Finding the “Sweet Spot” of Smartphone Use: Reduction or Abstinence to Increase Well-Being and Healthy Lifestyle?! An Experimental Intervention Study

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The present experimental study compared the impact of a total abstinence from smartphone use and of a reduction of daily smartphone use by 1 hr on well-being and healthy lifestyle. Participants (N\text{total} = 619) were smartphone users in Germany. The first experimental group (N = 200) waived smartphone use for 7 days, the second experimental group (N = 226) reduced its daily use by 1 hr, and the control group (N = 193) used smartphone as usual. Variables of smartphone use (time, intensity, problematic tendencies), life satisfaction, depressive symptoms, anxiety symptoms, physical activity, and smoking behavior were assessed via online surveys at four measurement time points (baseline; postintervention; 1 and 4 months after postintervention). Both interventions reduced smartphone use intensity, problematic use tendencies, depressive, and anxiety symptoms. In both groups, life satisfaction and physical activity increased. Most effects were stronger and remained more stable over 4 months in the reduction group than in the abstinence group. Moreover, in the reduction group only, the number of daily smoked cigarettes decreased. Thus, less time spent on the smartphone leads to more well-being and a healthier lifestyle; a complete smartphone abstinence is not necessary. Programs that focus on the increase of well-being and a healthier lifestyle could benefit from the integration of controlled reduction of smartphone use. A potential “sweet spot” of smartphone use is discussed.

Public Significance Statement
The present study suggests that conscious and controlled changes of daily time spent on smartphone use can contribute to subjective well-being (less depressive and anxiety symptoms, less problematic use tendencies, more life satisfaction) and to a healthier lifestyle (more physical activity, less smoking behavior) in the longer term. Already, a reduction of daily smartphone use by 1 hr can result in this positive effect, a complete abstinence is not necessary.

Keywords: abstinence from smartphone use, reduction of smartphone use, subjective well-being, physical activity, smoking behavior

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In the past decade, the smartphone has become people’s “best friend.” Today, more than 3.5 billion people own a smartphone and use it on average more than 3 hr daily (Kroker, 2020; Spajic, 2020). Through the mobile Internet access and the numerous online and offline applications, smartphone use makes our daily lives easier from work to leisure. In addition to permanent availability, it allows people to stay up-to-date about news, to access emails and social media accounts, to play games, to

Materials used in the present study are available on reasonable request from the corresponding author.

The study design and hypotheses were not preregistered. The analytic plan was not preregistered.

Julia Brailovskaia and Jasmin Delveaux conducted the study design. Julia Brailovskaia wrote the first draft of the article and conducted the statistical analysis. Julia Brailovskaia and Holger Schillack conducted literature searches. Julia Brailovskaia, Jasmin Delveaux, Julia John, Vanessa Wicker, Alina Noveski, and Seokyoung Kim conducted data collection and data preparation. Holger Schillack and Jürgen Margraf reviewed and edited the first draft. All authors contributed to and have approved the final article.

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All data, program code, and other methods developed by others are appropriately cited in the text and listed in the References section.

Data are available on reasonable request from the corresponding author.

The analytic code that was used in the present study is available as Supplemental Materials.
watch videos, and to use web mapping services and organizers (Elhai et al., 2019b).

However, despite the advantages, excessive smartphone use can negatively impact subjective well-being, physical health state, and academic performance (Elhai et al., 2017; Sohn et al., 2019; Vahedi & Saipho, 2018). People often engage in excessive smartphone use to escape overwhelming problems and negative mood (Elhai et al., 2019a). Active interaction with friends via social media or a passive following of other-generated content can in the short term contribute to relief, mood improvement, and inspiration. But in the longer term, time spent on smartphone use and the positive experiences can foster the development of a pathological emotional bond to the technical device that is linked to an obsessive need to permanently continue the use (Elhai et al., 2018; Lapierre et al., 2019; Montag et al., 2015). Nonuse can evoke physical and mental withdrawal symptoms and an often unconscious grasp of the smartphone (Cheever et al., 2014; Sapacz et al., 2016).

This phenomenon is often termed as problematic, compulsive, or addictive smartphone use (Elhai et al., 2017), but a consensus about a standardized term is currently missing. In the present study, we will use the term “problematic smartphone use” (Ting & Chen, 2020). In addition to withdrawal, problematic smartphone use is defined by characteristics like salience, tolerance, mood modification, lack of control and relapse, and conflicts (Elhai et al., 2017; Sohn et al., 2019).

So far, problematic smartphone use has not been recognized as a formal psychiatric disorder in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013) and in the International Classification of Diseases (ICD-11; World Health Organization, 2018). Nevertheless, available research emphasizes the negative effects of excessive smartphone use on well-being (Thomée, 2018). Longitudinal correlation studies that investigated time periods up to 3 years described that both the time spent on smartphone use in general and problematic smartphone use are positively linked to depressive and anxiety symptoms (Bickham et al., 2015; Lapierre et al., 2019; Rozgonjuk et al., 2018; Zhang et al., 2020). In cross-sectional studies, their relationship with life satisfaction was negative (Lachmann et al., 2018; Yang et al., 2019). Time spent on smartphone use was positively related to enhanced daytime sleepiness, and decreased sleep quality and sleepiness during bedtime, especially when using blue light smartphones (Heo et al., 2017; Li et al., 2015; Ng et al., 2020). Furthermore, excessive smartphone use negatively impacts physical health. Individuals who engaged in excessive use had enhanced levels of muscle fatigue and pain in the neck–shoulder region caused by the forward-leaning head posture, decreased posture, and respiratory function (Cudlar & Lamman, 2017; Inal et al., 2015; Jung et al., 2016; Kim & Koo, 2016; Xie et al., 2016). Time spent on smartphone use was associated with decreased physical activity and fitness, as well as enhanced obesity especially in adolescents and young adults (Fennell et al., 2019; Kenney & Gortmaker, 2017; Lepp et al., 2013). Moreover, smartphone use time and problematic use were negatively linked to academic performance in young students (Lepp et al., 2014, 2015); their association with academic procrastination was positive (Yang et al., 2019). In a longitudinal study, an increase of smartphone use time positively predicted a decrease in academic achievement of students over a 3-year period (Amez et al., 2019).

Considering the described negative impact of smartphone use, it seems highly desirable to understand how well-being and physical health can be protected in the age of the digital revolution. Available experimental research on social media use (e.g., Facebook, Instagram, Twitter) that can also negatively impact subjective well-being (Braïlovskaja, Teismann, et al., 2020; Braïlovskaja et al., 2019) showed that individuals who completely waived the use for a 1-week period had higher levels of life satisfaction than those who maintained their usual usage time (Tromholt, 2016). Reduction of daily time spent on social media for 30 min—which is less challenging than complete abstinence—for 3 weeks resulted in a decrease of depressive and anxiety symptoms (Hunt et al., 2018). Reducing the daily social media time for 20 min over a 2-week period contributed to an increase of life satisfaction and physical activity (e.g., jogging, cycling), whereas the intensity of social media use, problematic use, depressive symptoms, and smoking behavior decreased. The positive effects remained stable for up to 3 months (Braïlovskaja, Ströse, et al., 2020). Thus, abstinence from social media use as well as its reduction have positive effects on well-being and lifestyle.

However, can these findings be applied to smartphone use? In the past several years, several experimental studies investigated the abstinence from smartphone use. Most of them were conducted in laboratories where participants had to completely waive smartphone use for up to several hours while waiting or working on specific tasks (e.g., puzzles). Their results mostly reveal an increase of withdrawal and anxiety symptoms, especially in individuals who tend to excessive smartphone use (Cheever et al., 2014; Clayton et al., 2015; Cutino & Nees, 2017). This corresponds to our knowledge about restrictive interventions on addictive behavior such as alcohol, nicotine, and drug use (Gawin, 1991; Wetterling et al., 1996). In the initial craving stage that can continue for days or weeks, the individual typically experiences enhanced withdrawal and anxiety. In the later stage, the negative symptoms decrease. Because of the brief abstinence periods and lack of follow-up measurements in the available studies, it remains unclear how long the withdrawal and anxiety symptoms could persist in the context of smartphone use. Also, the external validity of the effects outside the laboratory is unclear.

Two experimental studies on the abstinence from smartphone use were conducted outside of the laboratory. In the first study, participants of the experimental group (N = 67) who completely waived smartphone use for 72 hr had significantly higher withdrawal and anxiety symptoms than the control group (N = 60) who used the smartphone as usual (Eide et al., 2018). In the second study (N = 19), after a 10-day abstinence from smartphone use, withdrawal symptoms decreased and experience of relief increased (Zinn & Rademacher, 2019). Thus, the craving stage seems to continue for at least 3 days, but for less than 10 days.

Considering the available experimental studies that lack follow-up measurements and focus on a small number of variables of well-being, it can be concluded that the current state of research cannot answer the question of whether the findings with respect to social media (Braïlovskaja, Ströse, et al., 2020; Hunt et al., 2018; Tromholt, 2016) are applicable to smartphone use: Abstinence from and/or reduction of the use can positively influence well-being and lifestyle in the longer term. However, finding an answer to this question is urgent considering the potential negative effects of excessive smartphone use (Elhai et al., 2019a).

Therefore, the present study aimed to investigate the influence of both the controlled experimental abstinence from smartphone use and the controlled experimental reduction of daily time spent on
smartphone use on subjective well-being and lifestyle over a longer period of time (up to 4 months). Because of the limited experimental findings on smartphone use, we formulated our hypotheses and designed our study mainly following the experimental research on social media (i.e., Brailovskaia, Ströse, et al., 2020; Hunt et al., 2018; Tromholt, 2016).

Regarding the smartphone use variables, we hypothesized that the abstinence from/reduction of daily time spent on this technical device is accompanied by a reduction of smartphone use intensity/integration into daily life (Hypothesis 1a). Previous research described time spent on smartphone use to foster problematic tendencies (e.g., Lapierre et al., 2019). Therefore, we assumed that abstinence from/reduction of daily smartphone use decreases the level of problematic smartphone use (Hypothesis 1b).

Following the dual-factor models (e.g., Keyes, 2005), subjective well-being consists of two interrelated but distinct dimensions: positive and negative. Only the investigation of both dimensions in parallel enables a comprehensive picture of a person’s well-being. Thus, based on earlier findings (Brailovskaia, Ströse, et al., 2020; Hunt et al., 2018; Tromholt, 2016), we assumed that the abstinence from/reduction of smartphone use time contributes to an increase of life satisfaction (Hypothesis 2a) and a decrease of depressive tendencies (Hypothesis 2b) and anxiety symptoms (Hypothesis 2c).

Brailovskaia, Ströse, et al. (2020) showed that the reduction of social media time influenced (un)healthy lifestyle—operationalized as physical activity (e.g., jogging: healthy lifestyle) and smoking behavior (consumed tobacco products: unhealthy lifestyle). They described that positive emotions experienced during physical activity could replace positive emotions evoked by social media use. Furthermore, reduction in social media use, enhancement of physical activity time and of well-being could contribute to the conscious striving for a healthier lifestyle in general, and thus at least partly explain the reduction of smoking behavior. On the basis of this framework, we expected that the abstinence from/reduction of smartphone use time increases the frequency of physical activity (Hypothesis 3a) and decreases smoking behavior (Hypothesis 3b).

So far, no study on social media or smartphone use directly compared the effects of complete abstinence from the use and its reduction. To avoid speculations, we additionally formulated two research questions:

Research Question 1: Do the effects of abstinence from smartphone use and of a reduction of time spent on smartphone use on well-being and lifestyle differ?

Research Question 2: If they differ, how do the effects of abstinence from smartphone use and of a reduction of time spent on smartphone use on well-being and lifestyle differ?

Materials and Method

Transparency and Openness

Data

Data used in the present study are available on reasonable request from the corresponding author.

Analytic Methods

The analytic code needed to reproduce current analyses is included as Supplemental Materials Analytic Code.

Materials

Materials used in the present study are available on reasonable request from the corresponding author.

Procedure

The present study was designed as a randomized controlled trial that included two experimental groups (i.e., abstinence group, reduction group) and a control group. Over a period of 7 days (= experimental manipulation period), participants of the abstinence group waived their daily smartphone use (= first experimental manipulation), participants of the reduction group reduced their daily smartphone use time (= second experimental manipulation), and participants of the control group did not change their usual smartphone use time. Smartphone use was defined as the use of all internet-based and not internet-based applications and features on the smartphone, except the use of telephony service (i.e., calling somebody, accepting incoming calls) in very urgent cases, such as for parents to find out whether a child has arrived at the place of destination.

In 2019, the mean daily smartphone use time ranged around 3 hr (e.g., MacKay, 2019; Wurmser, 2019). Following Brailovskaia, Ströse, et al. (2020), who chose a third of the mean social media use time for the reduction condition, we advised the reduction group to reduce the duration of daily smartphone use time by 60 min (i.e., one third of the 3 hr) over the 7 intervention days.

Data of the three groups were collected at four measurement time points via online surveys in German language. Participants received the online links to the surveys by email. Measurements took place on the day prior to the beginning of the experimental manipulation period (baseline, day 0) to assess a baseline of the investigated variables, after the 7 days of the manipulation period (postintervention, Day 8), 1 and 4 months after the postintervention measurement (see Figure 1). This procedure enables an investigation of the short- and long-term (up to 4 months) effects of the experimental manipulation of smartphone use time.

Participants

Data collection took place from April 2019 to November 2020. Participants were recruited by invitations displayed at public places in Germany, at German universities, and on social media such as Facebook and Twitter. Persons who were interested in participation contacted the principal investigators by email. In addition to their wish to participate, the email should include their mean daily smartphone use time (in min). The requirements for participation—voluntary and compensated by course credits for students—were the possession of a smartphone and its daily use for at least 75 min (to prevent a complete abstinence in the reduction group). Participants had to be at least 18 years old. All requirements were included in the invitation. All participants fulfilled the requirements. No participants were excluded. Implementation of the present study was approved by the responsible Ethics Committee. Persons who were interested in the
Figure 1
Investigation Timeline (Measurement Time Points: Baseline, Day 0; Postintervention, Day 8; 1 Month After Postintervention; 4 Months After Postintervention)

Experimental manipulations period:
Day 1 to Day 7

Measurement: Baseline (Day 0) Post-intervention (Day 8) 1 Month after Post-intervention 4 Months after Post-intervention

Investigation of short-term effect of experimental manipulations
Investigation of longer-term effect of experimental manipulations

participation received an email with the link to the baseline survey. At the beginning of the baseline survey, they were randomly assigned to one of the three groups. Participants were properly informed about the study and provided informed consent to participate online. The same day, members of both experimental groups received an email, including a Microsoft Word document ("Daily compliance diary"). The document included a table where participants entered daily whether they had complied with the instruction of their experimental condition (0 = no, 1 = yes). After the intervention period, the compliance diary was sent back by email to the principal investigators. Compliance was assessed when participants reported to comply with the group instruction for at least 5 of the 7 days of the experimental period. In addition to the diary, in the email of the reduction group, participants were asked to cut down their daily smartphone use time by 1 hr a day. To clarify this instruction, each participant was provided a concrete maximal time that he/her was allowed to spend on daily smartphone use for no longer than 120 min. Thus, the person was allowed to engage in smartphone use for no longer than 120 min daily. To prevent increased attention on smartphone use, the control group did not receive a compliance diary.

**Experimental Group Abstinence**

Overall, 227 persons were assigned to the abstinence group. At different stages of the investigation, 27 persons (11.9%) dropped out. Thus, the abstinence group consisted of 200 participants who completed all surveys, 79.5% women; \( M_{\text{age}} (SD_{\text{age}}) = 25.38 (7.14) \), range: 18–67; occupation: 77% university students, 22.6% employees, and one unemployed person; marital status: 42.5% single, 48.7% in a relationship but not married, 8.8% married; all Caucasian. Analyses of the compliance diaries revealed a compliance rate of 92.9% (\( n = 210 \)).

Following Tromholt (2016) and Brailovskaia, Ströse, et al. (2020), noncompliers were kept in the samples.

**Control Group**

Overall, 232 persons were assigned to the control group. The dropout rate was 16.8% (\( n = 39 \)). Thus, the control group consisted of 193 participants (75.1% women; \( M_{\text{age}} (SD_{\text{age}}) = 27.15 (10.08) \), range: 18–63; occupation: 69.4% university students, 29.5% employees, one unemployed person, and one retired person; marital status: 37.8% single, 45.6% in a relationship but not married, 16.6% married; all Caucasian).

Analyses of variance (ANOVA) revealed no significant group differences of demographic variables. Also, there were no significant differences of demographic variables between persons who dropped out and those who participated in all surveys. A priori power analyses (G*Power program, Version 3.1) indicated that at least a total sample size of \( N = 174 \) (\( n = 58 \) per group) was required for valid results (repeated measure ANOVAs, within-between factor-design; power \( \geq 0.80 \), \( \alpha = .05 \), effect size: \( f = 0.10 \); Mayr et al., 2007). However, much more people revealed the wish to participate in the study. As the study aimed to improve subjective well-being and lifestyle, each person was included in the study that wanted to participate based on ethical considerations.

**Measures**

**Smartphone Use**

**Duration of Smartphone Use.** Participants indicated the duration of their daily smartphone use (in min; current mean test–retest reliability calculated over all four measurement time points \( r_{\text{int}} \): abstinence group: \( r_{\text{int}} = .62 \), reduction group: \( r_{\text{int}} = .56 \), control group: \( r_{\text{int}} = .73 \)).
**Intensity of Smartphone Use.** Intensity of smartphone use and its integration into daily life was measured with a modified version of the Facebook Intensity Scale (FIS; original version: Ellison et al., 2007; German version: Brailovskaia, Röhm, et al., 2018). The term “Facebook” was replaced by the term “Smartphone”; four of the overall six items were included in the present investigation (i.e., “Smartphone use is part of my everyday activity,” “Smartphone use has become part of my daily routine.” “I feel out of touch, when I haven’t used my Smartphone for a while,” and “I would be sorry, if my Smartphone malfunctioned”). Two items of the original FIS were excluded because their content could not be transferred to smartphone use. The items are rated on a 5-point Likert-type scale (1 = disagree strongly, 5 = agree strongly, current reliability: abstinence group: Cronbach’s α = .72–.77, r_{int} = .63; reduction group: α = .65–.69, r_{int} = .67; control group: α = .64–.76, r_{int} = .64).

**Problematic Smartphone Use.** The level of problematic smartphone use was measured with a modified version of the brief Bergen Social Media Addiction Scale (BSMAS; original Version: Andreasen et al., 2016; German Version: Brailovskaia, Schillack, et al., 2020). In all six items that are formulated according to the six characteristics of problematic media use (i.e., salience, tolerance, mood modification, relapse, withdrawal, conflict), the term “Social Media” was replaced by “Smartphone” (e.g., “Felt an urge to use the Smartphone more and more?”). Items are rated on a 5-point Likert-type scale (1 = very rarely, 5 = very often; current reliability: abstinence group: α = .83–.89, r_{int} = .56; reduction group: α = .81–.89, r_{int} = .63; control group: α = .83–.93, r_{int} = .51).

**Subjective Well-Being**

**Life Satisfaction.** The Satisfaction with Life Scale (SWLS; original Version: Diener et al., 1985; German Version: Glaesmer et al., 2011) was used to measure global life satisfaction. This instrument includes five items that are rated on a 7-point Likert-type scale (e.g., “In most ways, my life is close to my ideal”; 1 = strongly disagree, 7 = strongly agree; current reliability: abstinence group: α = .86–.89, r_{int} = .73; reduction group: α = .86–.89, r_{int} = .76; control group: α = .84–.89, r_{int} = .70).

**Depressive and Anxiety Symptoms.** The depression and the anxiety subscales of the Depression Anxiety Stress Scales 21 (DASS-21; original Version: Lovibond & Lovibond, 1995; German Version: Nilges & Essau, 2015) measured depressive and anxiety symptoms with seven items, respectively, that are rated on a 4-point Likert-type scale (depression subscale: e.g., “I couldn’t seem to experience any positive feeling at all”; anxiety subscale: e.g., “I felt scared without any good reason”: 0 = did not apply to me at all; 3 = applied to me very much or most of the time; current reliability: depression subscale: abstinence group: α = .86–.89, r_{int} = .65; reduction group: α = .79–.89, r_{int} = .55; control group: α = .84–.87, r_{int} = .60; anxiety subscale: abstinence group: α = .76–.86, r_{int} = .64; reduction group: α = .82–.84, r_{int} = .62; control group: α = .77–.88, r_{int} = .64).

**(Un)Healthy Lifestyle**

**Physical Activity.** Following Brailovskaia, Ströse, et al. (2020), the frequency of physical activity was assessed with the item “How frequently do you engage in physical exercise (e.g., swimming, cycling, jogging, etc.)?” rated on a 5-point Likert-type scale (1 = never, 5 = four times a week and more; current reliability: abstinence group: r_{int} = .61, reduction group: r_{int} = .47, control group: r_{int} = .71). This brief instrument has been repeatedly reported to be a valid and reliable measure of physical activity (Brailovskaia, Teisemann, et al., 2018; Milton et al., 2011).

**Smoking Behavior.** Following previous research (Brailovskaia, Ströse, et al., 2020), participants were asked whether they regularly consume any tobacco products, such as cigarettes (0 = no, 1 = yes). Those who indicated to consume tobacco products were asked how many of them they consume daily (current reliability: abstinence group: r_{int} = .93, reduction group: r_{int} = .73, control group: r_{int} = .76).

The time instructions (e.g., over the last week, over the last month) of the questionnaires were adapted to the requirements of the individual surveys. For all used instruments, higher scores indicated higher levels of the measured variable. Investigated variables were assessed at all four measurement time points in all groups. Exception was duration of daily smartphone use (only baseline, 1 and 4 months after postintervention measurement). Note that between baseline and postintervention measurement, the duration of daily smartphone use of both experimental groups was experimentally manipulated.

**Statistical Analysis**

Statistical analyses were conducted with the Statistical Package for the Social Sciences (SPSS 26). There were no missing data. After descriptive analyses, repeated measure analyses of variance (ANOVA; within-between factor-design) to test possible short- and long-term effects (up to four measurement time points) and to compare the three investigated groups (abstinence group vs. reduction group; abstinence group vs. control group; reduction group vs. control group) were calculated. For all variables, there was a violation of the assumption of sphericity (Mauchly’s test). Thus, the Greenhouse–Geisser correction (ε) was applied. Partial eta-squared (η_p^2) was included as the effect–size measure of main effects (measurement time point; group condition) and of interaction effect (measurement time point × group condition). Cohen’s d was used as effect–size measure of post hoc comparisons between groups, Cohen’s d_repeated Measures (Morris, 2008) was assessed as effect–size measure of post hoc comparisons within groups. All post hoc comparisons were Bonferroni-corrected (level of significance: p < .05, two-tailed).

**Results**

Table 1 summarizes descriptive statistics of the investigated variables in all groups at the four measurement time points. Note, 20.5% (n = 41) of the abstinence group, 15.9% (n = 36) of the reduction group, and 14.5% (n = 28) of the control group regularly consumed tobacco products.

Figures 2 (time and intensity of smartphone use) and 3 (variables of well-being including problematic smartphone use and lifestyle) visualize the results of the ANOVAs.

The Supplemental Materials Table S1 presents results of pairwise comparisons within each group, whereas results of the pairwise comparisons between the three groups are summarized in the Supplemental Materials Table S2.
The ANOVA for time spent daily on smartphone use revealed a significant main effect for measurement time point, $F(1.93, 1186.95) = 53.675$, $p < .001$, $\eta^2_p = .080$, a significant main effect for group condition, $F(2, 616) = 3.343$, $p = .036$, $\eta^2_p = .011$, and a significant interaction effect, $F(3.85, 1186.95) = 6.754$, $p < .001$, $\eta^2_p = .021$. Pairwise comparisons indicated that in both experimental groups, smartphone use time was lower 1 and 4 months after postintervention measurement than at baseline. The within-group effects were stronger in the reduction group than in the abstinence group (see Supplemental Materials Table S1). Furthermore, pairwise comparisons indicated significant lower smartphone use time in the abstinence group than in the control group 1 and 4 months after

### Table 1

<table>
<thead>
<tr>
<th>Investigated variables</th>
<th>Group</th>
<th>Baseline M (SD)</th>
<th>Postintervention M (SD)</th>
<th>One month M (SD)</th>
<th>Four months M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphone use time (in min)</td>
<td>Abstinence</td>
<td>199.74 (105.79)</td>
<td>157.43 (91.00)</td>
<td>162.02 (111.89)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduction</td>
<td>215.96 (84.78)</td>
<td>176.26 (80.88)</td>
<td>170.96 (80.81)</td>
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<tr>
<td></td>
<td>Control</td>
<td>202.75 (125.41)</td>
<td>198.20 (125.41)</td>
<td>187.33 (111.34)</td>
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</tr>
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<td>Smartphone use intensity</td>
<td>Abstinence</td>
<td>15.86 (2.80)</td>
<td>14.60 (3.42)</td>
<td>14.57 (3.42)</td>
<td>14.12 (3.44)</td>
</tr>
<tr>
<td></td>
<td>Reduction</td>
<td>16.03 (2.59)</td>
<td>14.92 (2.78)</td>
<td>14.78 (2.77)</td>
<td>14.51 (2.95)</td>
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<tr>
<td></td>
<td>Control</td>
<td>15.99 (2.56)</td>
<td>15.39 (2.96)</td>
<td>15.51 (2.56)</td>
<td>15.35 (2.80)</td>
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<td>Life satisfaction</td>
<td>Abstinence</td>
<td>26.33 (5.46)</td>
<td>26.92 (5.43)</td>
<td>27.14 (5.52)</td>
<td>27.10 (5.82)</td>
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<tr>
<td></td>
<td>Reduction</td>
<td>26.28 (5.35)</td>
<td>26.88 (5.23)</td>
<td>27.09 (5.06)</td>
<td>27.44 (5.18)</td>
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<td></td>
<td>Control</td>
<td>26.33 (5.06)</td>
<td>26.16 (5.33)</td>
<td>26.15 (5.45)</td>
<td>26.09 (5.70)</td>
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<td>Problematic smartphone use</td>
<td>Abstinence</td>
<td>13.39 (5.15)</td>
<td>12.80 (4.81)</td>
<td>11.22 (4.80)</td>
<td>11.40 (4.83)</td>
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<tr>
<td></td>
<td>Reduction</td>
<td>12.91 (4.81)</td>
<td>13.01 (4.10)</td>
<td>10.96 (4.47)</td>
<td>11.05 (4.09)</td>
</tr>
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<td>Control</td>
<td>12.37 (4.74)</td>
<td>12.14 (4.54)</td>
<td>12.28 (5.05)</td>
<td>12.16 (4.95)</td>
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<td>Depressive symptoms</td>
<td>Abstinence</td>
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<td>3.29 (3.80)</td>
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<td></td>
<td>Reduction</td>
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<td>Control</td>
<td>3.60 (3.50)</td>
<td>3.58 (3.87)</td>
<td>3.61 (3.63)</td>
<td>3.82 (4.07)</td>
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<td>Anxiety symptoms</td>
<td>Abstinence</td>
<td>3.39 (3.42)</td>
<td>2.38 (3.52)</td>
<td>2.47 (3.27)</td>
<td>2.53 (3.46)</td>
</tr>
<tr>
<td></td>
<td>Reduction</td>
<td>3.09 (3.63)</td>
<td>2.50 (3.33)</td>
<td>2.46 (3.23)</td>
<td>2.08 (2.70)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.88 (3.17)</td>
<td>2.81 (3.87)</td>
<td>2.76 (3.45)</td>
<td>2.89 (3.67)</td>
</tr>
<tr>
<td>Physical activity</td>
<td>Abstinence</td>
<td>3.36 (1.15)</td>
<td>3.59 (1.06)</td>
<td>3.50 (1.08)</td>
<td>3.51 (1.07)</td>
</tr>
<tr>
<td></td>
<td>Reduction</td>
<td>3.39 (1.01)</td>
<td>3.58 (.97)</td>
<td>3.63 (.85)</td>
<td>3.77 (.87)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>3.35 (1.11)</td>
<td>3.38 (1.12)</td>
<td>3.41 (1.09)</td>
<td>3.27 (1.06)</td>
</tr>
<tr>
<td>Smoking behavior</td>
<td>Abstinence</td>
<td>5.76 (5.41)</td>
<td>5.61 (5.13)</td>
<td>5.44 (5.60)</td>
<td>5.49 (6.83)</td>
</tr>
<tr>
<td></td>
<td>Reduction</td>
<td>5.50 (4.84)</td>
<td>3.89 (4.42)</td>
<td>3.75 (4.87)</td>
<td>3.39 (4.07)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>5.25 (4.67)</td>
<td>5.25 (5.03)</td>
<td>5.86 (5.83)</td>
<td>5.75 (5.23)</td>
</tr>
</tbody>
</table>

**Note.** $M =$ mean; $SD =$ standard deviation. Experimental Group Abstinence: $N = 200$, Experimental Group Reduction: $N = 226$, Control Group: $N = 193$, exception: smoking behavior; Experimental Group Abstinence: $n = 41$, Experimental Group Reduction: $n = 36$, Control Group: $n = 28$; baseline to 4 months = measurement time points; smoking behavior: number of daily consumed tobacco products.

The ANOVA for time spent daily on smartphone use revealed a significant main effect for measurement time point, $F(1.93, 1186.95) = 53.675$, $p < .001$, $\eta^2_p = .080$, a significant main effect for group condition, $F(2, 616) = 3.343$, $p = .036$, $\eta^2_p = .011$, and a significant interaction effect, $F(3.85, 1186.95) = 6.754$, $p < .001$, $\eta^2_p = .021$. Pairwise comparisons indicated that in both experimental groups, smartphone use time was lower 1 and 4 months after postintervention measurement than at baseline. The within-group effects were stronger in the reduction group than in the abstinence group (see Supplemental Materials Table S1). Furthermore, pairwise comparisons indicated significant lower smartphone use time in the abstinence group than in the control group 1 and 4 months after

**Figure 2**

*Results of Repeated Measure Analyses of Variance (ANOVAs) for Smartphone Use: (A) Daily Time (in min), and (B) Intensity*

**Note.** Experimental group abstinence: $n = 200$, Experimental group reduction: $n = 226$, Control group: $n = 193$; Baseline to 4 months = Measurement time points.
Figure 3
Results of Repeated Measure Analyses of Variance (ANOVAs) for Variables of Well-Being Including Problematic Smartphone Use and Lifestyle: (A) Life Satisfaction, (B) Problematic Smartphone Use, (C) Depressive Symptoms, (D) Anxiety Symptoms, (E) Physical Activity, (F) Smoking Behavior

postintervention measurement (see Supplemental Materials Table S2).

For intensity of smartphone use, the ANOVA revealed a significant main effect for measurement time point, \(F(2.90, 1783.37) = 64.236, p < .001, \eta_p^2 = .094\), a significant main effect for group condition, \(F(2, 616) = 4.802, p = .009, \eta_p^2 = .015\), and a significant interaction effect, \(F(5.79, 1783.37) = 3.999, p < .001, \eta_p^2 = .013\). Pairwise comparisons revealed that use intensity was significantly lower at other measurement time points than at baseline in all three groups. The effects were stronger in both experimental groups than in the control group. In addition, use intensity was significantly lower 4 months after postintervention measurement than 1 month after it in the abstinence group (see Supplemental Materials Table S1). Furthermore, pairwise comparisons revealed that use intensity was significantly lower in the abstinence group (at postintervention, 1 and 4 months measurements) and in the reduction group (at 1 and 4 months measurements) than in the control group (see Supplemental Materials Table S2).

For problematic smartphone use, the ANOVA showed a significant main effect for measurement time point, \(F(2.93, 1805.79) = 34.504, p < .001, \eta_p^2 = .053\), a non-significant main effect for group condition, \(F(2, 616) = .274, p = .761\), and a significant interaction effect, \(F(5.86, 1805.79) = 8.400, p < .001, \eta_p^2 = .027\). As shown by pairwise comparisons, there was a significant decrease of problematic smartphone use in both experimental groups between baseline and measurements 1 and 4 months after postintervention, as well as between postintervention measurement and both later measurements. The effects were stronger in the reduction group than in the abstinence group (see Supplemental Materials Table S1). Furthermore, problematic smartphone use was significantly lower in the reduction group than in the control group 1 and 4 months after postintervention measurement (see Supplemental Materials Table S2).

For life satisfaction, the ANOVA showed a significant main effect for measurement time point, \(F(2.69, 1657.78) = 4.860, p = .003, \eta_p^2 = .008\), a non-significant main effect for group condition, \(F(2, 616) = 1.487, p = .227\), and a significant interaction effect, \(F(5.38, 1657.78) = 2.625, p = .020, \eta_p^2 = .008\). Pairwise comparisons showed that life satisfaction was significantly higher 1 month after postintervention measurement than at baseline in the abstinence group. In the reduction group, life satisfaction was significantly higher at all other measurement time points than at baseline (see Supplemental Materials Table S1). Moreover, life satisfaction was significantly higher in the reduction group than in the control group 4 months after postintervention measurement (see Supplemental Materials Table S2).

For depressive symptoms, the ANOVA revealed a significant main effect for measurement time point, \(F(2.84, 1749.69) = 7.119, p < .001, \eta_p^2 = .011\), a non-significant main effect for group condition, \(F(2, 616) = 1.206, p = .300\), and a significant interaction effect, \(F(5.68, 1749.69) = 2.677, p = .016, \eta_p^2 = .009\). Pairwise comparisons revealed that depressive symptoms were significantly lower at other measurement time points than at baseline in the abstinence group. In the reduction group, they were significantly lower at postintervention measurement and 4 months later than at baseline (see Supplemental Materials Table S1). Furthermore, depressive symptoms were significantly lower in the reduction group than in the control group 4 months after postintervention measurement (see Supplemental Materials Table S2).

Considering anxiety symptoms, the ANOVA showed a significant main effect for measurement time point, \(F(2.89, 1782.09) = 12.166, p < .001, \eta_p^2 = .019\), a non-significant main effect for group condition, \(F(2, 616) = .579, p = .561\), and a significant interaction effect, \(F(5.79, 1782.09) = 3.422, p = .003, \eta_p^2 = .011\). As shown by pairwise comparisons, there was a significant decrease of anxiety symptoms in both experimental groups between baseline and other measurement time points (see Supplemental Materials Table S1). The effects were stronger in the abstinence group than in the reduction group. Moreover, anxiety symptoms were significantly lower in the reduction group than in the control group 4 months after postintervention measurement (see Supplemental Materials Table S2).

For physical activity, the ANOVA showed a significant main effect for measurement time point, \(F(2.75, 1691.22) = 8.261, p < .001, \eta_p^2 = .013\), a significant main effect for group condition, \(F(2, 616) = 3.988, p = .019, \eta_p^2 = .013\), and a significant interaction effect, \(F(5.49, 1691.22) = 4.968, p < .001, \eta_p^2 = .016\). Pairwise comparisons indicated a significant increase of physical activity between baseline and postintervention measurement in the abstinence group. In the reduction group, physical activity was significantly higher at all other measurement time points than at baseline. Also, it was significantly lower at postintervention measurement than 4 months later (see Supplemental Materials Table S1). Moreover, physical activity was significantly higher in the reduction group than in the abstinence group and in the control group 4 months after postintervention measurement (see Supplemental Materials Table S2).

For smoking behavior, the ANOVA revealed a non-significant main effect for measurement time point, \(F(2.30, 234.59) = 1.761, p = .169\), and a non-significant main effect for group condition, \(F(2, 102) = 1.008, p = .368\), but a significant interaction effect, \(F(4.60, 234.59) = 2.549, p = .033, \eta_p^2 = .048\). The non-significant main effects might be due to the fact that only a small percentage of all three groups engaged in smoking behavior. A larger subsample size could lead to a significant finding. As shown by pairwise comparisons, smoking behavior was significantly lower at other measurement time points than at baseline in the reduction group (see Supplemental Materials Table S1). There were no significant differences between groups (see Supplemental Materials Table S2).

Discussion

Smartphone use is a curse and a blessing in the age of the digital revolution. It enables a permanent access to information and social interaction and facilitates many tasks of everyday life. However, an excessive use of the many possibilities can negatively influence well-being, physical health, and different areas of a person’s offline life (Amez et al., 2019; Elhai et al., 2019a; Xie et al., 2016).

Our findings reveal that abstinence from smartphone use, but also already an 1-hr reduction of daily time spent on the smartphone use over the period of 1 week significantly influences smartphone use habits. Moreover, both have a similar substantial positive effect on subjective well-being and lifestyle for up to 4 months. Effects of the reduction are even more stable than those of the abstinence with respect to variables such as life satisfaction and physical activity (see Research Questions 1 and 2).

Four months after the intervention, participants reduced their daily initial smartphone use time for about 38 min in the abstinence group and for about 45 min in the reduction group. No significant longitudinal changes of usage time were found in the control group. The intensity of smartphone use decreased in all three groups (partly...
confirmation of Hypothesis 1a). Thus, the regular completion of our survey could increase awareness of one’s own smartphone use in all participants, which might contribute to a more conscious and reflected consideration of its meaning for one’s own life (Hunt et al., 2018). However, the effect was stronger in the experimental groups than in the control group. This underlines that filling out surveys can be the first step to increase awareness for one’s own smartphone use intensity, but the conscious manipulation of usage time is necessary to increase and consolidate the effect.

Withdrawal symptoms belong to main characteristics of addictive behavior (Elhai et al., 2017). Following previous research, complete abstinence from smartphone use increases withdrawal symptoms at least in the first 3 days (Eide et al., 2018); after 10 days of abstinence, they decrease (Zinn & Rademacher, 2019). Our present findings refer to problematic smartphone use in general. The level of problematic tendencies did not significantly change between baseline and postintervention measurement in all groups. Because of missing between-intervention measurements, for example, at Day 3, the present study design does not allow conclusions about potential changes of problematic smartphone use within the intervention week. But in both experimental groups, problematic tendencies decreased 1 and 4 months after the intervention (confirmation of Hypothesis 1b), with a stronger long-term effect in the reduction group than in the abstinence group (see Research Questions 1 and 2). Thus, our results emphasize the positive long-term effect of the use time manipulation.

Moreover, our present results show that abstinence from and reduction of daily smartphone use contribute to a significant improvement in both dimensions of subjective well-being: Life satisfaction increases, whereas depressive and anxiety symptoms decrease (confirmation of Hypothesis 2a to Hypothesis 2c). Following considerations may at least partly explain the findings. Smartphones belong to the main technical devices used to enter online interaction in terms of social support (Lapierre et al., 2019). However, this dysfunctional strategy contributes to an alienation from social contacts in the offline world, a neglect of responsibilities, and an increase of interpersonal conflicts (Thomée, 2018). As a consequence, life satisfaction decreases, whereas depressive and anxiety symptoms increase (Bickham et al., 2015; Lapierre et al., 2019; Yang et al., 2019).

Further enhancement of smartphone use intensity is a common way to cope with negative offline experiences and emotions, especially in individuals with increased levels of addictive tendencies. However, this dysfunctional strategy contributes to further offline conflicts, and thus closes the vicious circle (Elhai et al., 2019b; Liu et al., 2019). To break the vicious circle without external support is often impossible (Wang et al., 2019). Our present study that requested abstinence from or reduction of daily smartphone use time controlled by compliance diaries provided the required external support to break the vicious circle. The experimental manipulation contributed to the decrease of smartphone use intensity and of problematic tendencies. The restricted online time enabled participants to consider functional coping strategies such as a direct facing of daily challenges, and provided time to consciously enjoy offline social interactions without a permanent disruption by smartphone use. This could foster the well-being of participants in both experimental groups. A comparison between the experimental groups revealed that some effects were stronger in the abstinence group, but the long-term positive changes of well-being (especially 4 months after the intervention) were more stable in the reduction group (see Research Questions 1 and 2).

The experimental manipulations contributed to significant changes in (un)healthy lifestyle. In line with research on social media (Brailovskaja, Ströse, et al., 2020), in both experimental groups, physical activity increased (confirmation of Hypothesis 3a). Physical activity is an important protective factor of physical health and subjective well-being (Eime et al., 2013). It fosters resilience and reduces suicide-related outcomes (Vancampfort et al., 2018). At least 150 min moderate physical activity throughout a week contributes to significant positive effects (World Health Organization, 2020). Smartphone use is negatively linked to physical activity and fitness. Furthermore, it is positively associated with obesity, muscle fatigue, and pain (Kenney & Gortmaker, 2017; Kim & Koo, 2016; Lepp et al., 2013). We did not advice our participants to engage in physical activity. But the conscious dealing with one’s own smartphone activity and well-being by answering the surveys and the experimental manipulation of smartphone use time seem to foster the individual to strive for a healthier lifestyle. In addition, physical activity can provide positive emotions through the achievement of self-determined goals and social support when engaging in individual activities with a friend (e.g., jogging) or in team activities (e.g., football) (Vancampfort et al., 2018). Such positive experiences can replace the positive effects of smartphone use (Brailovskaja, Ströse, et al., 2020). This could explain why participants in the experimental groups used the newly available time to engage in physical activity.

In the reduction group, we found a significant reduction of smoking behavior (partly confirmation of Hypothesis 3b). Prior to our investigation, participants consumed on average five to six tobacco products daily; 4 months after the intervention, the consume was reduced to an average of three to four products. This result provides further evidence for the assumption of striving for a healthier lifestyle by our participants. The striving could be evoked by the conscious consideration of one’s own smartphone use and the support to break the vicious circle. Moreover, the results underline the close interplay between the different factors of health-related behavior and well-being. Interventions that focus on one of the factors can significantly influence the other factors. In our study, the reduction of smartphone use time, improved well-being, enhanced physical activity, and reduced smoking behavior. This finding is of great importance considering the negative consequences of smoking behavior for the individual and for the community caused by the substantial costs of morbidity and mortality. Also, specific anti-smoking companies are often cost-intensive (Ghenadenik et al., 2020; Leventhal et al., 2015).
It is noteworthy that long-term effects on well-being, time spent on smartphone use, and problematic smartphone use were more stable in the reduction group than in the abstinence group. Furthermore, only in the reduction group, the increase of physical activity remained stable 1 and 4 months after postintervention measurement. In the abstinence group, the increase was only significant between baseline and postintervention measurement. Moreover, there were no changes of smoking behavior in the abstinence group, whereas there was a long-term decrease of smoking behavior in the reduction group. Thus, it seems that abstinance from smartphone use is an effective method to improve well-being and lifestyle. But a moderate reduction of use time has a similar or even more stable long-term effect. Following considerations contribute to the explanation of this phenomenon.

In addition to its social function, the smartphone combines many functions of other devices such as an alarm clock, navigator, organizer, electronic book reader, music, and video player. A complete “smartphone detox” seems to be effective after an initial craving phase (Eide et al., 2018; Zinn & Rademacher, 2019). But strictly maintaining abstinance over several weeks or months can be too demanding, especially for people who use the smartphone as a substitute for other devices in everyday life. Furthermore, face-to-face interaction is not always possible, and a complete deprivation of online social interaction over a longer period of time can negatively impact people’s social and/or working life (Brailovskaia, Ströse, et al., 2020). Moreover, it is well-known that very restrictive diets contribute to a quick weight loss, but often are followed by an yo-yo effect and weight gain in the longer term (Amigo & Fernández, 2007). Considering the current lack of evidence on the effects of abstinance from smartphone use for time periods longer than 4 months, we cannot exclude similar consequences with respect to smartphone deprivation.

The controlled reduction of time spent on smartphone use is less invasive and easier to maintain than a complete abstinance. It evokes less resistance and can contribute to a better understanding of the sense of the intervention. Notably, the present compliance rate was slightly higher in the reduction group than in the abstinance group. Also, the reduction group had the lowest dropout rate. The limitation of daily smartphone time can foster a more conscious and efficient handling of this technical device, and reduce the “just to beat boredom” use. Time spent on smartphone use may become more appreciated. Furthermore, the limitation provides smartphone-free time for offline activities, their conscious perception, and enjoyment.

Against this background, it can be assumed that we got closer to a “sweet spot” of smartphone use by reducing the time spent on smartphone. A “sweet spot” is a state when “a combination of factors comes together to produce the best results with greatest efficiency” (Killion & Kennedy, 2012, p. 10). Excessive smartphone use negatively impacts well-being (Lapierre et al., 2019). A complete nonsense over a longer time period is rather unrealistic and can overwhelm users (Brailovskaia, Ströse, et al., 2020). In contrast, as shown by our results, the average moderate reduction contributes to better well-being and a healthier lifestyle for at least 4 months. This corresponds to previous research that described that the best way to reach a “sweet spot” is a moderate change of the present state to the novel direction, instead of too little or too much novelty (He & Luo, 2017). Reaching of the individual “sweet spot” would allow to gain the advantages of smartphone use without experiencing its negative effects.

All participants of the reduction group reduced their smartphone use time by 1 hr daily. Considering that the individual “sweet spot” of smartphone use time can depend on different variables (e.g., personality traits, well-being, life conditions), we surely were not able to reach the “sweet spot” for all participants. This goes beyond the aim of our present study. However, our findings show that we took a step into the right direction. On this background, we recommend future studies to explicitly investigate the “sweet spot” of smartphone use time for different population groups.

Furthermore, our findings emphasize the necessity to discuss the time spent on smartphone use and to determine how much of its reduction is most beneficial during treatments of depressive and anxiety symptoms within the therapeutic setting. Moreover, considering the positive effects of the reduction of smartphone use on lifestyle, its incorporation into specific intervention programs aiming to enhance physical activity or to reduce smoking behavior is recommended. In addition, it should be investigated whether the reduction of smartphone use can positively influence further unhealthy behavior, such as alcohol consumption and overeating.

If our results can be confirmed by future research, incorporating the aspect of time spent on smartphone use into health prevention and treatment programs may increase their effectiveness and reduce their costs. This is important considering that an increase of online media use is accompanied by a decrease in well-being, especially in adolescents and young adults in the last decade (Brailovskaia & Margraf, 2020; Twenge et al., 2018).

Limitations and Further Research

It is important to consider some limitations when interpreting our findings. First, the mostly young, female, and well-educated composition of the investigated samples limits the findings’ generalizability. Future studies should replicate the present results in more population representative groups. Second, future research is suggested to include between-measurement time points (e.g., Days 3 and 5), a longer intervention period (e.g., 2 weeks), and longer follow-up periods (e.g., 12 months, 18 months) than those in our study. Third, following previous experimental research on problematic social media use (Brailovskaia, Ströse, et al., 2020), we assessed problematic smartphone use with a modified version of the BSMAS (Andreassen et al., 2016). Despite the similarity between both forms of problematic behavior, future studies are recommended to replicate our results with other measures of problematic smartphone use such as the Smartphone Addiction Scale-Short Version (SAS-SV; Kwon et al., 2013) to establish their validity. Fourth, all data including smartphone use time and physical activity were assessed by self-report measures that are prone to social desirability, distortions of perception, and same-source bias (Conway & Lance, 2010; Musch et al., 2002). To tackle this limitation at least partly, participants were asked to provide the daily smartphone use time that was tracked by their smartphone when completing the surveys. However, we did not assess how many participants had a smartphone with this feature. Therefore, the present data should be interpreted with caution. Fifth, future studies are suggested to additionally assess the time spent on other technical devices (e.g., laptops, tablets) that enable the use of the online world to control for a potential replacement of the smartphone use during the experimental abstinance or reduction period. Sixth, data were assessed between April 2019 and November 2020. Thus, the data...
collection took partly place during the global outbreak of the coronavirus disease 2019 (COVID-19; World Health Organization, 2021). To fight the pandemic spread, people had to reduce offline social contacts (“social distancing”). As a consequence, online activity as well as problematic smartphone use increased (Elhai et al., 2021; Lemenager et al., 2021), whereas well-being decreased (Liu et al., 2020; Rajkumar, 2020). The conceptualization of the present study was completed previously to the pandemic outbreak and it was not changed during the data collection to enable data comparability. Therefore, we did not assess specific data on the impact of COVID-19 on smartphone use, well-being, or lifestyle. And we also did not assess the participants’ location or whether they were affected by COVID-19 due to health-related issues. Thus, we cannot clarify whether and how our findings were influenced by the COVID-19 outbreak. Nevertheless, it is important to mention that the positive effect of smartphone abstinence and reduced smartphone use time was significant despite the pandemic and its consequences for everyday life.

**Conclusion**

Smartphones can be very useful in everyday life, but their excessive use can negatively influence well-being and physical health (Elhai et al., 2019a). The experimental design of our study adds to the causal interpretation of available correlational findings. Our results indicate that abstinence from smartphone use could contribute to the protection of subjective well-being and to a healthier lifestyle. However, a moderate and controlled reduction of daily time spent on smartphone use could be even more effective and provide more stable effects over a longer period of time.

**References**

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