores on trait self-control (see Table 5). Both were scored on a 5-point Likert scale, ranging from 1 (low self-control) to 5 (high self-control), but for the weekly score a final sum score was used. For 4 out of 6 participants, daily self-control scores turned out to be overall higher than their weekly self-control scores. Participant 2 reported daily scores ranging from medium to high self-control, while reporting mostly medium to low weekly self-control scores. Participants 3 and 4 both reported medium to high daily scores, while reporting mostly medium weekly scores. Participant 6 daily self-control scores showed much variability, ranging from low to high, but at

Figure 6

Jutta - Daily scores on self-control across each study phase

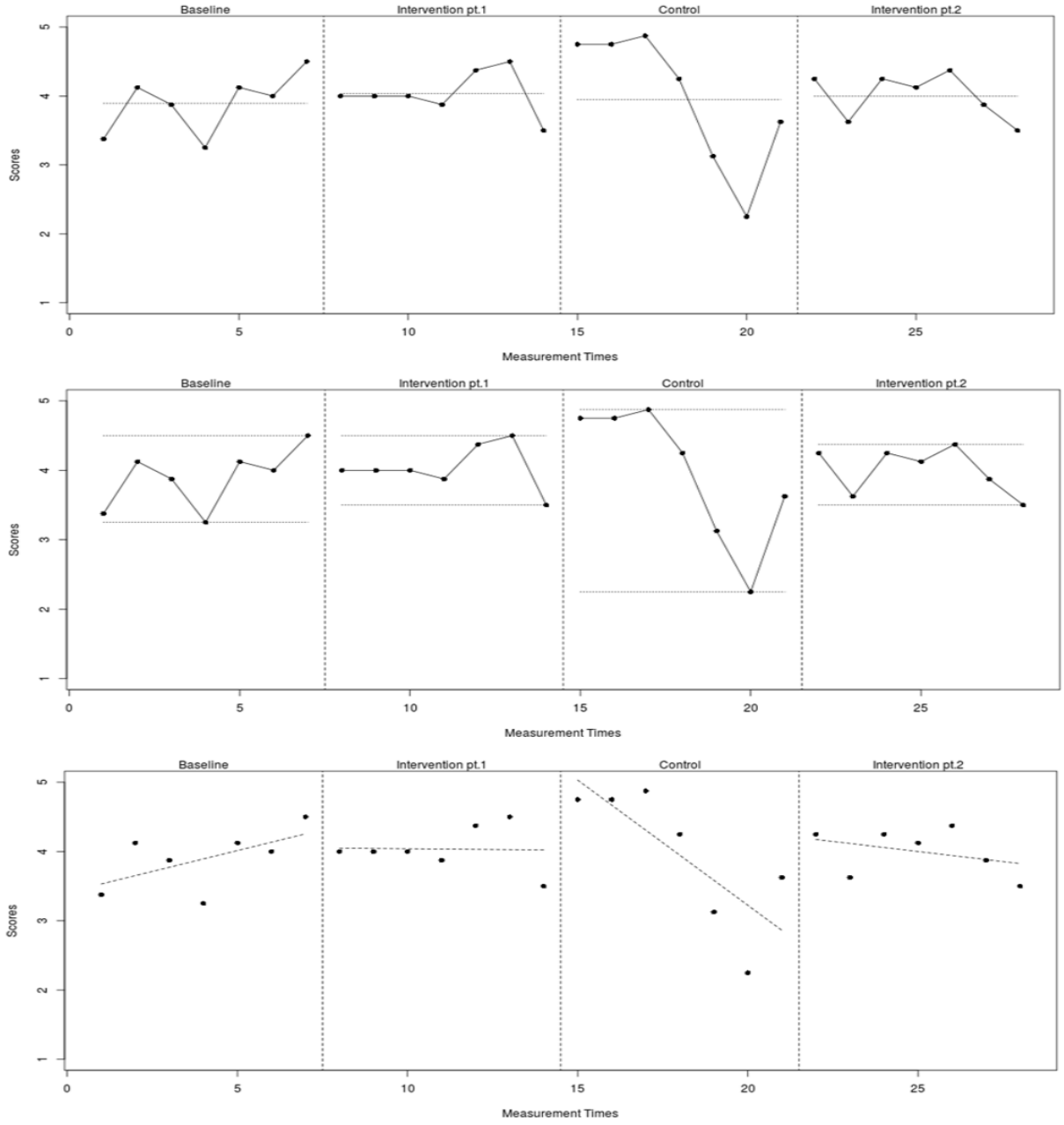
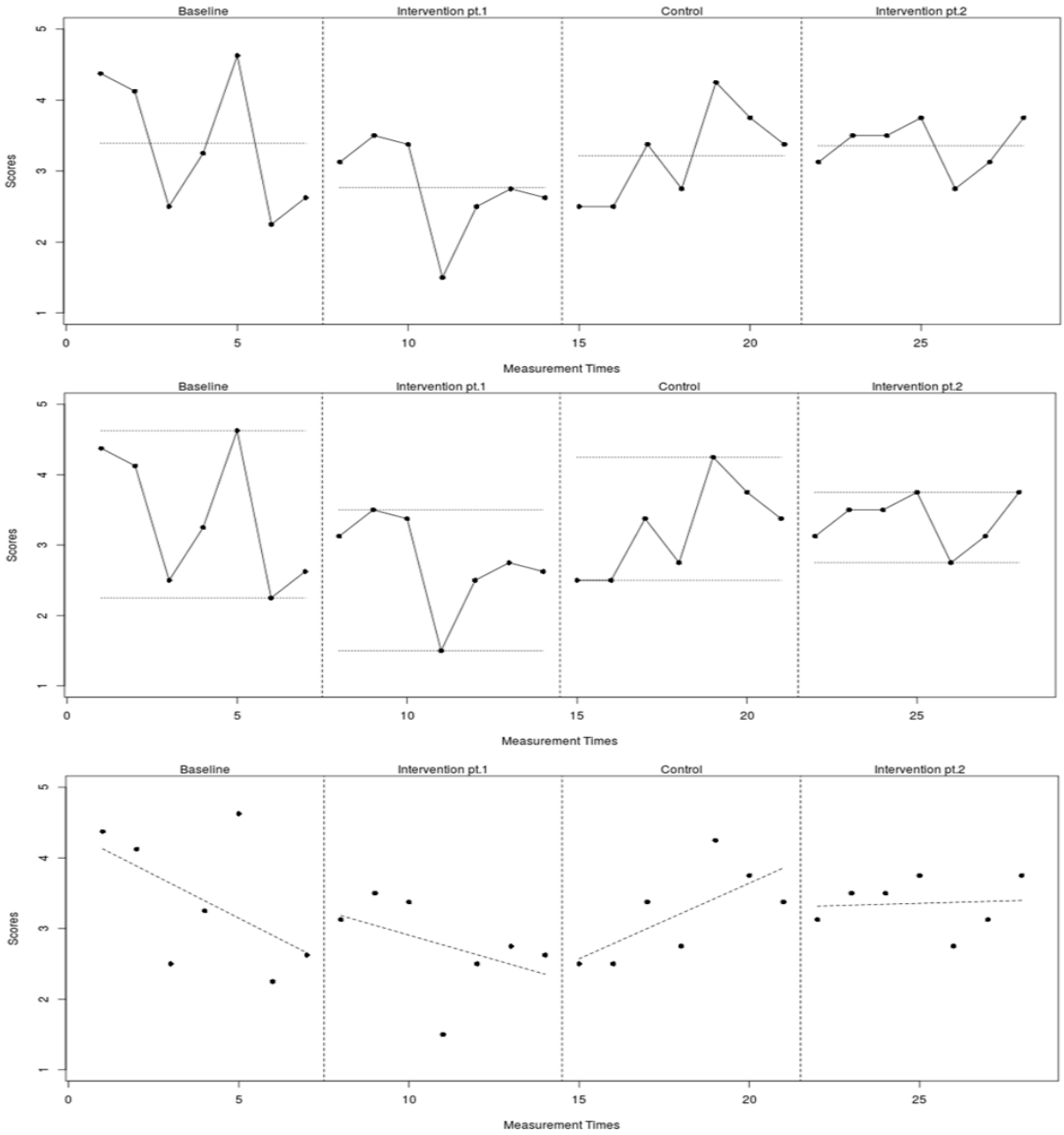


Figure 7

Esmee - Daily scores on self-control across each study phase



the same time reported only relatively low weekly self-control scores. For participant 1, the daily and weekly self-control scores appear similar since both were overall relatively high. For participant 5, the daily self-control scores turned out lower than the weekly scores.

When looking at Table 5 to compare participants' weekly scores on self-control on day 7 and day 14, it can be seen that self-control improved for all participants after 7 days of SCT. When comparing participants' scores on day 0 and 28, self-control improved for 5 out of 6 participants.

Figure 8

Daily scores on self-control across each study phase

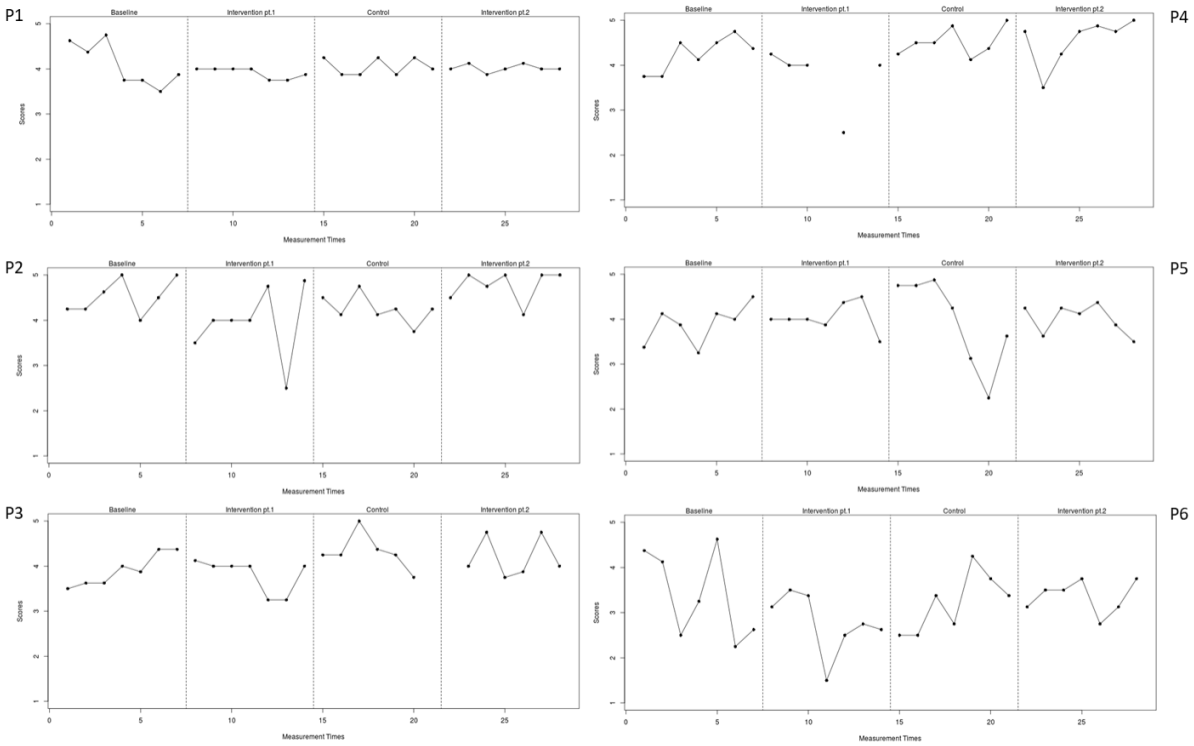


Table 5

Weekly scores on self-control

Participant	Day 0	Day 7	Day 14	Day 21	Day 28
1. Koen	45	43	44	47	51
2. Max	28	26	31	37	40
3. Sophie	37	-	43	40	40
4. Stijn	35	32	39	33	42
5. Jutta	44	47	48	47	48
6. Esmee	34	27	30	-	31

Note. Participants repeatedly filled in the Brief Self-Control Scale (BSCS). The items are summed up to a total score which can range from 13-65, a higher score indicates higher self-control.

Daily bedtime procrastination

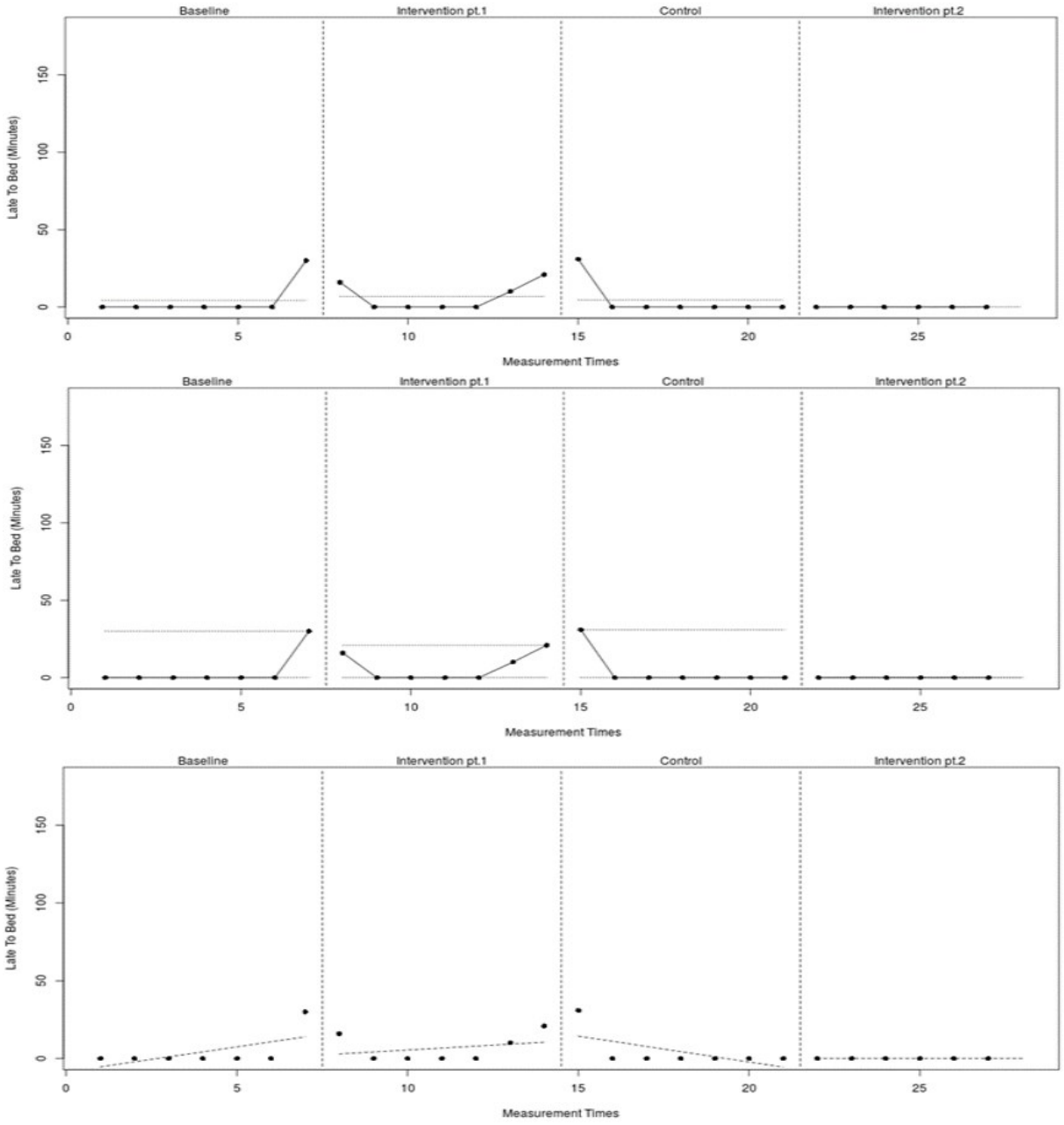
Individual participant results

Before analyses of participants' bedtime procrastination scores, it was checked whether participants went to bed later than intended due to reasons beyond their control. This turned out not to be the case, which is why no data was excluded from the analyses.

Koen, 22-year old Dutch male student. The bedtime procrastination scores of participant 1 show great stability across all four phases (see Figure 9). Few differences can be found between the baseline period (range: 0-30, $M = 4.29$), first intervention phase (range: 0-21, $M = 6.71$), control period (range: 0-31, $M = 4.43$), and second intervention phase (range: 0-0, $M = 0$). The observed test statistic and p-value show that the differences in participant 1's level of bedtime procrastination across phases were statistically non-significant ($p = .235$), which means that SCIPP did not affect bedtime procrastination for this participant (see Table 6).

Figure 9

Koen - Daily scores on bedtime procrastination across each study phase



Max, 34-year old Dutch male student. The bedtime procrastination in minutes of participant 2 appears to be relatively stable across all four phases (see Figure 10). Slight increases in bedtime procrastination are present in the beginning of both the first (range: 0-45, *M* = 18) and the second

intervention phase (range: 0-30, $M = 6$). The observed test statistic and p-value show that the differences in participant 2's level of bedtime procrastination across phases were statistically non-significant ($p = .947$), which means that SCIPP did not affect bedtime procrastination for this participant (see Table 6).

Table 6

SCRT and SCMA on participants' daily scores on bedtime procrastination

Participant	Observed test statistic	P-value	Effect size measure
1. Koen	1	.235	-0.08
2. Max	-12	.947	inf
3. Sophie	-0.54	.193	-0.03
4. Stijn	8.57	.679	0.18
5. Jutta	6.87	.426	-0.28
6. Esmee	16	.618	-0.36

Note. SCRT refers to Single-Case Randomization Tests. SCMA refers to Single-Case Meta-Analysis.

Sophie, 23-year old Dutch female student. During the baseline period and first intervention phase of participant 1, fluctuations in bedtime procrastination are present, ranging from going to bed on time to going to bed 30 minutes after the planned bedtime. In the second intervention phase there is no sign of bedtime procrastination at first, after which a steep increase is seen since the participant went to bed 90 minutes after their planned bedtime. The observed test statistic and p-value show that the differences in participant 3's level of bedtime procrastination across phases were statistically non-significant ($p = .193$), which means that SCIPP did not affect bedtime procrastination for this participant (see Table 6).

Figure 10

Max - Daily scores on bedtime procrastination across each study phase

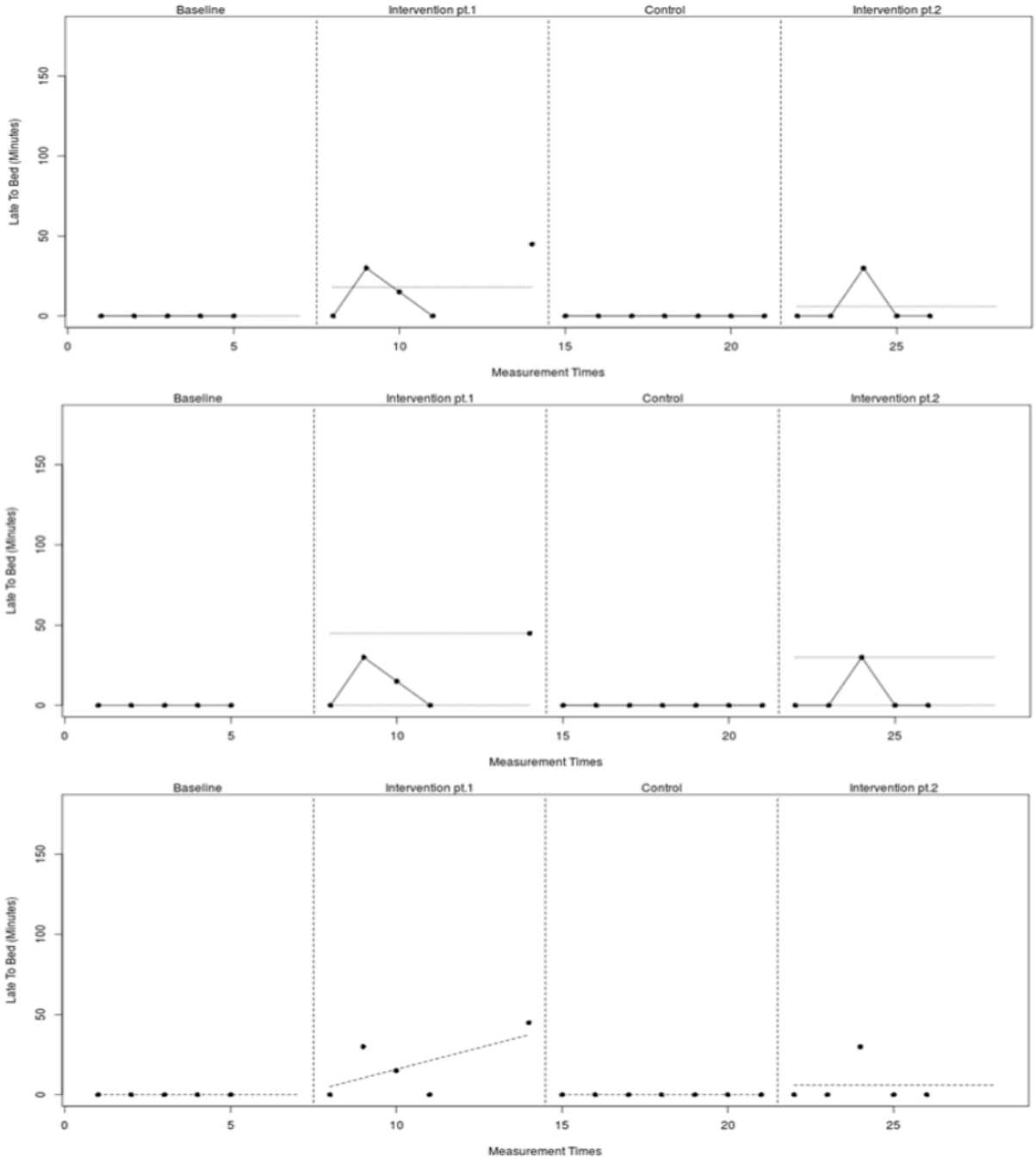
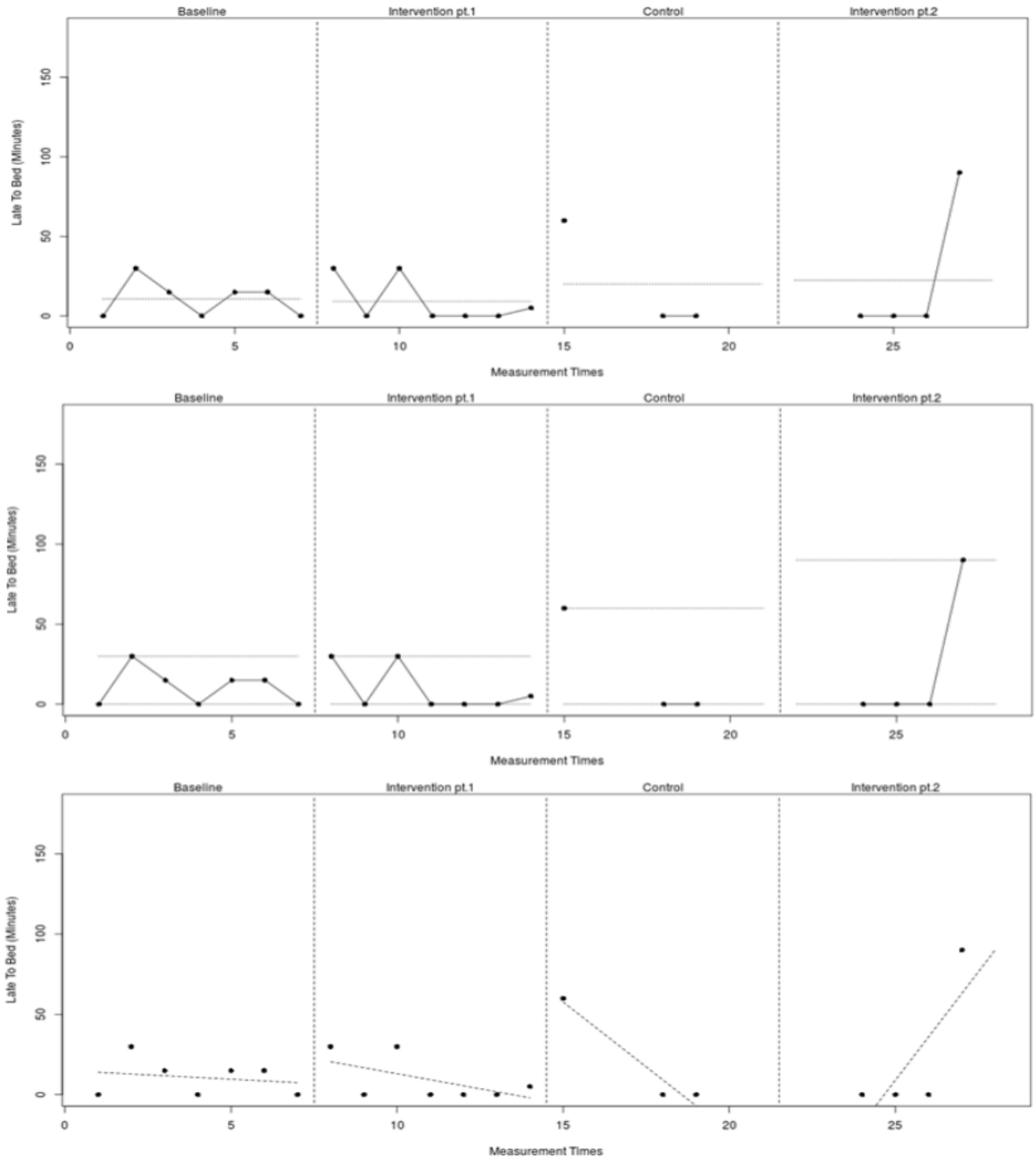


Figure 11

Sophie - Daily scores on bedtime procrastination across each study phase



Stijn, 22-year old Dutch male student. During the baseline period (range: 0-60, *M* = 21.43), first intervention phase (range: 0-120, *M* = 55.71), and control period (range; 0-150, *M* = 51.43),

participant 4 shows extreme fluctuations in bedtime procrastination (see Figure 12). Notable is that a negative autocorrelation effect seems to be present during the baseline period and the first intervention phase. For participant 4 this means that a higher score on bedtime procrastination on one day predicts a lower score on bedtime procrastination on the following day, and vice versa. The observed test statistic and p-value show that the differences in participant 4's level of bedtime procrastination across phases were statistically non-significant (p = .679), which means that SCIPP did not affect bedtime procrastination for this participant (see Table 6).

Jutta, 22-year old German female student. During the baseline period (range: 0-165, *M* = 33.57), first intervention phase (range: 0-60, *M* = 30), and control period (range: 0-45, *M* = 21), participant 5 reports fluctuations in bedtime procrastination (see Figure 13). Notable is that a negative autocorrelation effect seems to be present during the first and the second intervention phase. For participant 5 this means that a higher score on bedtime procrastination on one day predicts a lower score on bedtime procrastination on the following day, and vice versa. Furthermore, the variation in scores becomes less during each phase of the study. The observed test statistic and p-value show that the differences in participant 5's level of bedtime procrastination across phases were statistically non-significant (*p* = .426), which means that SCIPP did not affect bedtime procrastination for this participant (see Table 6).

Esmee, 23-year old Dutch female student. During the baseline period (range: 0-90, *M* = 42), first intervention phase (range: 0-120, *M* = 25), control period (range: 0-120, *M* = 45), and second intervention phase (range: 0-90, *M* = 30), participant 6 reports extreme fluctuations in bedtime procrastination (see Figure 14). A negative autocorrelation effect seems to be present, which means that a higher score on bedtime procrastination on one day predicts a lower score on bedtime procrastination on the following day, and vice versa. The observed test statistic and p-

Figure 12

Stijn - Daily scores on bedtime procrastination across each study phase

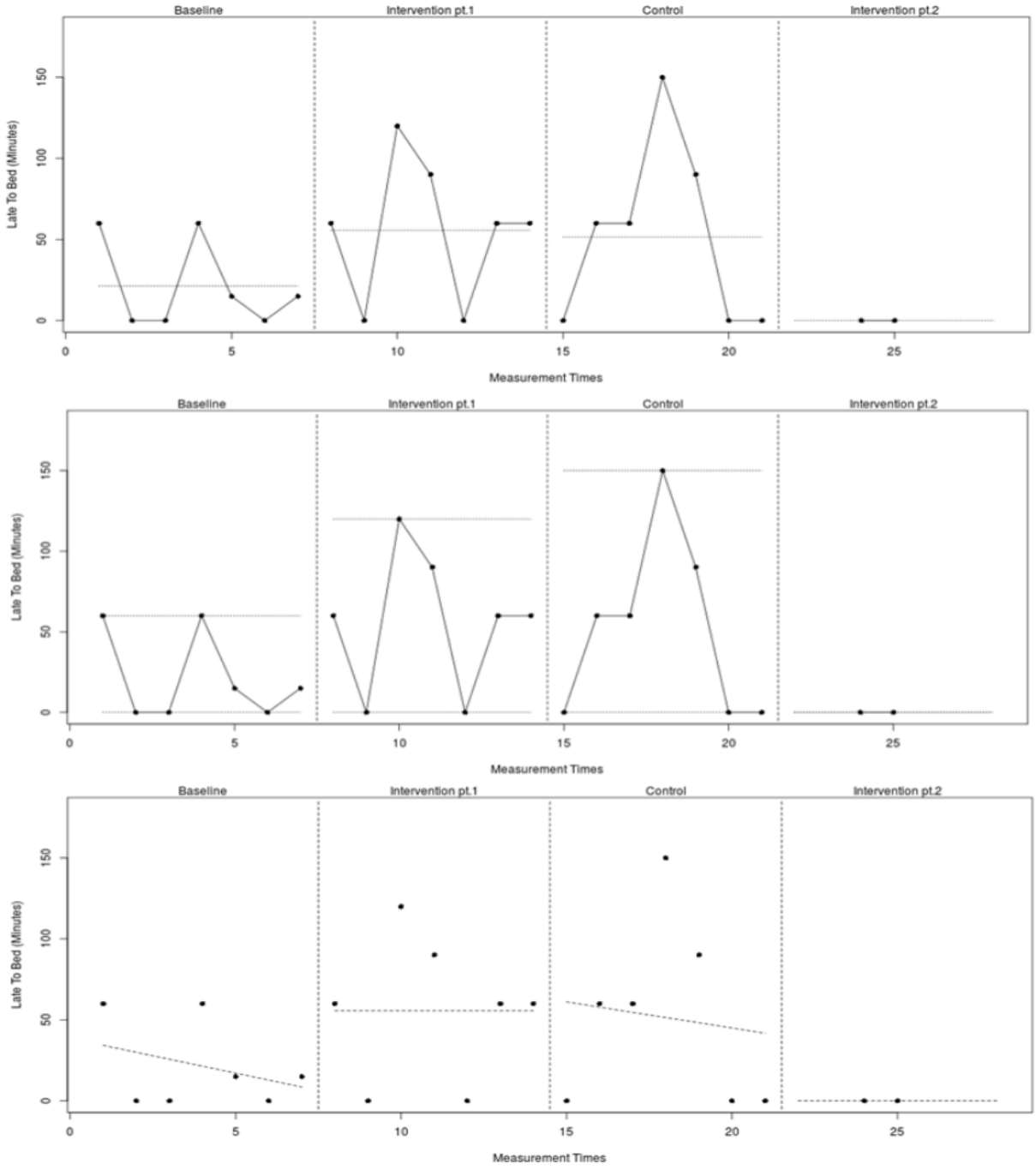
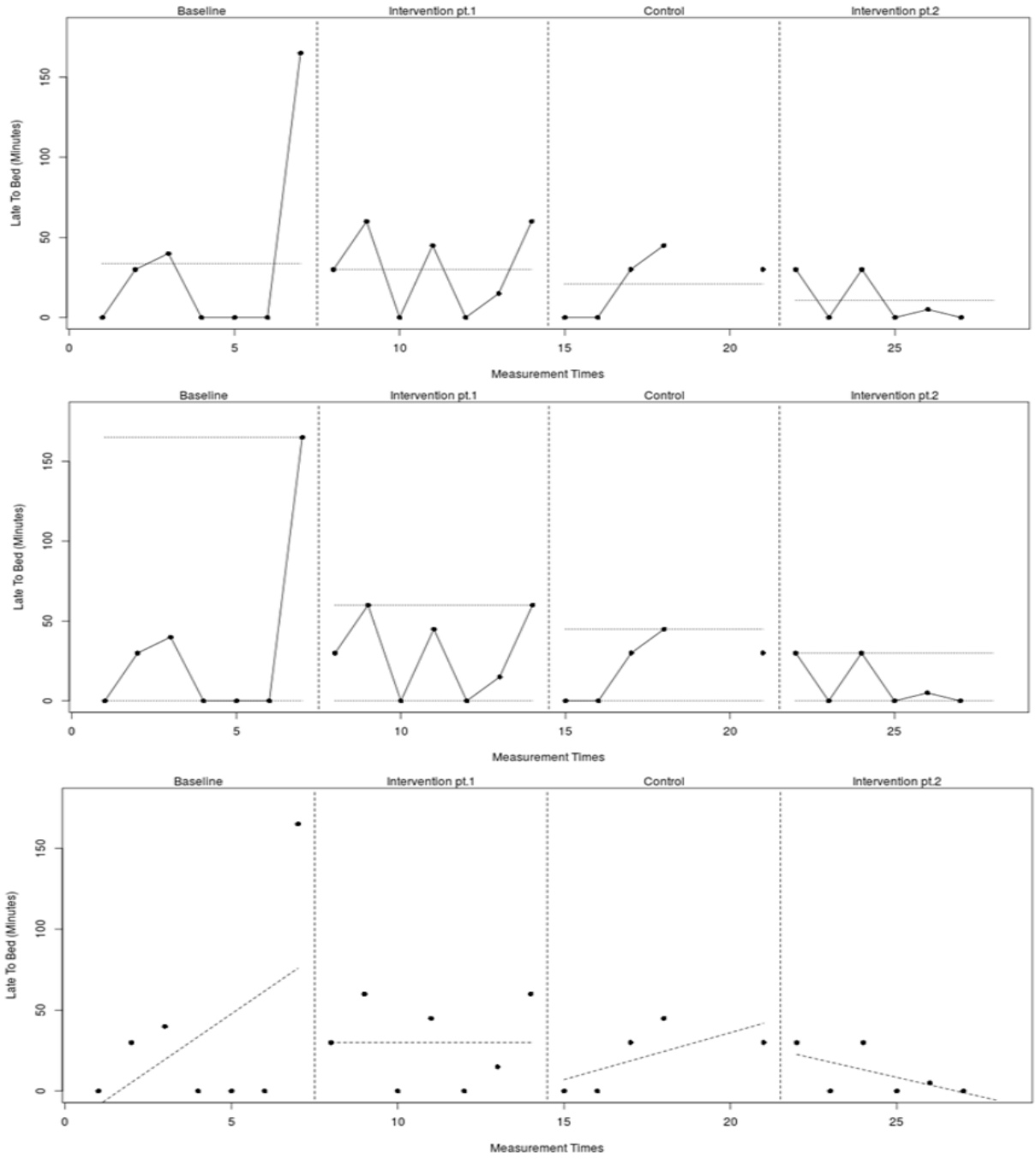


Figure 13

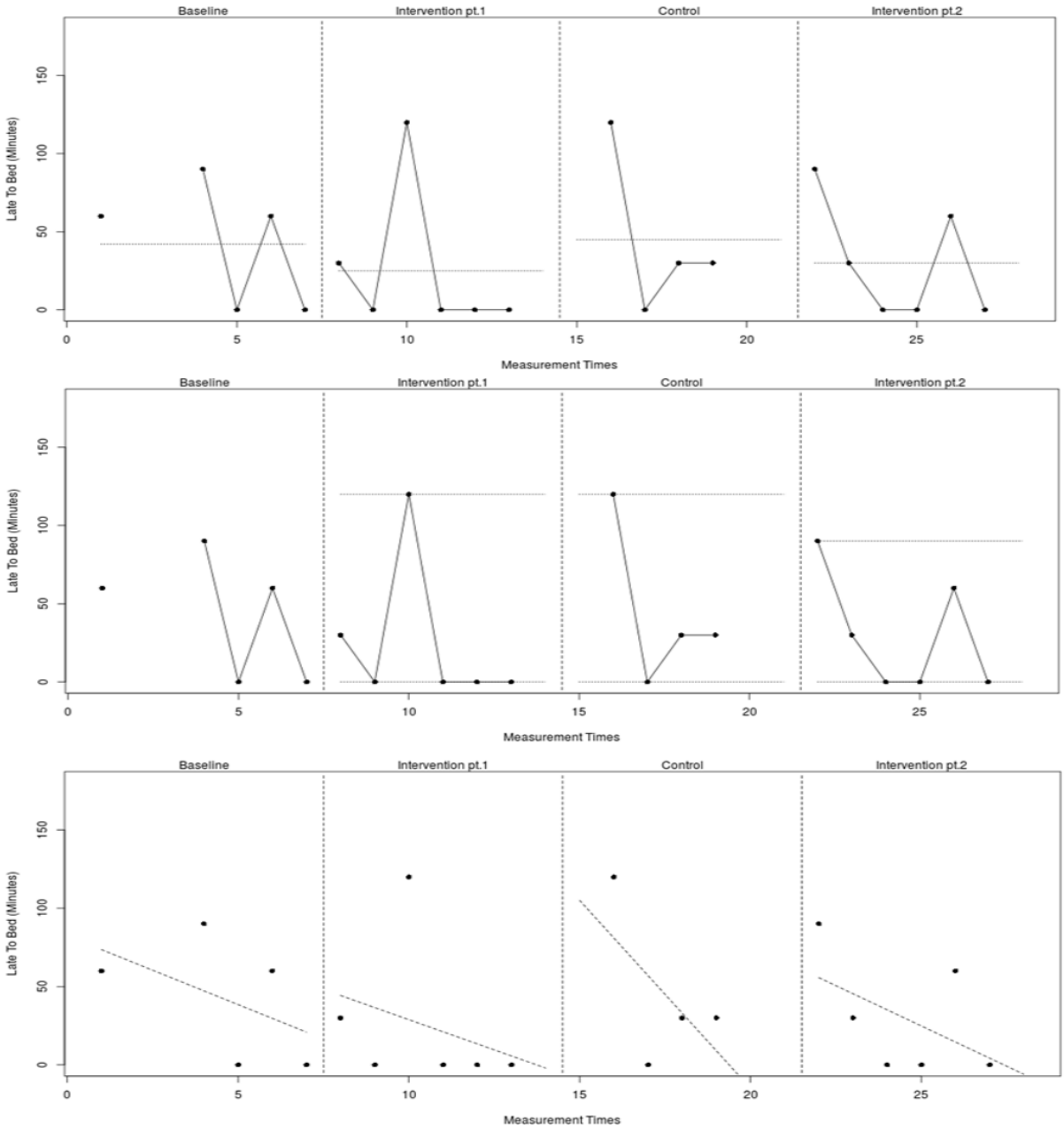
Jutta - Daily scores on bedtime procrastination across each study phase



value show that the differences in participant 5's level of bedtime procrastination across phases were statistically non-significant (p = .618), which means that SCIPP did not affect bedtime procrastination for this participant (see Table 6).

Figure 14

Esmee - Daily scores on bedtime procrastination across each study phase



Comparison of daily and weekly bedtime procrastination

Participants' daily bedtime procrastination measures (see Figure 15) were compared to their weekly measures on trait bedtime procrastination (see Table 7). For 4 out of 6 participants, the patterns that are visible in their plot seem to be in line with their score on trait bedtime procrastination. First, when looking at the plot of participant 1 and 2, it can be seen that they did not report bedtime procrastination throughout the majority of the study. These results are supported by their scores on trait bedtime procrastination, since it can be seen that both participants scored relatively low on bedtime procrastination throughout the study. Second, the plot of participant 3 shows that bedtime procrastination is present to some extent, with the participant on average going to bed 14 minutes later than initially planned. This is supported by their score on trait bedtime procrastination, which is considered neither high nor low. Third, participant 4 reported extreme fluctuations in bedtime procrastination, on average going to bed 39 minutes later than initially planned. Their score on trait bedtime procrastination proved high throughout the study.

Table 7

Weekly scores on bedtime procrastination

Participant	Day 0	Day 7	Day 14	Day 21	Day 28
1. Koen	23	22	20	19	25
2. Max	20	15	18	12	24
3. Sophie	27	-	23	20	28
4. Stijn	40	37	36	32	27
5. Jutta	26	21	30	28	29
6. Esmee	21	20	20	-	27

Note. Participants repeatedly filled in the Bedtime Procrastination Scale (BPS). The items are summed up to a total score which can range from 9-45, a higher score indicates high bedtime procrastination.

However, for participants 5 and 6 the patterns in their daily reported bedtime procrastination do not seem to correspond with their weekly measures on trait bedtime procrastination. Both participants show extreme fluctuations in daily bedtime procrastination, with participant 5 on average going to bed 24 minutes later than planned and participant 6 going to bed 34 minutes later than planned. Notably, participant 5 scores on trait bedtime procrastination are considered neither high nor low, which does not explain the pattern that is present in their daily scores. This is also the case for participant 6, whose scores on trait bedtime procrastination are considered relatively low.

When looking at Table 7 to compare participants' weekly scores on bedtime procrastination on day 7 and day 14, it can be seen that bedtime procrastination improved for 3 out of 6 participants after 7 days of SCT. When comparing participants' scores on day 0 and 28, bedtime procrastination improved for only 1 participant.

Table 7

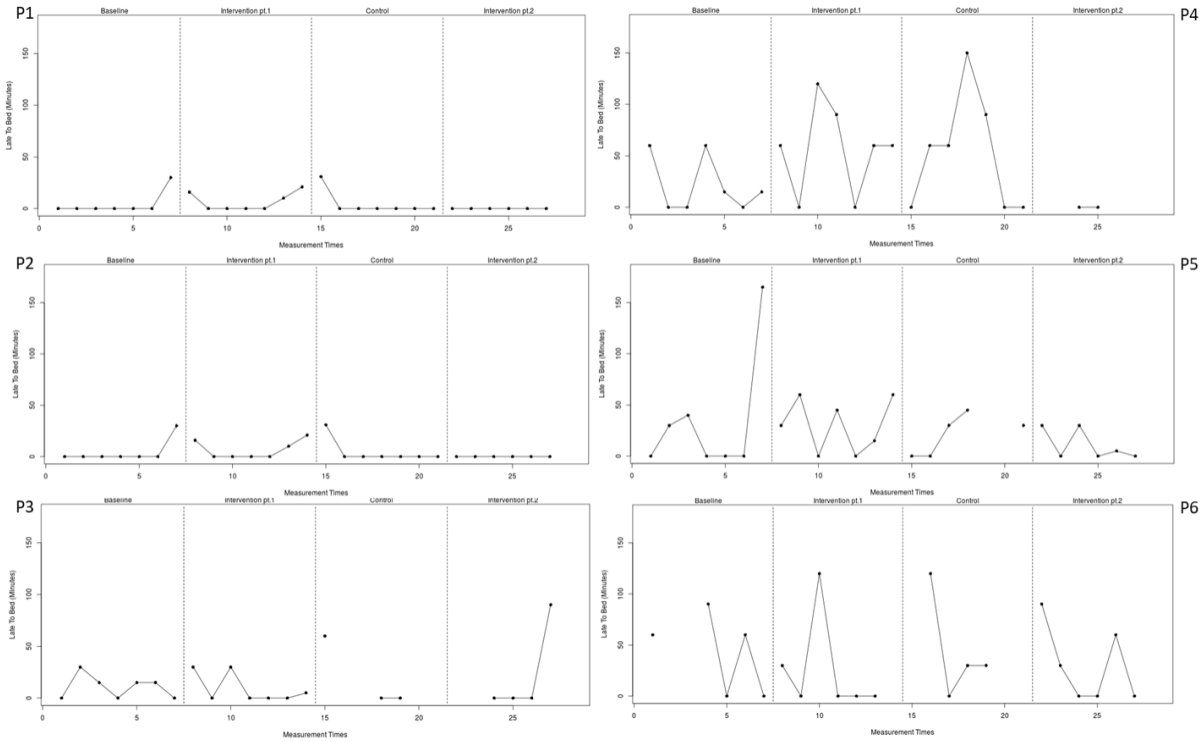
Weekly scores on bedtime procrastination

Participant	Day 0	Day 7	Day 14	Day 21	Day 28
1. Koen	23	22	20	19	25
2. Max	20	15	18	12	24
3. Sophie	27	-	23	20	28
4. Stijn	40	37	36	32	27
5. Jutta	26	21	30	28	29
6. Esmee	21	20	20	-	27

Note. Participants repeatedly filled in the Bedtime Procrastination Scale (BPS). The items are summed up to a total score which can range from 9-45, a higher score indicates high bedtime procrastination.

Figure 15

Daily scores on bedtime procrastination across each study phase



Discussion

Self-control and bedtime procrastination levels are considered important predictors of academic success in University students, by influencing academic attainment, course grades, and test scores (Duckworth & Carlson, 2013; Ghafoor et al., 2022). Gaining an understanding of how the use of technology, more specifically digital self-control training (SCT), affects both these factors could help students increase their academic performance. The first aim of this study was to explore how use of SCIPP, a digital SCT app, may influence self-control levels of Dutch university students. Another aim was to explore if and how SCIPP may influence bedtime procrastination levels of Dutch university students.

Overall, SCIPP does not seem to have an effect on both self-control and bedtime procrastination. For both variables, the visual and statistical analyses show no clear intervention effects. This is contrary to what was initially expected based on earlier research on digital SCT on which the SCIPP intervention is based (Kip et al., 2021; Friese et al., 2017). Various possible explanations for its lack of an effect on self-control can be offered. First of all, based on the voluntary feedback that the participants provided after the study, it becomes clear that the majority did not have an optimal experience using the app (see Appendix D). Some were not motivated by the app to use it, for instance because they did not think every challenge actually trained self-control or because they had difficulties using the app in general. Others did not find it convenient to use the app, since it was not part of their daily rhythm or because they experienced difficulties getting it to work on their phone. Research has shown that the younger generation has a low threshold for applications that fail to provide a great experience (Flamingo, 2018). According to them, the experience should be practical, convenient, and entertaining. An explanation can be offered for why the participants might have not used SCIPP to its optimal extent, since it seems like they did not feel like the app met these aspects. Moreover, the participants did not express an initial desire or motivation to train their self-control when volunteering for this study. Rather, they volunteered to help the researcher graduate. Therefore, it is possible that they were not internally motivated to use the app to its fullest potential and to overcome the difficulties they encountered. Thus, the suboptimal experience of the participants with SCIPP could explain why SCIPP did not have an effect on self-control.

Second, this study contained two intervention phases instead of one, which meant that participants engaged in two shorter durations of SCT (i.e. two times 7 days) instead of one longer period (i.e. 14 consecutive days). So, only in week 2 and 4 participants had to use SCIPP.

According to Turner and Piquero (2002), changes in self-control are less likely to occur when SCT is only applied for a short duration. This is confirmed by the meta-analysis by Friese et al. (2017), which shows that the majority of effective SCT are implemented for a minimum of 14 days, without interruptions. Perhaps a seven day period of SCT is not long enough to really affect the underlying working mechanisms that are responsible for possible changes in self-control.

Third, it is possible that not all challenges included in the app actually train self-control. For a task to train self-control it is necessary that an automatic response is repressed and replaced with a desired response (Friese et al., 2017; Finkel et al., 2009). By repeatedly repressing automatic responses, one will increase their self-control resource pool, which will eventually strengthen one's ability to control themselves (Baumeister, 2003; 2017). Regarding SCIPP, an example of a challenge which might not place an appeal on self-control for all participants is "*Hold a fork with your non-dominant hand*". All participants were right-handed, which means that they were asked to hold their fork in their left hand. However, this is common etiquette, so it is questionable to what extent this challenge asks participants to repress an automatic response.

However, even though the results did not provide evidence of an effect of SCIPP on state self-control, increases in trait self-control are present for most participants. After the first week of SCT, trait self-control scores increased for all participants. After two weeks of SCT, trait self-control scores increased for 5 out of 6 participants. The lack of an effect found on state self-control in this study could hint in the direction of problems with the state self-control measure.

Regarding the lack of an effect of SCIPP on bedtime procrastination, two more possible explanations can be offered. First of all, based on current dominating theories, changes in bedtime procrastination are expected to be caused by changes in self-control (Kroese et al., 2014;

see also Digdon & Howell, 2008; Exelmans & Van den Bulck, 2021; Kadzikowska-Wrzosek, 2018). This means that if there is no change in self-control, it is unlikely that the extent to which one procrastinates their bedtime will change. Since SCIPP does not seem to have an effect on state self-control, it is to be expected that there is thus also no effect on daily bedtime procrastination behaviours.

Second, it was expected that participants' scores on self-control and bedtime procrastination would co-vary negatively over time, meaning that a low score on self-control would predict a high score on bedtime procrastination and vice versa. This was expected since current theories see bedtime procrastination as a form of self-regulatory failure (Kroese et al., 2016b). Thus at times when self-control is high one is more likely to procrastinate less, and at times when self-control is low one is more likely to procrastinate more. However, when comparing the graphs on daily self-control with the graphs on bedtime procrastination, no such pattern could be identified for either one of the participants. This raises the question to whether bedtime procrastination is actually a matter of low self-control, or if other factors are at play. Kühnel et al (2018) investigated this matter and found no evidence of bedtime procrastination being a form of low self-control. In their study, adults with low levels of self-control actually engaged less in bedtime procrastination than adults with high levels of self-control, which is in contrast with current theories. Moreover, in this study, even though there were increases in trait self-control for the majority of the participants, this is not the case for participants weekly scores on bedtime procrastination. So, even on a trait level, there does not seem to be an association between increases in self-control and bedtime procrastination. To sum up, the results of both this study and the study by Kühnel et al. (2018) point in the direction that there is a lack of

association between bedtime procrastination and self-control. If this is the case, it can offer an explanation for why a SCT did not affect participants' scores on bedtime procrastination.

Next to the fact that this study examined the effectiveness of SCIPP on self-control and bedtime procrastination, it also observed participants daily bedtime procrastination behaviours for the duration of one month. For half of the participants, this revealed a pattern of lag 1 negative autocorrelation effects on bedtime procrastination. This suggests that a low score on bedtime procrastination will be followed by a high score the next day and vice versa. This autocorrelation effect has not yet been discussed in the context of bedtime procrastination (Kroese et al., 2014; Kroese et al., 2016b; Kadzikowska-Wrzosek, 2020; Magalhães et al., 2020). However, a possible explanation for this pattern can be found in the homeostasis aspect of the sleep regulation model (Landolt, 2008). This model states that one's need for sleep increases substantially after a period of sleep deprivation, and that this effect can be counteracted by a prolonged period of sleep. In other words, when someone deprives themselves of sleeping (e.g. by procrastinating going to bed), it is likely that they catch up on the missed sleep the day after. This could explain the bedtime procrastination pattern that was found during this study. For future studies regarding bedtime procrastination, it could be interesting to further investigate this pattern since it has not been mentioned yet as of now.

Strengths and limitations

This study has three main strengths. The first two strengths relate to the research design chosen, namely the single case experimental design. Firstly, this design makes it possible to draw clear causal relationships between an intervention and behavioural change in participants (Nock et al., 2007). Secondly, because of continuous individual assessment across alternating experimental and control phases it becomes possible to investigate individual patterns of change

in detail (Nock et al., 2007). This provides a rich understanding of the phenomena under investigation. Especially within the context of bedtime procrastination this is seen as a strength, since there is not much research on daily bedtime procrastination behaviours yet. Instead, most research treats bedtime procrastination as a stable variable (Kroese et al., 2014; Kroese et al., 2016b; Kadzikowska-Wrzosek, 2020; Magalhães et al., 2020). The third strength relates to the method of data gathering, experience sampling, since participant adherence during this study was high and there was relatively little missing data. Preventing missing data is a common struggle for studies that employ experience sampling (Myin-Germeys et al., 2018). By keeping the measurement moments and number of items to a minimum, as well as sending out reminders at the start and end of every phase, rich data collection was ensured.

Next to that, this study has two main limitations. The first limitation centres around the usability of SCIPP. After the study was completed, participants stated that they had difficulties using the app, in the sense that they could not change their answer once it was given (by mistake), that there were not enough reminders, that they had trouble navigating the app in general, or that they felt like a challenge did not train their self-control. These factors could have influenced the effectiveness of SCIPP, and therefore limit interpretation of the research results. As mentioned above, this could be due to generational differences in use of technology, with younger generations placing more value on practicality, convenience, and entertainment instead of the personal value of an app (Arning & Ziefle, 2007; Flambiingo, 2018; Hur et al., 2017). The second limitation is the limited period of time in which the study could be conducted. Because of this, the intervention had to be split in two different phases, each lasting seven days. Research shows that SCT are usually conducted for a minimum of 14 consecutive days, in order to be most effective (Friese et al., 2017).

Recommendations for future research

This is the first study to investigate the use of an app-based SCT in relation to self-control and bedtime procrastination. Regarding SCIPP and its effect on self-control, SCIPP's effectiveness might be limited due to the suboptimal experience that the relatively young participant group seemed to have while using the app. Since especially the younger generation could benefit from effective SCT, it is advisable to design a new version of SCIPP which puts more focus on entertainment, convenience, and practicality (Flamingo, 2018). Next to that, in order to make sure that SCIPP reaches its highest potential, it would be helpful to identify which components of the app are actually responsible for its effectiveness. This can be examined by means of fractions or full factorial designs (Collins et al., 2014). As of now, the effectiveness of some of the components of SCIPP have been investigated by means of a full factorial design already (e.g. app-based versus email based, number of tasks, user experience) (Kip et al., 2021). A focus point for further research could be the challenges itself, to examine whether each challenge actually places an appeal on the underlying working mechanism of self-control.

Regarding investigation of the interplay between daily self-control and bedtime procrastination, this study suggests that daily bedtime procrastination may not be a form of self-control failure. However, since this study failed to find an effect of SCT on self-control, the findings regarding bedtime procrastination can only be interpreted with caution. It is advisable to conduct additional research in which the relation between daily self-control and daily bedtime procrastination is explicitly investigated, since this shows a different side to bedtime procrastination as self-control failure than what was previously explored.

Lastly, this study investigated the effectiveness of SCIPP by splitting the 14 day training into two periods of 7 days. Since this proved unsuccessful in increasing self-control levels, the

question is raised how long SCT's should ideally be administered in order to be most effective. One possible way to examine this is to conduct a Randomized Controlled Trial (RCT), during which participants are randomly designed to different intervention durations (Stanley, 2007). Outcomes can then be compared in order to find out which duration leads to the most optimal results on self-control.

Conclusion

This study aimed to explore how use of SCIPP, a digital SCT app, may influence self-control levels of Dutch university students, as well as explore if and how SCIPP may influence their bedtime procrastination levels. Overall, the results suggest that SCIPP does not have an effect on either one and that bedtime procrastination might not be a form of self-control failure at all. Also, a previously undiscussed pattern seems present for bedtime procrastination, which future studies need to investigate both within and outside the context of self-control. This could provide valuable insight into the mechanisms underlying bedtime procrastination behaviours, which could be used to counteract the negative consequences associated with bedtime procrastination.

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Appendix A

Daily and weekly measures

Daily measures of self-control and bedtime procrastination

Self-control items

Geef voor elk van de volgende items aan of het op u van toepassing is op een schaal van 1 *helemaal niet* tot 5 *helemaal wel*.

1. Vond je het de afgelopen uren moeilijk om beslissingen te maken, zelfs over simpele dingen?
2. Had je de afgelopen uren minder mentale energie dan normaal?
3. Is het je gelukt om de afgelopen uren te doen wat je van plan was?
4. Is het je gelukt om de afgelopen uren verleidingen te weerstaan?

Bedtime procrastination items

Items 1 en 2 zijn open vragen waar een tijdstip ingevuld moet worden (voorbeeld: 22:00). Item 3 is ook een open vraag, maar deze mag beantwoord worden zoals u geschikt ziet.

1. Hoe laat ben je van plan om vandaag naar bed te gaan?
2. Hoe laat ben je gisteravond daadwerkelijk naar bed gegaan?
3. Was er iets wat buiten uw macht lag dat ervoor zorgde dat u op een andere tijd naar bed ging dan oorspronkelijk gepland?

Weekly measures of self-control and bedtime procrastination

Bedtime procrastination items (BPS) (Nederlandse vertaling)

Geef voor elk van de volgende items aan of het op u van toepassing is op een schaal van 1 *(bijna) nooit* tot 5 *(bijna) altijd*.

1. Ik ga later naar bed dan ik van plan was.
2. Ik ga vroeg naar bed als ik 's ochtends vroeg moet opstaan.*
3. Als het tijd is om 's avonds de lichten uit te doen, doe ik dat meteen.*
4. Vaak ben ik nog andere dingen aan het doen als het tijd is om naar bed te gaan.
5. Ik raak snel afgeleid door dingen op het moment dat ik eigenlijk naar bed zou willen.
6. Ik ga niet op tijd naar bed.
7. Ik heb een vaste bedtijd waar ik me aan houd.*
8. Ik wil op tijd naar bed, maar ik doe het gewoon niet.
9. Ik kan gemakkelijk stoppen met mijn activiteiten als het tijd is om naar bed te gaan.*

* Omgekeerd gecodeerd

Self-control items (BSCS) (Nederlandse vertaling)

Geef voor elk van de volgende items aan of het op u van toepassing is op een schaal van 1 *helemaal niet* tot 5 *helemaal wel*.

1. Ik vind het moeilijk om met slechte gewoontes te stoppen.

2. Ik kan verleidingen goed weerstaan.*
3. Ik ben lui.
4. Ik zeg ongepaste dingen.
5. Ik doe wel eens dingen die slecht voor me zijn als ze leuk zijn.
6. Ik weiger dingen die slecht voor me zijn.*
7. Ik zou willen dat ik meer zelfdiscipline had.
8. Mensen zeggen dat ik een ijzeren zelfdiscipline heb.*
9. Pleziertjes weerhouden me er soms van mijn (huis)werk af te krijgen.
10. Ik heb moeite met concentreren.
11. Ik kan goed werken aan lange termijn doelen.*
12. Soms kan ik mezelf niet inhouden iets te doen, zelfs als ik weet dat het verkeerd is.
13. Ik doe vaak dingen zonder goed na te denken over mogelijke alternatieven.

*Omgekeerd gecodeerd

Appendix B

Informed Consent

Doel van het onderzoek
Dit onderzoek wordt geleid door Renske van den Brink, in het kader van een afstudeeronderzoek voor de master Clinical Psychology and Technology aan de Universiteit Twente. Dit onderzoek wordt begeleid door dr. Tessa Dekkers.
Het doel van dit onderzoek is het testen van het effect van SCIPP op zelfcontrole, en het onderzoeken van de relatie tussen zelfcontrole en het onnodig uitstellen van naar bed gaan.

Hoe gaan we te werk?
U neemt deel aan een onderzoek waarbij we informatie zullen vergaren door u meerdere (korte) vragenlijsten voor te leggen gedurende een periode van 29 dagen, welke u kunt invullen via uw mobiele telefoon. Verder wordt u gevraagd om tijdens twee periodes de dagelijkse zelfcontrole oefeningen uit te voeren die in SCIPP weergegeven worden. SCIPP hoeft alleen gebruikt te worden van dag 9 t/m 15 en van dag 23 t/m 29. Tijdens de overige dagen wordt aangeraden om de app-meldingen voor SCIPP uit te schakelen op uw mobiele telefoon zodat u niet onnodig herinnerd wordt.

Om u te helpen herinneren wanneer SCIPP wel (of niet) gebruikt moet worden, zult u een aantal e-mails ontvangen. Dit zal altijd gebeuren de dag vóór een nieuwe periode begint.

Uitsluitend ten behoeve van het onderzoek zullen de verzamelde onderzoeksgegevens worden gedeeld met Universiteit Twente, gevestigd in Nederland.

Potentiële risico's en ongemakken
Er zijn geen fysieke, juridische of economische risico's verbonden aan uw deelname aan deze studie. U hoeft geen vragen te beantwoorden die u niet wilt beantwoorden. Uw deelname is vrijwillig en u kunt uw deelname op elk gewenst moment stoppen.

Vergoeding
U ontvangt voor deelname aan dit onderzoek geen vergoeding.

Vertrouwelijkheid van gegevens
Wij doen er alles aan om uw privacy zo goed mogelijk te beschermen. Er wordt op geen enkele wijze vertrouwelijke informatie of persoonsgegevens van of over u naar buiten gebracht, waardoor iemand u zal herkennen.
Voordat onze onderzoeksgegevens naar buiten gebracht worden, worden uw gegevens zo veel mogelijk geanonimiseerd.

In een publicatie zullen anonieme gegevens of pseudoniemen worden gebruikt. De formulieren en andere documenten die in het kader van deze studie worden gemaakt of verzameld, worden opgeslagen op een beveiligde locatie bij de Universiteit Twente en op de beveiligde (versleutelde) gegevensdragers van de onderzoekers.

De onderzoeksgegevens worden bewaard voor een periode van 3 jaar. Uiterlijk na het verstrijken van deze termijn zullen de gegevens worden verwijderd of worden geanonimiseerd zodat ze niet meer te herleiden zijn tot een persoon.
De onderzoeksgegevens worden indien nodig (bijvoorbeeld voor een controle op wetenschappelijke integriteit) en alleen in anonieme vorm ter beschikking gesteld aan personen buiten de onderzoeksgroep.

Tot slot is dit onderzoek beoordeeld en goedgekeurd door de ethische commissie van de faculteit BMS, goedkeuringsnummer: 230104 (domain Humanities & Social Sciences).

Vrijwilligheid
Deelname aan dit onderzoek is geheel vrijwillig. U kunt als deelnemer uw medewerking aan het onderzoek ten allen tijde stoppen, of weigeren dat uw gegevens voor het onderzoek mogen worden gebruikt, zonder opgaaf van redenen. Het stopzetten van deelname heeft geen nadelige gevolgen voor u.
Als u tijdens het onderzoek besluit om uw medewerking te staken, zullen de gegevens die u reeds heeft verstrekt tot het moment van intrekking van de toestemming in het onderzoek gebruikt worden.
Wilt u stoppen met het onderzoek, of heeft u vragen en/of klachten? Neem dan contact op met de onderzoeksleider. Wanneer u iets wil bespreken dat u niet met de uitvoerend onderzoeker wilt/kunnen bespreken, kan u contact opnemen met de onderzoeksbegeleider.

Onderzoeksleider: Renske van den Brink
E-mail: r.s.m.vandenbrink@student.utwente.nl

Onderzoeksbegeleider: Tessa Dekkers
E-mail: t.dekkers@utwente.nl

Voor bezwaren met betrekking tot de opzet en of uitvoering van het onderzoek kunt u zich ook wenden tot de Secretaris van de Ethische Commissie van de faculteit Behavioural, Management and Social Sciences. Indien u specifieke vragen hebt over de omgang met persoonsgegevens kunt u deze ook richten aan de Functionaris Gegevensbescherming van de UT door een mail te sturen naar dpo@utwente.nl.

Tot slot heeft u het recht een verzoek tot inzage, wijziging, verwijdering of aanpassing van uw gegevens te doen bij de onderzoeksleider.

Door dit toestemmingsformulier (digitaal) te ondertekenen erken ik het volgende:

1. Ik ben voldoende geïnformeerd over het onderzoek door middel van een separaat informatieblad. Ik heb het informatieblad gelezen en heb daarna de mogelijkheid gehad vragen te kunnen stellen. Deze vragen zijn voldoende beantwoord.
2. Ik neem vrijwillig deel aan dit onderzoek. Er is geen expliciete of impliciete dwang voor mij om aan dit onderzoek deel te nemen. Het is mij duidelijk dat ik deelname aan het onderzoek op elk moment, zonder opgaaf van redenen, kan beëindigen. Ik hoef een vraag niet te beantwoorden als ik dat niet wil.

Participant	Onderzoeker
Naam:	Naam:
Datum:	Datum:
Handtekening:	Handtekening:

Appendix C

E-mail instructions

Geachte participant,
Bedankt voor het inschrijven voor dit onderzoek. Het doel van dit onderzoek is het meten van zelfcontrole in het dagelijks leven en hoe het bepaalde aspecten van ons gedrag beïnvloed, zoals het uitstellen van naar bed gaan. Door het gebruik van bepaalde technologie kunnen we inzicht krijgen in deze dynamische interactie, wat ons kan helpen om dagelijkse fluctuaties te identificeren tussen constructies gerelateerd aan mentale gezondheid.

Ethica
Om data te verzamelen wordt Ethica gebruikt. Dit is een app die je op je mobiele telefoon moet downloaden. Wanneer je vervolgens de app opent wordt gevraagd om een account aan te maken en in te loggen met je e-mailadres. Hierna heb je toegang tot het onderzoek. Gedurende de gehele periode van het onderzoek dient Ethica dagelijks gebruikt te worden.

SCIPP: de Zelfcontrole App
SCIPP is een app die je helpt om zelf controle te trainen door middel van dagelijkse uitdagingen. Deze app moet je op je mobiele telefoon moet downloaden. Via de onderzoeker ontvang je een inlogcode waarmee jij vervolgens toegang krijgt tot je eigen account. Let op: SCIPP wordt niet gedurende het hele onderzoek gebruikt. Alleen tijdens dag 9 tot en met 15 en dag 23 tot en met 29 hoef je SCIPP te gebruiken. Tijdens deze dagen zul je ook meldingen ontvangen om de app te gebruiken.

Procedure en duur
Het onderzoek duurt 29 dagen. Op de eerste dag wordt een nulmeting gedaan waarvoor twee vragenlijsten moeten worden ingevuld via Ethica. Vanaf de tweede dag zal je meldingen ontvangen op je mobiele telefoon voor zowel Ethica als SCIPP (let op: het is noodzakelijk dat je beide apps toestemming geeft om je meldingen te sturen!).

De meldingen van Ethica zijn er om je te helpen herinneren om de dagelijkse vragen in te vullen. Er zijn twee meetmomenten per dag: tussen 11:00-13:00 en 19:00-21:00. Beide keren wordt gevraagd om maximaal 7 items te beantwoorden, wat ongeveer 1-2 minuten duurt (let op: beantwoord de items zo snel mogelijk, ze kunnen tot 2 uur na de melding ingevuld worden, daarna vervalt de vragenlijst!). Daarnaast moeten op dag 8, 15, 22 en 29 een vragenlijst worden ingevuld. Dit is altijd tussen 12:00 en 15:00 en hiervoor ontvang je een aparte melding. Deze vragenlijst vervalt na 5 uur.

De meldingen van SCIPP zijn er om je te helpen herinneren om aan de slag te gaan met de dagelijkse activiteiten. Aan het begin van een dag wordt gevraagd om te bevestigen dat je de

uitdaging aanneemt, en aan het einde van de dag wordt gevraagd of het gelukt is de uitdaging uit te voeren.

Voor vragen kun je altijd terecht bij de onderzoeker:
Renske van den Brink (r.s.m.vandenbrink@student.utwente.nl)

Bedankt voor je participatie!

Appendix D

Voluntary feedback from participants

Feedback van participanten over SCIPP

Participant number	Feedback
1	“Niet alle uitdagingen waren voor mij een uitdaging omdat ik die dingen al met mijn linkerhand doe.” “Bijvoorbeeld mijn vork vasthouden doe ik al met links, en mijn telefoon ook vaak.”
2	“Ik vind de app maar moeilijk te gebruiken hoor.”
3	“De app deed het niet goed op mijn telefoon volgensmij, ik kon wel de uitdaging iedere dag zien maar ik kreeg daarna geen melding om te zeggen hoe het ging.” “Of misschien deed ik iets fout, geen idee.”
4	-
5	“Ik heb soms in SCIPP per ongeluk een antwoord fout aangeklikt maar dan kon ik die daarna niet meer aanpassen, dus soms heb ik aangegeven dat het niet gelukt was om een uitdaging te doen wanneer ik hem wel had gedaan.”
6	“Ik moet eerlijk zeggen dat ik de eerste dagen vaak vergat dat ik uitdagingen moest doen en dat dit pas aan het eind van de week in mijn ritme zat.” “Misschien dat het wel helpt als het langer achter elkaar duurt ofzo.” “De reminders waren wel fijn maar ik denk dat ik er meer nodig had.”