Exploring the Association Between Smartphone-Based Screen Time and Positive and Negative Affect in University Students Using Experience Sampling Methodology

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Abstract

Smartphone-based screen time has consistently increased, and mental well-being in university students has decreased during the past years. However, research findings investigating the two are inconclusive and have methodological limitations. Because previous research consistently focused on mental health issues, this research focused on lower-level, more specific aspects of mental well-being, namely positive affect (PA) and negative affect (NA). Moreover, gender was assessed as a moderator of the association. Using an experience sampling methodology, participants (N = 38, M_{Age} = 23, SD_{Age} = 2.2, 57.9% women) were assessed for two weeks via the Ethica app, filling out two daily questionnaires measuring state affect and daily total screen time of the past day. The PANAS and a short form were used to assess the participants' trait and state-levels of PA and NA. Screen time measures were self-reported by the participants. Linear mixed model analyses revealed a negative association between-participants for trait PA and daily screen time (b = -64.11, SE = 28.29, 95% CI [-121.50, -6.72]), and a positive association for trait NA and daily screen time (b = 54.95, SE = 20.10, 95% CI [14.18, 95.72]). Only a negative association was found for state PA and screen time (b = -26.94, SE = 5.38, 95% CI [-37.53, -16.36]), but not for state NA. Gender was not found to moderate the relation between both affect types and smartphone screen time. These findings suggest that positive emotional states may influence students' decisions and behaviours regarding smartphone use.

Keywords: positive affect, negative affect, daily smartphone-based screen time, university students, experience sampling method

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As a consequence of the rapid development and implementation of technology, several inventions, especially smartphones, are found to play an indispensable and essential role in many people's lives. Based on recent estimates, 86% of Europe's population in 2021 were subscribed to a mobile service, with four in five of the service-connections being based on smartphones (Okeleke et al., 2022). Especially young adults aged 16 to 24 were found to spend the most time in front of their smartphone, with an average of 4.25 hours a day in 2022 (GWI, 2023). This increase in smartphone screen time has led to a growing interest in its association with mental health, especially in light of recent developments due to the COVID-19 pandemic.

Depressive symptoms and suicide rates have already steadily increased between the years 2010 to 2015, especially among women (Twenge et al., 2018). However, research has demonstrated that during the COVID-19 pandemic in 2020, major depressive disorders increased by 27.6% and anxiety disorders by 25.6% worldwide (Santomauro et al., 2021). Young female adults between the ages of 18 to 25 were more often affected by mental illnesses than young male adults or older adults (Santomauro et al., 2021; Substance Abuse and Mental Health Services Administration, 2021). In fact, one-third of first year college and university students meet the criteria for at least one mental disorder (Auerbach et al., 2018; Browning et al., 2021; Bruffaerts et al., 2019). The burden of dealing with any mental illness during an important period of most people's lives, paired with significant lifestyle changes and additional stressors when attending a university, could lead to long-term adverse outcomes for the sufferers when left untreated (Scott et al., 2016). Inspecting the relationship between screen time and mental health could thus provide crucial insights for the health of university students, helping in establishing and improving recommendations for possible treatment and intervention methods. Unfortunately, research findings have been mixed.

On the one hand, a considerable number of studies propose a negative association between high screen time and mental health. Findings include increases in the odds of having depressive symptoms and in the severity and levels of mental health issues (Deyo et al., 2023; Neophytou et al., 2021; Rosenthal et al., 2021; Twenge et al., 2018), positive associations with lower well-being in children and adolescents and lower self-esteem in adolescents and young adults (Neophytou et al., 2021; Twenge & Campbell, 2018), and negative associations with good mental health in adolescents (Babic et al., 2017). On the other hand, some researchers argue that the effect may be negligible, as they only found a small negative effect of screen time on mental health (Huang, 2010; Orben & Przybylski, 2019; Tang et al., 2021). Furthermore,

Przybylski & Weinstein (2017) suggest that moderate use of technology is not detrimental to the well-being of adolescents and may even be beneficial. In fact, smartphones can be helpful tools for working on personal well-being, as Chen et al. (2023) found that mobile mindfulness meditation helps reduce stress and anxiety, as well as increasing well-being and mindfulness in university students. Heffer et al. (2019) criticised the findings by Twenge, Joiner, et al. (2018) based on issues with their methodology, and subsequently found that social media use did not predict depressive symptoms.

In addition to these mixed findings, the studies often focused on psychopathologies, such as depression or anxiety, as instances of mental health. However, mental health not only comprises mental illnesses, and thus a crucial part is neglected in current research, namely mental well-being.

Mental Well-Being and Positive and Negative Affect

Mental health is commonly conceptualised as consisting of three distinct components, namely social well-being, psychological well-being, and emotional well-being (Keyes, 2002). Emotional well-being, also known as subjective well-being, is categorised into three components: happiness, life satisfaction, and positive over negative affect (Diener, 2009; Diener & Lucas, 1999). Thus, subjective well-being is defined as having high life happiness, satisfaction, and positive affect, and low negative affect (Diener & Lucas, 1999), emphasising that well-being does not only concern the absence of illness or pain. Positive affect (PA) pertains to feelings of enthusiasm, alertness, activeness, and general positive feelings, while negative affect (NA) pertains to feelings of distress and aversive mood states (Watson et al., 1988). Both affective states were shown to have trait-like and state-like dimensions (Tellegen, 1985, as cited in Watson et al., 1988; Watson et al., 1988). Studies have shown that PA and NA are components of mood and anxiety disorders, as they found that both affective states correlate with depression and that NA correlates with anxiety (Dyck et al., 1994; Jolly et al., 1994).

However, research still lacked to consider particular determinants of mental health, such as PA and NA, in association with screen time. Especially in light of the mixed results, focusing on these determinants instead of solely assessing pathological instances of mental health may shed some light on how the different findings come to exist. Additionally, the methodological shortcomings of previous studies further complicate the clarification of the association between screen time and mental health. For one, the studies employed different assessment methods for screen time, such as questionnaires asking the participants to estimate the duration of their technology usage, making it prone to bias and other reliability issues. Moreover, most research only focused on smartphone screen time as a predictor of mental health. However, placing sole

emphasis on screen time as a predictor does not help understand the true nature of the association and may lead to falsely identifying screen time as the cause of mental illness.

Furthermore, most studies used a cross-sectional design to investigate the relationship between screen time and mental health, measuring at a single point in time. This hinders the exploration of within-person variations and possible short-term effects, which could give valuable insights given that smartphone use and its relation to mental health are different for weekdays and weekend-days (Elhai et al., 2018; Filiposka & Mishikovski, 2013; Przybylski & Weinstein, 2017). Therefore, an experience sampling methodology appears to be the best fit for the current study.

Experience Sampling Methodology

Experience sampling methodology (ESM) is used to track experiences, such as mood or symptoms, by employing structured self-reports prompted to the participants several times a day over several days (Myin-Germeys & Kuppens, 2022). In contrast to how ESM studies were initially used, namely with pen and paper or personal digital assistants, the development of technology has enabled the inclusion of more modern devices. Thus, the participants' smartphones can be used to carry out the ESM study, in turn facilitating the process of data collection. This bears additional advantages, such as reducing the strain on participants for not needing to carry any additional study objects, and increasing the ecological validity of the study, which concerns the generalizability of the findings to the real world (Hormuth, 1986; van Berkel et al., 2018).

Besides assessing PA and NA on a trait-level, as most cross-sectional studies would, the nature of the ESM design allows to also investigate the temporal fluctuations in affect and daily smartphone screen time. This helps in providing a clearer picture of the dynamics within the association. Furthermore, the ESM design allows to investigate between-person and within-person variations. Because smartphone use differs for weekdays and weekend-days (Filiposka & Mishikovski, 2013), and research findings suggest that the correlation between screen time and mental-wellbeing and depressive symptoms is different for weekend-days and for weekdays (Elhai et al., 2018; Przybylski & Weinstein, 2017), it is important to consider the within-person variations of the participants within the current study. Moreover, understanding the dynamics of a relationship between two variables is often complex and complicated, which is why assessing the influence of other variables might result in gaining valuable perspectives. In the context of the association between screen time and mental well-being, the moderating effect of gender might play a crucial role.

Gender Differences

Notably, women are more susceptible to certain mental disorders, such as depression, anxiety, eating disorder, bipolar disorder (Institute for Health Metrics and Evaluation, 2020; Santomauro et al., 2021; Twenge et al., 2018). Moreover, it has also been found that time spent on specific screen-type activities varies by gender, where adolescent girls spend more time on smartphones, while boys engage in more video game play (Przybylski & Weinstein, 2017). A few studies have already inspected a potential moderation effect of gender: One study found that the association between screen time and mental health issues is stronger for adolescent girls, particularly for social media and internet use (Twenge & Farley, 2021). Similarly, another study found that greater depressive symptoms among adolescent girls predicted more frequent social media use, but not among boys (Heffer et al., 2019). Interestingly, the study did not find any evidence of a reversed effect of social media use predicting depressive symptoms. A systematic review of longitudinal studies investigating the association between screen time and mental health in young people did also find strong indications for the existence of sex differences, but those were mostly inconsistent on the direction of the effects (Tang et al., 2021). Nevertheless, this area of research lacks consistency in their findings, and primarily lacks research in the first place. Investigating the effect of gender might prove to help understand the association between affect and screen time even further.

Current Study

By focusing on PA and NA, this study aimed to examine specific determinants of mental well-being in association with screen time and the moderating effect of gender. The target group of university students was chosen based on their high susceptibility to mental illnesses, and the decrease to their mental health (Auerbach et al., 2018; Browning et al., 2021; Bruffaerts et al., 2019; Santomauro et al., 2021; Substance Abuse and Mental Health Services Administration, 2021). The decision to focus solely on smartphone-based screen time was guided by findings of a trend report, which indicated that the most time spent in front of digital devices is on smartphones and mobiles (GWI, 2023). Therefore, the current study aims to answer the following research questions:

Research Question 1 (RQ1): *To what extent do trait PA and NA predict total daily smartphone-based screen time in university students?*

Research Question 2 (RQ2): *How are state PA and NA related to same-day, total daily smartphone-based screen time in university students over time?*

Research Question 3 (RQ3): *Is the association between state PA and NA and same-day, total daily smartphone-based screen time in students moderated by gender?*

Research Question 4 (RQ4): *How are state PA and NA related to same-day, total daily smartphone-based screen time in university students on a within-person level?*

It is expected that PA negatively predicts screen time, on both the trait and state-level, and that NA positively predicts at both levels as well. These assumptions are based on previous findings suggesting associations between mental health and screen time. Furthermore, it is expected that gender will moderate the relation for both PA and NA, since research findings have already established gender differences in the association between screen time and mental health (Heffer et al., 2019; Przybylski & Weinstein, 2017; Tang et al., 2021; Twenge & Farley, 2021). Moreover, it is expected that the degree of the association will differ on a within-person level.

Methods

Design

The study project was conducted by three bachelor students from the University of Twente and was approved by the Ethics Committee of the Faculty of Behavioural Sciences (reference number: 230422). Through an exploratory repeated measures design, this study investigated the association between total daily, smartphone-based screen time, PA and NA on both the trait- and state-level in university students, and a possible moderator effect of gender. The present study was conducted using the platform Ethica (https://ethicadata.com), This platform allows researchers to create studies without needing extensive coding knowledge and experience. Thus, studies can be conducted via the platform's own application, which is suitable considering this study's ESM design. Besides using the triggering logic-feature to set the intervals for when the questionnaires are presented to the participants, notifications can be set up to remind the participants to fill out the questionnaires. The Ethica study included the informed consent (see Appendix A), the baseline questionnaire measuring PA and NA on the trait-level (see Appendix B), an information sheet with important information about the study which the participants could access at any time during the study (see Appendix C), and two daily questionnaires consisting of a questionnaire measuring PA and NA on the state-level, and a questionnaire measuring total daily smartphone screen time (see Appendix D for both daily questionnaires).

In total, the main data collection lasted 15 days. The choice was guided by the difference of smartphone use on weekdays and weekend-days (Filiposka & Mishikovski, 2013), requiring the study to measure at least one week to cover each day of the week. Since the assessment frequency is quite low with two daily momentary measurements, the study duration was extended to approximately two weeks so more data points could be gathered. This study made

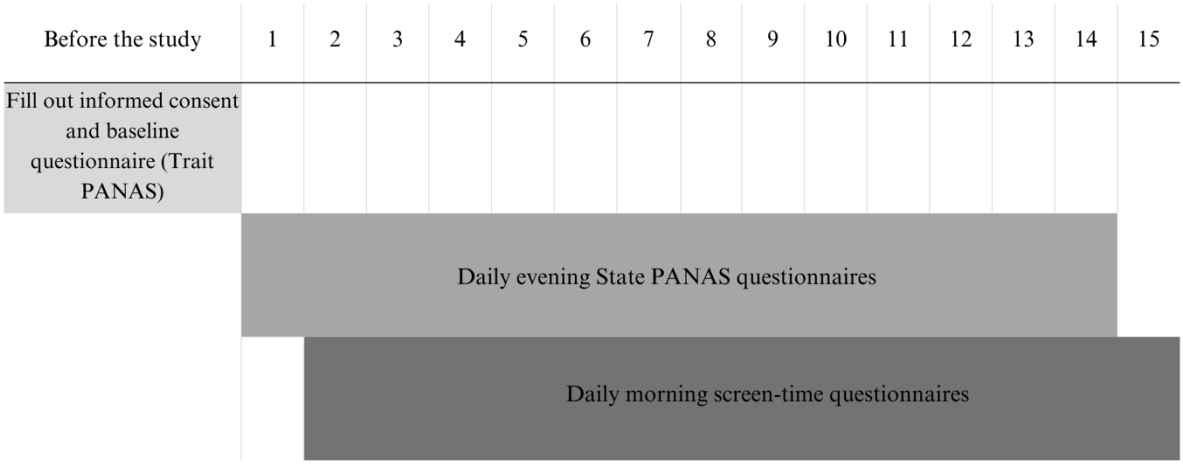
use of a fixed sampling scheme. The daily questionnaire asking about PA and NA was triggered to the participants at 7:00 p.m., and they had five hours to complete it. In order to remind the participants to complete the questionnaires, three notifications were set up. The first notification appeared immediately after the questionnaire was available, the second was set after two hours, and the last after four hours, one hour before the questionnaire was about to expire. Similar to the evening questionnaire, the daily questionnaire measuring screen time was triggered at 7:00 a.m., also remaining for five hours. Thus, the study started with the PA and NA questionnaire on the evening of Day 1 and ended with the screen time questionnaire on the morning of Day 15. Before publishing the study, it was pilot tested for four days among the three researchers. Afterwards, participant recruitment started on the 4th of April 2023. The actual data collection started on the 10th of April at 7:00 p.m. and lasted until 12 p.m. on the 25th of April. For an overview of the present study's timeline, see Figure 1.

Participants

Before the participants could take part in the study, they needed to give their informed consent (see Appendix B). The informed consent briefed the participants about the study's procedure and purpose, possible risks and benefits, confidentiality, about their rights as research subjects, the research method of experience sampling and how it is used. The participants were recruited via two ways, namely convenience sampling in the researchers' network and the subject pool SONA of the University of Twente. This study aimed for at least 19 participant based on the findings of a literature review on experience sampling methods (van Berkel et al., 2018). Participants who took part in the study via SONA were compensated with 1.75 credits,

Figure 1

Timeline of the Study



Note. The numbers in the top row represent the days of the study.

while the other participants were not reimbursed. To take part in the study, four inclusion criteria were chosen: Firstly, the participants needed to be above 18 years old. Secondly, the participants needed to be enrolled currently enrolled in a university or a university of applied science, since university students were the target group of the study. Thirdly, the participants needed to be proficient in English, as the study was fully conducted in the English language. Lastly, participants needed to own a smartphone and use it on a daily basis, based on the focus of daily smartphone-based screen time, and that the Ethica application needed to be downloaded and used daily on a smartphone as well. All participants took part voluntarily in the study.

Materials

Demographic Questionnaire

The demographic questionnaire consisted of questions about the participant's age, gender, whether they are currently enrolled in a university or a university of applied sciences, whether they own a smartphone that they use daily, and their nationality.

Baseline Questionnaire: PANAS

To measure PA and NA on the trait-level, the Positive and Negative Affect Schedule (PANAS) was used (Watson et al., 1988). This scale contains 20 items in total, with 10 items measuring positive affect and ten items measuring negative affect. The items consist of terms describing a state of mood which are rated on a 5-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely). Moreover, the scale can be used in seven different temporal instructions. For the baseline questionnaire, the time instruction "general" was used, as it was shown that both scales have a trait-like stability when using longer-term instructions (Watson et al., 1988). See Appendix B for the complete questionnaire. To compute the overall affect scores for each participant, the means of all ten items of each scale needed to be calculated (Watson et al., 1988). Thus, the higher the score (ranging from 1 to 5), the higher the participant's trait level of the measured affect.

Watson et al. (1988) found adequate test-retest reliabilities, with $r = .68$ for the PA scale and $r = .71$ for the NA scale. Furthermore, both scales indicated good convergent validity ($r = .94$ for the PA scale, $r = .93$ for the NA scale) and discriminant validity ($r = -.08$ for the PA scale, $r = -.12$ for the NA scale). The internal consistency reliability for the current study was good for NA ($\alpha = .82$), but remarkably lower for PA ($\alpha = .66$), considering that the reliability originally reported by Watson et al. (1988) for this scale was higher ($\alpha = .88$). Even though the consensus for an acceptable alpha lies at $\alpha > .70$ (Schmitt, 1996), the current alpha for PA will

still be regarded as acceptable, as the decrease may be due to the difference in sample size or sample characteristics.

Daily Questionnaires

PANAS Short-Form. In order to assess PA and NA at their state-level, a short from of the PANAS scale was used. This shortened version comprises 10 items, where five items with the highest factor loadings for each of the two scales were chosen. In order to measure PA and NA at their state-level, a short-term instruction was chosen, as it was shown that the scales are then sensitive to fluctuations (Watson et al., 1988). Because this was only assessed once a day, the time instructions "today" was used, for example, "Today, I felt enthusiastic". The same answering options were used as in the baseline questionnaire version, a 5-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely). See Appendix D for the PANAS short form. In the current study, the internal consistency reliabilities were high for both the PA (α = .87) and NA (α = .82) scales.

Daily Screen Time. To assess the screen time as objectively as possible, the participants were instructed to look up the data on their smartphones' internal screen time function. Instructions to look it up for two common operating systems, namely iOS and Android, were given in the initial email and in the information sheet. If the participants' smartphones did not possess over such a function, the participants were asked to estimate. The participants were asked to indicate the total time spent on their smartphone in minutes for the previous day, with answering options ranging from zero to 600 minutes.

Procedure

In the beginning, every participant received an email with clear instructions of the study, the inclusion criteria, what they are expected to do before and during the study, how to download the Ethica application, the registration code with which they can access the study, and instructions on how they can check their daily screen time via their smartphone's function (see Appendix E). After registration, the participants were able to immediately give their informed consent and fill out the baseline questionnaires. The participants were requested to fill them out as soon as they registered for the study, as without their consent, they were not eligible for participation in the study. On the first day of data collection, the 10th of April 2023, the participants received their first daily questionnaire at 7:00 p.m. in the evening, assessing their mood using the short form of the PANAS scale. From the 11th of April until the 24th of April, the participants received both daily questionnaires, assessing screen time in the morning and PA and NA in the evening. On the last day, the 25th of April, the participants received their last questionnaire at 7:00 a.m. measuring their daily screen time. During the last questionnaire,

the participants were informed that the study is finished, and they were thanked for their participation and contribution.

Data Analysis

For all statistical analyses, the software *R Studio* (version 2023.03.0+386) was used. The study data from Ethica were imported into the software and cleaned, for example by coding logical variables into numerical variables. Because Ethica creates separate datasets for each questionnaire, the data were merged into two main datasets, the first consisting of the demographic data and the second consisting of the data used for statistical analysis, namely the baseline and the daily questionnaire data. A timepoint variable was created in order to align the affect and the screen time measurements, since screen time was measured retrospectively. This variable consists of a sequence of numbers, ranging from one to 15, which correspond to the timeline of the study. Following from this, the values 7 and 13, and 8 and 14 correspond to the weekend-days Saturday and Sunday, respectively.

Subsequently, mean PANAS scores of the baseline measure were computed and added as a variable to the analysis dataset. This was also done for the daily PANAS measure to compute the participants' daily affect scores, but this time only computing the mean of the five items per scale. Furthermore, response rates were calculated for the daily morning and evening questionnaires.

For the statistical analyses, linear mixed models (LMM's) were applied. These mixed-effect models can account for the multilevel nature of the ESM data, since repeated measurements are nested within participants, resulting in two-levelled data (Myin-Germeys & Kuppens, 2022). Furthermore, mixed-effect models can appropriately handle the complexities of repeated measurements data, such as missing data and subject-level variability. To account for the covariance structure of the data, each model was plotted using a first-order autoregressive covariance structure (AR1), which assumes a decline in the correlations among the measurement points with increasing distance between them. Moreover, the variables Day and Participant were specified as the random effects in each model.

All LMM's were plotted using the *nlme* package in R (Pinheiro et al., 2023), as it allows to include the covariance structure in the model. For the first research question (RQ1), two LMM's were performed, where total daily screen time was set as the dependent variable, and trait PA and NA as the fixed covariate. For RQ2, again two models were performed, with total daily screen time set as the dependent variable and state PA and NA as the fixed covariate for each model. The LMM's for RQ3 were performed the same as for RQ2, with gender as the moderator variable. Since RQ1 and RQ2 are more of exploratory nature, significance testing

was only applied to RQ3, with a statistical significance threshold of $p < .05$. Moreover, the assumptions of a linear mixed model were tested for all LMM's that were performed, which did not indicate any violations. Furthermore, for illustrative purposes, separate LMM's were performed in order to compute the estimated marginal means (EMM) of the variables screen time, state PA and state NA per participant and over time.

To answer RQ4, two participants were chosen, based on having completed the full 15 days of data collection, and representing both genders that were investigated, namely male and female. For the sake of readability, fictional names were assigned. The chosen participants' EMM's for total screen time, daily PA and daily NA over time were plotted individually and compared.

Results

Participant Demographics

From the initial sample of 50 participants that took part in the study, 12 had to be excluded from analysis due to not giving their consent and having completed less than seven days of data collection. The decision to exclude participants that in total generated substantially less than seven days of complete data, meaning having answered to both daily measurements, was based on requiring data for at least all seven days of the week to be able to compare weekdays and weekend-days. Consequently, the final sample consisted of 38 participants.

The ages of the participants ranged from 18 to 33 ($M = 23$, $SD = 2.2$) years. Moreover, 22 participants were female (57.9%), while 16 participants were male (42.1%). All participants were German. The mean of the response rates were similar for the morning and evening questionnaires, with 82.6% and 86% respectively. When looking at the results of the trait measures of the participants' affect, PA was higher ($M = 3.4$, $SD = 0.5$) than NA ($M = 2.4$, $SD = 0.6$), with scores ranging from 2.4 to 4.1 for PA and 1 to 3.6 for NA. See Appendix F for an overview of the trait PA and NA measures per participant. Regarding the state measures of affect, participants again displayed more PA ($M = 2.9$, $SD = 0.6$) than NA ($M = 1.8$, $SD = 0.8$). Furthermore, the participants spent around four hours a day in front of their smartphones ($M = 250.8$, $SD = 85.1$ minutes), with times ranging from 115 minutes a day up to 462 minutes.

Trait Affect and Screen Time

When looking at the results of the LMM of trait PA, it appears to have a quite large, negative effect on screen time of approximately one hour ($b = -64.11$, $SE = 28.29$, 95% CI [-121.50, -6.72]; see Table G1). This suggests that higher levels of trait PA are associated with lower levels of screen time minutes. However, the confidence interval for this estimate is wide, ranging between six minutes to 120 minutes, which implies an uncertainty in the strength of the

effect. Trait NA was found to have a positive effect on screen time of nearly an hour, while the range of the confidence interval is also wide (*b* = 54.95, *SE* = 20.10, 95% CI [14.18, 95.72]).

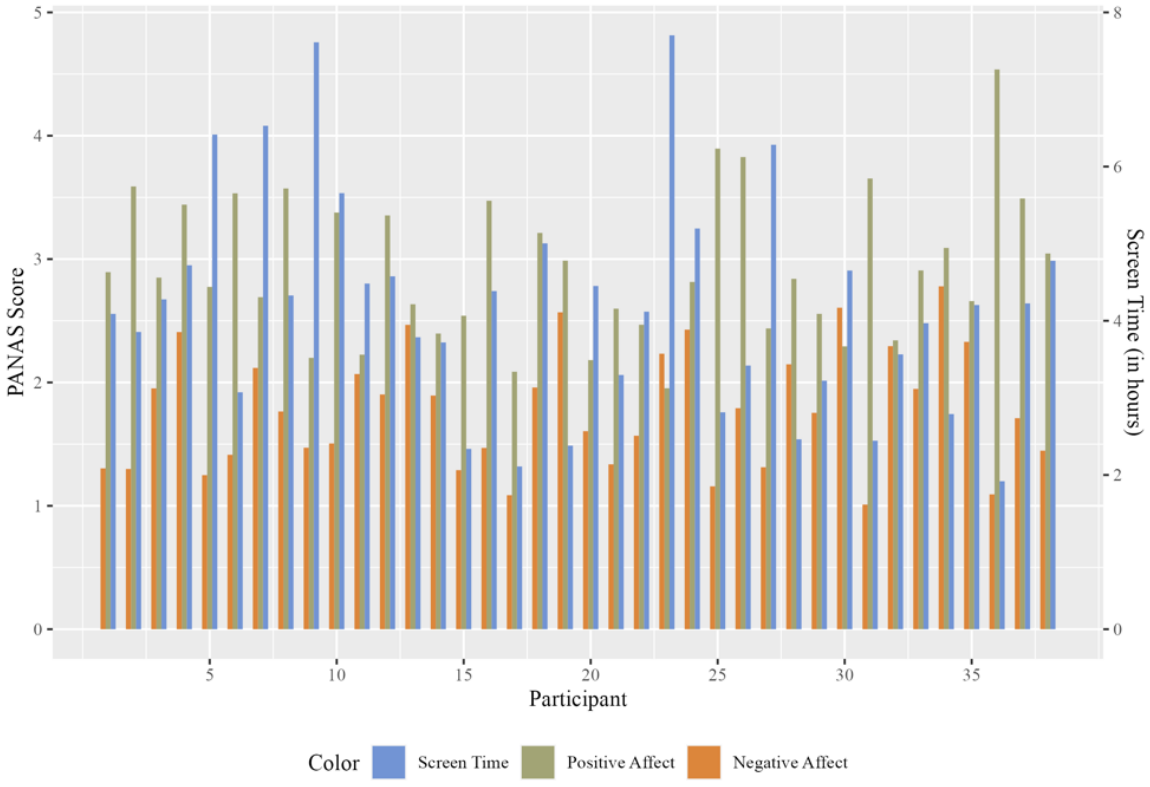
State Affect and Screen Time

The association between state PA and screen time is also negative, although the effect with approximately 27 minutes is smaller compared to trait PA (*b* = -26.94, *SE* = 5.38, 95% CI [-37.53, -16.36]; see Table G2). Nevertheless, the confidence interval supports the certainty of this estimate, as the ranges are considerably narrow. The effect of state NA on screen time is positive, but visibly small with six minutes (*b* = 6.97, *SE* = 6.73, 95% CI [-6.25, 20.20]). The confidence interval for this estimate is large and ranges from negative to positive values, which suggest an unreliable estimate

Figure 2 displays the EMM's for the three daily measures, namely screen time, PA and NA, per participant, illustrating the differences between each participant. In general, almost all participants show higher average daily PA than NA. A few participants stand out with their high average daily screen time, such as Participant 9 and Participant 23. When looking at their respective affect measures, Participant 9 indicates higher PA, while Participant 23 indicates higher NA. Putting this into perspective, it appears that a link between lower PA and higher screen time might exist on a between-person level. Both Participant 9 and Participant 23 have a considerably lower PA average compared to the other participants. Moreover, participants with a visibly higher PA average have markedly lower daily screen times, such as Participant 25, Participant 26, or Participant 36.

Figure 2

EMM's for Total Screen Time and PA and NA per Participant



When inspecting the plot of the three measures over time (see Figure 3), both affect types stay fairly consistent, while screen time indicates small but palpable fluctuations that do not exceed one hour. This implies that the participants' daily levels of affect and screen time may not vary significantly on both a within-person and between-person level.

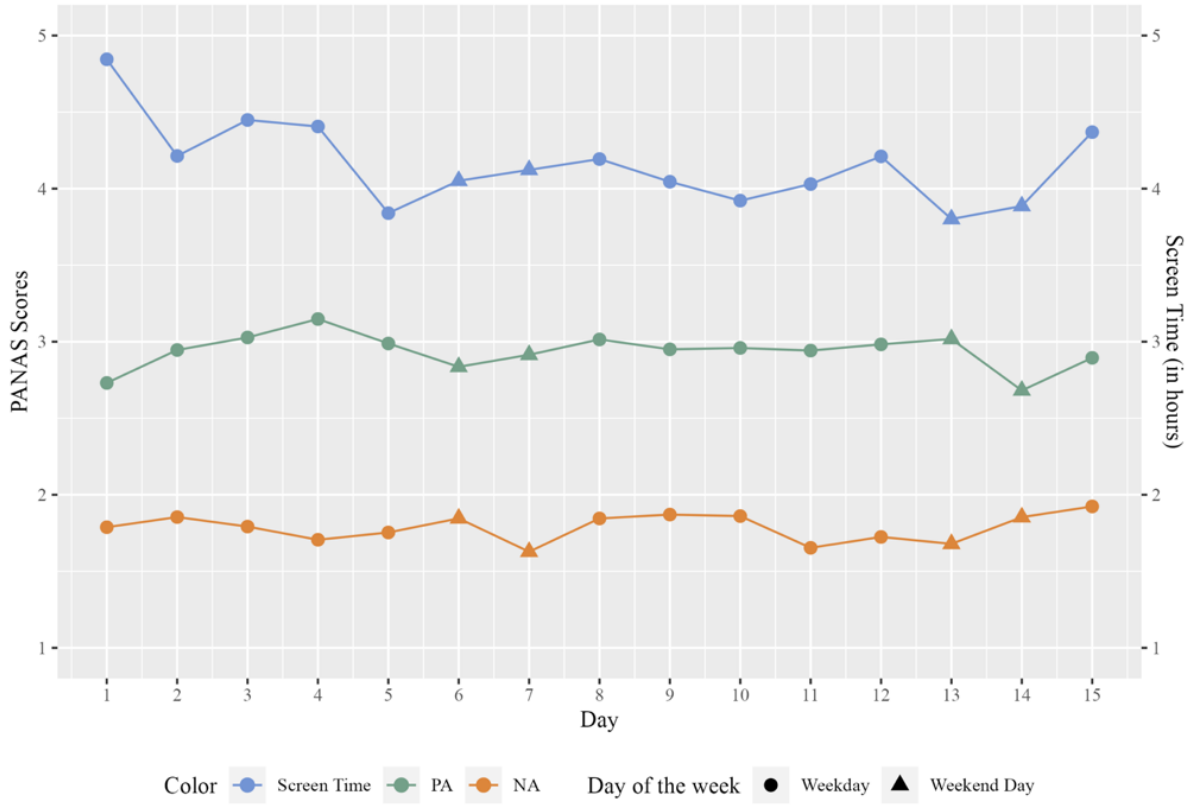
Gender Moderation

The results of the moderation analysis are insignificant, for both daily PA (b = -6.25, t = -0.58, p = .56) and daily NA (b = 7.73, t = 0.55, p = .58). Thus, the null hypothesis that gender does not moderate the relation between screen time and both PA and NA can be accepted. For an overview of the estimates, see Table G3.

This findings is also reflected in the trait measures for PA and NA per gender. The differences in trait PA between the female participants (M = 3.5, SD = 0.5) and the male participants (M = 3.3, SD = 0.4) are very small. This also applies to trait NA, where women score slightly higher (M = 2.6, SD = 0.6) compared to men (M = 2.2, SD = 0.7). The differences in states measures are even smaller. For PA, the women's mean score (M = 2.9, SD = 0.6) is almost the same as for the men (M = 3, SD = 0.6). Similarly, the scores for state NA do virtually not differ between women (M = 1.8, SD = 0.5) and men (M = 1.7, SD = 0.5). For screen time, there is not a big difference in the overall means per gender, which were 250.3 minutes (SD = 17.9) for women and 248 minutes (SD = 25) for men.

Figure 3

EMM's for Total Screen Time and PA and NA Over Time



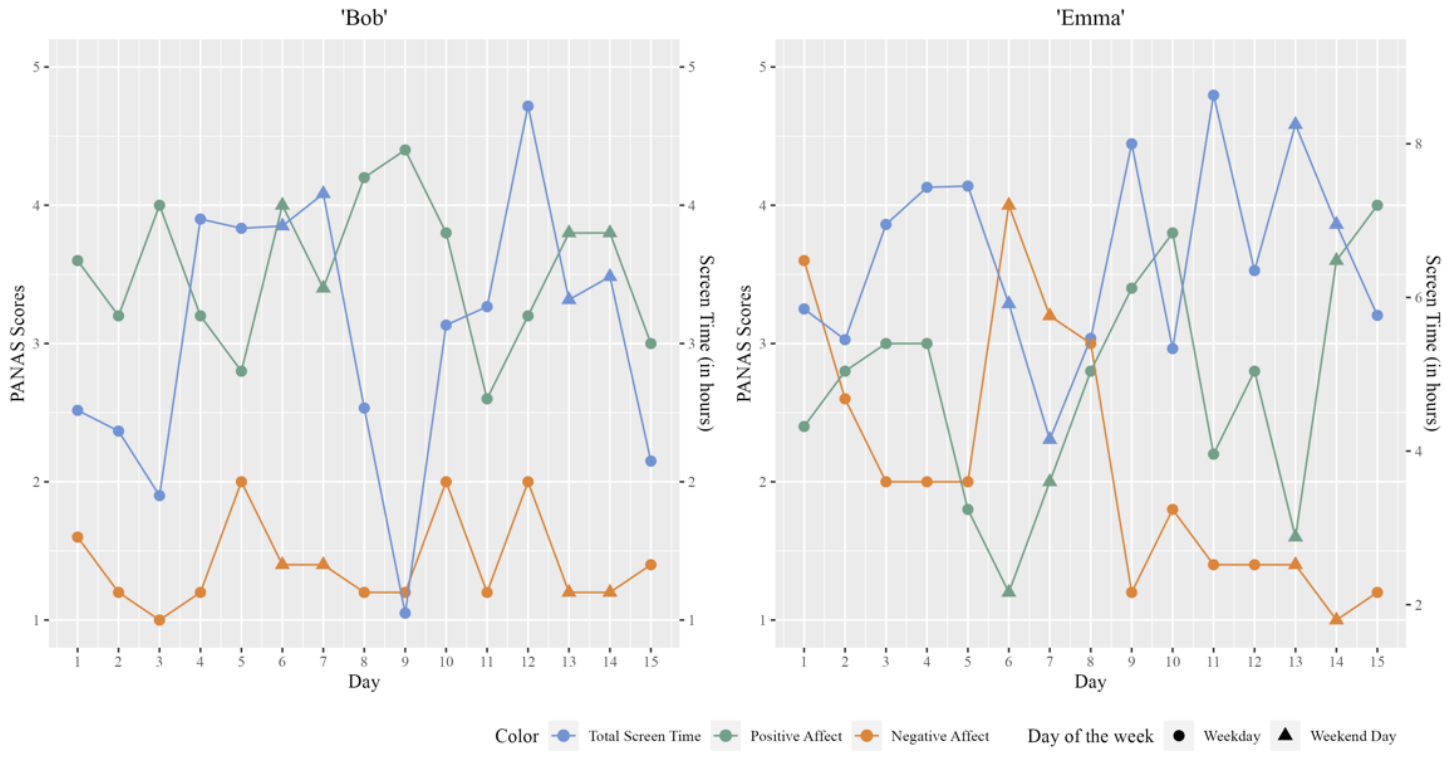
Within-Person Analysis: Individual Cases

The two chosen participants for this individual case analysis were Participant 6, from now on named ‘Bob’, and Participant 7, now called ‘Emma’. When looking at their EMM’s for all three measures for the whole duration of the study (see Figure 2), one can see that Bob (Participant 6) demonstrates above average PA, average NA, and below average screen time. In contrast, Emma (Participant 7) demonstrates above average NA and screen time, and just below average PA. When looking at the individual plots for Bob (see Figure 4), large fluctuations are noticeable in screen time. Furthermore, Bob’s PA levels also fluctuate, however, all within a range of 2.5 and 4.3, which may be considered ordinary. Bob’s levels of NA stay fairly consistent. In this case, small indications for an association between PA and screen time are observable, but not certainly, as on some instances, Bob’s screen time increases when his PA level increases.

Continuing with Emma (see Figure 4), it is immediately noticeable that her daily screen time is higher, and PA levels are lower than for Bob. Obvious fluctuations are noticeable for screen time, especially during the second week of the study (from Day 8 to Day 14). With Emma, a pattern can be observed: One can clearly see how when Emma’s PA level goes up, screen time decreases (e.g., Day 10). In contrast, when screen time increases again, Emma’s PA level decreases (e.g., Day 11). However, this pattern is not so clear for Emma’s NA levels. Nevertheless, this may indicate that an association between state PA and total daily screen time exists on a within-person level, but only for certain individuals.

Figure 4

EMM’s for ‘Bob’ and ‘Emma’



Discussion

The aim of the current study was to explore the association of screen time and affect and additionally test for a possible effect of gender as a moderator by using an ESM study design over the course of 15 days. The results suggest that both trait PA and NA predict daily smartphone screen time on a between-person level over time. More specifically, PA negatively predicted screen time, meaning that the higher the participant scored on trait positive affect, the lower their daily smartphone screen time was. Accordingly, NA positively predicted screen time, indicating that smartphone screen time increased the higher the participant's level of trait negative affect was. State PA also had a certain negative effect on screen time, while NA shows an uncertain association with screen time. Gender was found not to moderate the associations between state PA and NA and screen time.

The significant association between affect and screen time is in line with previous studies, which found an association between lower mental health and higher daily smartphone screen time (Anderl et al., 2023; Przybylski & Weinstein, 2017; Rosenthal et al., 2021; Twenge & Campbell, 2019). This is reasonable, given that these studies used mental well-being measures that accounted for mood and the hedonic aspect of well-being, except for Rosenthal et al. While other authors argue that the significance of this association may be negligible (Huang, 2010; Orben & Przybylski, 2019; Tang et al., 2021), the studies in these systematic reviews varied in their measure of mental health, and mostly consisted of measures for depression, anxiety, and other mental health issues. Consequently, this result implies that affect may play a fundamental role in the explanation of the association between mental well-being and screen time, instead of emphasising the role of mental illnesses. Moreover, this result has shown a different direction of association compared to previous literature, which suggests that positive emotional states may influence individuals' decisions and behaviours regarding smartphone use, and not the other way around. However, these results do not provide a clarification for the causality of this association.

In an attempt to explain this finding, the *displacement hypothesis* might be helpful, as this theory posits that screen time replaces other recreational activities, such as social activities (Kraut et al., 1998; Neuman, 1988). PA has been associated with a variety of social behaviours (Myers & Diener, 1995; Watson & Clark, 1997), suggesting that higher levels of PA lead to more social behaviour and social interactions, thus decreasing the time spent using smartphones. However, Berry & Hansen (1996) have found that NA is also positively associated with social interaction, and (Valkenburg & Peter, 2007) found more support for the *stimulation hypothesis* than for the displacement hypothesis, which argues that modern

technologies encourage online communication (Bryant et al., 2006). Therefore, more research is needed to investigate the role of trait affect in relation to screen time.

Furthermore, this study found that state PA is associated with daily smartphone screen time over time both between and within participants, however, this was not found for NA. Comparable studies that used a repeated measure design to investigate the association between screen time and mental well-being have contradictory findings. For one, Elhai et al. (2018) have found that higher levels of depression symptoms actually decrease screen time. Contrarily, Anderl et al. (2023) found that increased smartphone use led to lower psychological well-being and lower feelings of social connectedness, which supports the displacement hypothesis. While these studies did find associations, even though contradicting, Rozgonjuk et al. (2018) did not find any significant association between depression and screen time. Because the current findings are not in line with these results, further research using a repeated measures design is required to clarify the temporal associations and the directionality of the association between daily screen time and PA. Nevertheless, the current findings suggest that an individual's level of PA may influence their screen time behaviours. The finding that no association was found for NA may be explained because of the participants' stable NA measures, or because individuals may engage in other coping strategies or different types of activities that are not related to screen time.

The moderator analysis did not find a significant effect of gender on the association between affect and screen time. This is plausible, given that previous literature consistently found no significant gender differences in PA and NA (Crawford & Henry, 2004; Huebner & Dew, 1996; Watson et al., 1988; Watson & Clark, 1994). This is also in line with the present study's findings of both trait and state measures of affect, as they did not differ substantially between both genders. Similarly, the means for screen time were nearly exactly the same for both women and men. Even though previous research found significant gender differences in overall screen time and its association with mental health (Heffer et al., 2019; Przybylski & Weinstein, 2017; Tang et al., 2021; Twenge & Farley, 2021), it appears that these differences pertain to mental health issues, such as depression and anxiety, instead of mood and affect.

Moreover, the current study's findings indicated that for between-participants, state PA and NA did not show a clear association with screen time. However, based on the individual cases that were examined, it could be concluded that this association might be more relevant on a within-person level. One participant clearly showed an association between state PA and screen time, while the other participant displayed uncertain, but still visible indications. For both participants, no association was seen between state NA and screen time, which is in line

with the results of the regression analysis. This suggests that within individuals, fluctuations in PA are predictive of same day smartphone screen time.

The difference in the degree of the association between the participants could be explained by their level of trait affect. For instance, Bob had above average trait PA and below average screen time, while Emma, with the visible association, had above average NA and screen time. This implies that for people who already show lower levels of trait PA and higher levels of trait NA, the association between positive affect and screen time is more prominent. Again, it has not become clear why that might be. More research on screen time and mental well-being using a repeated measures design is needed to further explore the dynamics over time, and what implication this might have.

Strengths and Limitations

This study showcases notable strengths worth highlighting. First, by the use of an ESM study design, several limitations of previous studies were circumvented, more specifically those of cross-sectional studies. Second, by making use of the participants' smartphone's integral screen time function, this study made best efforts to reliably collect data on screen time. Third, this study added to the body of research examining screen time in university students and its association with mental well-being, by focusing on the more personal, hedonic aspect of affect as a determinant of well-being, granting a clearer picture of the association between the variables.

Nevertheless, several limitations of this study need to be acknowledged as well. For one, the internal consistency reliability for trait PA was unexpectedly small for this study's sample, which may have impeded the significance of the outcomes. In addition, the small sample size, only consisting of German university students, also limits the generalizability of this study's findings to the general population of university students. Furthermore, the short form of the PANAS questionnaire to measure daily affect comprises ten items with the highest factor loadings for each scale, reported by Watson et al., (1988) in his original paper. However, this short form has not been validated beforehand, and not within the scope of this study as well. A validated, international short form of the PANAS has been developed by Thompson (2007) which could have been used instead, however, this was only discovered after data collection had already started. While it is not expected that the short form that was used in this study will have substantial influences on the internal validity of the scale itself, or on the significance of the outcomes of the study, it is still an important consideration to view the results critically.

Future Implications

This study's findings suggest that improving individuals' PA levels could help in reducing excessive smartphone screen time. Interventions or well-being programs targeting university students can be developed to raise awareness about the potential influence of the students' mood on their smartphone screen time. These programs could focus on enhancing PA as a means to promote healthier smartphone usage habits, but also to improve the well-being and mental health of the students.

It is recommended that future research aims at investigating the directionality of the association between daily affect and daily screen time and its underlying causes or contributing factors. Because it is not clear yet whether one aspect influences the other, or whether the relation is of bidirectional nature, providing suggestions for practical implications is limited. Given the inconclusive findings of past research, the association needs to be thoroughly tested and explored, so insights become most meaningful and valuable to the realm of mental health research. Moreover, future research should additionally inspect other variables that may have an influence on the association between affect and screen time, such as the type of smartphone use, the reason for use, or the time of use. Przybylski & Weinstein (2017), for instance, have found that the association between any screen time and well-being depended on whether the activities occurred during the week or on weekend days. Moreover, they found that the association changed for some types of digital activities: Technologies that require more active effort, such as the smartphone or video games, had lower inflection points on weekdays, meaning that negative effects of screen time on well-being occurred after less screen time exposure for those activities than for other digital activities.

Conclusion

The current study provided new insights on the association between mental well-being and daily screen time, by focusing on both trait and state affect. Findings revealed that both trait PA and NA predict daily screen time, as well as state PA. No association was found between state NA and screen time, and gender did not moderate either relationship. The association for state PA and screen time appeared to be more prominent on a within-person level, and it was proposed that the participant's trait affect levels might influence the degree of that association. Future implications include using these findings in interventions and well-being programs for university students to improve the mental health, and to promote healthier smartphone usage. Future research should investigate the directionality of this association and other variables that may have an influence.

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Appendix A

Informed Consent

Informed consent

Dear participant,

We appreciate your participation in our study on smartphone screen-time and well-being! Please read the following information thoroughly.

Purpose of the Research

This study aims to investigate the relationship between daily screen-time on smartphones and mental health-related constructs. By taking part in this study, you will help us contribute to the scientific knowledge of daily screen-time on smartphones and social media, as well as its relationship to positive and negative affect and self-esteem.

You are eligible to participate in this study if you are at least 18 years old, proficient in English, enrolled at a university or university of applied sciences, and use your smartphone daily.

Procedure

This research will take place over the course of 15 days beginning on April 10th, 2023. Once you've signed up for our study, you'll get an email with further instructions on how to participate in our study, including information on how to download the needed application 'Ethica' on your smartphone with the respective Study ID that will allow you to access our study within Ethica. After you successfully entered our study in Ethica, you will be presented with the informed consent. After you agreed to participate in our study, you will be asked to fill out demographic data, and to complete three different baseline questionnaires about self-esteem, creativity, and positive and negative affect. It will take roughly 15-20 minutes to complete this questionnaire, and you will only have to answer it once. On April 10th, 2023, in the evening, you will receive your first daily questionnaire via the Ethica App. From April 11th until April 24th, you will receive two brief questionnaires daily via the Ethica App. The first one you will receive in the morning about your smartphone screen time for the previous day. In the evening, you will receive two brief questionnaires about self-esteem, and negative and positive affect, that will take approximately two minutes to complete. On the last day, 25th of April, 2023, you will receive your final questionnaire in the morning to indicate your smartphone screen-time for the previous day. After that, the study is over. It is important to fill out as many questionnaires as possible to ensure the success of the project. Continue

answering the following questions even if you miss one. Please make sure that the notifications on your device for Ethica are turned on.

Risks and Benefits

There are no anticipated risks associated with participating in this study. One possible effect is an increased awareness of your smartphone usage, self-esteem, and negative and positive affect. For this reason, please consider your participation in this study carefully if you are sensitive to these topics. Moreover, if applicable, as a psychology or communication science student of the University of Twente, you are eligible to collect SONA credits as compensation. Finally, your participation helps us to investigate the relationship between smartphone screen time and well-being in university students.

Confidentiality

Your responses will be kept confidential, and your personal information will be anonymised. We will not share your data with any third party or publish it outside of this study. If you wish to receive the research results, you can contact the researchers.

Right to Withdraw

You do not have to participate in this study if you do not wish to do so. Moreover, you may stop participating in our study at any time without having to give a reason. Even after the study has been completed, it is possible to withdraw. On request, the personal data given during the study will be destroyed and will not be used for further analysis.

The Ethics Committee of the University of Twente has approved this study. If you have any questions or concerns, please feel free to contact the researchers at any time, whether before, during, or after your participation.

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I hereby declare that I have fully read and understood the text above and I am willing to participate in this study. By ticking ‘Yes’, I actively consent to participate in this study and the processing of my data.

- Yes, I agree.
- No, I do not agree.

Appendix B

Baseline Questionnaire – PANAS Scale

This following questionnaire consists of 20 words that describe different feelings and emotions. Read each item and then mark the appropriate answer. Indicate to what extent you **have felt this way during the past year**.

Interested.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Distressed.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Excited.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Upset.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Strong.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Guilty.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Scared.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Hostile.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Enthusiastic.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit

- (5) Extremely

Proud.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Irritable.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Alert.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Ashamed.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Inspired.

- (1) Very slightly or not at all

- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Nervous.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Determined.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Attentive.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Jittery.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Active.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Afraid.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Appendix C
Information Sheet

Hello!

Here are some general information about the study.

Firstly, you are required to answer to the consent form (If you do not agree, you cannot participate in our study), fill out demographic information, and three baseline questionnaires, which you can find here on Ethica. You will only need to fill out this once.

You will receive the first daily questionnaire on the **10th of April at 07.00 pm** to answer a few questions about your daily level of self-esteem and affect.

Starting from the **11th of April until the 24th of April 2023,** you will receive two daily questionnaires.

The first one you will receive at **07.00 am in the morning** and you will have time until 12.00 pm (noon) to finish this. This one is about your screen-time and social media consumption of the previous day. Please look up your screen-time on your smartphone's integrated screen-time features *(You can find instructions about how to find these on your smartphone below)*

The second one, you will receive at **07.00 pm in the evening** and you will have time until 12.00 am (midnight) to finish these. This one is about your daily levels of self-esteem and affect.

Each questionnaire will take about 1-2 minutes to complete.

In case you did not fill out these daily questionnaires immediately, you will receive notifications to remind you. Please do not forget to enable notifications on Ethica.

There might be some situations in which you are not able to fill out these questionnaires in the given time (e.g., when you are driving), however, please continue with the study in the following days.

On the **25th of April at 07.00 am**, you will receive the last questionnaire in which you have to indicate your screen-time of the previous day.

In case you still have questions, feel free to contact the researchers of this study:

Nina Böcher: n.bocher@student.utwente.nl

Sarah Kast: s.kast@student.utwente.nl

Jenni Eske: j.eske@student.utwente.nl

Supervisor Gerko Schaap: g.schaap@utwente.nl

Instructions on how to find screen-time tool on your smartphone

For **Android:**

Go to **Settings > Digital Well-being & parental controls > Dashboard** and check the time under **Screen time**.

For **iOS:** simply go to **Settings** > **Screen time**.

If your smartphone does not have this feature, please make an estimation about your screen-time.

Appendix D

Daily Questionnaire Items

Screen Time Items

Good morning! We will now ask you questions about your screen time and usage from yesterday.

In the following questions, we will **focus only on smartphone screen time.** Therefore, please go to your smartphone's 'Screen Time' function. If you do not have that, then please make an estimation.

Please indicate the **total time** you spent on **your smartphone** yesterday in minutes.

Thank you! See you in the evening! :-)

PANAS Items

Hello again! First, we would like to know how you feel.

This following questionnaire consists of five words that describe different feelings and emotions. Read each item and then mark the appropriate answer. Indicate to what extent you have felt this way **today**.

Today, I felt **enthusiastic**.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Today, I felt **scared**.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Today, I felt **interested**.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Today, I felt **afraid**.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Today, I felt **determined**.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Today, I felt **upset**.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit

- (5) Extremely

Today, I felt **excited**.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Today, I felt **distressed**.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Today, I felt **inspired**.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

Today, I felt **jittery**.

- (1) Very slightly or not at all
- (2) A little
- (3) Moderately
- (4) Quite a bit
- (5) Extremely

That's it for today, thank you!

Appendix E

Participant Email

Email for Participants Who Were Recruited via Convenience Sampling

Dear Participant,

We are pleased to welcome you to our study on smartphone screen time and well-being!

In this email, we would like to introduce you to our study and its experience sampling method. We want to make sure that you understand the whole procedure and feel comfortable during your participation.

The purpose of the study is to investigate students' smartphone screen time and usage in association to their well-being in their day-to-day lives. By asking a few questions about your smartphone usage and screen-time, and well-being at two different times of the day, we want to gain insight into student's behaviour and feelings on a daily basis. For that, you are required to download the smartphone application "Ethica" (See specific instructions below).

For this study you need to fulfil the following characteristics to participate:

- Be above 18 years old
- Be enrolled in a university or university of applied science
- Be fluent in English
- Own a smartphone and use it on a daily basis

Here's what you need to do before and during the study:

Step 1: Download the application "Ethica" from your AppStore or Playstore. Create an account (register as a participant) and log in. It is important that you enable notifications from Ethica. To access this study, fill in the following **Registration Code: 3226**.

Step 2: Once you have registered and accessed the study, you need to fill out the first activity that will be immediately available to you. This activity consists of the **informed consent form** (if you do not give your consent, you cannot participate in this study), **demographic data** (age, gender, nationality), and **three baseline questionnaires**. This will take roughly 15-20 minutes to finish. It is important that you finish these as soon as you have entered the study in Ethica.

Step 3: On the **10th of April 2023**, the first daily assessment will start in the evening at 07.00 pm. You will have time until 12 am to finish this survey. From **April 11th to April 24th**, you will receive two daily questionnaires.
You will receive the first one at 07.00 am in the morning and you'll have time to finish it by 12.00 in the noon.
You will receive the second one at 07.00 pm in the evening and you'll have time to finish it by 12.00 am. Each questionnaire will take approx. 1-2 minutes to complete. We also help you to remember filling out the questionnaire by sending notifications.

Step 4: On the **25th of April 2023**, you will receive your last questionnaire at 7.00 am in the morning. After that, you are done with the study.

Some Important Information for you:

- For the success of our study, we need you to respond to as many assessments as possible. In the case that you missed one assessment, please make sure to continue with the following questionnaires.
- In our study, you will be asked about your smartphone screen-time. For that, please check your screen time on your smartphone.

For **Android:**
Go to **Settings > Digital Well-being & parental controls > Dashboard** and check the time under **Screen time**.

For **iOS:** simply go to **Settings** > **Screen time**.

If your smartphone does not have this feature, please make an estimation about your screen-time.

We thank you in advance for your participation and time that you will invest in our study. We hope the study is interesting or even beneficial to you as well and that you are enjoying the assessments!

For further questions, feel free to contact the researchers:

Nina Böcher: n.bocher@student.utwente.nl

Jennifer Eske: j.eske@student.utwente.nl

Sarah Kast: s.kast@student.utwente.nl

(Supervisor: Gerko Schaap: g.schaap@utwente.nl)

Email for Participants Who Were Recruited via SONA

Hey!

You recently signed up to take part in the study: "Smartphone Screen Time and Well-Being" on SONA.
Here is some important information about the study.

First, the study will start on the **10th of April**. However, there are some small steps you need **to do before the study starts:**

Step 1: Download the application "Ethica" from your AppStore or Playstore. Create an account (register as a participant) and log in. It is important that you **enable notifications** from Ethica.To access this study, fill in the following **Registration Code: 3226**.

Step 2: Once you have registered and accessed the study, you need to fill out the first activity that will be immediately available to you. This activity consists of the **informed consent form** (if you do not give your consent, you cannot participate in this study), **demographic data** (age, gender, nationality), and **three baseline questionnaires**. This will take roughly 15-20 minutes to finish. It is important that you finish these as soon as you have entered the study in Ethica (You need to fill these out **before 07.00 pm on 10th April 2023!**)

Step 3: On the **10th of April 2023**, the first daily assessment will start in the evening at 07.00 pm. You will have time until 12 am to finish this survey. From **April 11th to April 24th**, you will receive two daily questionnaires.
You will receive the first one at 07.00 am in the morning and you'll have time to finish it by 12.00 in the noon.
You will receive the second one at 07.00 pm in the evening and you'll have time to finish it

by 12.00 am. Each questionnaire will take approx. 1-2 minutes to complete. We also help you to remember filling out the questionnaire by sending notifications.

Step 4: On the **25th of April 2023**, you will receive your last questionnaire at 7.00 am in the morning. After that, you are done with the study.

Some Important Information for you:

- For the success of our study, we need you to respond to as many assessments as possible. In the case that you missed one assessment, please make sure to continue with the following questionnaires.
- In our study, you will be asked about your smartphone screen-time. For that, please check your screen time on your smartphone.

For **Android:**
Go to **Settings > Digital Well-being & parental controls > Dashboard** and check the time under **Screen time**.

For **iOS:** simply go to **Settings** > **Screen time**.

If your smartphone does not have this feature, please make an estimation about your screen-time.

For the success of our study, we need you to respond to as many assessments as possible. In the case that you missed one assessment, please make sure to continue with the following questionnaires.

We thank you in advance for your participation and time that you will invest in our study. We hope the study is interesting or even beneficial to you and that you are enjoying the assessments!

For further questions, feel free to contact the researchers:

Nina Böcher: n.bocher@student.utwente.nl

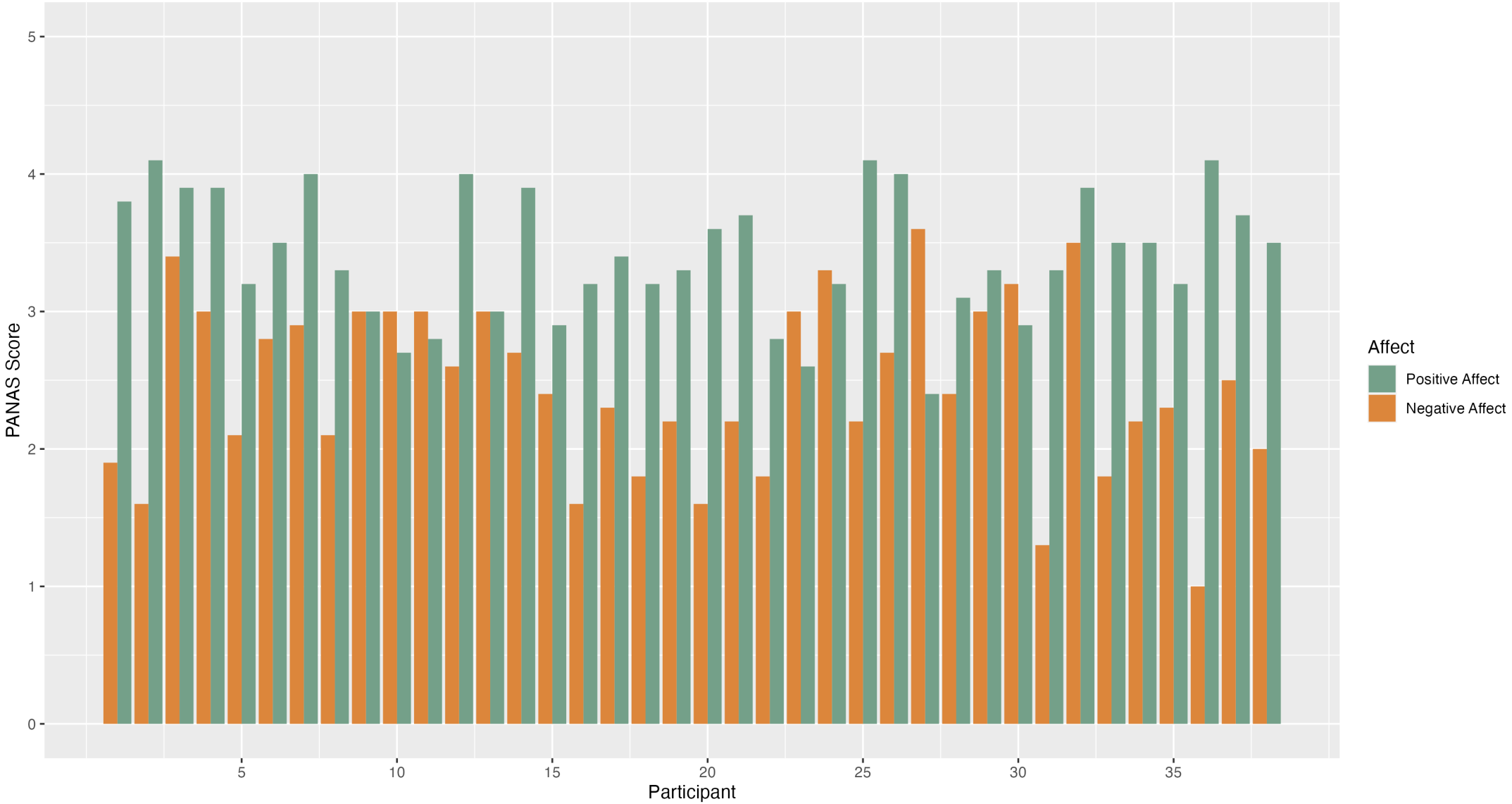
Jennifer Eske: j.eske@student.utwente.nl

Sarah Kast: s.kast@student.utwente.nl

(Supervisor: Gerko Schaap: g.schaap@utwente.nl)

Appendix F

Trait Measures of PA and NA per Participant



Appendix G

LMM Regression Estimates

Table G1

Regression Results of LMM for RQ1

Variable			95% CI	
	B	*SE*	*LL*	*UL*
Positive Affect				
Intercept	471.03	97.29	279.81	662.26
Trait PA	-64.11	28.29	-121.50	-6.72
Negative Affect				
Intercept	114.80	50.77	15.01	214.58
Trait NA	54.95	20.10	14.18	95.72

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

Table G2

Regression Results of LMM for RQ2

Variable			95% CI	
	B	*SE*	*LL*	*UL*
Positive Affect				
Intercept	332.65	20.52	292.31	372.99
State PA	-26.94	5.38	-37.53	-16.36
Negative Affect				
Intercept	241.04	18.25	205.14	276.94
State NA	6.97	6.73	-6.25	20.20

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

Table G3

Moderation Regression Results of LMM for RQ3

Variable					95% CI	
	B	*SE*	*t*	*p*	*LL*	*UL*
Positive Affect						
Intercept	325.53	27.54	11.82	**<.001**	271.39	379.67
State PA	-24.06	7.33	-3.28	**.001**	-38.46	-9.66
Gender	15.33	41.56	0.37	.714	-68.96	99.62
State PA * Gender	-6.25	10.83	-0.58	.564	-27.54	15.04
Negative Affect						
Intercept	247.59	23.94	10.34	**<.001**	200.52	294.67
State NA	4.12	8.45	0.49	.627	-12.50	20.73
Gender	-17.04	37.54	-0.45	.653	-93.17	59.10
State NA * Gender	7.73	14.00	0.55	.581	-19.80	35.26

Note. *p*-values in bold are significant with $p < .05$; CI = confidence interval; *LL* = lower limit; *UL* = upper limit.