Understanding the Relationship between Smartphone Use, Flow, and Productivity

Bachelor Thesis

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Abstract

Smartphones are widely prevalent in today's society, they have not only changed the way we communicate with others, but also the way we work. While there are clear benefits to using a smartphone, being constantly online and available could affect the way we work and how productive we are. This study aimed to address the relationship between smartphone addiction risk, the ability to experience flow states, and productivity. Specifically, it was examined whether flow acts as a mediator between smartphone addiction risk and productivity. While this relationship has been suggested before, studies examining it are scarce. Participants (N = 134) were assessed using a cross-sectional self-report questionnaire about smartphone addiction risk, flow proneness and the degree to which their productivity is inhibited due to the smartphone. The results indicated that all three concepts were correlated, and that flow proneness partially mediated the relationship between smartphone addiction risk and productivity. Smartphone addiction risk was associated negatively with flow proneness, which in turn had a positive effect on productivity. These results suggest that being able to experience flow might help to be less affected by the smartphone in one's productivity. At the same time, smartphones seem to threat the proneness to experience such states of flow. Implications and other important factors contributing to this relationship are discussed and suggestions for future research are provided.

Understanding the Relationship between Smartphone Use, Flow and Productivity

Smartphones are found in almost every aspect of most people's lives, they are operated on the go, on the bus and at the dinner table, but often also while working. Indeed, since their introduction about a decade ago, smartphones are widely prevalent in today's society. In Germany, for example, 81% of the population is using a smartphone to access the internet (Statistisches Bundesamt, 2016). Having a small device in your pocket to communicate with others and to access almost every piece of information and entertainment available makes smartphones particularly attractive to use. Generally, smartphones are used for process usage or social usage. The former refers to the gratification the user receives by consuming media content, while the latter refers to the gratification received from maintaining social relationships over the smartphone (van Deursen, Bolle, Hegner, & Kommers, 2015). Although the use of smartphones certainly makes our lives easier, there are also increasing concerns about them. One domain of concern is privacy, particularly the commercial use of user data by applying so-called data mining methods (Cheng & Wang, 2018). Another domain of concern, however, is the increased use of the smartphone and its potential to over-use.

Smartphone Addiction

Large parts of smartphone use behaviour can be described as a 'checking habit' (Oulasvirta, Rattenbury, Ma, & Raita, 2012). Thus, using the smartphone can become habitual. Oulasvirta et al. (2012) found that this checking habit leads to a shorter duration of use per session compared to traditional computers, while it might lead to increased overall usage time. Research indicates that smartphones can lead to addiction and interfere with everyday life (Duke & Montag, 2017b; Roberts, Yaya, & Manolis, 2014). According to Kwon, Kim, Cho, and Yang (2013) smartphone addiction can be considered a serious behavioural addiction. How smartphone addiction should be classified and whether it is a distinct diagnosis or part of a broader internet addiction remains a subject of discussion (see Duke & Montag, 2017a; Lin, Lin, Yang, & Kuo, 2017 for a discussion). Nonetheless, a range of addiction-related symptoms were described in the context of smartphones, such as a failure to control smartphone usage (Kwon, Lee, et al., 2013), withdrawal symptoms and a preoccupancy with the smartphone (Duke & Montag, 2017a). Moreover, poor quality of sleep (Lanaj, Johnson, & Barnes, 2014) and pain in neck and wrist (İNal, Demİrcİ, ÇetİntürkAkgönül, & Savaş, 2015) were found to be associated with smartphone use. Tools to examine smartphone addiction, such as the Smartphone Addiction Scale Short Version (Kwon, Kim, et al., 2013) are not intended for

purpose of pathological diagnosis but more to indicate tendencies toward addiction and to identify high-risk groups.

While discussing over-use or addiction, however, one has to be careful not to pathologize everyday smartphone use (Duke & Montag, 2017a). Montag and Walla (2016) argue that overuse begins when one's smartphone is distracting on a permanent minute-to-minute basis. Hence, it is crucial to investigate how this constant distraction of the smartphone affects an individual. Specifically, this paper aims to examine the interrelatedness between smartphone addiction risk, productivity, and flow among young adults between 18 and 30 years of age, as this age group used smartphones as a primary communication device for most of their lifetime. Moreover, there are indications that this younger generation is more inclined to be constantly online using the smartphone, and to see it as necessarily integrated into daily life (Anshari et al., 2016; Zhitomirsky-Geffet & Blau, 2016).

Smartphones and Productivity

Several studies have investigated the effects of smartphones on productivity. For example, frequent interruptions by the smartphone were found to increase attentional deficits and hyperactivity, resulting in a decrease in self-reported productivity, as shown in a sample of 221 undergraduate University students (Kushlev, Proulx, & Dunn, 2016). Duke and Montag (2017b) report a similar association between smartphone addiction tendencies and lowered self-reported productivity. An increased risk of smartphone addiction can also increase perceived stress and negatively influence academic performance (Samaha & Hawi, 2016). Students using their smartphone while reading a text, for instance, needed significantly more time to do so compared to the control group not using the phone (Bowman, Levine, Waite, & Gendron, 2010).

Generally, technology has the potential to increase our productivity (Montag & Walla, 2016), for instance, one can use the smartphone for navigation or easily find important information on the smartphone. If, however, it is overused it can have the opposite effect. Montag and Walla (2016) hypothesize this relationship as a reverted 'U-shape'. To a certain extent, the smartphone supports us in being more productive, but at one point it stops being supportive and instead decreases our productivity and distracts us. This might be the case for individuals who display increased smartphone addiction tendencies. However, Montag and Walla (2016) emphasize that more research is needed to support this finding. It remains unclear whether there is a specific amount of usage time at which productivity decreases; it might be

that constant interruptions have a greater negative effect than overall usage time (Montag & Walla, 2016).

Moreover, the sole presence of the smartphone has been shown to have detrimental effects on task performance. Thornton, Faires, Robbins, and Rollins (2014) demonstrated that the mere presence of the smartphone, while one is working on a difficult task, can lead to a decrease in task performance. This effect was, however, not apparent on simple tasks. It might be that the presence of the smartphone evokes thoughts unrelated to the task at hand so that the mind wanders and therefore interferes with task performance (Thornton et al., 2014). A study by Ward, Duke, Gneezy, and Bos (2017) further emphasised the pertinence of the smartphone's mere presence. In a set of experiments, they found that participant's cognitive capacity was affected by the presence of the smartphone, as shown by less capacity of working memory and functional fluid intelligence. This effect was stronger (also in terms of benefits of the absence of the mobile device) for people who had an increased smartphone dependency (Ward et al., 2017). Yet, using the smartphone while taking a break from a cognitively demanding task was also shown to result in cognitive depletion similar to not taking a break at all. It appears that we interact differently with different types of screens; cell phones seem to make returning to focused attention more difficult than computers (Kang & Kurtzberg, 2019).

Flow States

While smartphones were found to decrease cognitive capacities and undermine task performance, they could do so to an extent which hinders experiences of flow. Flow "describes a particular kind of experience that is so engrossing and enjoyable that it becomes autotelic, that is, worth doing for its own sake even though it may have no consequence outside itself" (Csikszentmihalyi, 1999, p. 824). Being in a state of flow, a person's action and a person's awareness merge. One is consciously acting but at the same time, one is not aware of one's awareness (Csikszentmihalyi, 2014). In other words: One is not preoccupied with one's thoughts, but instead purely absorbed by the task at hand; not thinking about past or future but only the present action itself. The tendency to experience these states of flow frequently can be referred to as flow proneness.

Flow experiences are also linked to productivity, Duke and Montag (2017b) argue that one can be very productive during flow states. Furthermore, concentration and creativity, among other factors, were found to be increased during flow states compared to non-flow states (Csikszentmihalyi & LeFevre, 1989). Csikszentmihalyi and LeFevre (1989) suggest that

working might be more enjoyable in a state of flow and therewith, one might work more effectively. Moreover, Ara et al. (2009, p. 1) argue that finding means for people to achieve more flow states "could be a lever of more productive work". Still, flow does not only enhance productivity. People who experience feelings of flow often also report more positive feelings and experience more purpose and meaning in their lives (Csikszentmihalyi, 1999).

In order to enter a state of flow, the situation has to be specific as to its outcome, there need to be opportunities for action or a specific goal and the means for action need to lie within the person's abilities or skills. If so, then one enjoys the moment and achieves increased capabilities for learning (Csikszentmihalyi & Csikszentmihalyi, 1992). Importantly, however, one needs some time of unbroken attention to be fully focused and absorbed by the task at hand (Montag & Walla, 2016). Csikszentmihalyi (2014, p. 139) emphasizes that "to insure that people will concentrate on their actions, potentially intruding stimuli must be kept out of attention."

Smartphone Notifications and Self-Interruptions

Unbroken attention is a focal point when it comes to smartphones and flow. In a sequence task experiment, Altmann, Trafton, and Hambrick (2014) showed that interruptions as short as 2.8 seconds lead to increased error rates and thus, can derail our train of thoughts. Smartphone use can act as an interruption and thus might interrupt the state of flow. Furthermore, it is noteworthy that one does not immediately return to focused attention after being disrupted. It took participants in a computing exercise on average 10 to 15 minutes until they continued to work on their task in focused activity after being disrupted (Iqbal & Horvitz, 2007). Thus, even short interruptions can cause a considerate delay in concentration until full attention is restored. Smartphones might be a factor which undermines attention during flow, as a study by Lee, Cho, Kim, and Noh (2015) found that increased smartphone addiction levels lead to decreased levels of self-regulated learning and learning flow.

One way in which the smartphone might interrupt states of flow is via notifications. Notifications can be of auditory or haptic (vibration) nature and are used to inform the user about incoming messages, calls, emails etc. (Chang, Chung, Shih, Chang, & Lin, 2017). The study by Chang et al. (2017) found that 68% of users who get notifications on their smartphone while not actively using the phone did immediately attend to the notification. Moreover, there is evidence that smartphone notifications are greater interruptions compared to interruptions which take place face-to-face (Glushakow, as cited in Smith & Dulay, 2014). Thereby the

smartphone has the potential to disrupt users in their state of flow and may therefore negatively reduce the users' productivity (Duke & Montag, 2017b).

Nonetheless, receiving notifications is not a necessity for the smartphone to be interruptive. The habit-forming nature of smartphones can be another source of distraction in the context of flow, as the average person operates the smartphone 88 times per day, which means the phone is unlocked approximately every 18 minutes (Markowetz, 2015). Habits, together with the symptoms of addiction such as withdrawal symptoms, as described previously, can lead users to distract themselves by using the smartphone whilst working on a task. In a study by Oulasvirta et al. (2012), users who accessed a specific piece of information on the smartphone, were also likely to use this as a gateway to seek more information or entertainment on their smartphone, beyond their original goal. Similarly, Kushlev et al. (2016) argue that while turning off audio or haptic notifications can help some people to have fewer distractions, others might display increased self-interruptions because they fear to miss important notifications. Hence, using the smartphone as self-interruption can lead to not entering, or disrupting the state of flow and therewith potentially reduce productivity.

It is important to note, however, that it is also possible to experience flow in activities which are not productive but instead have a destructive or addictive nature, or simply are a waste of time (Csikszentmihalyi, 1999). Therewith, one might also experience flow while using the smartphone (Duke & Montag, 2017b).

The Present Study

Taking this information into consideration, it is the positive influence that frequently being in a flow state has on one's meaning of life and positive emotions which makes the relationship between smartphone addiction tendencies, flow states, and productivity particularly important to study. Moreover, being more productive and less distracted might lead to increased efficiency, leaving the individual more time to pursue other interests. Studying the role that smartphone usage behaviour has on productivity and the frequency of flow states is therefore crucial. The following research question and sub-questions can be drawn from this:

1. To what extent is the relationship between smartphone addiction risk and inhibited productivity mediated by the frequency of self-reported flow states?

a. To what extent is smartphone addiction risk correlated to inhibited productivity?
b. To what extent are flow states correlated to inhibited productivity?
c. To what extent is smartphone addiction risk correlated to flow states?

Method

Design

A quantitative, cross-sectional design was employed, using a digital Questionnaire. This study was part of a larger study, including several topics related to smartphone use, only those topics relevant to this research are described here. Three variables were assessed, namely smartphone addiction risk, flow proneness and the dependent variable about the degree to which productivity is inhibited.

Participants

A total of 181 voluntary participants were gathered. Inclusion criteria were sufficient English language proficiency and the possession of a smartphone, as well as being between 18 and 30 years of age. Participants outside the targeted age range were excluded (n = 2). Removing partial data resulted in a total of N = 134 participants. The average age of the participants was 21.91 (SD = 2.25) years. 69% of the participants were female (n = 92) and 31% were males (n = 42). Participants from 12 nationalities were included in the sample, most participants were German (72 %), Dutch (14 %), and Turkish (4%). The sample consisted of students (n = 118), employees (n = 12) and others (n = 4).

Materials

An online questionnaire was created using the survey software Qualtrics. The questionnaire contained demographic questions, namely age, gender, nationality, and occupation.

In order to assess tendencies towards smartphone addiction, the Smartphone Addiction Scale Short Version (SAS-SV) was used (Kwon, Kim, et al., 2013) (Appendix A). The SAS-SV does indicate the risk level but does not diagnose addiction. This questionnaire uses a ten-item scale where each item is rated on a six-point Likert scale, covering a range from one (*strongly disagree*) to six (*strongly agree*). Several items of the scale were rephrased to a first-

person format to enhance understanding. For instance, the item “Feeling pain in the wrists or at the back of the neck while using a smartphone” was reworded into “I feel pain in the wrists or at the back of the neck while using a smartphone.” Additionally, the item “Constantly checking my smartphone so as not to miss conversations between other people on Twitter or Facebook” was changed to “I constantly check my smartphone so as not to miss conversations between other people on WhatsApp, Instagram or Facebook”, to incorporate more recent instant messaging and social media platforms. The SAS-SV’s internal consistency was verified by Kwon, Kim, et al. (2013) with a Cronbach’s alpha of .91, in this study, Cronbach’s alpha was .81. Moreover, the original SAS-SV demonstrated concurrent and content validity (Kwon, Kim, et al., 2013). The 10 items of the SAS-SV were feasible for factor analysis, as the Kaiser-Meyer-Olkin measure of sampling adequacy was .85 and Bartlett's test of sphericity was significant ($\chi 2$ (45) = 347.81, $p < .001$). Two initial Eigenvalues indicated to explain 39% and 12% of the variance, respectively. However, a single factor solution was chosen to fit one single score of smartphone addiction risk. Factor loadings for the single factor ranged from .39 to .78. The questionnaire has total scores ranging from a minimum of 10 to a maximum of 60, which indicates the highest risk towards smartphone addiction.

To assess self-reported productivity, two items of the Work Productivity and Activity Impairment – General Health (WPAI-GH) questionnaire (Reilly, Zbrozek, & Dukes, 1993) were adapted to smartphone-related productivity and a third question using the same response scale was added (Appendix B). The items use a response system on an 11-point Likert scale from 0 to 10, where 0 was labelled as *not at all* and 10 was labelled as *a great deal*. The items originally ask to what extent health-related problems affected the participant’s productivity at work, as well as in daily activities, such as housework. A score of zero indicates that productivity was not at all affected by health, while a score of ten indicates a complete inability to be productive. In the original questionnaire, both items use term *health*, which was exchanged for the word *smartphone* in this study. A third question about self-reported productivity was added, asking for the effect of the smartphone on productivity in leisure activities, for instance, meeting friends. Internal consistency for productivity was acceptable ($\alpha = .73$). As the Kaiser-Meyer-Olkin measure of sampling adequacy was .58 and Bartlett's test of sphericity was significant ($\chi 2$ (3) = 103.71, $p < .001$), factor analysis was applied. A single factor solution explained 65% of the variance and showed that all three items were correlated strongly to one single component, with factor loadings ranging from .73 to .90. The mean score of all three items was calculated into one score for productivity, the highest possible score

being 10 and the lowest score being zero, describing to what extent productivity was inhibited by the smartphone.

Lastly, the frequency of flow states was examined using the Swedish Flow Proneness Questionnaire (SFPQ) (Ullén et al., 2012), which is a self-report measure to examine how frequently participants experience flow in three different areas of life, namely work, maintenance and leisure. For this study, however, participants were asked to imagine themselves in their most prominent domain of life and respond to the questions considering the chosen domain. For example, one item states "how often does it happen that you have a sense of complete control?" The questionnaire contains 22 items, seven for each life domain. The seven items aim to resemble the seven main dimensions of flow. Hence, for this study, seven items were used (Appendix C). Each item follows a response scheme on a 5-point Likert scale, ranging from one (*never*) to five (*every day, or almost daily*). One item had to be reversed to indicate flow proneness. Factor Analysis proved the content validity of the questionnaire and internal consistency assessed by Cronbach's alpha was found to be high ($\alpha > .80$) (Ullén et al., 2012). In this study, Cronbach's alpha was .66. Factor analysis was feasible, indicated by a Kaiser-Meyer-Olkin score of .72 and a significant result of Bartlett's test of sphericity ($\chi 2$ (21) = 141.40, $p < .001$). Initial Eigenvalues showed two factors can account for 36% and 15% of variance, respectively. A one factor solution was favoured, as a single score of flow proneness was intended and to keep the integrity of the scale. The items correlated to the one factor with correlations between .41 and .71, with the exception of one item which had a factor loading of -.003. Lastly, the mean of all items was used to quantify one single score of flow proneness, with five being the highest, and one being the lowest possible score.

Procedure

The study was approved by the Ethics Committee of the Faculty of Behavioural, Management and Social Sciences of the University of Twente (request number 200335). Participants were recruited using convenience sampling (e.g. Etikan, 2016). As the questionnaire was distributed online, participants were able to enter the survey from any device with a working internet connection, either through the test subject pool website of the University of Twente, *Sona*, or they entered the survey via a direct, anonymous link to Qualtrics. The direct link was distributed by the researchers through instant messengers (e.g. WhatsApp) and social media (Facebook) among their network(s), aiming for participants in the targeted age range (below 30 years of age) and participants who are actively using a

smartphone. The 51 participants who entered the survey via *Sona* were compensated by gaining 0.25 virtual credit points, the remaining 130 participants were not compensated for their participation.

First, a brief description of the study was shown to the participants. Afterwards, anonymity and confidentiality were assured by informed consent, and the participants were asked to actively give their consent. If consent was denied, participants were not directed to the questionnaire. First, demographic questions were to be answered, followed by the specific items to measure smartphone addiction risk, productivity, and frequency of flow. Participants were also asked to fill out several other questionnaires for other research. After completion of the questionnaire, the participants were thanked for their participation and informed that their responses were collected.

Data Analysis

All analyses were done using IBM SPSS Statistics 26 for Windows-PC. First, descriptive statistics were calculated to illustrate participants demographic information. The data were tested for normality using a Shapiro-Wilk test. Gender differences in SAS-SV scores were examined using a Mann-Whitney-U test to see whether previous findings apply to the current sample. Due to the non-parametric distribution of the data, a series of Spearman's Rho correlations were run to answer sub-question a, b and c about the relationship between smartphone addiction risk, flow proneness and inhibited productivity. A correlation was considered weak (.10), moderate (.30) or strong (.50) (Cohen, 1988). Lastly, to answer the main research question about a mediation effect of flow proneness on the relationship between smartphone addiction risk and inhibited productivity, the SPSS add-on PROCESS (Hayes, 2013) was used, applying a 95% confidence interval using 5000 bootstrap samples. A mediation effect was present when the confidence interval of the indirect effect did not include zero.

Results

Descriptive Statistics

The average score for smartphone addiction risk was 29.94 (SD = 8.26). The respective means for females and males were 29.92 (SD = 7.92) and 29.97 (SD = 9.08), however, this difference was non-significant (U = 1929.00, z = -.01, p = .99). These average scores fall

beneath the suggested cut-off score of 31 for males and 33 for females for a high-risk of smartphone addiction (Kwon, Kim, et al., 2013). Nonetheless, split by gender, 19 males (45%) and 29 females (32%) exceeded the respective cut-off scores. The result indicates that the mean of smartphone addiction risk in this sample inclined towards a high-risk of smartphone addiction. The smartphone addiction scale was validated by Kwon, Kim, et al. (2013), who found the mean score for females was 27.89 and for males 23.75 in their sample of 540 South Korean high school students. In contrast, the average score in this study was two points higher for females and six points higher for males.

The mean score of flow proneness was 3.35 (*SD* = .47). This average score indicates a slight tendency toward flow proneness, as the maximum score obtainable is five. The score in this study was slightly lower than in the original sample used to validate the SFPQ (3.56) (Ullén et al., 2012). Still, the scores are comparable.

Lastly, the average score on inhibited productivity was 4.20 (*SD* = 2.08), which suggests that in this sample, the participants perceived to be inhibited in productivity by their smartphone by around 42% on average.

Correlations

All three variables were not distributed normally, as the Shapiro-Wilk test indicated a significant difference from normality of data for smartphone addiction risk, $W(134) = .98$, $p = .04$, flow proneness, $W(134) = .96$, $p < .001$, and inhibited productivity ,$W(134) = .96$, $p = .001$. Hence, Spearman's Rho correlations were feasible.

Sub-question 1a.

There was a strong positive correlation between smartphone addiction risk and the degree to which productivity is inhibited, $r_s(132) = .55$, $p < .001$. Accordingly, higher scores on smartphone addiction risk are associated with more inhibited productivity.

Sub-question 1b.

Flow proneness and the degree to which productivity is inhibited were found to correlate moderately negative, $r_s(132) = -.32$, $p < .001$. Thus, higher scores on flow proneness are related to less inhibited productivity.

Sub-question 1c.

Smartphone addiction risk and flow proneness showed a weak negative correlation, $r_s(132) = -.21$, $p = .01$. Hence, higher scores on smartphone addiction risk are associated with less flow proneness.

Mediation

The relationship between smartphone addiction risk and the degree to which productivity was inhibited was mediated by flow proneness. As can be seen in Table 1 and Figure 1, smartphone addiction risk was significantly associated with inhibited productivity both without controlling for flow (path c) and with controlling for flow (path c'), while the standardized coefficient was reduced by around 10% when flow was included. Still, the relationship remained significant, which indicates that there was no full mediation. Participants who had higher tendencies towards smartphone addiction also experienced slightly less flow (path a) and participants who were more prone to flow states experienced less inhibited productivity (path b).

The standardized indirect effect was (-.272)(-.176) = .048. The bootstrap confidence interval based on 5000 bootstrap samples showed the unstandardized indirect effect of smartphone addiction risk on inhibited productivity through flow proneness (*ab* = .012) was significant, as it was entirely above zero (.0019 to .0246). Thus, indicating a mediation effect.

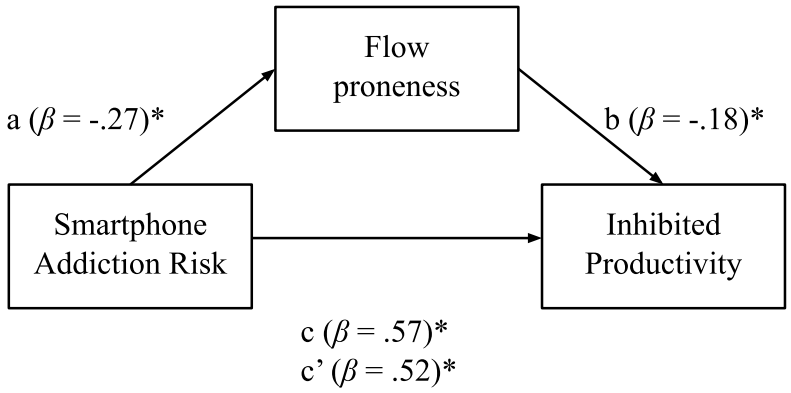

Figure 1. Mediation analysis with smartphone addiction risk as independent variable, flow proneness as the mediating variable and the degree to which productivity is inhibited as the dependent variable. a = path a; b = path b; c = path c, total effect of smartphone addiction risk on productivity; c' = direct effect of smartphone addiction risk on productivity, mediated by flow proneness; β = standardized regression coefficient.
* $p < .05$.

Table 1

Results of the different pathways in the simple mediation model.

	Coefficients					Model	
Path	*B*	*β*	*SE*	*t*	*p*	*F*	R^2
a	-.015	-.272	.005	-3.25	.001	(1, 132) 10.57*	.07
b	-.778	-.176	.324	-2.40	.017	(2, 131) 35.15*	.35
c (total effect)	.143	.566	.018	7.89	<.001	(1, 132) 62.26*	.32
c' (direct effect)	.130	.518	.019	7.07	<.001	(2, 131) 35.15*	.35

Note. Degrees of freedom for the corresponding *F*-value are in parentheses. *B* = unstandardized regression coefficient; *β* = standardized regression coefficient.

* $p < .05$.

Discussion

This study aimed to investigate the relationship between smartphone addiction risk, flow proneness and productivity and more specifically, whether the relationship between smartphone addiction risk and productivity was mediated by flow proneness. All three constructs were associated with each other, although the strengths of these correlations differed. The association between smartphone addiction risk and inhibited productivity turned out to be strong, while flow proneness and inhibited productivity were found to correlate moderately. Smartphone addiction risk and flow proneness were associated weakly. The results indicated that flow proneness mediated the relationship between smartphone addiction risk and inhibited productivity, however, this effect was rather small.

Main Findings

Smartphone addiction risk was strongly correlated to inhibited productivity in this study. Individuals with a higher smartphone addiction risk were found to be stronger inhibited in their productivity. The strong correlation in this study favours the results of Duke and Montag (2017b), who reported a moderate correlation between smartphone addiction tendencies and productivity. The association can be explained in light of prior research about the smartphone's effect on productivity (Kushlev et al., 2016) and cognitive capacities (Thornton et al., 2014; Ward et al., 2017), which is stronger in highly dependent individuals (Ward et al., 2017). Considering the proposed U-shaped relationship between smartphone use and productivity (Montag & Walla, 2016), the findings suggest that being at risk of smartphone

addiction might be beyond the inflection point, significantly decreasing productivity.

A further finding was that the degree to which a participant was prone to experience flow states was moderately correlated to inhibited productivity. Participants who were more prone to experience flow showed a lower tendency to be inhibited productivity. This result supports the finding that increased concentration was associated with flow states (Csikszentmihalyi & LeFevre, 1989), as well as the proposed direct link between flow and productivity (Duke & Montag, 2017b).

Nonetheless, the relationship was of moderate nature. Productivity is perhaps not only dependent on experiencing flow, but one can also be less disturbed in one's productivity by the smartphone due to other factors. For instance, simply having the phone in another area, physically separated, might help people to be less inhibited in productivity. Physically separating the phone was demonstrated to make more cognitive capacities available (Ward et al., 2017). While this, on the other hand, might make some individuals more nervous due to possible withdrawal symptoms or a fear of missing out (Kushlev et al., 2016).

As it is crucial to be uninterrupted to experience flow states (Csikszentmihalyi, 2014; Montag & Walla, 2016), a tendency towards smartphone addiction could be expected to hinder experiences of flow. This was the case in the current study; surprisingly, however, the effect was relatively small. Still, higher tendencies towards smartphone addiction were negatively associated with flow states, meaning that people who experienced a higher tendency towards smartphone addiction showed less proneness to experience flow. This finding is in line with a study which found that smartphone addiction levels were associated with lower levels of learning flow (Lee et al., 2015). Frequent habitual checking-behaviour and self-interruptions (Kushlev et al., 2016; Markowetz, 2015; Oulasvirta et al., 2012), as well as the immediate attending of notifications (Chang et al., 2017) offer plausible explanations for this finding.

Yet, the rather weak correlation raises questions. As no causal evidence can be derived from the current study, it might be due to the potential to experience flow during activities which are addictive (Csikszentmihalyi, 1999), that some individuals were, in fact, more prone to experience flow while using their smartphone. This might have decreased the overall strength of the association, as in the latter case, the relationship would be positive and not negative. Another possible explanation might be that participants in this study did, on average, not exceed the cut-off threshold for actual high-risk of smartphone addiction and therefore might use their smartphone a lot but not to an extent which strongly hinders experiences of flow. The results may be clearer when the sample actually falls stronger within the high-risk

category. Additionally, as discussed in the limitations below, the author tentatively suggests the measurement of flow proneness as a possible explanation for the weak association.

While smartphone addiction, flow proneness, and inhibited productivity were all associated in a bivariate nature, this study ought to illustrate all three concepts in a single framework. The results indicated that the relationship between smartphone addiction risk and inhibited productivity was partially mediated by flow proneness. This provides evidence for the line of argumentation made by Duke and Montag (2017b), who stated that smartphones might interrupt users in their state of flow and consequently reduce their productivity. In line with prior research (Lee et al., 2015), this study found smartphone addiction tendencies being related to less flow proneness, possibly due to habitual self-interruptions (Kushlev et al., 2016; Markowetz, 2015; Oulasvirta et al., 2012) as flow states require long periods of uninterruptedness. Moreover, less experience of flow was found to result in a higher loss of productivity. The mediating role of flow in this framework suggests that the habitual use of smartphones has the potential to undermine an individual's ability to experience flow and substantially affect productivity as a result. As productivity was assessed in terms of the extent to which the smartphone affects it, this finding indicates that flow might, to a certain extent, prevent the negative consequences that the smartphone has on self-reported productivity. Therefore, supporting Ara et al. (2009) in their proposal that helping people to experience more flow will result in more productive work. Flow states can, on the one hand, be promoted by less phone usage and one the other hand, they can enhance productivity. This underscores the crucial role that smartphone usage behaviour has. Being more conscious about the frequency one picks up the phone is important in order to avoid constant distractions and be able to achieve such states of flow to work more efficiently. As smartphones are widely prevalent in today's life, buffering its' negative effects, particularly in the work environment, is crucial. Thus, achieving an increase in flow states might be a possible tool against the threat of impaired productivity due to the phone. One should strive to achieve more of these flow states, as this can be very beneficial, not only for one's productivity but also because flow states can lead to more positive feelings in general (Csikszentmihalyi, 1999).

The indirect effect of flow was, however, rather small and might not be sufficient to be fully conclusive; flow did not fully explain this relationship. Hence, other factors also play a role in explaining why individuals who are increasingly addicted to their smartphone are less productive. In light of research which suggests a deficit in inhibitory control in excessive smartphone users (Chen, Liang, Mai, Zhong, & Qu, 2016), one possible factor might be self-

control. Individuals with higher addiction tendencies might be less in control of their smartphone usage and therefore experience a loss of productivity. Furthermore, Duke and Montag (2017b) found a mediating effect of the hours lost due to smartphone use on the relationship between smartphone addiction level and productivity, indicating that the actual time spent on the phone is an important element. Another possible factor could be the fear of missing out. Individuals who are addicted to their phone might particularly cherish the social functions of the smartphone and increasingly use it to prevent from missing out any important information. This assumption seems credible considering findings that fear of missing out was strongly associated with problematic smartphone use and particularly social use of the smartphone (Wolniewicz, Tiamiyu, Weeks, & Elhai, 2018). Thereby, these individuals might experience a significant decrease in productivity because they fear to miss out on something while working. Similarly, attention span and working memory capacity might also play a role, as smartphones, with all their distracting features, can lead to less available cognitive capacities (Ward et al., 2017) and might, in turn, lead to less productive working.

Nonetheless, considering the associations found in this study, no causal evidence was examined, and alternative explanations are also plausible. It might be possible that individuals who are not being productive start to use their phones more often, consequently leading to higher addiction tendencies. Similarly, it might also be that individuals who are generally working more productively are consequently able to experience states of flow more often. They might, for instance, display more self-control, as studies have found that differences in self-control can account for differences in managing distractions (Mark, Czerwinski, & Iqbal, 2018; Mark, Iqbal, & Czerwinski, 2017). High self-control might result in allowing fewer distractions, therewith enabling flow states more often.

Lastly, another noteworthy finding was the increased average result of the SAS-SV compared to the original study. At the same time, it likewise did not exceed the cut-off threshold for a high risk of smartphone addiction. This difference might be explained by a different cultural background as well as a different age group; while Kwon, Kim, et al. (2013) assessed junior high school students from South Korea, this study consisted of adults with a European background. High-school students might be regulated by parents in their smartphone use, which does not apply to adults. Moreover, smartphone addiction risk in South Korea perhaps differs compared to Europe.

Contrary to the original study (Kwon, Kim, et al., 2013), no significant gender

difference was found in this study, which might be due to the smaller sample size and a difference in gender distribution in the current sample.

Strengths and Limitations

A particular strength of this study was the sample, which consisted of adults between 18 and 30 years of age. This age group grew up using smartphones and most individuals this age have a very tight relationship to their phones. As the prevalence of smartphones will likely increase in the future, studying this age group can give insight into how the relationship between the smartphone, flow states and productivity is developing, also in future generations. As this generation grows older and is in its active working years, having ideas about their smartphone use and its diverse effects will become increasingly important for them and their employers.

A further strength is that this study might, to the best of the authors' knowledge, be one of the first to provide evidence for a relationship between smartphone addiction risk, flow and productivity. While this relationship has been suggested before (Duke & Montag, 2017a, 2017b), research so far focused on either the relationship between smartphone addiction level and learning flow (Lee et al., 2015), smartphone addiction and productivity (Duke & Montag, 2017b), or flow and productivity (Csikszentmihalyi & LeFevre, 1989), but did not examine all three in a single framework.

Still, some limitations apply to this study. One limitation to be mentioned are the psychometric properties of the Swedish Flow Proneness Questionnaire (SFPQ). The reliability was rather low (α = .66) and one item did not properly function with the one-factor solution. However, this item was not removed as the seven items of this questionnaire all add to the content validity of this scale. Each of the seven items is meant to measure a distinct dimension of flow and could therefore not be removed. A possible explanation for the low psychometric properties might be the difference in how this questionnaire was administered. The original SFPQ is intended to measure flow in three distinct dimensions of life. Hence, all seven items are used three times in three different contexts. In this study, in order to keep the overall questionnaire as user-friendly and short as possible, only one of these three dimensions was used, and each item was only used once, possibly leading to the difference in psychometric properties and reliability. This perhaps contributed to the rather weak correlation between SAS-SV results and flow, and the small mediation effect.

A further point that needs to be mentioned in terms of limitations applies to the general

quantifications of the three variables measured. All three concepts, smartphone addiction risk, flow proneness and productivity are rather complex phenomena, which might be difficult to capture in their true extent using self-report questionnaires. Using self-report measures can be problematic in terms of reliability, as individuals often do not recall past events correctly or experience distorted or biased perceptions (see Montag, Duke, & Markowetz, 2016). Moreover, using a single score for smartphone addiction risk does indicate usage tendencies but does not offer insight into more specific factors, such as how the smartphone is used while working, or quantification of the actual time spent on the phone.

Another limitation applies concerning the gender distribution of the current sample. The vast majority of participants was female (70%) and thus, male participants were underrepresented. Also, the cross-sectional design did not allow for any causal evidence, therefore, one has to keep in mind the correlational nature of the findings. Lastly, the current study was conducted during the acute COVID-19 pandemic in Europe. Social life in Germany and the Netherlands, where participants mostly came from, dramatically changed due to a lock-down. This different situation might have led participants to answer the survey questions differently than this would have been the case under other circumstances. For instance, most people had to work from home and reduce social contacts to a minimum. As a result, participants were potentially more drawn to use their phone, as it was the central tool to maintain social relationships. Moreover, when working in isolation one is not observed by others, potentially more inclined to use the phone more often. Therefore, SAS-SV scores were potentially inflated.

Future Research

While this study certainly introduces underlying tendencies between smartphone addiction risk, flow proneness, and productivity, future research should shed a more differentiated light when exploring these concepts more objectively. For instance, capturing the frequency of unlocking the smartphone and its' overall usage time might give conclusive evidence of which of these two actions have a greater negative impact on both flow and productivity. Similarly, productivity in this study was assessed by asking for the extent to which the smartphone affected productivity in three different areas of life. While this was sufficient for the scope of this study, other designs could be favourable. On the one hand, an observational study, giving participants a task while introducing different levels of distractions by the phone might be more conclusive. On the other hand, a longitudinal design, using several

points in time to collect data could provide more causal evidence.

Furthermore, future research could investigate specific personality features (such as self-control) when examining the effect of smartphone addiction risk on flow proneness and productivity, as this might yield interesting results which could help people to achieve more states of flow. In a similar vein, it might be interesting to further study the motivation and cause of using the smartphone while working on a task, as this can give more insight into how to prevent such behaviour from arising.

While this study captured the perhaps most impacted age range, it would be interesting to compare the results between different age cohorts. Specifically, comparing how the relationship between smartphone addiction risk, flow and productivity may differ compared to older individuals, where it would be expected that smartphones are less prevalent and perhaps less addictive, as has been suggested before (Zhitomirsky-Geffet & Blau, 2016). Also, it could be interesting whether the mediating effect of flow on the relationship between smartphone addiction tendencies and productivity is increased in a generation, where notifications by the smartphone are a rather recent experience.

Practical Implications

Smartphones are virtually used everywhere and while they are certainly a helpful tool, this does not apply to every situation. In a very fast-moving society, the relationship with the smartphone deserves our attention, as it is inconceivable that their prevalence will decrease anytime soon. This study gave some more insight into the effect the smartphone can have on one's flow proneness and productivity. It became clear that, while not all of these effects may be tremendously strong, our productivity and flow proneness are significantly related to smartphone addiction risk. Certainly, to get work done more efficiently, it can only be beneficial to enter flow states more often. However, to get there, one would be advised to be conscious about the relationship with the smartphone and to put the smartphone out of sight when trying to achieve an environment in which one can experience flow and be more productive.

Conclusion

The aim of this study was to illustrate the interrelatedness between tendencies towards smartphone addiction, flow proneness, and productivity. All three concepts were related to each other. A negative relationship between smartphone addiction risk and flow proneness was evident but rather weak, while flow and productivity were moderately associated. A strong

negative correlation was found between smartphone addiction risk and productivity. This relationship between smartphone addiction risk and productivity was, to a certain extent, mediated by flow proneness. Hence, one's smartphone use does not leave flow states and productivity unaffected. Being able to enter states of flow more often can lead to more productive working, while smartphone addiction tendencies not only negatively relate to productivity directly but also through the frequency of experiencing states of flow.

References

Altmann, E. M., Trafton, J. G., & Hambrick, D. Z. (2014). Momentary interruptions can derail the train of thought. *Journal of Experimental Psychology: General, 143*(1), 215-226. doi:10.1037/a0030986

Anshari, M., Alas, Y., Hardaker, G., Jaidin, J. H., Smith, M., & Ahad, A. D. (2016). Smartphone habit and behavior in Brunei: Personalization, gender, and generation gap. *Computers in Human Behavior, 64*, 719-727. doi:10.1016/j.chb.2016.07.063

Ara, K., Sato, N., Tsuji, S., Wakisaka, Y., Ohkubo, N., Horry, Y., . . . Hayakawa, M. (2009, 17-19 June 2009). *Predicting flow state in daily work through continuous sensing of motion rhythm.* Paper presented at the 2009 Sixth International Conference on Networked Sensing Systems (INSS).

Bowman, L. L., Levine, L. E., Waite, B. M., & Gendron, M. (2010). Can students really multitask? An experimental study of instant messaging while reading. *Computers & Education, 54*(4), 927-931. doi:10.1016/j.compedu.2009.09.024

Chang, Y.-J., Chung, Y.-J., Shih, Y.-H., Chang, H.-C., & Lin, T.-H. (2017). *What do smartphone users do when they sense phone notifications?* Paper presented at the Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2017 ACM International Symposium on Wearable Computers, Maui, Hawaii. doi:10.1145/3123024.3124557

Chen, J., Liang, Y., Mai, C., Zhong, X., & Qu, C. (2016). General Deficit in Inhibitory Control of Excessive Smartphone Users: Evidence from an Event-Related Potential Study. *Frontiers in Psychology, 7*(511). doi:10.3389/fpsyg.2016.00511

Cheng, F.-C., & Wang, Y. S. (2018). The do not track mechanism for digital footprint privacy protection in marketing applications. *Journal of Business Economics and Management, 19*(2), 253-267.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2 ed.). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Csikszentmihalyi, M. (1999). If we are so rich, why aren't we happy? *American Psychologist, 54*(10), 821-827. doi:10.1037/0003-066X.54.10.821

Csikszentmihalyi, M. (2014). Play and Intrinsic Rewards. In M. Csikszentmihalyi (Ed.), *Flow and the Foundations of Positive Psychology: The Collected Works of Mihaly Csikszentmihalyi* (pp. 135-153). Dordrecht: Springer Netherlands.

Csikszentmihalyi, M., & Csikszentmihalyi, I. S. (1992). *Optimal experience: Psychological studies of flow in consciousness*: Cambridge university press.

Csikszentmihalyi, M., & LeFevre, J. (1989). Optimal experience in work and leisure. *Journal of personality and social psychology, 56*(5), 815-822.

Duke, É., & Montag, C. (2017a). Smartphone Addiction and Beyond: Initial Insights on an Emerging Research Topic and Its Relationship to Internet Addiction. In C. Montag & M. Reuter (Eds.), *Internet Addiction: Neuroscientific Approaches and Therapeutical Implications Including Smartphone Addiction* (pp. 359-372). Cham: Springer International Publishing.

Duke, É., & Montag, C. (2017b). Smartphone addiction, daily interruptions and self-reported productivity. *Addictive Behaviors Reports, 6*, 90-95. doi:10.1016/j.abrep.2017.07.002

Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics, 5*, 1. doi:10.11648/j.ajtas.20160501.11

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY, US: Guilford Press.

İNal, E. E., Demİrcİ, k., ÇetİntürK, A., Akgönül, M., & Savaş, S. (2015). Effects of smartphone overuse on hand function, pinch strength, and the median nerve. *Muscle & Nerve, 52*(2), 183-188. doi:10.1002/mus.24695

Iqbal, S. T., & Horvitz, E. (2007). *Disruption and recovery of computing tasks: field study, analysis, and directions*. Paper presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, San Jose, California, USA. doi:10.1145/1240624.1240730

Kang, S., & Kurtzberg, T. R. (2019). Reach for your cell phone at your own risk: The cognitive costs of media choice for breaks. *Journal of behavioral addictions, 8*(3), 395-403. doi:10.1556/2006.8.2019.21

Kushlev, K., Proulx, J., & Dunn, E. W. (2016). *"Silence Your Phones": Smartphone Notifications Increase Inattention and Hyperactivity Symptoms*. Paper presented at the Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, San Jose, California, USA. doi:10.1145/2858036.2858359

Kwon, M., Kim, D.-J., Cho, H., & Yang, S. (2013). The smartphone addiction scale: development and validation of a short version for adolescents. *PLOS ONE, 8*(12), e83558-e83558. doi:10.1371/journal.pone.0083558

Kwon, M., Lee, J.-Y., Won, W.-Y., Park, J.-W., Min, J.-A., Hahn, C., . . . Kim, D.-J. (2013). Development and Validation of a Smartphone Addiction Scale (SAS). *PLOS ONE, 8*(2), e56936. doi:10.1371/journal.pone.0056936

Lanaj, K., Johnson, R. E., & Barnes, C. M. (2014). Beginning the workday yet already depleted? Consequences of late-night smartphone use and sleep. *Organizational Behavior and Human Decision Processes, 124*(1), 11-23. doi:10.1016/j.obhdp.2014.01.001

Lee, J., Cho, B., Kim, Y., & Noh, J. (2015, 2015//). *Smartphone Addiction in University Students and Its Implication for Learning.* Paper presented at the Emerging Issues in Smart Learning, Berlin, Heidelberg.

Lin, Y.-H., Lin, S.-H., Yang, C. C. H., & Kuo, T. B. J. (2017). Psychopathology of Everyday Life in the 21st Century: Smartphone Addiction. In C. Montag & M. Reuter (Eds.), *Internet Addiction: Neuroscientific Approaches and Therapeutical Implications Including Smartphone Addiction* (pp. 339-358). Cham: Springer International Publishing.

Mark, G., Czerwinski, M., & Iqbal, S. T. (2018). *Effects of Individual Differences in Blocking Workplace Distractions*. Paper presented at the Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, Montreal QC, Canada. doi:10.1145/3173574.3173666

Mark, G., Iqbal, S., & Czerwinski, M. (2017). *How blocking distractions affects workplace focus and productivity*. Paper presented at the Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2017 ACM International Symposium on Wearable Computers, Maui, Hawaii. doi:10.1145/3123024.3124558

Markowetz, A. (2015). *Digitaler Burnout: warum unsere permanente Smartphone-Nutzung gefährlich ist*. München: Droemer eBook.

Montag, C., Duke, É., & Markowetz, A. (2016). Toward Psychoinformatics: Computer Science Meets Psychology. *Computational and Mathematical Methods in Medicine, 2016*, 2983685. doi:10.1155/2016/2983685

Montag, C., & Walla, P. (2016). Carpe diem instead of losing your social mind: Beyond digital addiction and why we all suffer from digital overuse. *Cogent Psychology, 3*(1), 1157281. doi:10.1080/23311908.2016.1157281

Oulasvirta, A., Rattenbury, T., Ma, L., & Raita, E. (2012). Habits make smartphone use more pervasive. *Personal and Ubiquitous Computing, 16*(1), 105-114. doi:10.1007/s00779-011-0412-2

Reilly, M. C., Zbrozek, A. S., & Dukes, E. M. (1993). The Validity and Reproducibility of a Work Productivity and Activity Impairment Instrument. *PharmacoEconomics, 4*(5), 353-365. doi:10.2165/00019053-199304050-00006

Roberts, J. A., Yaya, L. H. P., & Manolis, C. (2014). The invisible addiction: cell-phone activities and addiction among male and female college students. *Journal of behavioral addictions, 3*(4), 254-265. doi:10.1556/JBA.3.2014.015

Samaha, M., & Hawi, N. S. (2016). Relationships among smartphone addiction, stress, academic performance, and satisfaction with life. *Computers in Human Behavior, 57*, 321-325. doi:10.1016/j.chb.2015.12.045

Smith, J., & Dulay, N. (2014, 24-28 March 2014). *RingLearn: Long-term mitigation of disruptive smartphone interruptions.* Paper presented at the 2014 IEEE International Conference on Pervasive Computing and Communication Workshops (PERCOM WORKSHOPS).

Statistisches Bundesamt. (2016). 81 % der Internetnutzer gehen per Handy oder Smartphone ins Internet [Press release]. Retrieved from https://www.destatis.de/DE/Presse/Pressemitteilungen/2016/12/PD16_430_63931.html

Thornton, B., Faires, A., Robbins, M., & Rollins, E. (2014). The Mere Presence of a Cell Phone May be Distracting: Implications for Attention and Task Performance. *Social Psychology, 45*, 479-488. doi:10.1027/1864-9335/a000216

Ullén, F., de Manzano, Ö., Almeida, R., Magnusson, P. K. E., Pedersen, N. L., Nakamura, J., . . . Madison, G. (2012). Proneness for psychological flow in everyday life: Associations with personality and intelligence. *Personality and Individual Differences, 52*(2), 167-172. doi:10.1016/j.paid.2011.10.003

van Deursen, A. J. A. M., Bolle, C. L., Hegner, S. M., & Kommers, P. A. M. (2015). Modeling habitual and addictive smartphone behavior: The role of smartphone usage types, emotional intelligence, social stress, self-regulation, age, and gender. *Computers in Human Behavior, 45*, 411-420. doi:10.1016/j.chb.2014.12.039

Ward, A. F., Duke, K., Gneezy, A., & Bos, M. W. (2017). Brain Drain: The Mere Presence of One's Own Smartphone Reduces Available Cognitive Capacity. *Journal of the Association for Consumer Research, 2*(2), 140-154. doi:10.1086/691462

Wolniewicz, C. A., Tiamiyu, M. F., Weeks, J. W., & Elhai, J. D. (2018). Problematic smartphone use and relations with negative affect, fear of missing out, and fear of negative and positive evaluation. *Psychiatry Research, 262*, 618-623. doi:10.1016/j.psychres.2017.09.058

Zhitomirsky-Geffet, M., & Blau, M. (2016). Cross-generational analysis of predictive factors of addictive behavior in smartphone usage. *Computers in Human Behavior, 64*, 682-693. doi:10.1016/j.chb.2016.07.061

Appendix A

Smartphone Addiction Scale Short Version

Questionnaire Items

Please indicate to what extent you agree with the following ten statements concerning your smartphone use.

I miss planned work due to smartphone use.

- ○ Strongly Disagree
- ○ Disagree
- ○ Weakly Disagree
- ○ Weakly Agree
- ○ Agree
- ○ Strongly Agree

I have a hard time concentrating in class, while doing assignments, or while working due to smartphone use.

- Strongly Disagree
- Disagree
- Weakly Disagree
- Weakly Agree
- Agree
- Strongly Agree

I feel pain in the wrists or at the back of the neck while using a smartphone.

- Strongly Disagree
- Disagree
- Weakly Disagree
- Weakly Agree
- Agree
- Strongly Agree

I won't be able to stand not having a smartphone.

- ○ Strongly Disagree
- ○ Disagree
- ○ Weakly Disagree
- ○ Weakly Agree
- ○ Agree
- ○ Strongly Agree

I feel impatient and fretful when I am not holding my smartphone.

- ○ Strongly Disagree
- ○ Disagree
- ○ Weakly Disagree
- ○ Weakly Agree
- ○ Agree
- ○ Strongly Agree

I have my smartphone in my mind even when I am not using it.

- ○ Strongly Disagree
- ○ Disagree
- ○ Weakly Disagree
- ○ Weakly Agree
- ○ Agree
- ○ Strongly Agree

I will never give up using my smartphone even when my daily life is already greatly affected by it.

- ○ Strongly Disagree
- ○ Disagree
- ○ Weakly Disagree
- ○ Weakly Agree
- ○ Agree
- ○ Strongly Agree

I constantly check my smartphone so as not to miss conversations between other people on WhatsApp, Instagram or Facebook.

- ○ Strongly Disagree
- ○ Disagree
- ○ Weakly Disagree
- ○ Weakly Agree
- ○ Agree
- ○ Strongly Agree

I use my smartphone longer than I had intended.

- ○ Strongly Disagree
- ○ Disagree
- ○ Weakly Disagree
- ○ Weakly Agree
- ○ Agree
- ○ Strongly Agree

The people around me tell me that I use my smartphone too much.

- ○ Strongly Disagree
- ○ Disagree
- ○ Weakly Disagree
- ○ Weakly Agree
- ○ Agree
- ○ Strongly Agree

Appendix B

Productivity

Questionnaire Items

During the past 7 days how much did your smartphone use affect your productivity while you were studying and/or working?

- ○ 0 Not at all
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 A great deal

During the past 7 days how much did your smartphone use affect your ability to do regular daily activities, e.g. housework?

- ○ 0 Not at all
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 A great deal

During the past 7 days how much did your smartphone use affect your ability to engage in leisure activities, e.g. doing sports or meeting friends?

- ○ 0 Not at all
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 A great deal

Appendix C

Flow Proneness

Questionnaire Items

Please think of a domain of your life where you work most for (e.g. University, Job, ...). How often does it happen that ...

... you feel bored?

- Never
- Rarely
- Sometimes
- Often
- Everyday, or almost everyday

... it feels as if your ability to perform what you do completely matches how difficult it is?

- Never
- Rarely
- Sometimes
- Often
- Everyday, or almost everyday

…you have a clear picture of what you want to achieve, and what you need to do to get there?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Everyday, or almost everyday

…you are conscious of how well or poorly you perform what you are doing?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Everyday, or almost everyday

...you feel completely concentrated?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Everyday, or almost everyday

...you have a sense of complete control?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Everyday, or almost everyday

...what you do feels extremely enjoyable to do?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Everyday, or almost everyday
