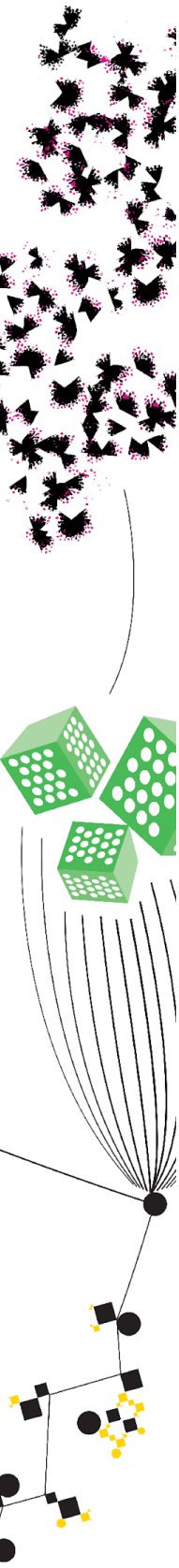

Smartphone Screen Time and Mental Health: Are they related?

Bachelor Thesis Psychology

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Abstract

Young adults use their smartphones for around three to six hours daily. Existing literature is mixed whether the increased smartphone screen time relates to the increased depression and suicide rates of the last decades. Individuals higher in trait self-control spent less time in front of smartphones and were less prone to the risk of experiencing symptoms of depression. The present study examined whether trait self-control moderates the relationship between daily smartphone screen time and symptoms of depression among young adults aged between 18 and 29 years.

Method. A cross-sectional online research design was applied, including the Center for Epidemiologic Studies Depression Scale (CES-D) and Brief Self-Control Scale (BSCS*)*. 88,43% of the 124 participants indicated their smartphone screen time based on tracking applications. Correlation and multiple regression analysis were used to examine the hypotheses.

Results. Symptoms of depression were positively associated with daily smartphone screen time. Multiple regression analysis showed that trait self-control does not act as a moderator on the relationship between daily smartphone screen time and symptoms of depression. No inferences can be made about a causal relationship between the concepts based on the limitations of a cross-sectional study design.

Discussion. The current study arrived at similar results as previous research and found a significant, positive, weak relationship between smartphone screen time and symptoms of depression. However, the findings indicated that the level of trait self-control did not play a role in this association. Future research might examine different smartphone usage behaviors and users' screen time appraisal.

Keywords. daily smartphone screen time, symptoms of depression, trait self-control, young adults

Introduction

Screen-based technologies are embedded in daily lives, and the time young adults spend in front of them had increased over the last years, especially during the Covid-19 pandemic (Giuntella et al., 2020). Students spend, on average, three to six daily hours on their smartphones (David et al., 2017). This time is called daily smartphone screen time, defined as the cumulative time spent looking at/watching the screen of electronic gadgets (Anuradha, 2019). The increased smartphone screen time has been discussed in publicly and raised concerns on users' mental health (Reeves et al., 2020).

Mental health was defined as "a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community." (World Health Organization, 2004). However, smartphone screen time's effect on mental health has not been proven straightforward (Reeves et al., 2020).

According to previous research, smartphone screen time's impact on mental health was mixed. The study of Przybylski and Weinstein (2017) showed that moderate levels of smartphone screen time had beneficial effects on adolescents' mental health and well-being. However, other research indicated a negative impact of increased screen time on the user's mental health (Neophytou et al., 2019; Orben & Przybylski, 2019). In line with these findings, other research also detected a negative impact of smartphone screen time but pointed out that the association was small and explained at most 0.4% of the variance in mental health (Orben & Przybylski, 2019). Notwithstanding, the study of Neophytou et al. (2019) demonstrated that higher smartphone screen time correlated, among other adverse outcomes, with lower self-esteem, severity of mental health issues, and even with a higher risk of premature cognitive decline.

Researchers discovered that the increased depression and suicide rates among young people were positively associated with increased usage of smartphones (Twenge et al., 2017). Young people who spent more time with other activities were not as prone to the risk of suffering from mental health issues as symptoms of depression (Jiang & Zhao, 2016; Neophytou et al., 2019; Twenge et al., 2017).

Smartphone screen time and symptoms of depression

According to the International Statistical Classification of Diseases and Related Health Problems (10th Revision) and the American Psychiatric Association (n.d.), depression is an affective or mood disorder characterized by sadness or loss of interest and pleasure that

overreach normal daily fluctuations. According to the DSM-5, the severity of depression depends on how many of the nine symptoms (sadness or depressed mood, loss of pleasure or interest, changed appetite, sleeping disturbances, loss of energy or fatigue, behavioral change, feeling of worthlessness or guilt, concentration troubles, suicidal thoughts) an individual experienced over two weeks (American Psychiatric Association, n.d). Depression is one of the leading causes of disability worldwide, with 6.70% affected adults each year. The disorder, on average, appears first during the teens and mid-20s, and women are more vulnerable to suffer from this mental illness (American Psychiatric Association, n.d.; Bundesinstitut für Arzneimittel und Medizinprodukte, 2018; World Health Organization, 2019).

According to prior research, the risk of experiencing symptoms of depression increased when smartphone screen time did in accordance. Interestingly, higher levels of depression symptoms did not lead to more time spent in front of the screens. Compared to other devices like watching TV, smartphone screen time had the most substantial negative impact on symptoms of depression (Tang et al., 2021). However, there was evidence that higher smartphone screen time for specific consumption patterns lowered depression symptoms, like reading e-books.

The impact of smartphone screen time differs among populations. Young people and university students were the most vulnerable group. Especially, young, well-educated females seemed to be uttermost prone to the adverse effects of higher smartphone screen time (Busch & McCarthy, 2021; Jiang & Zhao, 2016). Unfortunately, the typical university student spends most of their smartphone screen time on social networking and photo/video sharing applications, which were associated with the most potent negative effect on symptoms of depression compared to other applications and consumption behaviors (David et al., 2017). Young people with lower trait self-control spend more time on their smartphones which made this population especially vulnerable to the adverse effects of high smartphone screen time (Busch & McCarthy, 2021; Jiang & Zhao, 2016; Soror et al., 2012).

Trait self-control and smartphone screen time

The concept trait self-control was connected to smartphone screen because as smartphones are portable devices, these devices challenge users' temptation daily to regulate behavior and emotions (Busch & McCarthy, 2021; Han et al., 2017).

Gleitman et al. (2010) defined the skill of self-control as "the ability to pursue a goal while adequately managing internal conflicts about it or delaying pursuing a goal because of other considerations or constraints" (p. 628). However, in most research, self-control was more

often seen as a trait and was defined as "the self's capacity to override or change one's inner responses, as well as to interrupt undesired behavioral tendencies and to refrain from acting on them" (Tangney et al., 2004, p. 274 as cited in Lindner, Nagy, & Retelsdorf, 2015). Trait self-control resembles more a person's character, whereas the skill of self-control was more open to change. In other words, trait self-control was related to the degree to which an individual typically could withhold from or initiate a particular behavior.

In a study by Kopp (1982) people high in trait self-control were better able to resist temptations and adjust their actions accordingly. Hence, trait self-control can explain why people, despite good intentions, engage in undesired behavior (Berger et al., 2018). Additional, trait self-control was found to play a significant role in the development of addictive behavior. For instance, problematic smartphone use, smartphone addiction, and also internet addiction were all associated with low trait self-control (Busch & McCarthy, 2021; Gökçearslan et al., 2016).

Previous research outlined that especially individuals lower in trait self-control spend more time on their smartphones (Busch & McCarthy, 2021; Jiang & Zhao, 2016; Soror et al., 2012). These findings might be explained by difficulties resisting temptation. For instance, low trait self-control predicted immediate pick-ups of the smartphone after receiving a message or notification. The opposite was true for individuals with high trait self-control (Berger et al., 2018). An additional explanation might be that people used smartphones to distract themselves or flee from negative emotions by increasing positive feelings (Han et al., 2017).

The most frequently identified consequences of problematic smartphone use were emotional health issues (Busch & McCarthy, 2021). This was underlined by previous research, which showed adverse effects of lower trait self-control on mental health, like depression (Tangney et al., 2004).

Smartphone screen time, symptoms of depression, and trait self-control

The extensive research of Tangney et al. (2004) showed that individuals with lower trait self-control had a poorer psychological adjustment, a higher risk of experiencing depression symptoms, and lower emotional stability. In the face of failure to resist a temptation, low trait self-control individuals were less capable of coping with their own transgression than higher trait self-control individuals (Tangney et al., 2004).

Additionally, trait self-control served as a protective factor on the relationship between smartphone addiction and symptoms of depression. The study found that university students who had trouble controlling their smartphone time were more likely to experience symptoms

of depression. Based on the study about smartphone addiction, it was assumed that trait self-control moderated the relationship between smartphone screen time and symptoms of depression as well (Geng et al., 2021).

Prior research indicated a negative effect of smartphone screen time on mental health (Neophytou et al., 2019; Orben & Przybylski, 2019; Twenge et al., 2017). In particular, screen time was mainly associated with symptoms of depression when compared to other mental health disorders. Studies found evidence that higher screen time led to symptoms of depression in young people, but not the other way around (Tang et al., 2021). Consequently, the assumption was that young adults who spend more time in front of their mobile phones experienced more symptoms of depression (Busch & McCarthy, 2021; David et al., 2017; Jiang & Zhao, 2016).

Research showed a beneficial effect of higher levels of trait self-control on symptoms of depression as well as on smartphone addiction. Moreover, higher levels of trait self-control were found to be a protective factor for suffering from symptoms of depression (Geng et al., 2021). Also, high trait self-control individuals spent less time on their smartphones (Busch & McCarthy, 2021; Soror et al., 2012; Tang et al., 2021).

Current research

Because trait self-control played a role in smartphone addiction and symptoms of depression among young adults, the present study proposed that trait self-control weakens or strengthens the influence of smartphone screen time on symptoms of depression. Therefore, the current research aimed to test if trait self-control could be a protective variable in this relationship as well. Research and clinical practice could profit from the insight of this study which will broaden the knowledge of the relationship between the smartphone screen time, symptoms of depression and trait self-control. The following research question was framed: Does trait self-control moderate the relationship between daily smartphone screen time and symptoms of depression in young adults?

H1: There is a relation between daily smartphone screen time and symptoms of depression.
H2: Trait self-control moderates the relationship between daily smartphone screen time and symptoms of depression.

The relations between the three concepts are visualized in Figure 1.

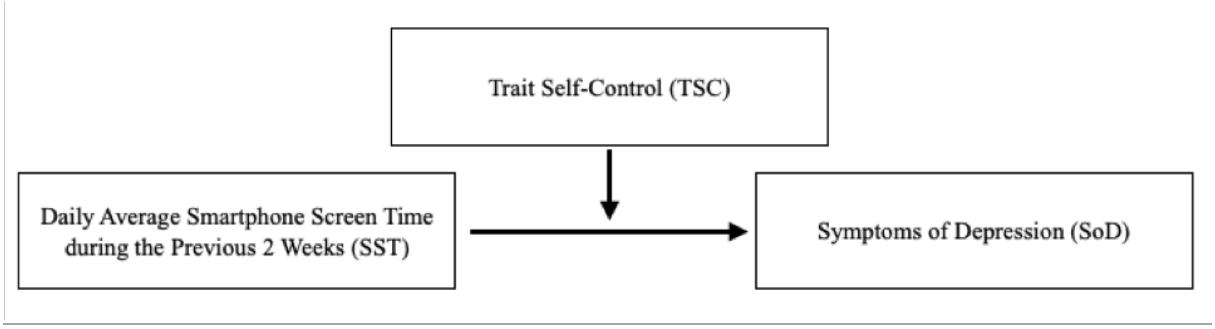

Figure 1. Conceptual model of the expected moderation effect. Trait self-control may have a moderation effect on the impact of smartphone screen-time on symptoms of depression.

Methods

Design

A quantitative cross-sectional study design was employed to examine the hypotheses. Cross-sectional study designs do not allow to draw inferences about causal relationships. Nonetheless, these study designs are cost-effective, saving resources and gathering solid data at one point in time and with low effort for the participants (Hulley et al., 2011; Mann, 2003).

Participants

The ethics committee of the Faculty of Behavioural, Management, and Social Sciences of the University of Twente (Approval code: 21123) approved the study. The recruitment method convenience sampling was applied because of its low cost and easiness (Etikan et al., 2016). The survey link was distributed via the researcher's private social media channels on Facebook, Instagram, and WhatsApp, including a uniformed recruitment message. Moreover, the study was placed into the SONA system, a psychology test subject pool for bachelor students provided by the University of Twente. Participants who participated via the SONA system were rewarded with 0.25 credit points. Moreover, the inclusion criterion was being over 18 years old.

The intended sample size was calculated with the program G*Power 3.1. In the interest of the study, multiple linear regression with a fixed model and single regression coefficient was selected as a statistical test. The a priori type of power analysis encompassed the input parameters of one tail test, an effect size of .15, α error probability of .05, and two predictors. The total intended sample size was 74 (actual power: .95) based on the calculation.

Materials

In collaboration with four other researchers, an online questionnaire was constructed using the online survey tool Qualtrics. The full survey included other scales which were part of

other researchers' projects. However, only the scales that were relevant to the present study will be discussed further.

A total of 41 questions were relevant to address the research question about whether the association between daily average smartphone screen time and symptoms of depression was moderated by trait self-control among young adults. Therefore, the survey encompassed questions about demographic characteristics and smartphone screen time during the past two full weeks, as well as the Center for Epidemiologic Studies Depression Scale (CES-D) and the Brief Self-Control Scale (BSCS).

Demographic questions. Four demographic questions about age, gender, nationality, and occupational status were asked at the beginning of the survey (Appendix A). Participants were provided with the response options of "prefer not to say" and "other" for each question, the latter having the option to specify the answer.

Smartphone screen time of the last two full weeks was assessed by questions pertaining to the subjects' screen time (Appendix B). The questions promoted the assessment of accurate data from diverse smartphone types by enabling different options to insert the data of screen time tracking applications based on the participant's device type. Nonetheless, the questionnaire included the alternative option of estimating the smartphone screen time. The total questionnaire included 11 questions; however, only four were relevant for the present study and were discussed further here.

The screen time data collection started with a brief explanation of screen time, according to Anuradha (2019). Participants who indicated not to use a smartphone at all were scored as having zero smartphone screen time. Smartphone users were provided with questions targeted for their mobile phone type, including a written explanation and a video on how to access the screen time recordings. Apple users inserted their daily average smartphone screen time of the last two full weeks. Android and other brand users were asked to provide their total smartphone screen time of the last 14 days. Estimating the daily average smartphone screen time of the last two weeks were provided as an alternative for participants who had not installed screen time tracking application on their phones.

Based on the participant's answer to the smartphone screen time questions, the researcher could process the gathered data (format was hours.minutes) and calculated a unified score for each participant's daily average smartphone screen time during the previous two weeks.

The *Center for Epidemiologic Studies Depression Scale (CES-D)* was designed to research the behavioral, cognitive, and affective symptoms of depression within a non-

psychiatric population (Radloff, 1977). Moreover, the CES-D took only around five minutes to complete and was free of charge (Fisher, 2009; Radloff, 1977).

Participants rated on a 4-point Likert scale how frequently they experienced specific feelings or behaved in a certain way during the previous week. All 20 items ranged from 0 "rarely or none of the time (less than 1 day)" to 3 "all of the time (5-7 days)". Items included statements like "I felt sad." and "I felt that everything I did was an effort.". The total score of the scale ranged from 0 to 60. Scores underneath 16 indicated that the individual appeared not to experience high levels of depressive symptoms at this time. On the other side, higher scores indicated individuals at risk of suffering from depression (Radloff, 1977).

Previous research found that the scale was applicable among diverse age groups and cultures, had good reliability, moderate test-retest reliability, and, according to the research of Van Dam and Earleywine (2011), high internal consistency (α = .93) (Fisher, 2009; Miller et al., 2007; Pinquart & Sörensen, 2003; Radloff, 1977; Van Dam & Earleywine, 2011).

The Brief Self-Control Scale (BSCS), developed by Tangney et al. (2004), assessed adults' level of trait self-control (Lindner et al., 2015). Filling out the 13-item multiple-choice questionnaire took fewer than 10 minutes (RAND Corporation, 2018). Participants rated on a 5-point Likert scale how much each statement reflected their typical reaction or thought pattern. Each item ranged from 1 "not at all" to 5 "very much." Examples of items were "I am good at resisting temptation.", "I am lazy." and "I wish I had more self-discipline.". The scale's total score ranged from 13 to 65. The higher the overall score, the more trait self-control an individual possessed (Tangney et al., 2004).

The BSCS showed good psychometric properties. Previous research found that the BSCS had high internal consistency (α = .83 and α = .85), and satisfactory test-retest reliability of a three-week-interval (α = .87) (Tangney et al., 2004). The short version of the scale with 13-items performed nearly as well as the full-length version with 36-items (Tangney et al., 2004).

Procedure

The data collection phase was between October 24, 2021, and December 12, 2021. The studies link was distributed via Facebook, Instagram, WhatsApp, and the SONA-system website, including a recruitment text. Participants who entered the survey via the SONA-system were rewarded with 0.25 credit points. The survey started with the consent form, providing general information about the study, the study's goal, the duration of participation (25 to 45 minutes), anonymity, confidentiality, withdrawal at any time without reason, and the

researchers' contact details (Appendix C). In the next step, participants had the option to agree to the informed consent and continued with the survey (Appendix D).

The questionnaire started with demographical questions and continued with the smartphone screen time questions, followed by the CES-D and BSCS scales. After completing the survey, the participants were thanked for taking part in the study.

Data analysis

The data were analyzed with the computer program IBM SPSS Statistics version 27. The data was prepared in SPSS for analysis, and incomplete responses were removed. Smartphone screen time was transformed from the format hours and minutes toward minutes. Thereby, having no access to a smartphone at all equaled zero minutes.

Descriptive analysis was conducted. Therefore, the mean scores, the sum scores, and the standard deviations were calculated of the smartphone screen time scale, the CES-D scale, and the BSCS. The normal distribution of the data was examined by the Kolmogorov-Smirnov test, which is applicable for larger samples (Field, 2013). Furthermore, the reliability of the scales was calculated. Thereby, alpha values of $\alpha > .70$ were thought to be acceptable (Field, 2013; Tavakol & Dennick, 2011). The frequencies and percentages of the demographic variables (age, gender, nationality, and occupational status) were examined as well.

The first hypothesis was tested by a Pearson's correlation analysis. Therefore, significant correlations were found when $p < .05$, and the effect sizes were interpreted as weak if $r < .3$, moderate if $r = .3 - .5$, and strong if $r > .5$. Significant correlations were found when $p < .05$ (Cohen, 2013). The second hypothesis was tested by moderation analysis in order to answer the research question of whether the relationship between daily average smartphone screen time (independent variable) and symptoms of depression (outcome) was moderated by trait self-control (moderator variable). Therefore, multiple linear regression analysis was applied with the extension tool PROCESS v4.0 by Andrew F. Hayes (Rockwood & Hayes, 2020).

Results

In total, 178 participants volunteered their time for the study. After excluding incomplete questionnaires, 124 respondents remained for statistical analysis. The post hoc calculation in G*Power yielded that the statistical power was clearly above .95 (.9951) with 124 respondents and an effect size of .15. The final sample was aged between 18 and 29 years (M= 20.94; SD = 2.38). In total, 93 females (75.0%), 29 males (23.4%), 1 other (0.8%) and 1 participant without

gender specification (0.8%) took part. The sample consisted of 74 Germans (59.7%), 23 Dutch (18.5%), 25 other nationalities (20.2%), and 2 participants who did not specify their nationality (1.6%). 117 respondents were students at a university (94.4%), and 7 respondents followed a different activity (e.g., employment, pupil, internship, unemployment) (5.6%). Concerning the 121 participants who used a smartphone (97.58%), 107 participants indicated their smartphone screen time based on tracking applications (88.43%), and 14 participants estimated their smartphone screen time (11.57%).

Descriptives. The daily average smartphone screen time was 4 hours and 42 minutes (*SD* = 2 hours 12 minutes). The minimum daily average smartphone screen time was 0 hours and 0 minutes, and the maximum was 10 hours and 30 minutes. The scores of the CES-D scale ranged from 2.00 to 54.00 (*M* = 19.17; *SD* = 11.35). A score above 16 indicated a population at risk of experiencing mild to moderate levels of symptoms of depression (Radloff, 1977). The scores of BSCS ranged from 20.00 to 59.00 (*M* = 39.94; S*D* = 8.40).

Normality. According to the Kolmogorov-Smirnov test, smartphone screen time (p = .20), and BSCS (p = .20) were normally distributed, and CES-D (p < .01) was not normally distributed**.** Nevertheless, CES-D can be analyzed by parametric methods based on sufficiently large sample size (Ghasemi & Zahediasl, 2012). Additionally, the analysis included testing for linearity.

Reliability. The scales CES-D (Cronbach's α = .92) and BSCS (Cronbach's α = .82) were reliable based on a Cronbach's Alpha above α > .70.

Table 1.

Correlations among Study Variables

Variable	Pearson Correlation		
	1	2	3
1. Smartphone Screen Time [a]	—		
2. Symptoms of Depression	.20*	—	
3. Trait Self-Control	-.33**	-.29**	—

[a]Values reflect the daily average across 2 weeks

** p < .05 ** p < .01*

The first hypothesis was that there is a relation between daily smartphone screen time and symptoms of depression. The correlation analysis yielded a significant, weak, positive association between smartphone screen time and symptoms of depression (r = .20; p = .023). Thus, the first hypothesis was accepted.

The second hypothesis was that trait self-control moderates the relationship between daily smartphone screen time and symptoms of depression. The overall model of the moderation analysis was significant ($F(3,120) = 3.33$, p = .022, R^2 = .087). Neither the predictor smartphone screen time (b = 0.01; p = .757), nor the moderator trait self-control (b = -.29; p = .323), or the interaction term (b < 0.001; p = .967) had a significant effect on the outcome variable symptoms of depression. Thus, the second hypothesis was rejected.

Discussion

The research aimed to investigate if trait self-control moderated the relationship between daily smartphone screen time and symptoms of depression among young adults.

The first hypothesis, "*There is a relation between daily smartphone screen time and symptoms of depression.*," was accepted. The study's findings indicated that increased smartphone screen time related to a higher risk of experiencing symptoms of depression. These findings were in line with previous research, which also found a significant, weak, positive correlation (Busch & McCarthy, 2021; Jiang & Zhao, 2016; Neophytou et al., 2019; Orben & Przybylski, 2019; Tang et al., 2021; Twenge et al., 2017). However, concluding that the raised smartphone screen time contributed to the increased depression rates among young people might be misleading.

On the one side, new insight from a recent study argued for a threshold effect after 5 hours of smartphone screen time. Young adults who spend more than 5 hours daily on their mobile phones were more often depressed compared to their peers who spend less time on their smartphones (Rosenthal et al., 2021). On the other side, the association was repeatedly small among the studies (Busch & McCarthy, 2021; Jiang & Zhao, 2016; Neophytou et al., 2019; Orben & Przybylski, 2019; Tang et al., 2021; Twenge et al., 2017). Some researchers argued that smartphone screen time's small effect on symptoms of depression is negligible (Tang et al., 2021). These researchers advised specifying other aspects like user content, context, motivation, or appraisal of screen time instead (Shaw et al., 2020; Tang et al., 2021).

The second hypothesis, "*Trait self-control moderates the relationship between daily smartphone screen time and symptoms of depression*," was rejected. Multiple linear regression analysis in PROCESS revealed that the relationship between daily smartphone screen time and

symptoms of depression was not moderated by trait self-control. Thus, trait self-control did not act as a protective factor in the relationship.

The present study showed that trait self-control played no moderation role within the relationship of smartphone screen time and symptoms of depression. As mentioned in the introduction, the second hypothesis was built on study findings about smartphone addiction (Geng et al., 2021). The present study's assumption that trait self-control would moderate the relationship between smartphone screen time and symptoms of depression as well was disapproved.

A possible explanation might be that recent research found individuals' subjective evaluations of their smartphone usage were more likely to predict and explain differences in symptoms of depression (Shaw et al., 2020). The total smartphone screen time might overly focus on objectivity and dismiss essential individual psychological processes. Regulating technology use might not always be possible for people, and this discrepancy between actual and desired use could lead to negative or positive appraisals. Therefore, Shaw et al. (2020) recommended neglecting the raw time spent on smartphones and focusing on an individual's usage appraisal and how individuals regulate their usage.

Moreover, the moderation analysis showed that when considering trait self-control as moderator, the hypothesized predictor smartphone screen time had no longer a significant effect on symptoms of depression—these findings questioning the previous detected relationship. Trait self-control might be a confounding variable in the relationship which was neglected by previous research.

It might be that the overall smartphone screen time was inconclusive and should be narrowed down on specific usage patterns to understand smartphones' adverse effects. Previous research found that the level of trait self-control was able to predict diverse smartphone use patterns (David et al., 2017; Jiang & Zhao, 2016; Tang et al., 2021). People with low trait self-control tended to use their smartphones more often for interacting with others and for entertainment reasons. Individuals with higher trait self-control used their smartphones more often for information seeking (Jiang & Zhao, 2016). In line with these findings, other research proved that different smartphone applications predict varying mental health outcomes. For example, photo/video sharing apps were associated with higher depression rates and e-book apps with lower depression rates (David et al., 2017; Tang et al., 2021).

Nevertheless, future research in this field is needed to unravel the mixed findings. Despite the previous research mentioned above, young adults with lower trait self-control had

a higher screen time in total regardless of the consumption pattern (Busch & McCarthy, 2021; Jiang & Zhao, 2016; Soror et al., 2012).

Strength and Limitations of the study

A clear benefit of the study was the assessment of smartphone screen time based on tracking apps, which most participants (88.43%) did. Hence, unlike many other studies, this study relied on accurate data and minimized estimation biases (Kaye et al., 2020; Vizcaino et al., 2019). Nonetheless, the format hours.minutes was misunderstood by some participants and should be changed in future studies. Therefore, guiding the participants more precisely is advisable by using a slider as an answer option to indicate the smartphone screen time instead of an open text entry.

One limitation of the study was the cross-sectional design. The research could not prove a causal direction between smartphone screen time and symptoms of depression in the hypothetical assumptions of the multiple regression analysis. As other studies have shown, symptoms of depression might also influence smartphone screen time (Nesi & Prinstein, 2015). However, the hypothetical assumption that smartphone screen time predicted symptoms of depression was reasonable in the face of recent literature reviews of longitudinal studies, which dis-promoted a vice-versa relationship (Busch & McCarthy, 2021; Jiang & Zhao, 2016; Neophytou et al., 2019; Orben & Przybylski, 2019; Tang et al., 2021; Twenge et al., 2017).

Implications

This study showed that despite a detected relationship between daily smartphone screen time and symptoms of depression, the association was small and might be negligible in clinical practice. Moreover, increasing trait self-control in clinical practice would not minimize the potential adverse consequences of high smartphone screen time on depression symptoms.

The study findings question previous research results about adverse effects of smartphone screen time on symptoms of depression. The current study found out that trait self-control neither strengthened nor weakened the relationship between smartphone screen time and symptoms of depression. Possible assumptions were provided for future research.

Further recommendations

Based on the study's findings, future research about screen-based technologies' impact on mental health and symptoms of depression should consider trait self-control. On the one side, whether the findings are replicable among other populations. Therefore, further statistical

analyses like hierarchical regression analysis were recommended to understand why trait self-control dissolved the significant association between smartphone screen time and symptoms of depression. On the other side, future research should minimize bias among potential conclusions about the association.

In line with other research, future studies should investigate different usage patterns and individuals' appraisals (David et al., 2017; Jiang & Zhao, 2016; Shaw et al., 2020). As Shaw et al. (2020) discovered, it may be advisable to investigate individuals' appraisal about their smartphone use pattern instead of only focusing on the raw time spent in front of them. Individuals' subjective evaluations about their smartphone usage were more likely to predict and explain differences in symptoms of depression (Shaw et al., 2020).

Due to the limitations of an online cross-sectional study design, longitudinal and randomized controlled research is needed to make inferences about a causal relationship between the concepts of interest.

Conclusion

Trait self-control did not moderate the relationship between daily smartphone screen time and symptoms of depression among young adults. Thus, trait self-control was not a protective factor. Interestingly, considering trait self-control dissolved the significant relationship between smartphone screen time and symptoms of depression. Future research could profit from the new insight and might examine potential causes of the phenomenon. Therefore, further statistical analyses like hierarchical regression analysis were recommended. Due to the weak association between smartphone screen time and symptoms of depression, future research should focus on specific aspects of smartphone screen time, for instance, the individuals' appraisal of screen time and usage patterns.

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Appendices

Appendix A

Demographic Questions

1. What is your gender?

□ Male

□ Female

□ Other: _____

□ Prefer not to say

2. What is your age? (You need to be 18 or older to participate)

□ Age: _____

□ Prefer not to say

3. What is your nationality?

□ Dutch

□ German

□ Other: _____

□ Prefer not to say

4. What is your current status? (Multiple answers possible)

□ Student

□ Employed/Self-employed

□ Pupil

□ Internship

□ Unemployed

□ Other: _____

□ Prefer not to say

Appendix B

Smartphone Screen Time Scale

Screen time is defined as the cumulative time spent looking at/watching the screen of electronic gadgets. Such gadgets can be, for instance, television, video screens, computer, smartphone, video game consoles, and tablets (Anuradha, 2019).

In the following questions, we will **focus only on smartphone screen time**. Therefore, we, please ask you only to indicate the screen time usage of your smartphone. You can do that by entering the screen time recordings of your phone or by estimating your screen time.

1. Do you use a smartphone at all?

□ No* *(when selected, participant is directed to the end of the scale)*

□ Yes

2. The purpose of a screen time tracking function is to track the time you spent on the applications you used throughout the day/ week. Such a screen time tracking function is often already pre-installed in smartphones or you might have an external application. In the following videos, we will provide you with detailed instructions on where to find your tracking function.

Below you can find a video description for android and apple smartphones. Please take a moment to review the one that corresponds to your phone.

In case you recognize that you do not possess a tracking function or that the function did not track the time during the last two weeks, it is always possible to select 'No' and move on to the next question where you will estimate your screen-time. However, we highly appreciate the most accurate data you can provide us with.

iPhone Screen Time Average Video (0:00:19): https://youtu.be/0JKm-FCArpc

Android Screen Time Average Video (0:00:32): https://youtu.be/g3LauOGP538

Do you have a screen time tracking function on your smartphone?

□ Yes

□ No *(When selected, participant is directed to item 4.1)*

□ I don’t know *(When selected, participant is directed to item 4.1)*

3. What kind of smartphone do you use?

□ Apple

□ Android

□ Other: _____

4.1 Please estimate the **average daily screen time** you used your smartphone **during the last full two weeks** (*data gathered from Monday to Sunday*).

You can do so by estimating for each day how much screen time you approximately had and then divide it by 7. Say that Monday you spent 4 hours, Tuesday 3 hours, Wednesday 5 hours, Thursday 2 hours, Friday 8 hours, Saturday 9 hours and Sunday 9:30 hours, then you need to add all these numbers up and divide by 7. Please use the following format: hour.minutes (e.g. 6.43). _____

4.2 Please open the screen time tracking application of your smartphone and write down the **daily average screen time** (hours and minutes) you used your smartphone **during the last two full weeks** (*data gathered from Monday to Sunday*). Please use the following format: hour.minutes (e.g. 6.43).

Please follow the instructions of the video on how to retrieve your screen time data.

iPhone Screen Time Average Video (0:00:19): https://youtu.be/0JKm-FCArpc

How to view your screen-time report?

The apple application Screen Times gives you a report showing how your device is used, apps you've opened, and websites you've visited. To see the report, go to Settings > Screen Time and tap See All Activity under the graph. From there, you can see your usage. If you turned on Share Across Devices, you can view overall usage across devices that are signed in with your Apple ID and password. Please make sure only to indicate your smartphone usage.

How to view your daily average screen time of the last full week?

You can view the last full week's daily average screen time by selecting Week in the left upper corner. The number above the graph indicates your daily average screen time of the week. Depending on the current weekday, you may have to swipe the graph to the right to see the last full week.

Week 1 _____

Week 2 _____

4.3 Please open the screen time tracking application of your smartphone and write down the **total time** (hours and minutes) you used your smartphone **during the last two weeks**. Please indicate this for each day separately. Please use the following format: hour.minutes (e.g. 6.43).

Please follow the instructions of the video on how to retrieve your screen time data.

Android Screen Time Average Video (0:00:32): https://youtu.be/g3LauOGP538

Android: How to view your screen-time report?

For Android devices, you go to Settings > Digital Wellbeing and parental controls and tap the hours that are shown there to see your daily usage.

Day 1 _____ ; Day 2 _____ ; Day 3 _____ ; Day 4 _____ ; Day 5 _____ ; Day 6 _____ ; Day 7 _____ ; Day 8 _____ ; Day 9 _____ ; Day 10 _____ ; Day 11 _____ ; Day 12 _____ ; Day 13 _____ ; Day 14 _____

Appendix C

Opening Statement for the Online Survey Screen-time and mental health: are they related?

Welcome to the survey. Thank you for taking the time to participate.
Please take a moment to read the following information carefully.

You are invited to participate in a research study titled Screen-time and mental health: are they related?. This study is being done by Sylvia Föckel and four other students from the Faculty of Behavioural, Management and Social Sciences at the University of Twente, under the supervision of Karla Duarte.

This research study aims to understand how individual differences impact the relationship between screen-time and mental health. The survey will take you approximately 30 to 45 minutes to complete. The data will be used for academic purposes regarding the bachelor theses. To participate, you have to be above the age of 18 as well as a university student.

Your participation in this study is entirely voluntary, and you can withdraw at any time. You are free to omit any question. It would be best if you had a working internet connection and a screen-based device, preferably a laptop or computer to fill out the survey, since it will be necessary to briefly use your phone while completing it and tabbing out of the survey might preemptively close it.

The survey consists of questions targeting demographic information, participants' mental health (subjective well being and depression), screen-time usage, and other psychological factors (including self-control, neuroticism, sleep quality, perceived social support, and loneliness). Please, read the information carefully and answer the questions honestly. There are no right or wrong answers since we are interested in your very own experience.

We believe there are no known risks associated with this research study; however, as with any online-related activity, the risk of a breach is always possible. To the best of our ability, your answers in this study will remain confidential. We will minimize any risks by storing the data according to the Research Data Management (RDM) of the University of Twente. Moreover, the collected data will be anonymized and cannot be traced back to you. No information about your identity will be collected or retained. The information you provide will solely be used in

order to investigate the purpose of the study. The information will not be disclosed to third parties outside the research team.

Study contact for further information

If you have any concerns, questions, complaints, or remarks, do not hesitate to contact us.

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please get in touch with the Secretary of the Ethics Committee of the Faculty of Behavioural, Management and Social Sciences at the University of Twente by ethicscommittee-bms@utwente.nl.

Appendix D

Consent Form for Screen-time and mental health: are they related?

I consent voluntarily to participate in this study and understand that I can refuse to answer questions and withdraw from the study at any time without having to give a reason.
□ Yes □ No

I understand that taking part in the study involves filling out an online questionnaire and encompasses questions about my demographic information, mental health (subjective well being and depression), screen-time usage, and other psychological factors (self-control, neuroticism, sleep quality, perceived social support, and loneliness).
□ Yes □ No

I understand that information I provide will be used for academic purposes regarding the bachelor theses at the University of Twente.
□ Yes □ No

I understand that personal information collected about me that can identify me will not be shared beyond the study team.
□ Yes □ No

I give permission for the anonymized answers that are derived from the survey to be archived in the University of Twente Research Information repository so it can be used for future research and learning.
□ Yes □ No

If you have any concerns, questions, complaints, or remarks, do not hesitate to contact us.
I declare that I have read the information and agree to participate in this study.
□ Yes □ No

End of survey

This is the end of the survey. We thank you for your participation!
If you have any questions left concerning the purpose of the study, the data privacy, or anything else, don't hesitate to send us an email.