Bachelor Thesis

Exploring the Relationship Between Smartphone Screen Time and Affect in University Students, Moderated by Trait Creativity: An Experience Sampling Method Study

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Abstract

Background: Despite growing public awareness that excessive smartphone screen time has detrimental effects on physical and mental well-being of university students, there is limited research on the relation with daily fluctuations of affect. The understanding of how individual differences influence these associations is also scarce. Therefore, this study explored the association between smartphone screen time and both positive and negative affects separately. The personality trait creativity was included as potential moderator.

Method: The Experience Sampling Methodology was applied for a period of 15 consecutive days among 38 university students (M_{age}= 22.9, SD_{age}= 2.2; 58% female, 100% German). Participants' level of trait creativity was assessed utilizing Gough's Creative Personality Scale. Each morning, self-reported smartphone screen time of the previous day was assessed retrospectively. The evening questionnaires measured the state positive and negative affect levels of that day using the PANAS. Data were visualised with Estimated Marginal Means and Linear Mixed Models were employed to test for both association and moderation.

Results: A significant association was only found between smartphone screen time and positive affect ($p < .001$). While trait creativity did not significantly influence the relationship between screen time and affect, it did show a main effect on positive affect ($p = .011$). Notably, in the presence of trait creativity in the model, screen time lost its statistical significance as a predictor of positive affect.

Conclusion: The findings showed that increasing smartphone screen time leads to decreasing positive affect, but not, if creativity is considered. This highlighted the importance of accounting for individual traits like creativity in understanding the impact of screen time on affect. Further ESM research is required to better understand the relationships between the variables.

Keywords: Smartphone, Screen time, Well-being, State Affect, Creativity, Experience Sampling Methodology, University Students

Exploring the Relationship Between Smartphone Screen Time and Affect in University Students, Moderated by Trait Creativity: An Experience Sampling Method Study

The greatest and fastest change in society during the past decades has been the digital evolution of technological devices, especially after the first introduction of a smartphone in 2007 by Apple (Harris et al., 2020). Since then, increased usage across any socioeconomic and age group has been detected in both daily private as well as occupational life. The global smartphone ownership is consistently expanding, and this trend is expected to continue over the following years. Currently, around 86% of the German and 90% of the Dutch population own a smartphone (Wike et al., 2022). In particular, younger generations have been identified as the main consumers of smartphone devices, services, and applications (Al-Barashdi et al., 2015). Young adults spend on average four hours during the day and one hour during the nighttime on their smartphone (Della Vedova et al., 2022; Sigh & Samah, 2018).

Smartphones have become an indispensable part of students' lives and bring several advantages. Students are able to obtain any kind of information through online resources in an effortless and time-saving manner. This promotes the creation of knowledge and opinions, and enhances overall productivity (Haleem et al., 2022; Elhai et al., 2017). Furthermore, smartphones facilitate social connections among students through various social media platforms. The sense of connectedness and the ability to exchange study-related matters has been linked to increased well-being, reduced loneliness, and lower perceived stress levels (Busch & McCarthy, 2021). Lastly, entertainment and gaming are services that are reported to reduce boredom, alleviate mood, and distract from negative emotions and stressors of students (Busch & McCarthy, 2021).

However, a growing body of research indicates that some users rely on the presence of their phone and use it in an excessive manner resulting in poorer overall health (Singh & Samah, 2018). Besides physical health complaints such as neck pain, disturbed sleep, musculoskeletal damage, decreased visual health, and migraine (Wacks & Weinstein, 2021), students’ educational performance is negatively affected by increased smartphone usage. Research shows that it is linked to decreased recall of lecture material and more generally to poorer academic grades. Lower academic outcomes are found to be associated with lower well-being and life satisfaction (Bücker et al., 2018). Apart from its impact on educational careers, the use of smartphones, and particularly social media applications, can diminish relationship quality among students (Eichenberg et al., 2021). With fast text messaging characterizing modern communication, personal face-to-face interactions become secondary

(Singh & Samah, 2018). Social media platforms are further a source of negative interactions and cyberbullying, leading to feelings of isolation, low self-esteem, depression and anxiety (Seabrook et al., 2016). Overall, it becomes visible that smartphone screen time can significantly affect students' psychological well-being in various ways.

Well-being is a complex construct that encompasses different conceptualisations depending on research. In this study, well-being is approached as a subjective measure of affect, whereby high well-being is characterized with the presence of positive emotions and the absence of negative emotions (Diener et al., 1999; Watson et al., 1988). Affect, in literature also referred to as mood, is an intrinsic aspect of human experience and refers to the realm of emotions and feelings (Barrett & Bliss-Moreau, 2010). Watson and Tellegen (1985) proposed a two-dimensional conceptualization of affect, comprising positive affect and negative affect. *Positive affect (PA)* represents a person's level of enthusiasm, energy, and engagement. High PA is associated with heightened energy, focused attention, and enjoyable involvement, while low PA is characterized by sadness and lack of motivation (Watson & Tellegen, 1985). Positive affect is related with a range of positive outcomes, including better physical health, higher levels of life satisfaction, and increased social support (Pressman & Cohen, 2005). In contrast, *negative affect (NA)* encompasses various unpleasant mood states, such as anger, disgust, guilt, fear, and nervousness, representing subjective distress and unpleasurable engagement. Low NA corresponds to a state of calm and serenity. Higher levels are however associated with increased stress levels, poorer physical health, lower levels of life satisfaction, and decreased social support (Pressman & Cohen, 2005). There is evidence for NA being a factor underlying depression and anxiety disorders (Watson et al., 1988). It also shares similar physiological correlates with these mental disorders, such as impairments in cardiac autonomic function (Bleil et al., 2008). The two dimensions of affect are largely independent over time, meaning both can coexist and that fluctuations in PA not necessarily correlate with changes in NA (Watson et al., 1988).

There is only limited research addressing the association between smartphone screen time and affect. Broadly, the evidence for a concrete connection between screen-time and decreased well-being is mixed (Busch & McCarty, 2021; Harris et al., 2020; Lepp et al., 2014; Singh & Samah, 2018; Tang & Lee, 2021). Systematic literature reviews of Elhai et al. (2017) and Sohn et al. (2019), however, point at a parallel increase of smartphone screen time and mental disorders in young adults, particularly depression and anxiety. Generally, smartphone usage has stronger effects on short-term well-being, such as affect, than long-term well-being. For instance, using entertaining services, students can be distracted from

daily stressors and positive affect increases, while reading hostile comments on social media can enhance momentary negative affect (Dienlin & Johannes, 2020; Kardefelt-Winther, 2014). Social connectedness through social media is found to alleviate negative emotional states and promote positive affect. This is particularly important for university students, as this population often experiences negative emotions related to stressful life events in their study (Park & Lee, 2012). While smartphone usage has impacts on affect, affect itself is also found to influence smartphone screen time. For example, individuals who report higher levels of stress and negative affect are more likely to use their smartphones for coping purposes (Flynn et al., 2020). In total, there seems to be an association between the amount of smartphone screen time and affect, but this relationship has not been thoroughly explored yet, and its directionality is still subject of an ongoing debate (Twenge & Campell, 2018).

Most of the research in this field applied a cross-sectional study design. Criticism has been voiced demanding, firstly, longitudinal designs that also allow for within-person investigation, and secondly, the assessment of short-term effects of smartphone screen time on affect (Anderl et al., 2023; Dienlin & Johannes, 2022; Luhmann et al., 2021). The *Experience Sampling Methodology (ESM)* is a suitable and increasingly popular longitudinal approach to data collection and is defined as a "a structured self-report diary technique that assesses mood, symptoms, context and appraisals [thereof] in daily life" (Myin-Germeys et al., 2018). ESM has its roots in ecological psychology, which focuses on the interaction between any real-world experiences and the natural environment in which they occur (Myin-Germeys et al., 2018). Accordingly, ESM yields at capturing moment-to-moment changes in psychological mechanisms in real-time (or close to it). The studies usually involve participants reporting on their experiences, behaviours, and subjective states multiple times throughout the day. A main advantage is the decreased chance of recall bias and memory restrains that might occur when participants retrospectively report on the construct at stake (Eisele et al., 2022). By using ESM, researchers can therefore obtain a more accurate and ecologically valid understanding of individuals' experiences, as compared to relying solely on retrospective self-reports or global assessments of cross-sectional designs. When exploring the relationship between smartphone screen time and affect, ESM studies enable researchers to get a more granular view of the relationship, capturing potential fluctuations in state affect in response to varying levels of smartphone screen time over time.

Since the excessive use of smartphones has emerged as a significant social concern, there is a demand for better understanding contributing factors and new interventions for conscious, healthy use. To achieve this, more research has to be conducted on the variables

that are possibly included in the relationship, such as personality differences. A construct that has associations with both smartphone screen time and affect, is creativity. Trait *creativity* is defined as the production of ideas, products, or procedures that are (a) novel and (b) potentially useful or practical (Amabile, 1993). Creativity is a cognitive element requiring adaptivity and a social purpose to fully unfold, while it is also increasingly recognized as a fundamental aspect of an individual's personality (Feist, 1998). Creative thoughts and actions can be impeded with environmental distractions, such as smartphone notifications (Elhai et al., 2017; Marty-Dugas & Smilek, 2020). There is also biological evidence that cortical activity patterns change in response to smartphone usage, leading to diminished creative cognition (Li et al., 2023). Moreover, creativity can be reduced in individuals experiencing high levels of negative affect as they become more risk-averse, inflexible, and avoidant of new experiences (George & Zhou, 2001; Gable & Harmon-Jones, 2010). Positive affect, in contrast, signals opportunities for exploration and testing alternative actions, resulting in increased attention and divergent thinking, ultimately encouraging creative thinking and performance (Madrid & Patterson, 2018). This association acts bidirectionally with creativity fostering positive emotions and reducing perceived daily stress (Conner et al., 2018; Tamannaeifar & Motaghedifard, 2014). Thus, creativity can be a means to cope with study-related stress, which represents a healthy coping strategy compared to distraction by a smartphone Tang et al. (2021). It remains unclear, however, how creativity acts on the smartphone screen time-affect relationship.

The present study aims at overcoming past research design limitations by applying the Experience Sampling Methodology, and at expanding the conceptual understanding of the association between daily total smartphone screen time and state levels of affect. Hereby, smartphone screen time is assumed to be the predictor of affective states. Moreover, while some research started investigating the effect of smartphone screen time on affect level in the light of personality characteristics (mostly Big 5 Personality traits), there has been no research on how trait creativity affects the association (Eichenberg et al., 2021). By exploring the moderating effect of creativity, this study aims to understand how individual differences in that trait may influence the impact of daily smartphone screen time on state affect. Hence, the following research questions are formulated (see Figure 1):

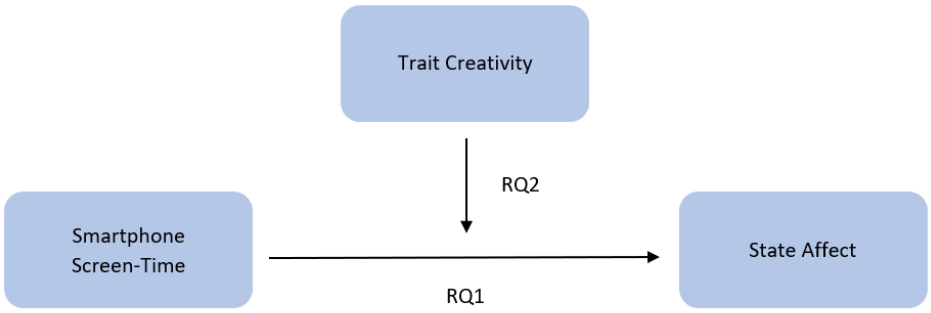
> Research Question 1 (RQ1): *To what extent is daily total smartphone screen time associated with state affect over time in university students?*

Research Question 2 (RQ2): *To what extent does trait creativity moderate the relationship between daily total smartphone screen time and state affect over time in university students?*

Based on the past research, it is expected that daily total smartphone screen time in university students will be negatively associated with state positive affect and positively associated with negative affect over time. In addition, it is expected that trait creativity moderates these associations by weakening the link between smartphone screen time and both affect states, leading to increased positive affect and decreased negative affect.

Figure 1

Hypothesised Model for Effects of Daily Total Smartphone Screen-Time on State Positive and Negative Affect, Moderated by Trait Creativity



Methods

Study Design

The study was part of a research project by three researchers, who each examined other relationships with smartphone screen time. Therefore, only inquiries relevant to the previously stated research questions were addressed. The research was of exploratory, descriptive nature applying the Experience Sampling Methodology to allow the detection of fluctuations and associations of the variables. For data collection, the platform Ethica Data was used, which the participants could download as an application on their smartphone. To ensure comprehensive data collection, it is recommended to account for a possible difference between weekdays and weekends (Myin-Germeys & Kuppens, 2022). Consistent with this view, it is generally suggested to conduct smartphone studies over a period of at least two weeks (van Berkel, 2017), accordingly the study length was set to 15 days.

During the design process of the notifications, instructions and items, it was important to take the size of smartphone screens into consideration. Long sentences and complex text input were omitted. Motivational incentives after responses should drive the participants to keep complying to the daily assessment. A minimized number of items and only two assessment a day were posed to the participants to reduce response burden and interference with their daily lives. The BMS Ethics Committee of the University of Twente (registration number: 230422) approved the study on the 29th of March 2023. After the researchers pilot-tested the study for four days on their own smartphone, a recruitment period of one week started.

Participants

To take part in the study, the participants had to be university students, including research universities, universities of applied sciences and (German) equivalents. Moreover, they had to be over 18 years old, proficient in English, and use a smartphone on a daily basis. The respondents were partly conveniently sampled by the researchers to obtain university students from their own social environment. Recruitment was executed either orally or via social media networks (i.e., WhatsApp, Instagram). Concurrently, students from the University of Twente were recruited through the research management system SONA, offering an incentive of 1.75 credits.

Participant data was excluded from analysis in case the baseline questionnaires were not filled out. A response rate below 50% was regarded as insufficient to warrant further analysis (Conner & Lehmann, 2012). This relatively modest threshold was applied considering the realistic expectations for low participation rates in extensive studies. In total, 50 students took part in this study, however, 12 had to be excluded. Consequently, the final sample consisted of 38 participants with an overall response rate of approximately 87%. Participants were aged between 18 and 33 years (M= 22.9; SD = 2.2) and the gender distribution was relatively equal (female = 58%; male = 42%). All participants were from Germany.

Materials

Baseline Questionnaires

Demographics. The demographic questionnaire assessed participants' age, gender, nationality, whether they are enrolled in a university (of applied sciences), and whether they use their smartphone on a daily basis (see Appendix A).

Trait Creativity Measurement. The Gough's Creative Personality Scale (GCPS) of the Gough's Adjective Checklist is administered (see Appendix B). This checklist gave the participants a total of 30 items, with 18 items being adjectives associated with creativity (e.g., inventive, reflective, intelligent) and 12 items standing in contrast to being creative (e.g., narrow interest, conventional, submissive) (Gough, 1979). Participants could select adjectives that they thought of being applicable to their personality. There was no predetermined minimum or maximum of adjectives to be selected. In accordance with Gough's scoring protocol, a single point is given for each of the positive items, while one point is subtracted each time one of the negative items is checked. Consequently, the scores range from -12 to +18 (Zampetakis, 2010). This scale has been widely used due to its advantage of simple and efficient administration (Qian et al., 2019). For the present sample, the reliability measure Cronbach's alpha indicated an acceptable reliability ($\alpha = .74$).

Daily Questionnaires

Morning Questionnaire – Smartphone Screen Time. All morning questionnaires assessed the total smartphone screen time of the previous day. The item "Please indicate the total time you spent on your smartphone yesterday in minutes." could be responded to with the Visual Analogue Scale (VAS) offering options that spanned from 0 to 600 minutes (see Appendix C). Pearson's correlation coefficient ($r = .72$) suggested a high correlation between mean measurements of screen time of week one (i.e., day 1 to 7) and of week two (i.e., day 8 to 16). This indicates an acceptable test-retest reliability for the measurement approach.

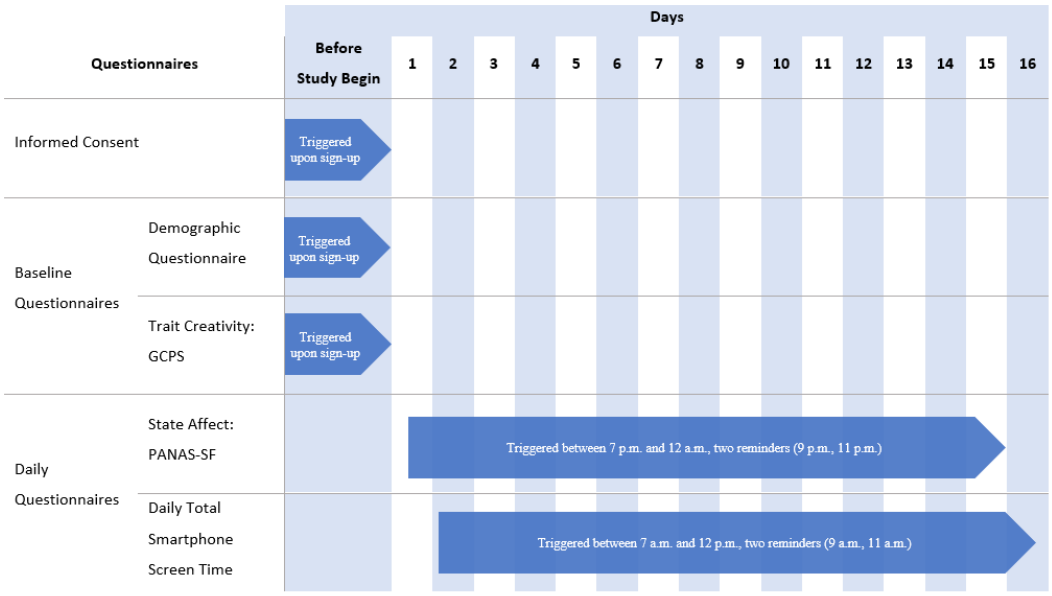
Evening Questionnaire – State Affect. The evening questionnaires executed repeated measurements of state positive and negative affect. The Positive and Negative Affect Schedule (PANAS) is a suitable tool for gaining insights into individuals' momentary emotional experiences and proves sensitivity to transient changes (see Appendix D). Shortened forms of the schedule maintain good reliability and validity levels (Watson et al., 1988), which resulted in the selection of 10 items for this study based on factor loadings. Positive affect items hereby included the words enthusiastic, interested, determined, excited, and inspired, whereas negative affect items were scared, afraid, upset, distressed, and jittery. The items were to be rated on a 5-point Likert scale ranging from "very slightly or not at all" (1) to "extremely" (5), corresponding to possible scores from 5 to 25 (Watson et al., 1988). Different time frames can be applied to this schedule; this study used a retrospective assessment of the day, "today". For the present sample, reliability measures of the shortened PANAS were both good, with the positive affect (PA) scale having a Cronbach's alpha of .87, and the negative affect (NA) scale showing an alpha of .82.

Procedure

Upon registration, participants received an email with further instructions for downloading the application Ethica, creating a participant account, and enrolling with the provided registration code (see Appendix E). Before the daily assessments, participants were asked to give informed consent (see Appendix F) and to respond to the baseline questionnaires in Ethica. All participants started the experience sampling on the same evening by reporting on their affect experienced during that day. The ESM assessment continued in the morning of the second day. Participants had to indicate their total smartphone screen time of the past day by either estimating or making use of the screen time report function of their smartphone. The same questionnaire was repeatedly filled out during mornings, while the affect questionnaire was posed during the evenings. Following a fixed sampling scheme, assessments are generated at predetermined and equally distributed time points. Notifications were sent to the participants requesting their response, and in instances where assessments were not completed after the initial notification, two follow-up reminders were sent. The predictability in measurement timings and the reminders were used to yield higher compliance rates among participants (Myin-Germeys & Kuppens, 2022). After completion of all questionnaires, participants were thanked for participation, and if applicable, rewarded with the SONA credits. See Figure 2 for an overview of the study's set-up.

Figure 2

Overview of the Study Set-up and Questionnaires for all Days, Including Relevant Variables, Trigger Times, Expiration Time and Reminder Times



Data Analysis

All data were exported from Ethica Data to SPSS (Version 28) for the further analyses. The data were morphed so that the retrospective measurements of smartphone screen time and daily measures of affect align to the same day. Reliability was assessed with Cronbach's alpha coefficient for GCPS and PANAS, and with Pearson's coefficient for test-retest reliability of screen time measurements. Descriptive statistics of demographics, trait creativity, daily total smartphone screen time, and state positive and negative affect were reported with mean (*M*) and standard deviation (*SD*). Individual trait creativity scores were graphically presented in a bar chart. Daily smartphone screen time and state affect were visualised using Estimated Marginal Means (EMMs) to examine differences among participants and timepoints. In the EMMs calculated per participant, the *ID* was considered a fixed factor, while the dependent variable was either *Screen Time* or *Positive Affect*/*Negative Affect*. The EMMs over time were calculated by treating the measuring point *Day* as a fixed factor, with the same dependent variables. Visualisations were utilized to obtain preliminary indications of potential associations between variables.

To answer Research Question 1, a Linear Mixed Model (LMM) was employed. LMMs are appropriate for analysing clustered data, which applies in this study for both participants and days (Monsalves et al., 2020). Moreover, the models are well-suited for handling missing data, which is a common occurrence in ESM studies. A first-order autoregressive covariance structure AR(1) was included to account for the temporal dependencies in the data (Myin-Germeys & Kuppens, 2022). Either *Positive Affect* or *Negative Affect* was set as the outcome variable (DV) and *Screen Time* as the fixed covariate predictor (IV). In addition, EMMs of two participants were visualised to further explore the associations on an individual level.

To answer Research Question 2, the previous models were expanded with the trait creativity variable as a fixed covariate and an interaction effect (*Screen Time* * *Creativity*). A 95% confidence interval and a significance level of $\alpha \leq .05$ were utilized to assess the statistical significance of relationships, and all effect sizes were presented in their raw, unstandardized format.

Results

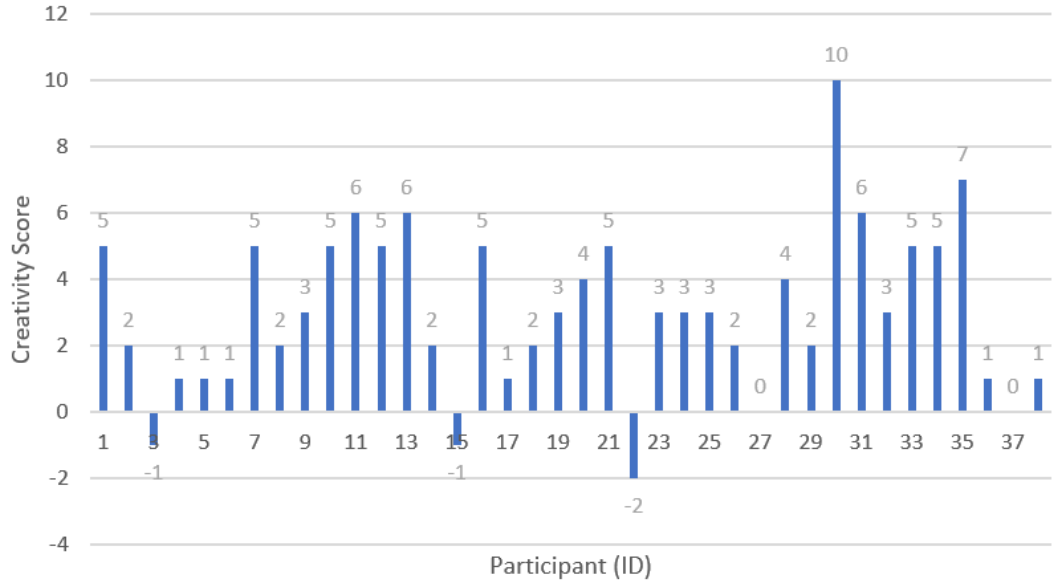
Descriptive Statistics

The participants scored between -2 and 10 points on the GCPS ($M = 3$; $SD = 2.9$). Although the overall creativity scores seem to be moderate in the sample, the high value of the standard deviation indicates great variability among the participants' trait creativity

scores. The visualisation of participant scores (Figure 3) shows extreme values of participant 11, 22, 29, 33, and 36. While the first four scored substantially below the average, participant 36 scored remarkably high compared to the overall sample.

Figure 3

Simple Histogram Displaying Total Trait Creativity Scores of all Participants (N = 38)



Daily total smartphone screen time was on average 4.1 hours, with a standard deviation of 1.9. The substantial differences between individuals' screen time are visualised in Figure 4. For example, participants 9 and 23 spent averagely over 7 hours on their smartphone per day, while participants 17 and 37 scored just around 2 hours. Average screen time showed a slight general downwards trend with some fluctuations across days (see Figure 5). Participants scored on average 14.8 points on the positive affect scale. The standard deviation (SD = 4.5) demonstrates great differences in measurements. The same accounts for the negative affect scale (M = 8.8; SD = 3.8). Overall, positive affect seemed to be higher than negative affect in participants, with the exception of participant 23 and 29 (see Figure 4). This is supported in Figure 5, showing that both affects are relatively stable over time, while their lines are not crossing. However, the EMMs did not reveal any associations. Although both participant 23 and 30 exhibited high screen time and high negative affect, other individuals with high screen time, such as participants 5, 9, and 27, did not demonstrate a similar trend.

Figure 4

Estimated Marginal Means of State Positive Affect, State Negative Affect, and Daily Total Smartphone Screen Time per Participant (N = 38)

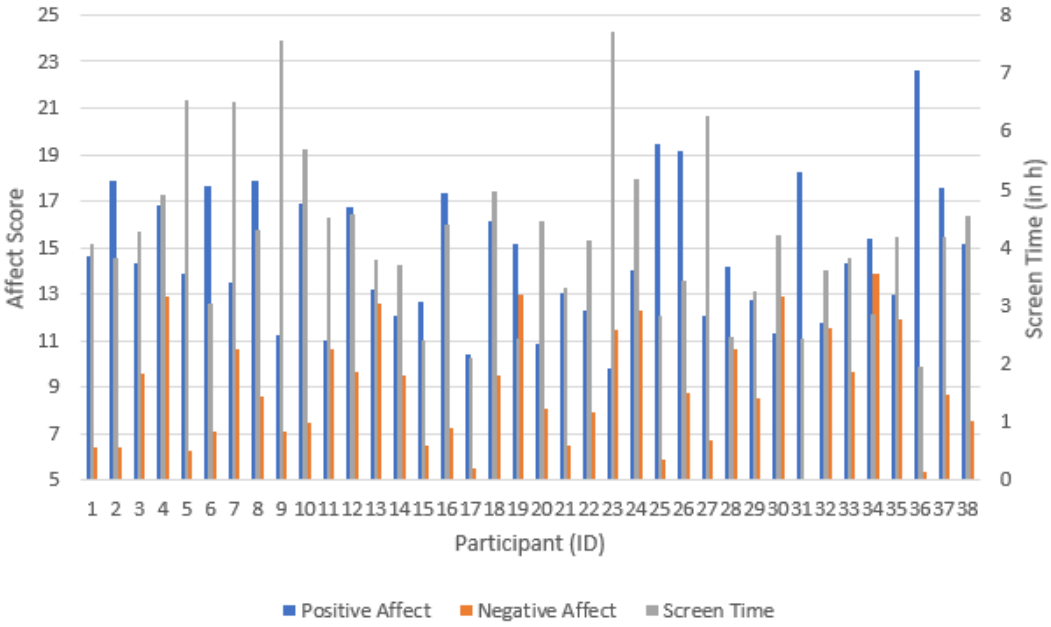
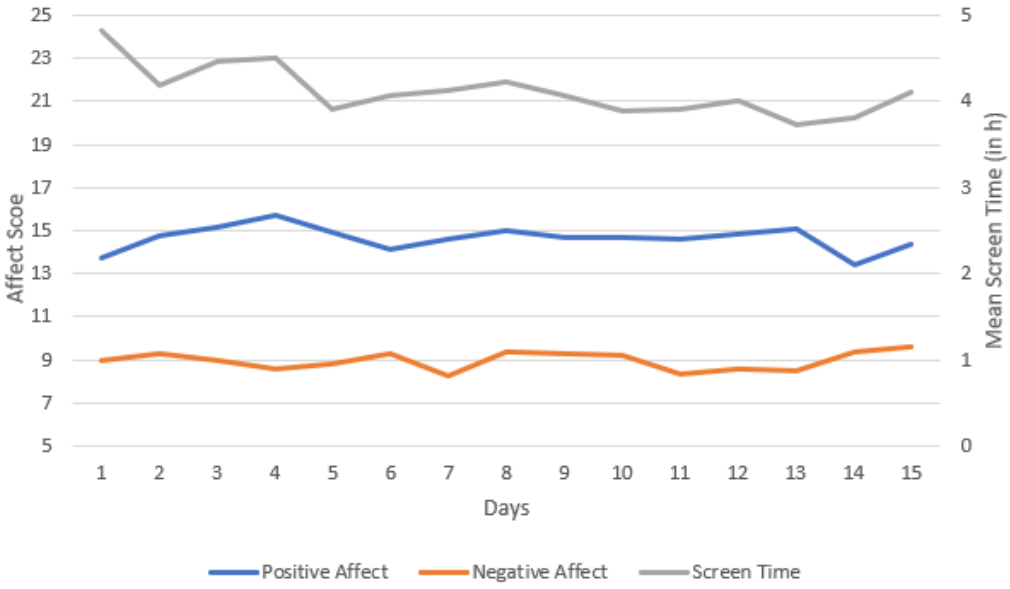


Figure 5

Estimated Marginal Means of State Positive Affect, State Negative Affect, and Daily Total Smartphone Screen Time Over Time (Days)



Association Analyses

The outcome of the LMM indicated no significant association between smartphone screen time and negative affect (b = 0.14, SE = 0.1, 95% CI [-0.06, 0.33]). However, the association between smartphone screen time and positive affect showed significance (b = -

0.63, *SE* = 0.12, 95% CI [-0.86, -0.39]). This means that by every increase of one hour of smartphone screen time, positive affect decreases by 0.63 units.

Exploring Individual Cases

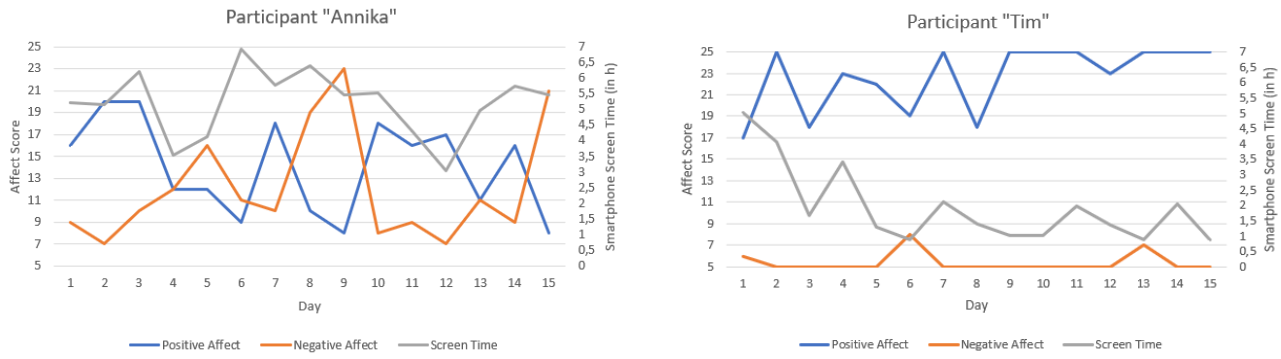
Considering these results, examining and visualising individual data can contribute to a deeper comprehension of within-person fluctuations and the relationships among the variables (see Figure 6). Participants 24 and 36, referred to as "Annika" and "Tim" respectively, were chosen due to outstanding scores and a response rate of 100%.

Data of participant “Annika” is generally characterized by strong fluctuations over time in all three variables. Daily time spent on the smartphone varied greatly from 3.05 to 6.93 hours. Positive affect fluctuated from 7 to 23, and similarly, negative affect scores ranged from 8 to 20. Unlike the overall trend in the sample, negative affect is higher than positive affect at times. When the participant scored high on the positive affect scale, the scores on the negative affect scale tend to be low and verse visa. There is no consistent pattern regarding an association to screen time.

Participant “Tim” displayed relatively extreme values with less variability across all variables. The participant had the lowest screen time scores across the sample (*M* = 1.9). Generally, the scores tend to decrease over time. At the same time, the individual shows the highest positive affect scores (*M* = 22.6). The mean negative affect score is also the lowest in the sample (*M* = 5.4) and stays at the minimum scale score for most days except two small fluctuations. Interestingly, screen time values drop at these points. However, no general trend is visible.

Figure 6

Individual Data of Participants “Annika” and “Tim” Displaying Estimated Marginal Means of State Positive Affect, State Negative Affect, and Daily Total Smartphone Screen Time Over Time



Moderation Analysis

Results indicated no significant effects of trait creativity on the associations between smartphone screen time and both positive and negative affect (see Table 1). It is noteworthy, however, that the main effect of creativity on positive affect was significant (b = 1.80, SE = .67, t = 2.71, p = .011, 95% CI [0.44, 3.16]). In other words, for every increase in trait creativity score by one unit, positive affect increased by 1.8 units. Meanwhile, the previously demonstrated association between screen time and positive affect lost statistical significance when the moderator was added to the model. All effects are displayed in Table 1.

Table 1.

Overview of Main Effects from Moderation Analyses, Presented in Unstandardized Format

Parameter	*B*	*SE*	*t*	*p*	*95% Confidence Interval (CI)*	
					Lower Bound	*Upper Bound*
State Positive Affect (DV)						
Intercept	8.35	2.88	2.90	.007	2.45	14.24
Creativity	1.8	0.67	2.71	.011	0.44	3.16
Smartphone Screen Time (in hours)	0.82	0.58	1.42	.167	-0.36	2.00
Interaction Term	-0.27	0.13	-2.05	.050	-0.54	0.000
State Negative Affect (DV)						
Intercept	8.82	3.05	2.89	.007	2.58	15.06
Creativity	0.06	0.70	0.09	.931	-1.38	1.50
Smartphone Screen Time (in h)	0.23	0.61	0.38	.705	-1.01	1.48
Interaction Term	-0.08	0.02	-0.59	.560	-0.37	0.20

Discussion

The current study examined the association between total daily smartphone screen time and state affect in university students over a period of 15 days using the Experience

Sampling Methodology. Trait creativity of the participants was measured and investigated as potential moderator of this association.

The Association between Smartphone Screen-Time and Affect over Time

Regarding Research Question 1, a negative association between smartphone screen time and state positive affect was found. Positive affect decreases greatly with increased smartphone screen time, indicating that the impact of screen time is meaningful. This finding is in line with previous research that identified smartphone screen time as predictor of general lower well-being (Marty-Dugas & Smilek, 2020; Rotondi et al., 2017; Twenge & Campbell, 2018). Nevertheless, when solely looking at positive affect, limited research has been conducted, with previous studies giving conflicting results. Mostly, an opposite trend with no effects on positive affect became apparent (Horwood & Anglim, 2019). In some studies, however, positive affect increased, if the smartphone is used to a moderate degree (Horwood & Anglim, 2019) or for social purposes (Anderl et al., 2023).

There was no association between smartphone screen time and state negative affect. Contrary to this finding, negative affect was associated with problematic smartphone use in past studies (Wolniewicz et al., 2018). However, when distinguishing between problematic and non-problematic smartphone use, a meta-analysis of studies showed association between smartphone screen time and mood-related variables also finds no evidence for an impact on negative affect (Vahedi & Saiphoo, 2018). It is noteworthy that the present sample generally displayed low negative affect states throughout the assessment. This could be explained with the participants experiencing occasion-specific variables that vary from moment-to-moment and, therefore, might correlate with momentary affect (Luhmann et al., 2021). It is plausible that there were no significant negative events occurring during the assessment period, leading to the observed low negative affect. In related research, it is also found that that momentary well-being is generally characterized by more positive than negative emotions, suggesting that positive emotions prevail in participants' daily experiences (Luhmann et al., 2021). Alternatively, other variables, such as social support or emotion regulation, might have a more substantial impact on negative affect than smartphone screen time. Research indicated that these factors act protectively against rising levels of negative affect (d'Arbeloff et al., 2018).

In general, the participants of this study differed greatly in their scorings of smartphone screen time and affect. This is in line with other research that has assessed state affect across participants (Luhmann et al., 2021). This finding might be attributed to differences in affect regulation. Affect regulation strategies such as distraction or suppression

of emotions vary in their effectiveness, and individual differences in how often people use specific strategies may therefore account for individual differences in both mean level and within-person variability in affect (Kuppens et al., 2010). A dysfunctional strategy is smartphone usage as distraction and coping mechanism for experienced negative affect (Luhmann et al., 2021). As it became apparent in other studies, the differences in affect and screen time as well as the uncertainty about associations might be both explained with the type of smartphone usage that participants engaged in. Particular categories of smartphone applications or smartphone usage have been found as predictors of either negative or positive affect (Marty-Dugas & Smilek, 2020; Pera, 2020). In that way individual data of the study could be better explained. For example, contrary to the study's findings, a participant might exhibit both high scores of screen time and positive affect due to feeling connected to friends and family through social media. Taken together, the association between smartphone screen time and both positive and negative affect is not conclusive yet.

The Moderating Effect of Trait Creativity

Trait creativity had great discrepancies between individual values. When examining Research Question 2, creativity could not be identified as statistically significant moderator. However, it is striking that, with the inclusion of creativity as moderator variable, the previously demonstrated association between smartphone screen time and positive affect is not significant anymore. Instead, creativity itself emerges as a significant factor for positive affect. Reasons for this change in association might be that creatively inclined individuals tend to seek out and engage in meaningful and fulfilling activities that align with their interests and values. This engagement in purposeful activities could lead to a greater sense of well-being and positive affect, overriding any negative effects of excessive screen time. In addition, smartphones can also serve as tools for creative expression. For example, the photography feature is found to elicit positive affect (Chen et al., 2016). More broadly, person-level variables can account for individual differences in levels of momentary affect (Luhmann et al., 2021). Studies and meta-analyses have specifically pointed at the great positive influence creativity has on positive affect levels (Acar et al., 2021; Grace et al., 2009; Tamannaeifar & Motaghedifard, 2014; Tan et al., 2019). Thus, creativity might be more a predictor of positive emotions, casting doubts on a significant relation between smartphone screen time and positive affect in the first place.

Strengths and Limitations

The study demonstrates strengths in the design and implementation by being the first to employ the ESM to investigate daily smartphone screen time and separately positive and

negative affect over time in university students. Although previous research has examined creativity in relation to each smartphone screen time and well-being separately, this study is the first to incorporate creativity as a moderating trait variable into the model. Moreover, the sample size is relatively large for longitudinal study and was characterized by a balanced distribution across gender. The response rate of daily assessments was high, being an indication for a study design with low participant burden and comprehensible assessments.

However, some limitations to the study should be acknowledged. The sample consisted of German participants only, hindering drawing conclusions about greater, diverse populations. Further, additional items in the demographic and baseline questionnaires would give more insights into sample characteristics and facilitate interpretation of data. For example, it would have been insightful to assess the type of school and programme the students attend and whether they differ in trait reports of affective well-being. The latter has shown that stable beliefs and trait affect may influence state levels of affect and vice versa (Brose et al., 2013). The baseline questionnaire measuring the creativity level was chosen due to its efficiency and ability to measure creativity as a personality trait. However, Qian et al. (2019) suggest that the GCPS is an outdated tool that should be either replaced with a more extensive questionnaire or used in conjunction with the Creative Behaviour Inventory (CBI), measuring actual creative achievements and activities. The way daily screen time was measured can also be considered a limitation. While it is superior of past assessments that were solely based on retrospective self-reports, it is still possible that participants did not make use of the screen time report of their smartphone and estimated, limiting convergent validity of actual use (Verbeij et al., 2021). Moreover, differentiating the type of smartphone usage was neglected due to time restraints. A growing body of research suggests that the impact of smartphone screen time on well-being depends on the activities engaged in (Dienlin & Johannes, 2022; Marty-Dugas & Smilek, 2020). For instance, smartphone usage concerning social connectedness, productivity, and safety are related to well-being, which stands in contrast to the present findings (Horwood & Anglim, 2019; Haleem et al., 2020). Therefore, different usage types may be associated with different outcomes and should be taken into account when interpreting findings. In the study's context, participants might have engaged in creative activities on their smartphone that could have been assessed in relation to affect. Additionally, the short form of the PANAS has not been validate before and was based on factor loadings, while there already exist validated PANAS short forms (e.g., 10-items International PANAS by Thompson, 2007). This has only been noticed after the study has been published. Affect was assessed once retrospectively for the day, while ideal ESM

assessments are conducted at multiple time points during the day. Research has shown that participant burden increases with longer questionnaires, but it does not show the same effect with increased sampling frequency (Eisele et al., 2020). Lastly, when drawing conclusions from the results, it should be considered that the question of directionality was not addressed in this study and that smartphone screen time was assumed to be the predictor and affect the outcome variable.

Future Implications

The study's findings contribute to the theoretical understanding of the relationship between screen time, well-being, and creativity in university students. It suggests that increasing smartphone screen time leads to lower positive affect of university students. Meanwhile, trait creativity is associated with positive affect. Based on this, interventions and educational programs for students could be implemented to limit screen time and foster creativity in individuals.

Nevertheless, the findings partially contradict past research and leave room for further exploration, so that it is advisable to conduct additional studies building upon this research while taking into account its limitations. Future studies should aim for a more diverse sample, including students from other universities, various academic disciplines as well as geographical backgrounds. This might give insight on differences in creativity, as it also is a culturally shaped construct (Shao et al., 2019). Achieving this could involve employing different sampling methods and establishing collaborations with educational institutions. Trait creativity levels should be more thoroughly measured before the daily assessments or it should be looked further into GCPS-high and -low scoring individuals, and how they feel and engage with their smartphone. In a more general approach, usage types should be assessed beyond daily total smartphone usage, for example by reporting daily hours spent on certain apps or usage types such as communication, work/education, entertainment. Screen time could be more reliably measured by uploading a screenshot of the smartphone's screen time report (Bradley & Howard, 2023). Moreover, it could help to detect and understand associations by zooming in on the fluctuations of both affect and screen time multiple times per day. In that way, changes in affect can be detected, possibly in relation to smartphone usage patterns. Hereby, a validated short form of the PANAS should be utilized. To understand the overall relationship between smartphone screen time and state affect and to draw meaningful implications for the real-world setting, future research should address the debate about the directionality further.

Conclusion

Overall, the study showed that increasing daily smartphone screen time leads to decreasing state positive affect in university students over time. However, this is not the case anymore when adding trait creativity to the association. Trait creativity seems to have a direct positive influence on positive affectivity. This highlights the importance of accounting for individual traits like creativity in understanding the impact of screen time on affect. Since research on the associations between the variables is contradicting, further ESM research, is required. By adjusting measurement tools and frequency and delving deeper into differences in creativity as well as in smartphone usage types, a more refined comprehension of the variables can be achieved. In case the findings find more scientific ground, practical implications such as creativity interventions could be derived implemented to increase positive affect in university students.

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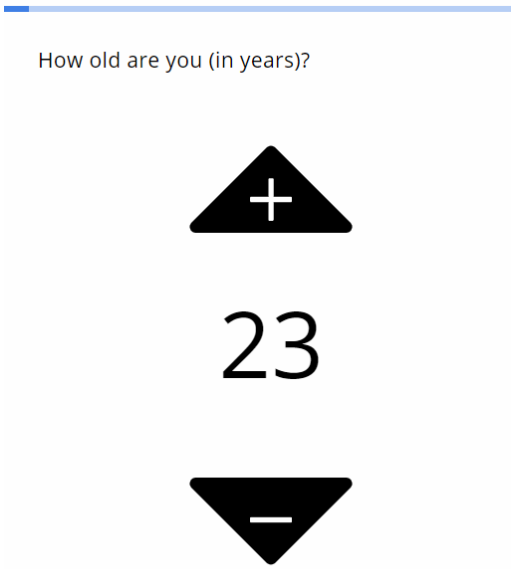
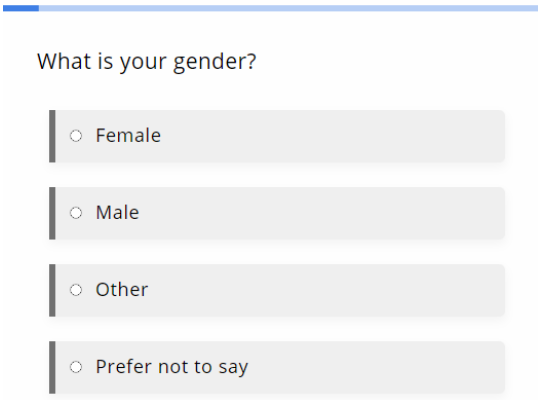
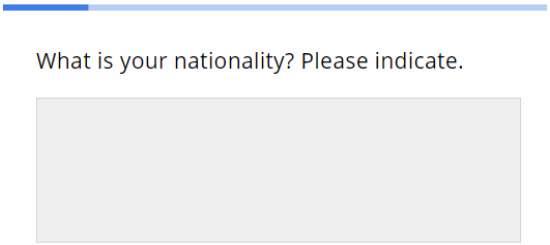
Appendix A

Baseline Questionnaire - Demographic Information







Are you currently enrolled in a University or University of Applied Science (HBO, Hochschule) ?

- ○ Yes
- ○ No

Do you own a smartphone that you use daily?

- ○ Yes
- ○ No

Thank you for filling out your personal information!

In the next pages, you will receive 3 separate questionnaire, that you will only need to fill out once.

Enjoy!

Appendix B

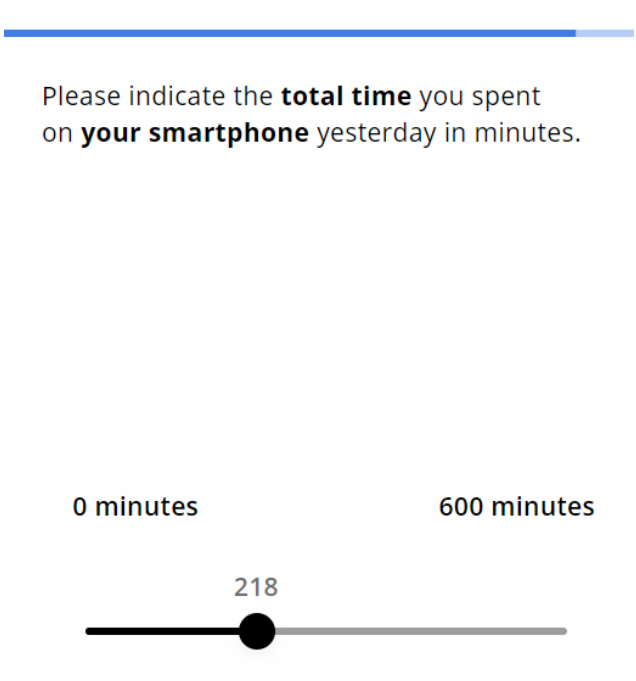
Baseline Questionnaire - Gough Personality Scale (Creativity)

Participants select the items that apply to themselves.

□ Capable □ Honest □ Artificial □ Intelligent □ Clever □ Well-mannered □ Cautious □ Wide interests □ Confident □ Inventive □ Egotistical □ Original □ Commonplace □ Narrow interests □ Humorous □ Reflective □ Conservative □ Sincere □ Individualistic □ Resourceful □ Conventional □ Self-confident □ Informal □ Sexy □ Dissatisfied □ Submissive □ Insightful □ Snobbish □ Suspicious □ Unconventional

Appendix C

Daily Assessment: Screen Time (Morning Questionnaire)



Appendix D

Daily Assessment PANAS – Short Form (Evening Questionnaire)

5 Items for PA:

• Enthusiastic • Interested • Determined • Excited • Inspired

5 Items for NA:

• Scared • Afraid • Upset • Distressed • Jittery

Likert Scale: - 1 (very slightly or not at all) - 2 (a little) - 3 (moderately) - 4 (quite a bit) - 5 (extremely)

Appendix E

ESM Briefing (Email to Participants)

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 Wellbeing & 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)

Appendix F

Informed Consent Form

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 10 th , 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 anonymized. 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.

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

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

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

Supervisors: Gerko Schaap: g.schaap@utwente.nl

Marijke Schotanus-Dijkstra: m.schotanus@utwente.nl

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.