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Exploring Problematic Smartphone Use and Cyberchondria – Measures, Relationship, and Correlates

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Preface

This thesis, "Problematic Smartphone Use – Measures and Correlates" represents a novel contribution to the field, comprising four empirical cross-sectional studies conducted over three years, starting from the autumn of 2020. The topic of problematic smartphone use (PSU), the internet, and technology in general has been around for more than two decades. However, it has only relatively recently become a trending topic, finding itself at the heart of the debate around behavioral addictions and pathologizing now overly spread use of smartphones and the internet.

This topic differed from my previous research interest – measures of narcissism and its contemporary conceptualizations. However, I was lucky to have my master's degree in general psychology, giving me an excellent methodological background and the opportunity to delve into a new area of research, whichever caught my curiosity. I was unaware of how excessive smartphone use is widespread or how people are tied to their devices, old and young, until my one-year stay in China after finishing my master's thesis. It seemed odd at first, but soon, I found myself using my phone more than ever, and the habit continued even when I returned to Europe. I became interested in this topic, but I was not aware of how complex it is, well after starting my PhD. New papers were published daily worldwide, but only a few were from my country, Serbia. After doing the initial research using the SABAS instrument, I realized it should be adapted to the Serbian language since I could not find any tools to research the Serbian population. Although the question of whether a PSU or smartphone addiction (SA) could be considered an addiction was not the main topic of these studies, it was impossible to avoid discussing it throughout the thesis due to the ongoing debate.

Besides PSU, another technology-related problematic behavior that is the focus of this thesis is *cyberchondria* – a compulsive online health information search that leads to negative psychological consequences. Incorporating cyberchondria into my topic emerged since few publications investigated the relationship between problematic smartphone use and cyberchondria. I started researching the topic of smartphone addiction around the time the coronavirus pandemic started. When preparing for my first research, I still could not have imagined the impact of the pandemic on well-being and the increase of technology-related problematic behaviors. Cyberchondria became the focus of researchers, and the articles connecting the cyberchondria-characteristic behavior during the pandemic started coming out. I got interested in this phenomenon, having experienced it myself, but it seemed, but only at first glance, off my topic (smartphone addiction). We use smartphones to access the internet; they are often more convenient than desktop or laptop computers, at least for simple browsing. I found only a few publications studying the connection between smartphone use and cyberchondria. Although the relationship between excessive use of smartphones and cyberchondria seems obvious, the nature of this relationship still needs to be investigated due to the close relatedness of the internet and smartphone use.

Outline

The studies in this dissertation are not presented in the chronological order in which they were conducted but in a more logical order, making it easier for a reader to follow. After the brief introduction of behavioral addictions, the PSU/SA was introduced and defined from a broad perspective, not explicitly declaring the construct as an addiction. Motives and use purposes for smartphone use are elaborated, along with the main personal and psychopathological correlates and some major models revolving around the phenomenon. In a separate chapter, cyberchondria was introduced as yet another technology- and internet-related problematic (and potentially addictive) behavior. Then, the four studies are presented in the same form they were published, followed by a general discussion and conclusion of the thesis.

The first introduced study is titled "Psychometric Properties of the Serbian Smartphone Application-Based Addiction Scale (SABAS) and Validation of the English Version Among Non-native English Speakers." After doing my first research (presented as second in the thesis), where we established the connection between perceived stress and hedonic use with smartphone addiction, using the English version of SABAS, we had concerns about the results since the majority of our sample was Serbian. However, the survey was administered in English and through social networks worldwide. We needed to adapt the SABAS to the Serbian language since the Serbian population appeared most reachable for me and my research team. Importantly, we also wanted to establish the test-retest reliability of the newly adapted instrument. That comprised the Part 1 of the Study 1. At the same time, in the second part of Study 1, we wanted to use the subset of the data from Study 1 (only participants from Serbia) and more thoroughly examine the psychometric properties of the English SABAS used by non-native speakers, thus validating the results from Study 1 in some sense.

The second study demonstrated in the thesis was titled "Hedonic Use, Stress, and Life Satisfaction as Predictors of Smartphone Addiction." It was the first research we conducted to shed light on different motives/purposes of use and their connection with the problematic use of smartphones. We were curious whether the purpose could be easily measured, and we hypothesized that the use of smartphones to fulfill a certain task or for a job/school would not be as strongly related as the use for pure entertainment, pastime, or out of boredom. We named the former "utilitarian" and the latter "hedonic" use. Although the results indicated that the operationalization of use motives could be straightforward (for example, measured with a single item), distinguishing different motives and their definition takes time and effort. We replicated previous findings of smartphone addiction being related to perceived stress and entertainment use, while the relationship with satisfaction with life remained as not as clear.

The third study, titled "Are Cyberchondria and Intolerance of Uncertainty Related to Smartphone Addiction?" is the culmination of our research, and it sheds light on a crucial relationship that exists between smartphone addiction and cyberchondria. We used two powerful tools – SABAS and SCS – to assess the Serbian population's smartphone addiction and measure cyberchondria's core aspects. We chose SCS over CSS-12 due to its clear unidimensionality and short length of only four items. We also included intolerance to uncertainty, a construct that is closely related to anxiety, stress, and, therefore, cyberchondria and smartphone addiction. Our primary objective was to demonstrate that there is a unique and significant connection between smartphone addiction and cyberchondria. We considered IU, depression, and anxiety symptoms, as well as smartphone usage frequency and motives (measured with slightly modified items from the second study) to establish this relationship. It was suggested that at least a moderate relationship exists between smartphone addiction and cyberchondria. Finally, we could utilize the tools we adapted, the SABAS, for assessing smartphone addiction in the Serbian population and the SCS for measuring cyberchondria. We also included intolerance to uncertainty (IU) – a construct that lies beneath anxiety, stress, and worrying, and therefore contributes to cyberchondria and smartphone addiction as well. The main goal was to show that there is indeed a unique association between smartphone addiction and cyberchondria, when the IU, depression, and anxiety symptoms, as well as smartphone use frequency and motives (measured with slightly modified items from the second study).

The fourth presented study is titled "Cyberchondria and Questionable Health Practices: The Mediation Role of Conspiracy Mentality." It was the second one in chronological order, and while the cyberchondria caught my attention, I soon realized that the problem of lacking Serbian-adapted instruments must be solved. That is how this emerged. The primary goal was to translate and validate one of the most used cyberchondria assessment tools – the CSS-12 and the less-known SCS, which is ultra-short and unidimensional. For our convenience, the SCS was initially written in Croatian and required only slight adaptation due to the close resemblance of Serbian and Croatian. The secondary goal of Study 3 is to investigate lesser-known mechanisms of the relation of cyberchondria, COVID-related pseudoscientific practices, the general use of CAM, and the mediating role of conspiracy mentality. My team and I felt the urge to contribute to the literature related to the pandemic.

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1 The Main Objective of This Thesis

The main objectives of this thesis can be summarized as 1) establishing the connection between hedonic smartphone use and smartphone addiction operationalized by the components model of addiction; 2) Translate, adapt, and validate the Smartphone Application-Based Addiction Scale (SABAS; Csibi et al., 2018) from English to Serbian, and confirm its unidimensional factors structure, where the six components of addiction, namely salience, tolerance, withdrawal, mood modification, conflict, and relapse make the core components of any (potentially addictive) behavior. Additionally, the applicability of the English version of the SABAS on non-native speakers was to be examined as well; 3) Translate, adapt, and validate two cyberchondria assessment tools – Cyberchondria Severity Scale (CSS-12; McElroy, 2019), and Short Cyberchondria Scale (SCS; Jokić-Begić et al., 2019), given the lack of any published and validated instruments for cyberchondria screening in Serbian language at the time. Moreover, the secondary goal is to examine the mechanism of cyberchondria affecting pseudoscientific practices (PSP) through conspiracy mentality in the Covid context and on the use of complementary-alternative medicine (CAM) in COVID-19 and general context; 4) Next, the goal was then to scrutinize the connection of cyberchondria and smartphone addiction (SA), taking into account critical psychopathological variables – such as depression and anxiety symptoms, as well as transdiagnostic construct named intolerance to uncertainty (IU); 5) Next, the goal was to interpret the results in the two seemingly opposing paradigms – one that sees SA (or problematic smartphone use) as a coping strategy and compensatory behavior, and not as an addiction per se, and other that sees SA as a (potential) behavioral addiction, but undoubtedly, both SA and cyberchondria are technology- and internet-related problematic behaviors. This final objective also tries to explain the connection between smartphone use and cyberchondria-related behaviors, discussing the possibility of cyberchondria resembling behavioral addictions, if not being an addiction itself.

Again, we note that we use the terms smartphone addiction (SA) and problematic smartphone use (PSU) interchangeably (Busch & McCarthy, 2021) to avoid any terminological confusion. Likewise, internet addiction (IA) and problematic internet use (PIU) denote the same phenomenon in our text. Additionally, we do give our opinions about the status of SA; however, we cannot make strong claims about whether SA or cyberchondria should be classified as addictions or not because that was not the principal aim of our studies, and this could not have been directly concluded from the results we got.

1.1 Connecting the Studies

1.1.1 Smartphone Addiction Research on the Serbian Population

Our research on PSU in the Serbian population is a novel contribution to the field. To our knowledge, few published studies concerning PSU from Serbian researchers who utilized objective smartphone use measures (Stanković et al., 2021). The Smartphone Addiction Scale – Short Version (SAS-SV; Kwon et al., 2013) was translated and adapted to Serbian, and its psychometric characteristics were examined. However, no confirmatory factor analysis was performed to validate its structure (Nikolic et al., 2022).

Nevertheless, the PSU studies have not gained real momentum among the Serbian research community. Certain online behaviors and internet addiction were examined on a smaller scale (e.g., Hinić, 2008, 2012). An article in Serbian language by Nikolić (2021) gives a global overview of the PSU/ SA topic. Still, it does not deal with this phenomenon in the context of the Serbian population (Nikolić, 2021).

Since my research team and I conducted the first study using the English version of the SABAS (Csibi et al., 2018), for the following study, we decided that this instrument should be properly translated, adapted, validated, and thus offered as a tool for quick screening for the problematic smartphone use in Serbian language, based on the components model of addiction. The translation and adaptation process involved a team of bilingual experts who followed a rigorous methodology, including back-translation and cultural adaptation, to ensure the tool's validity and reliability in the Serbian context. Additionally, the psychometric properties of the English SABAS were administered exclusively to Serbian-speaking participants (most participants in Study 2). They were examined to check how this version applies to non-native English speakers. We call for further validation of both instruments, SABAS (Vujić, Volarov, Latas, Griffiths, & Szabo, 2023) and SAS-SV (Nikolic et al., 2022), to facilitate the research of PSU among the Serbian-speaking population.

1.1.2 Cyberchondria Among Serbian Population

Similarly, by the time of the initiation of the study in 2021 (Vujić et al., 2022), we were unaware of published studies on cyberchondria among the Serbian population. We adapted the short form version of the Cyberchondria Severity Scale (CSS-12; McElroy et al., 2019) to Serbian language, as well as the Short Cyberchondria Scale (SCS; Jokić-Begić et al., 2019) from Croatian. The SCS has already been validated for the Croatian population. Due to the cultural and language similarities with the Serbian population, only slight wording changes were made, and no extensive validation steps were taken. Given the lack of other available tools in Serbian to assess cyberchondria, we utilized the SCS scale to examine the convergent validity of the CSS-12 scale, among other measures.

Furthermore, in the Study 4, the two primary goals were combined. First, to validate CSS-12 and to translate the SCS tools, and second, to further examine the mechanisms of how cyberchondria affected the use of complementary-alternative medicine (CAM) and pseudoscientific health practices (PSP). The study was conducted during the ongoing pandemic, and we felt the urge to contribute to further understanding of mechanisms related to cyberchondria, CAM, and PSP. As said, these results are best viewed in the context of the ongoing pandemic. We examined the mediating role of conspiracy mentality, which was previously shown to have relations to CAM or PSP.

1.1.3 Connecting Cyberchondria and Problematic Smartphone Use

As presented in the Introduction of Study 4 chapter, some researchers recently established the relationship between the PSU and cyberchondria. My research team and I propose that smartphone use can facilitate the behaviors characteristic of cyberchondria, given that they provide easy access to the internet at practically any place and time. Some studies showed that cyberchondria was positively related to internet use during the nighttime (Kanganolli & Praveen, 2020). Smartphones make it easy to access the internet while lying in bed, for example, before sleep. Furthermore, using smartphones in bed is a common behavior that can lead to other problems, such as sleep disturbance or procrastination (e.g., Tu et al., 2023). Due to its portability, we can also assume that a person might access the internet to search for health information online in situations where it would otherwise be impossible (such as using a desktop or even laptop computer), for instance, while commuting, being on the public transport or just out of the home. Therefore, it was also suggested that high-frequency smartphone use, and smartphone addiction were positively related to higher cyberchondria scores (Alwi et al., 2022; Köse & Murat, 2021; Yam et al., 2021). Again, we emphasize that the directionality remains unclear; that is, we still cannot know for sure whether the PSU (or frequent use of smartphones) cases cyberchondria, or vice-versa, or perhaps the association is circular, as it is probably a case with PSU and other psychopathologies (e.g., Elhai et al., 2017).

The first study was initiated in September 2020, primarily identifying the use purpose most associated with the risk of developing SA/PSU. This soon proved to be a difficult, if impossible task since there were numerous ways to classify motives or use purposes. Additionally, classifying specific smartphone applications (or application categories) into predetermined categories (such as entertainment or productivity) was even more difficult. It would uncover little about why an individual is, for example, playing a particular game, watching videos via smartphone, reading e-books, or scrolling through social networks or news. In other words, focusing on the motives behind any activities would make more sense in the SA/PSU research context.

However, as said at the beginning of the paragraph, categorizing motives also proved challenging, although several such categorizations were offered previously, as presented in this introduction. Thus, we decided to take a similar approach to van Deursen and colleagues (2015) or Horwood and Anglim (2019), using the simple dichotomous classification of what we call use purposes rather than motives. This approach is simple but not ideal either since the term *motive* might imply a more profound inner characteristic of a person than just *use purpose*. We also decided to use the term hedonic use instead of process or entertainment, as in van Deursen et al. (2015) or Horwood and Anglim (2019). This was not done to introduce new constructs or add to the terminological confusion. Still, we defined two purposes (entertainment and work/school) that differed somewhat from those in the previous studies.

Nonetheless, there needed to be a well-established terminology regarding the motives or purpose of smartphone use. Next, although a single person can use a smartphone (usually the case) for various purposes, we decided to apply the "forced-choice" approach in asking this question to a lower or greater extent. In other words, a person would undoubtedly use their smartphone for both entertainment and pastime, but also for paying bills, communication, job-related tasks, and similar, but due to already accumulated literature about PSU/SA, and the motives, use purpose, and specific smartphone applications being investigated as particularly associated with the problematic use. However, one of these two broad purposes would dominate in each individual. So, we asked the participants to assess their usage on a continuum – productive to hedonic use. In this study, other important variables were included, such as satisfaction with life, as a part of psychological well-being, and perceived stress. Smartphone addiction was defined in terms of the components model of addiction (Griffiths, 2005), while in interpretation, we have utilized the compensatory use theory (Kardefelt-Winther, 2014), among the others, which was not in collision with the components model in this context, since we clearly defined that by smartphone addiction we understand the problematic smartphone use. The association of perceived stress and the SA/PSU aligns with the compensatory internet use theory. One plausible explanation would be that stressed individuals use smartphones increasingly to alleviate distress. However, we note that increased dysfunctional smartphone use might also lead to increased stress. One final remark, although this can also be speculative, is that we have put *gathering information* as hedonic use since there is some evidence that "people are not addicted to their smartphones, they are addicted to the information, entertainment, and personal connections it delivers" (e.g., Emanuel et al., 2015, p. 12).

2 Behavioral Addictions

Addiction is a disease, with compulsive behavior and loss of control as its main characteristics, which endure despite the negative consequences it brings (Coombs, 2004). A broader definition, and according to more modern understanding, would perhaps be that addiction is a process that includes biological, psychological, and sociocultural factors (Hollen, 2009; Maté, 2009; Pontes, 2022). At its core, addiction "is any repeated behavior, substance-related or not, in which a person feels compelled to persist, regardless of its negative impact on his life and the lives of others" (Maté, 2009, p. 128). Different books give slightly different essential characteristics of behavioral addictions. Still, they can usually be summed up as compulsiveness of the behavior, lack of control, persistence despite obvious consequences, irritability or craving, uneasiness when the award is not readily available, and being preoccupied with the given activity (Ascher & Levounis, 2015; Maté, 2009). As we can see, no consensus exists that all criteria can equally apply to every "addictive" behavior. Many researchers find it problematic to utilize the criteria from substance addictions for non-substance-related disorders, following the example of gambling disorder and The Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association [APA], 2013; Flayelle et al., 2022).

Interestingly, the word addiction comes from the Latin addicere – to assign. It had a different meaning in English in the past, denoting a habitual activity and carrying a positive connotation. Conversely, for the Romans, the addictus was a person unable to return his debt and was assigned to his lender as a slave (Maté, 2009). In the verb form addico, a few meanings are to adjudge, to sentence, and to enslave (Mahoney, n.d.). This meaning is rather close to the concept of addiction, as most people understand it today.

Addictions have been traditionally related to substance intake, such as drugs, alcohol, and nicotine. In the APA dictionary from 2013, the term addiction is equated with the term substance dependence (VandenBos, 2013). However, other behaviors that do not include substance intake, have also been considered as potentially addictive. The first behavior that comes to mind is gambling, named gambling disorder, formerly known as pathological gambling. This renaming happened in shifting between The Diagnostic and Statistical Manual of Mental Disorders (DSM-4-TR; 4th ed., text rev. American Psychiatric Association [APA], 2000) to DSM-5 (APA, 2013), and the gambling disorder was moved from impulse control disorders not elsewhere classified (kleptomania, pyromania, intermittent explosive disorder) to the section of substance-related and addictive disorders, under the subsection of non-substance addiction disorders, where it is a single diagnosis for now (APA, 2013; Petry, 2016). So, perhaps surprisingly, behavioral addictions were officially introduced quite recently, in 2013, when the fifth version of DSM was published.

The similarities between gambling disorder and substance-related disorders include the same pattern of cravings, such as the need to increase the amount of money included in gambling over time or agitation and irritability accompanied by ceasing attempts (Barlow & Durand, 2013). Cruel consequences arising from uncontrollable and excessive gambling were a common motive in classical antiquity (Rosenberg & Feder, 2014). In the nineteenth century, exaggerated sexual desire was described as a possible condition by Benjamin Rush (Rosenberg & Feder, 2014). The common features between substance use disorders and behavioral addictions are indicated in comorbidity, genetics, response to treatment, phenomenology, and neurobiology (Maté, 2009; Petry, 2016).

In the literature, books, as well as journal articles, many different dysfunctional behaviors are regarded as "addictions" (Coombs, 2004; Grant et al., 2016; Rosenberg & Feder, 2014), but the reason such behaviors are not yet included in the DSM-5 is the lack of consensus or evidence regarding certain problematic behaviors that do not include substance use, apart from gambling, to be classified as behavioral addictions. These problematic behaviors involve activities such as sex, work, shopping, exercise, video gaming, and internet use, and more recently internet and smartphone use (Pontes, 2022; Rosenberg & Feder, 2014). In other words, the amount of evidence and peer-reviewed studies is still considered insufficient (Rosenberg & Feder, 2014). Moreover, the evidence coming from neuroscience supports a unified neurobiological theory of addictions that can include both substance-related addictions as well as non-substance-related activities (APA, 2013; Rosenberg & Feder, 2014). A similar view was proposed by Gabor Maté, where he understands that addictive behavior is a process that can be expressed as a drug dependency but also as any other activity, such as overeating, excessive gambling, problematic gaming, workaholism, and many more (Maté, 2009). Moreover, the term behavioral addiction is closely related to the terms process addictions (Coombs, 2004), non-substance addiction, and impulse control disorder (Grant et al., 2016).

However, it is important to note that despite that the constructs, here including the problematic smartphone use/smartphone addiction, are not recognized in the official classification, that does not mean that they lack clinical significance or that they are not indeed disorders (Petry, 2016). It also makes those behaviors, including PSU/SA, legitimate research subjects from an "addiction" perspective or any other.

A broader definition was needed that would include such non-substance addictions. Marlatt and colleagues (1988) defined addiction as a repetitive behavior pattern that increases the chance of adverse consequences (functional impairment) for a person, often subjectively experienced by the loss of control over behavior, that includes immediate gratification, and often with long-term adverse outcomes. Attempts to stop or control this behavior frequently result in relapse (Griffiths, 2005; Marlatt et al., 1988). The components model of addiction tries to encompass common features of behavioral and substance addictions (Griffiths, 2005).

Behavioral addictions are similar to substance use disorders due to the characteristic of the inability to resist an impulse (drive or temptation) to perform an act that is harmful to the person or others. Those behaviors are recurring, and this repetitive pattern eventually interferes with the person's functioning (Grant et al., 2010). A similar feature of behavioral addictions and substance use is the preceding thrill or tension before engaging in the behavior or the sense of gratification, pleasure, or relief when performing the action. However, over time, addictive behaviors (both substance and non-substance) can become driven less by positive reinforcement and more by negative reinforcement. In other words, the behavior can turn into a habit or compulsion that a person performs to alleviate negative feelings, which is similar to obsessive-compulsive disorders (Grant et al., 2010). Increased impulsivity and compulsivity can be understood as two independent features that are common in different disorders. It is believed that behavioral addiction lies between impulsivity and compulsivity. Namely, impulsivity has a vital role in the onset of addictive behavior, while compulsive behavior develops later as a result of a maladaptive learning process (Rosenberg & Feder, 2014).

The obsessive-compulsive disorder (OCD) spectrum conditions and behavioral addictions have certain characteristics in common, such as repetitive thoughts and actions. Nonetheless, some authors claim that behavioral addictions are more characterized by impulsiveness and reward-seeking behaviors, while the main feature of OCD is harm avoidance. On the other hand, the cortico-basal ganglia-thalamo-cortical loop has increased activity in OCD-related activities, while it decreased in the gambling context (Grant et al., 2016).

Although depression and anxiety symptoms and addictive behaviors frequently accompany each other, it is difficult to say whether behavioral addictions are just the result of depressive or anxious disorders or whether depressive and anxiety symptoms are secondary and are consequences of repeated addictive behavior. However, there are some indications that in some cases, even when depression or anxiety symptoms are gone, the addiction repertoire is continued, which suggests that addictive behaviors are relatively independent of depression and anxiety (Grant et al., 2016). Addictive behaviors and addictive processes have the purpose of yielding pleasure and serving as an escape from emotional or physical pain (Rosenberg & Feder, 2014). This is the point of view of Maté as well that a painful experience is the root of any addiction. He is cautious, however, not to equate the seriousness of the consequences of, say, heroin dependency and internet addiction or his own "classical music addiction" (although by his behavior description, it resembles a "shopping addiction" just explicitly related to classical music, or even hoarding), since the heroin or substance addictions are clearly life-threatening (Maté, 2009). He views addiction as an addictive process or a process addiction. He states that addiction is not related to an object nor an activity itself but "our relationship to whatever is the external focus of our attention or behavior" (Maté, 2009, p. 205).

I deliberately avoided providing any prevalence data for behavioral addictions in general and the specific types since such data might be considered unreliable due to the lack of clearly defined criteria and the consensus of the researchers about those criteria (Bishop, 2015; Petry, 2016). This brief introduction to behavioral addictions had the goal of presenting a current place of the conceptualization of behavioral addictions in psychology, psychiatry, and related disciplines. Much debate is still ongoing regarding behavioral addictions, especially regarding the specific behavior that aspires to be categorized as such.

To summarize, the shifting of gambling disorders (previously pathological gambling) from impulse control disorders to substance and non-substance-related addictive disorders paved the way for other non-substance-related behaviors to be classified alongside the gambling disorder. Of course, the gambling disorder, being subjected to decades of research, has often served as a "blueprint" for diagnostic criteria of other behaviors and their transition to behavioral addictions. Furthermore, internet gaming disorder is being actively under consideration for official inclusion in the DSM-5 (APA, 2013). A year after the publication of DSM-5, an article concluded that there indeed was not enough evidence to include sex (hypersexual disorder), shopping (compulsive buying), and stealing (kleptomania) as addictions (Piquet-Pessôa et al., 2014).

According to The International Statistical Classification of Diseases and Related Health Problems (ICD-11; World Health Organization, 2019), gambling disorder is put under disorders due to addictive behaviors, together with gaming disorder, where both can be predominantly online or predominantly offline (WHO, 2019). In the meantime, different books propose more or less the same behaviors to be reconceptualized from obsessive-compulsive and impulse control disorder groups to the new behavioral addictions group. For example, the often mentioned non-substance-related behaviors that could be considered as addictive behaviors are problematic sexual behavior (Ascher & Levounis, 2015; Coombs, 2004; Grant et al., 2016; Mack et al., 2016; Petry, 2016; Pontes, 2022; Rosenberg & Feder, 2014; Sussman, 2020), workaholism (Ascher & Levounis, 2015; Coombs, 2004; Pontes, 2022; Sussman, 2020), compulsive buying/shopping (Coombs, 2004; , Grant et al., 2016; Mack et al., 2016; Rosenberg & Feder, 2014; Petry, 2016; Pontes, 2022; Sussman, 2020), kleptomania (Grant et al., 2016; Mack et al., 2016), internet addiction (Grant et al., 2016; Mack et al., 2016; Montag & Reuter, 2017; Rosenberg & Feder, 2014; Petry, 2016; Pontes 2022), problematic (online) gaming (Petry, 2016; Rosenberg & Feder, 2014, Sussman, 2020), social network addiction (Pontes, 2022; Rosenberg & Feder, 2014), smartphone addiction (Montag & Reuter, 2017, Pontes, 2022), love addiction (Ascher & Levounis, 2015; Pontes, 2022; Rosenberg & Feder, 2014), exercise addiction (Petry, 2016; Pontes, 2022; Rosenberg & Feder, 2014), hair pulling and skin picking (Grant et al., 2016), tanning addiction (Ascher & Levounis, 2015; Petry, 2016; Sussman, 2020).

Finally, as Petry (2016) points out, just because many of the listed behaviors are still not officially included in the DSM-5 does not mean that they cannot represent conditions or psychiatric disorders. However, many considered the evidence for their inclusion to be still scarce, at least in 2016 (Petry, 2016).

3 Internet Addiction

Internet addiction (IA) has almost three decades of research history now. Therefore, more findings have accumulated over time compared to the SA. Although the IA or problematic internet use (PIU) is a construct distinct enough from SA and cyberchondria (Montag & Reuter, 2017; Starcevic et al., 2019), it is crucial for understanding the former two, since both SA and cyberchondria include internet use, or better to say activities performed on the internet (Griffiths & Szabo, 2014; Pontes et al., 2015). The second edition of the Internet addiction book edited by Montag and Reuter includes an additional chapter dedicated to smartphone addiction, showing that the topic was rapidly developing and recognized as a critical problematic behavior from the family of technology-related disorders (Montag & Reuter, 2017).

It was suggested that internet addiction could not be considered an "umbrella construct" that would incorporate specific problematic online behaviors since the most common problematic online behaviors they considered shown to be substantially distinct from one another and, therefore, should be treated as such – specific online activities, as stated in spectrum hypothesis of problematic online behaviors[*] (Baggio et al., 2022; Billieux & Fournier, 2023). This partly conflicts with the theory that assumes generalized problematic internet use or generalized internet addiction (Chen et al., 2020; Montag & Reuter, 2017; Yoshimura et al., 2022) since such a construct would not be plausible according to the former view. The two debates are yet to be resolved. The first one is that some authors still propose that SA is just a type of internet addiction (Pontes, 2022) and not a distinct disorder, and the second is whether it is meaningful to distinguish the generalized internet addiction – which would designate relatively purposeless online activities, for instance, casually surfing the web; and the specific internet addiction, which is related solely to a particular activity on the internet, such as gaming, gambling, social networking, and pornography consumption (Montag et al., 2015).

Similarity with problematic internet use led to the suggestion that problematic smartphone use should be classified as problematic internet use, predominately mobile (Montag et al., 2021). A smartphone without an internet connection is almost useless (Montag & Reuter, 2017). To what extent are the two constructs, IA and SA, related?

[*] For this thesis, it is essential to note that this hypothesis includes cyberchondria, among other problematic online behaviors (Baggio et al., 2022).

The shared variance between internet addiction and smartphone addiction scores was perhaps unexpectedly low, from 18% to 24% (Montag & Reuter, 2017). Nevertheless, this depends on the content validity and reliability of the instruments used to operationalize these phenomena. The idea of classifying the problematic internet use-related behaviors as predominantly mobile and predominantly non-mobile was also subject to criticism, where the critics raised concerns for "diagnostic inflation," which would bring more complications in the already muddled taxonomy of the behavioral addictions (Starcevic et al., 2021).

There are two types of individuals with PIU. First are those who suffer from different psychopathologies, including depression, anxiety, OCD, and substance abuse. The second is those with no prior diagnosis, and their internet addiction appears to be the first noticed condition. Still, it is challenging to say the antecedents and the consequences (Montag & Reuter, 2017). Perhaps a similar reasoning can be applied to smartphone addiction. As will be mentioned in the next chapter, IA and SA share some of the vulnerability factors in terms of personality traits, such as lower agreeableness, conscientiousness, self-directedness, higher neuroticism, social anxiety, need for physical contact and materialism (Montag & Reuter, 2017), and sleep disturbance (see Exelmans & Van Den Bulck, 2016; Pontes, 2022; Sohn et al., 2019). The fact that the same models or theories were first used to describe/explain the IA, applied later to smartphone addiction also says something about the closeness of the two constructs. The first one is obvious: the components model of addiction since it was generated to apply to all potentially addictive behaviors. However, the uses and gratification theory (Katz et al., 1973), compensatory internet theory (Kardefelt-Winther, 2014), cognitive behavioral model (see Pontes, 2022), and I-PACE model (Brand et al., 2019) have all been used as a framework for smartphone addiction as well.

There are now numerous studies on PIU and PSU. However, different perspectives are still needed, such as qualitative research and clinical data, especially the evidence that will show the clinically relevant harm of, say, smartphone addiction. The complex nature of the smartphone addiction phenomenon obliges us to continue to research these phenomena of the modern age. In all our publications presented here, we were not decisive about the PSU/SA (regardless of naming) or other online behaviors, such as cyberchondria being considered bona fide behavioral addictions. However, that does not mean they cannot be defined as such (Pontes et al., 2015). We hope that a large amount of accumulating knowledge about PSU and PIU will detect their place concerning officially recognized clinical disorders.

4 Problematic Smartphone Use

4.1 The Age of Smartphones

More than fifty years ago, the first cellphone was invented. However, it was not until the beginning of this century and the rise of the internet that the rapid development of mobile phones began. In the early 2000s, mobile phones were equipped with internet connectivity and cameras. Even before the introduction of smartphones, as we know them today, excessive usage of mobile phones was noticed among young people, especially in Asian countries such as Korea and Japan (Bianchi & Phillips, 2005; Igarashi et al., 2008; Leung, 2008). Texting, making phone calls, and playing games could be primary activities that one could spend an increased amount of time doing using the device. The Apple corporation introduced the iPhone in 2007, and the following year, the first Android-based device appeared on the market (Chantel, n.d.; Lanxon, 2023).

A smartphone appeared as a compact device, with a wide touchscreen, camera, full 2G internet, and WiFi. More importantly, it could obtain third-party applications for any purpose imaginable. People can interact more with their smartphone than the classic mobile phone, especially through personalization and custom applications. Features such as touchscreen operations, tactile feedback, and overall design stimulate user’s expressive nature (e.g., Kim et al., 2014). The greater spectrum of functionalities is another thing that makes smartphones distinctive from classic cell phones (Kim et al., 2014). Smartphones' physical and other characteristics can also affect the user’s attachment to the device, such as small size, portability, and overall accessibility and affordability (Elhai et al., 2019). Smartphones have an engaging user interface; the layout, colors, and shapes of application icons and such are designed to be appealing, and they encourage the increasing use of the device (e.g., Kim et al., 2014; Panova & Carbonell, 2018). There are now (in 2024) approximately more than 4.9 billion smartphone users worldwide (Turner, 2024). Smartphones are an integral part of modern life and are often seen as "extensions of a man" (Harkin & Kuss, 2021; Kuss, 2017, p. 142), which admittedly has a transhumanistic connotation. Perhaps even now, one could say that this device is a part of a person's body, or an extension, in the sense that a person is often not aware of using it, checking on it, or habitually taking it out of pocket. Perhaps we have not reached this stage yet, but as interestingly noted, a simple pair of glasses are an extension of ourselves as well; they are "part of our body". We wear them to enhance our vision, but most of the time we are not aware of having them in front of our eyes (Harkin & Kuss, 2021; Philosophy Tube, 2022). Despite all the benefits that technologies such as the internet and smartphones bring, there are undoubtedly adverse consequences of their exaggerated use.

4.2 Definition of the Problematic Smartphone Use

Beside problematic smartphone use, and smartphone addiction, various terms were used to describe the same or similar constructs, including words such as *abuse*, *excessive*, *dependent*, *compulsive*, *disordered use*, *compensatory use*, and *nomophobia* (Billieux et al., 2015a; De-Sola Gutiérrez et al., 2016; Elhai et al., 2017). The PSU and SA (the two most frequent terms) are often used synonymously. However, the "addiction" part in the context of problematic behaviors involving smartphones is in dispute (Busch McCarthy, 2021). Confusingly, many instruments contain the term "addiction" in their name. Still, they do not intend to serve as diagnostic tools, nor they assess the behavioral addiction related to smartphones, but they asses the SA in the sense of smartphone-related problematic behaviors or they try to screen for the "risk of developing smartphone addiction". I believe that PSU is a safer term to use, compared to SA at this point, since there is still no consensus among scientists about the true nature of this construct. Nevertheless, we also believe that it is justified to use the term smartphone addiction since it is well rooted in the literature, as long as it is clearly indicated that by this term, behavioral addiction is not (yet) implied.

In Busch & McCarthy's (2021) paper, the PSU was defined as repetitively experiencing a craving to use a smartphone, characterized by diminished control and deteriorating functioning in daily life. One could define PSU as an excessive and maladaptive use of smartphones that leads to adverse psychological, social, and/or physical harm and interferes with different spheres of an individual’s life. The key point in this definition is related to the negative consequences as a result of smartphone use, because it seems that people use smartphones "excessively" in everyday life for various reasons. Still, they do not experience any negative changes in their psychosocial and/or physical well-being (Kardefelt-Winther, 2017). Namely, smartphone use has become an integrated part of everyday life worldwide (Panova & Carbonell, 2018). Smartphones are relatively affordable and accessible, and their use has been normalized. Therefore, increased use of smartphones might not be considered a well-founded criterion for PSU/SA (Billieux et al., 2015a; Kardefelt-Winther et al., 2017; Panova & Carbonell, 2018).

4.3 Problematizing Smartphone Use

Problematic smartphone use (PSU) or smartphone addiction (SA) has received great attention from researchers recently. The phenomenon itself is still not recognized as a condition in either the International Classification of Diseases (WHO, 2019) or the DSM-5 (APA, 2013). In DSM-5, however, closely related to the PSU or SA, Internet gaming disorder (IGD) is listed among the potential mental disorders in DSM-5, which could be included in the classification in the future and is already included in ICD-11 (WHO, 2019). This would be another behavioral addiction officially added to the DSM, next to gambling disorder. This would also pave the road to officially recognizing other emerging problematic technology-related behaviors, such as social media addiction, fear of missing out, nomophobia, cyberchondria, and something that we could call – an internet addiction (Montag et al., 2021; Young, 1998).

4.4 The Recognized Problem of Dysregulated Use of Technology

Problematic smartphone use, measured with the most used instrument in the field – the Smartphone addiction scale, showed the highest rate of problematic behavior in China, Saudi Arabia, Malaysia, Iran, Canada, South Korea, Iran, and Turkey. In other words, higher problematic use seems to characterize more collectivistic cultures (Olson et al., 2022).

For example, in China, a closely related to the PSU, excessive gaming among youth that leads to psychosocial impairment has been a great public health problem, and the government has already imposed certain measures to decrease the consequences of this widespread phenomenon, although the effectiveness of these restrictions has been questioned (APA, 2013; Zendle et al., 2023). Similarly, in Japan, a phenomenon named *hikikomori* has been recognized as a serious issue and is also related to spending an excessively large amount of time using a computer (i.e., the internet) while significantly diminishing the real-world social life, and it is not restricted only to Japan but now already presents a global problem (Kato et al., 2019; Takefuji, 2023). In a similar vein, the World Health Organization considered excessive smartphone use as a public health concern (Kuss et al., 2018; Lopez-Fernandez et al., 2017). Diagnostic criteria for smartphone addiction have been proposed (Lin et al., 2016), but the PSU/SA remains outside of the official classification, even with DSM-5-TR (APA, 2022) being published in 2022.

4.5 Why Was Smartphone Use Problematized in the First Place?

Despite the debate whether the PSU truly is a behavioral addiction, compensatory behavior (Kardefelt-Winther, 2014, 2017), or a maladaptive behavior that is an expression of certain underlying, person-specific psychopathologies (Billieux et al., 2015a; Billieux et al., 2015c; Flayelle et al., 2022), the topic is worth investigating, since it has been repeatedly shown that the improper and increased use of smartphones is related to negative psychological, physical, and social outcomes (Busch & McCarthy, 2021).

In a comprehensive review of the literature, Elhai and colleagues (2017) found that problematic smartphone use (PSU) appears to have a stronger association with depression than with anxiety. Furthermore, stress was also found to be linked to PSU. The authors concluded that these mental health issues were consistently associated with PSU, with at least a moderate effect size (Elhai et al., 2017). Additionally, other negative outcomes associated with PSU or increased smartphone usage include lower academic performance, sleep disturbances, feelings of loneliness, shyness, social phobia, PTSD, and alcohol consumption problems, as indicated by various studies (Amez & Baert, 2020; Bian & Leung, 2015; Chung et al., 2018; Demirci et al., 2015; Elhai et al., 2017; Enez Darcin et al., 2016; Grant et al., 2019; Hawi & Samaha, 2016; Liu et al., 2017). Moreover, physical consequences have been related to excessive smartphone use, such as cervical pain, which is the result of the increased pressure on the cervical spine due to the position in which individuals look at their smartphones (M.-S. Kim, 2015; Park et al., 2015). Other correlates include wrist, hand, and shoulder pain (Mustafaoglu et al., 2021) and vision impairment (Fu et al., 2021). However, there are opinions that the majority of the conclusions regarding the impact of technology use on mental health may be unsound (Ellis, 2019). This conclusion is attributed mainly to the shortcomings of the (self-report) psychometric tools used to measure smartphone use. Still, some physical consequences of exaggerated smartphone use, even indirect, such as obesity among children, where a child could be lacking physical activity due to smartphone use for a prolonged time, are acknowledged in the same paper (Ellis, 2019).

Social problems are associated with problematic smartphone use as well. One such problem is known as *phubbing* (a term coined from terms "phone" and "snubbing"), and it denotes a socially undesirable behavior of not paying attention to the surroundings, especially in social situations, such as face-to-face interactions (Ivanova et al., 2020; Lai et al., 2022). After all, both *components model of addiction* (Griffiths, 2005), and a *pathway model of problematic smartphone use* (Billieux et al., 2015a; Pivetta et al., 2019; Sohn et al., 2019) consider the negative social impact that problematic smartphone use can have in a person's life.

4.6 Problematic Smartphone Use and Personality Characteristics

4.6.1 Personality Traits and Psychological Characteristics

In The Interaction of Personality-Affect-Cognition-Execution Model (I-PACE; see subsection 4.7.2), the personality traits (among other factors) correspond to a person's core characteristics. The traits mentioned are, for example, impulsivity, self-esteem and conscientiousness, neuroticism, extraversion, and shyness, but the authors rightfully note that the basic personality traits might be too vague to associate them with the particular potentially addictive behaviors, including the SA (Brand et al., 2019). That might be why the fundamental personality traits (such as the Big Five [John et al., 2008]) are only moderately related to the measures of general PSU (Brand et al., 2019). The most consistent finding suggests that PSU is moderately correlated with neuroticism in a positive direction and conscientiousness in a negative direction (Horwood & Anglim, 2018, 2021). The relationship of PSU with the other three basic traits (from a Five-Factor or Big-Five model) needs to be more consistent (see Busch & Mcarthy, 2021; Hussain et al., 2017; Knack & Harbke, 2021).

At first, it appeared that extraversion was substantially related to the overall PSU (e.g., Bianchi & Philips, 2005; Billieux, 2012), especially in the context of the pathways model (Billieux et al., 2015a; the pathways model of addiction is discussed in section 3.9), but subsequent studies showed very low importance of extraversion (Canale et al., 2021; Pivetta et al., 2019). The extraversion-introversion dimension is related to the specific types of smartphone use, such as entertainment and social use, while only the former was positively associated with the PSU (Abd Rahim et al., 2020). This finding is in line with the newer studies since the more extraverted individuals tended to use smartphones for social purposes, which was weakly related to the PSU, while more introverted used them more for entertainment, which more likely led to the PSU (Abd Rahim et al., 2020). A recent meta-analysis partly confirmed what was presented in this subsection: extraversion and conscientiousness are consistently related to PSU, but a slight negative correlation between agreeableness and PSU exists (Gao et al., 2022). However, the authors also claim that the findings support the pathway model, namely, the extraversion pathway, having found a small but positive effect of extraversion on PSU.

It should be noted that this effect was significant only among adolescents and in individualistic cultures (Gao et al., 2022). The inconsistent findings show that the relationship between extraversion and PSU is complex and probably depends on factors such as age, gender, culture, and operationalization of the PSU construct. De-Sola Gutiérrez et al. (2016) indicated in their review that extraversion and neuroticism (among the core personality traits) are associated with the PSU.

One explanation that aligns with the pathways model is that individuals with high neuroticism use smartphones to maintain social and emotional reassurance. If combined with low self-esteem or insecure attachment, such individuals can start using their smartphones in a problematic way (Horwood & Anglim, 2018). Another possible explanation, and not mutually exclusive with the previous, is given that neuroticism comprises proneness to negative emotions, such as anxiety, depression, and worrying, and characteristics such as vulnerability, impulsiveness, and self-consciousness; individuals with high neuroticism can engage in smartphone use to cope with or escape the negative feelings. This use can lead to the PSU (Gao et al., 2021). The kind of uses that can become problematic in these scenarios are entertainment use (e.g., playing games on a smartphone to relieve anxiousness or distress) or social media use (e.g., a highly self-conscious person is excessively checking social media for "likes," which will bring the reassurance about self, or repeatedly checking social media due to FoMO – fear of missing out – vital information, news or any other content) (Gao et al., 2021; Knack & Harbke, 2021). The escapism behavior is especially concordant with the compensatory internet use theory (Kardefelt-Winther, 2014).

More extroverted people use their smartphones to fulfill their need for social interactions through communication functionalities or, more likely, through social media. Although we said that social use is not as related to PSU as entertainment use, some authors argue that their positive attitude prevents them from slipping into problematic use (Horwood & Anglim, 2018). That does not mean that a particular extraverted individual can become a problematic smartphone user since some subdimensions of extraversion (such as excitement seeking) are positively related to problematic use (Horwood & Anglim, 2018; Knack & Harbke, 2021). Other interpretations of this relationship include sensitivity to reward among extraverts, which is related to compulsive use, loss of control, and increased tolerance, which in turn leads to addiction, but again, the effect is inconsistent and small. Hence, these mechanisms need to be investigated further (see Gao et al., 2020).

Conscientiousness is characterized by self-discipline, order, and dutifulness, among others, and individuals with higher conscientiousness would be less likely to spend excessive time using smartphones for activities unrelated to other important daily duties and things that a person needs to get done. Furthermore, highly conscientious individuals have increased behavioral control and the ability to delay immediate gratification, preventing the behavior from becoming addictive (Gao et al., 2021; Horwood & Anglim, 2018), which makes smartphone use less likely to become problematic (Knack & Harbke, 2021).

People with elevated agreeableness tend to have a "tender-minded" personality with lower neuroticism; they also tend to be "calmer" and "more stable", which is negatively associated with the PSU (Knack & Harbke, 2021). Care for others and compliance can prevent such individuals from using a smartphone in inappropriate situations and during face-to-face interactions, which can be perceived as rude or unpleasant by others. Furthermore, agreeable people usually have available social support and are less likely to engage in maladaptive coping, such as PSU (Gao et al., 2021). However, the effect size of agreeableness on PSU needs to be more prominent and consistent. Thus, these findings should be explored in the more granulated context of the agreeableness dimension concerning different kinds of smartphone use and social situations.

The inconsistent and small negative effect of openness on PSU could be explained by the tendency of individuals opened to experiences to try new activities instead of sticking to a familiar behavioral pattern, among them being the use of smartphones as a "safety blanket" or entertainment (Knack & Harbke, 2021). The absence of association between openness and PSU is explained by the fact that smartphones no longer represent a novel piece of technology, making them less attractive for individuals highly open to experience. Another explanation is that, although smartphones are evolving, this being continuously novel, individuals with increased openness can be interested in many other spheres of life, not just technology (Gao et al., 2021).

When it comes to personality traits outside of the Big Five (John et al., 2008) or the Five-factor model (FFM; McCrea & Costa, 2008) prism, Honesty-Humility from the HEXACO model (Lee & Ashton, 2004) was negatively and moderately related to PSU (Horwood & Anglim, 2018). Other personality characteristics found to be associated with PSU are impulsiveness (Billieux et al., 2008; Billieux et al., 2015a; Kim et al., 2016; Roberts et al., 2015), intolerance of uncertainty (IU; Busch & McCarthy, 2021; Rozgonjuk et al., 2019), distress tolerance, mindfulness (Elhai et al., 2018; Moqbel, 2020; Regan et al., 2020), life satisfaction, (Samaha & Hawi, 2016) psychological and subjective well-being (Horwood & Anglim, 2019), loneliness and perceived stress (Enez Darcin et al., 2016; Samaha & Hawi, 2016; Shen & Wang, 2019), self-esteem, self-identity and self-image (see De-Sola Gutiérrez et al., 2016). Many other constructs beyond these listed could be considered correlates and antecedents of the PSU, but some constructs are identified as consequences of PSU. For a more detailed discussion, see Busch & McCarthy, 2021. Given the importance of smartphone use in PSU, the next chapter is dedicated solely to motives for smartphone use and the purpose of its use.

As mentioned in section 4.5, depression and anxiety are stable correlates of problematic technology use, including smartphones. In Study 1, worrying was used in addition to depression and anxiety for the validation of the SABAS. The anxiety measured with a subscale of the Depression Anxiety Stress Scale (DASS-21; Lovibond & Lovibond, 1995; Jovanović et al., 2014), captures mostly on the physiological arousal aspect of anxiety, while this is not the case with worrying, which could be considered a cognitive response (Carleton, 2016). A study showed that the stress subscale from the DASS-21 did not appear psychometrically sound on the Serbian adaptation (Mihic et al., 2021). Therefore, worrying was used as a complement to depression and anxiety.

Worrying is also tightly related to the intolerance of uncertainty (IU), used in Study 4. Namely, in Study 4, we tried to isolate the unique contribution of the IU, in addition to anxiety and depression, to the variability of PSU. The IU can be a causal factor for worrying (Ladouceur et al., 2000; Volarov et al., 2024) and depression and anxiety (Carleton, 2016). Additionally, worry and intolerance of uncertainty were identified as important correlates in previous studies, although not many (see Pontes, 2022).

The relationship between PSU on the one side and cyberchondria and IU on the other remains modestly researched. The special context in which studies presented in this thesis occurred was the ongoing pandemic, where great emphasis was put on problematic technology uses. Another specific thing is that in the Serbian population there were no studies of cyberchondria nor research focusing on the association of PSU with IU and cyberchondria. Therefore, adequate instruments needed to be validated, and the mentioned relationships were inspected.

4.6.2 A Brief Overview of Neurobiological Correlates of Smartphone Addiction

It is beyond the scope of this thesis to dive deep into the neurobiological characteristics of addictions, specifically internet and smartphone addictions; therefore, the most important findings will be summarized and described very briefly. The neurobiological studies of behavioral addictions borrow the design and paradigms from the studies of substance use disorders and gambling disorders. Dopamine is now a well-known neurotransmitter included in several brain systems, usually related to reward and motivation, and it seems that it plays a role in both substance and non-substance-related addictions (Young, 2011). A strong relationship exists between dopamine, that is, lesser D_2 receptor density in internet addicts, and playing video games, for example, initiates the dopamine surge (Monthag & Reuter, 2017). The dopaminergic system is over-reactive in people with an addiction, and it is triggered by anticipation of, say, playing games or using the internet, as well as when the behavior is already engaged in. In simplistic terms, a behavior that brings pleasure leads to dopamine intoxication, which further leads to addictive behavioral patterns. This addictive behavior leads to negative consequences in important areas of a person's life, as well as intrapsychic consequences for a person. A person then repeats the pleasurable activity to alleviate the bad mood, anxiety, and other unpleasant symptoms, which continues the cycle. An addicted person gets accustomed to elevated levels of dopamine (Montag & Reuter, 2017). Of course, other neurotransmitters also play important roles, such as serotonin, endorphins, cortisol, etcetera (Maté, 2009; Pontes, 2022).

Structural changes in IA, SA, and gaming disorder also showed mutual similarities with other types of addictions. The brain structure striatum is related to habits and reward systems and is particularly important. The striatum consists of caudate nucleus, putamen, and nucleus accumbens (part of ventral striatum). The stronger activities in this area were found in gamers while playing games, as in other addicted individuals, when presented with their "own stimuli" (Montag & Reuter, 2017). Another critical area identified was the anterior cingulate cortex (ACC), which is important for impulse control and conflict regulation. In internet addicts, the functioning of this area seems impaired, and the study directly dealing with smartphone-addicted participants showed decreased grey matter volume in ACC (Horvath et al., 2020).

In a study by Horvath et al. (2020) using fMRI differences were found between the "addictive" and the "non-addictive" (control) group of participants. Decreased grey matter volume in the left orbitofrontal area, left anterior insula, inferior temporal, and parahippocampal cortex was found in the first group. In the right ACC decreased intrinsic neural activity was also found in the first group (Horvath et al., 2020). The study was cross-sectional so that no solid causal conclusions could be drawn. Additionally, the authors used the Smartphone Addiction Inventory (SPAI; Y.-H. Lin et al., 2014) cut-off scores generated on the Korean population and used them in their (presumably) German population, which could have been problematic.

Nevertheless, there are indeed shared neural mechanisms that underlie behavioral addictions related to technology, including smartphone addiction (Schmitgen et al., 2022). In a systematic review of fMRI studies on internet and smartphone addiction, the diminished cognitive control associated with reward processing and executive functioning were found to be common neurological characteristics of internet and smartphone addiction (León Méndez et al., 2024). It is believed that the enduring impact of smartphone usage on our brain is demonstrated by its influence on neural motor regions (see Montag & Reuter, 2017).

That was also found in people with IA (Montag & Reuter, 2017). Magnetic resonance studies also found changes in the orbitofrontal cortex (OFC) and dorsolateral prefrontal cortex (dlPFC) in people with SA and gaming disorder, usually as decreased grey matter volume (Pontes, 2022; Horvath et al., 2020). Improper functioning of the prefrontal cortex is related to impaired self-regulation (Maté, 2009), and dlPFC and OFC have a role in various executive functions and cognitive processing (Montag & Reuter, 2017).

As Young pointed out, the neuroscientific studies on the internet can probably addiction generalize to other technology-related problematic behaviors, what she called "internet-enabled compulsive behavior" or "digital compulsion," given that most of the devices function primarily through the internet, being it laptop/desktop computers, modern gaming consoles, and other devices as well, including smartphones (Young, 2011). Indeed, the similarities between internet addiction and other addictions in terms of neurobiology are evident (Montag & Reuter, 2017). First, on a physiological level, like other addicted persons, individuals with IA show increased heart rate, higher pulse volume, and lower skin temperature when presented with the cues. For a more detailed overview of various biopsychological and neuroscientific models, please refer to Pontes (2022), Montag & Reuter (2017), Maté (2009), and Young (2011).

It is essential to keep in mind that putting too much emphasis on a specific neurotransmitter, such as dopamine, or a specific brain region in explaining addictions (or any psychopathology) could not be helpful. As said in the Introduction, addiction is a multilayered phenomenon, and it can be reduced to a single framework (e.g., just biological or just psychological; Maté, 2009).

4.6.3 Motives and Use Purpose

We said that the use time cannot be a credible indicator of the PSU, and this was acknowledged soon after the research on this phenomenon had started. Some of the important identified factors were actual habits (Oulasvirta et al., 2012), such as frequent, habitual, and mindless checking of the smartphone device. That led to recognizing that a pattern of use plays an important role in differing problematic and non-problematic use, such as the pattern of very frequent checking but with short use sessions versus not very frequent use but where sessions were longer and purposeful (Tossell et al., 2015).

Furthermore, the time of the day when a smartphone is used can be an interesting marker of distinguishing problematic from non-problematic users, where, for example, a problematic user would use a smartphone (by means of checking or using it continuously in one session) during late night hours (Kanganolli & Praveen, 2020; Lemola et al., 2015).

As for internet addiction, the focus should be on specific activities, such as gaming, social networking, and pornography, rather than on general use (Griffiths & Szabo, 2014). Likewise, the activity one performs on a smartphone should be of greater importance when researching smartphone addiction. It might be difficult to claim that someone is addicted to the internet or to the smartphone in general; rather, it would be more precise to specify the person's preferred activity/application/use purpose or motive (Pontes et al., 2015). A well-known analogy states that saying that someone is addicted to the internet (or smartphone) is like saying that someone is "addicted to the bottles" (Kuss & Griffiths, 2017, p. 8). A similar analogy could be made by saying that a person is addicted to a casino instead of gambling since the activity of gambling is performed in casinos, as any activity, such as social networking or video gaming, is performed *on* the internet (Starcevic, 2013). That is why some authors propose abandoning the term "internet addiction," as it is a vague term representing only a medium for activities (Starcevic, 2013). Alike could be said for "smartphone addiction" as well.

This is related to the problem that exists in the internet addiction construct, that mobile phone dependence could be an inadequate term since individuals are not "dependent" on the device itself but rather on the activities that are performed using the device as a medium (for example, chatting, social networking, gaming, etc.), or the use of the device is driven by different needs or motives of the individuals, for example, someone with insecure attachment style may use smartphone excessively to maintain affective relationships (Lopez-Fernandez et al., 2017). The focus should, therefore, be on the type and quality of smartphone use rather than on frequency of use (Lowe-Calverley & Pontes, 2020).

It is quite obvious that the purpose of use, or use motive, is intertwined with the use pattern. Perhaps it is more plausible to believe that the different motives drive different use patterns. Hence, very broadly, we think that a person might have an instrumental motive, i.e., for fulfilling some concrete tasks and a motive for pure gratification. These motives are not mutually exclusive since, depending on a situation or context, an individual's use of a device can be primarily driven by one of the two or driven simultaneously by both but with a different intensity.

An instrumental motive could lead to a longer session, with a person being highly concentrated on fulfilling a task – perhaps a job- or a school-related (for example, a phone call, online meeting, sending emails, etc.). Here, a smartphone would be a tool to complete a task that does not have immediate gratification as a primary goal. Another example is when a child can be on a long video call with its grandmother who lives far away, and again, a smartphone is a tool in this case, which greatly helps maintain social contact with close family members. On the other hand, a smartphone can be utilized to obtain immediate reward or gratification. Such use motivations can be reflected in activities performed on a smartphone that would lead to positive reinforcement, such as instantaneous joy or pleasure, or in terms of negative reinforcement, activities on the smartphone would be used to alleviate a negative mood, relieve the anxiety, escape real-life problems, etcetera (e.g., Chen et al., 2017; Elhai et al., 2017). Examples of such behaviors are scrolling through social media, "getting into rabbit holes of YouTube videos", playing mobile games, constantly checking, and anticipating notifications, and doing anything for entertainment or pastime. Even mindless fiddling with a smartphone can be rewarding – like experiencing tactile sensations from the screen and phone itself, changing wallpaper, icon layout, and interface theme, and personalizing the device in numerous ways.

It is not easy to classify different types of use/motives into clearly distinctive categories. Particular applications (or application categories) can be used as a proxy to assess the use purpose. However, this approach can be problematic since one kind of application can be used to satisfy different motives at different times. For instance, a person can spend much time scrolling through *X* app (formerly known as Twitter) out of habit and boredom, without a particular goal. Still, another time, perhaps in an urgent situation, he/she can be gathering crucial information, disseminated by official and personal accounts on the platform. In fact, Twitter established itself as a service that often broke the news before the official channels and became an important source of instant information, especially in times of sociopolitical crisis or natural disasters. One example is the San Francisco earthquake, when the news about it was quickly spread over the platform, and the true value of this network was discovered (ColdFusion, 2020). In a like manner, other applications can be used for completely different aims.

Dividing the use motivation to productive/instrumental or entertainment/ gratification is only one of the many plausible means of classifying the catalyst for different activities performed using a smartphone. Furthermore, the identical or, to a great extent, similarly conceptualized motives were given different names. As an illustration, the two kinds of smartphone use were named process and social use, where the former designates "process-related gratifications" which result from the consumption of media (in this case via smartphone), and the latter relates to engaging in social interaction (van Deursen et al., 2015). Both are closely connected to problematic internet use, and both types of uses are believed to lead to problematic, "habitual" or "addictive" behaviors. In another study, the process use was renamed to *entertainment use* and social use to *communication use* (Horwood & Anglim, 2019). The authors rightfully pointed out that the items belonging to this scale mostly describe communication through calls and text messaging rather than spending time on social media, i.e., "social networking" or scrolling through social media.

Yet in another study, the items were used to assess the process, this time named *process/non-social* and social smartphone use (Rozgonjuk et al., 2019). Moreover, Rozgonjuk et al. described non-social use as the use of smartphones for productivity or entertainment, although the item content is related more to entertainment, pleasure, and boredom-avoiding but also information gathering and "staying up to date with the latest news". In our opinion, the kind of information-gathering that the items measured are more related to everyday news, is not the best characterized as productivity-related information gathering. Another example of a dichotomized classification is the assumption of entertainment motive and escapism motive (Wang et al., 2015). The latter stemmed from a different perspective on PSU, namely *compensatory internet use* theory, which started departing from the conceptualization of PSU as an addiction (Kardefelt-Winther, 2014). Nevertheless, it can be seen that this classification shifts the focus on the inner drives of a person. More precisely, the entertainment motive can lead a person to play games, watch videos, or do any activity for the sake of entertainment or relaxation. In contrast, if driven by the escapism motive, a person can perform the same activities on a smartphone but to alleviate the stress and negative mood or simply escape reality (e.g., Kardefelt-Winther, 2014, Panova & Lleras, 2016). In this case, a smartphone can serve as a "security blanket," but this coping strategy is not exactly adaptive and can lead to further worsening of well-being (Panova & Lleras, 2016).

The previous paragraph only scratched the surface of the complexity of precisely defining the motivation or the reasons behind the particular patterns of smartphone use. It seems, if not impossible, to make an optimal classification. Going beyond the dichotomous motives, more fragmented categorizations were attempted. For example, Zheng et al. drew the concepts of substance-related and excessive internet use problems and defined motives for smartphone addiction, namely, enhancement (information seeking, perceived enjoyment), social (social relationship), coping (mood regulation, pastime), and conformity motive, which implies conformity (Mostyn Sullivan & George, 2023; Zhang et al., 2014).

In our Study 1, we have utilized the term *hedonic use*, and we conceptualized it as entertainment use, for recreation or pastime, as opposed to the productive use (*utilitarian use*), often related to job, school, or fulfillment of a concrete task (e.g., Linnhoff & Smith, 2017). Thus, we present here how hedonic use was defined and used in some other studies, which was not necessarily defined in our study. As we saw, regarding the motives or purpose of smartphone use, there was no strictly established terminology. We used the term rather loosely, while other studies relied on philosophical definitions of hedonic/eudaimonic motives.

Some studies distinguished the *hedonic approach* from *hedonic avoidance* (H. Chen & Zeng, 2023), which is in concordance with previously associated hedonic behavior with positive reinforcement, such as seeking pleasure, but with negative reinforcement as well, such as deflecting negative moods (Elhai et al., 2017). Those two kinds of hedonic motivations can have opposite effects on well-being (H. Chen & Zeng, 2023, 2024).

4.7 Important Theoretical Frameworks of Smartphone Addiction

4.7.1 Components Model of Addiction

The mentioned components model of addiction has often been used as a theoretical framework for various, then emerging, behavioral addictions, such as sex, work, overeating (Griffiths, 2005), exercise (Griffiths et al., 2005), internet (Kuss et al., 2013), gambling, social networking (Kuss & Griffiths, 2017) and smartphone addiction (Csibi et al., 2018; Jameel et al., 2019). The model views addictions as a biopsychosocial process, where the behavior lies on a continuum of severity of use (Griffiths, 2005). The common components of any addiction, being substance or non-substance-related, are salience, mood modification, tolerance, withdrawal, conflict, and relapse. Salience is related to a person's preoccupation with an activity, in a behavioral, emotional, and cognitive sense. Mood modification refers to a feeling of arousal or excitement when performing the activity or feeling relieved from anxiety or being distressed, often related to the feeling that a person "escaped" from a problem or being "numbed" to an unpleasant effect. The tolerance component describes the phenomenon of needing higher amounts of the specific activity to attain previous results is occurring. Withdrawal denotes negative emotions and/or physical changes when the activity is suspended or decreased. A person with a purportedly addictive behavior also experiences conflicts, which can be interpersonal (that is, a conflict of a person with their own social environment), and intrapersonal, which can be experienced as a subjective loss of control because of the inability to reduce or to cease the activity. Finally, relapse signifies returning to a behavioral pattern in the same or even higher amounts than before the period of temporary interruption of the activity (Griffiths, 2005).

Although these components should be common in all addictive behaviors, they might not be equally important for each kind of activity; this was also noted by the author in the original paper (Griffiths, 2005). For example, the salience in the context of smoking or alcohol drinking is not that clear since those activities could be performed simultaneously with other activities, and they will not completely dominate the person's thoughts, which is not the case with activities such as gambling or sex. A smoker can carry cigarettes around while performing daily activities, but then the salience could occur in a period of longer unavailability of the cigarettes (for example, during a long flight), in the form of a person's total preoccupation with the thought of smoking; "smoking becomes a single most important thing in that person's life…" (Griffiths, 2005, p. 193). The same could be said for smartphone use since smartphones are also carried around all day and provide constant internet access and access to all functionalities.

Recently, the components model has been criticized for applying criteria from substance addiction and gambling to the plethora of other (problematic) behaviors, a priori conceptualizing them as addictions. For example, a recent study criticized the components model regarding its unitary structure. Namely, components such as salience and tolerance were not related to psychopathological symptoms, meaning that they did not represent indicators of a disorder (Fournier et al., 2023). Others tried to refute these findings, drawing a conclusion that the structure is indeed unitary (Amendola, 2023b), and the debate was still going on as of writing this thesis (Amendola, 2023a; Fournier et al., 2024).

As mentioned earlier, some criteria taken from the substance use disorders criteria, such as salience and tolerance (Panova & Carbonell, 2018), might not be valid in the context of behavioral addictions, specifically technology-related addictions. Besides, for all behavioral addictions, other criteria are found to be questionable, such as withdrawal symptoms, as withdrawal in terms of severe physical and psychological symptoms, for example, internet addiction and opioid addiction, cannot be equated (Starcevic, 2016). Withdrawal symptoms in behavioral addictions usually refer to negative emotional states, such as irritability, anger, tension, and similar (Starcevic, 2016), and a withdrawal in the form of stress caused by not being able to reach own smartphone might have something to do with the anxiety of not being able to contact with important others in both personal and professional sphere (Panova & Carbonell, 2018). On the other hand, the importance of the withdrawal criterion was emphasized in a study where the diagnostic criteria for the SA were proposed (Lin et al., 2016). After all, withdrawal is a suggested criterion for both gambling and the planned internet gaming disorder included in DSM-5 (APA, 2013).

However, it is not solely the components model of addiction that is criticized, but the overall "addiction" framework in studying these problematic activities. Conversely, some critiques relate to specifically conceptualizing problematic smartphone use as an addiction. The debate about the idea behavioral addictions, components model of addiction, and the status of problematic smartphone use is still ongoing and there is no clear consensus about its status. Regardless of that, the books about behavioral addictions were written, some activities are being actively considered for formal inclusion in the official classifications, such as IGD; internet gaming disorder. Nevertheless, in the mentioned studies, it is not completely clear whether the validity of the model was questioned or whether the instrument represents the model. Despite the debate around this particular model and the criticism of the overall "addiction" framework, the components model of addiction still appears to be used as a theoretical model for problematizing different behaviors as of 2023 (e.g., Khazaal et al., 2018; Pakpour et al., 2023; Zarate et al., 2023).

4.7.2 I-PACE Model

The Interaction of Personality-Affect-Cognition-Execution Model (I-PACE) is exceptionally important for behavioral addiction research, and it tries to capture a problematic (or addictive) behavior in all its complexity. Brand and colleagues described a model of the development and maintenance of internet addiction, especially gaming disorder (Brand et al., 2016). The I-PACE model conceptualized addiction as a complex, multilayered process, such as a person's environment, general (such as genetics, personality traits, and psychopathology), and specific predisposing characteristics, the psychological mechanism that includes gratification, compensation, habits, coping style, cue reactivity, and cognitive bias, to name a few elements. The entire mechanism is described for both the early development stage and, later, the maintaining stage, and ultimately leads to addictive behavior with reduced control and adverse consequences. For more details, see Brand et al., 2019.

The authors prefer the term specific-internet disorder to just internet disorder since it emphasizes the content or the activity on the internet in question. This decision is concordant with the internet gaming disorder included in the ICD-11, which represents one of the specific internet disorders. Other activities can be internet gambling disorder, internet shopping- and pornography-related problematic behaviors, and many others (Brand et al., 2016). Problematic smartphone use can also be one of those activities since, as we mentioned, specifying the particular problematic activity and the motivation for smartphone use is especially important (Pontes et al., 2015). Another important thing pointed out by Brand and colleagues is related to the term addiction. They acknowledged that the label internet addiction is questionable and controversial, and they prefer to use the term internet-use disorder, which is harmonious with the term used in ICD-11 (internet gaming disorder). Similar is the current situation with problematic smartphone use and smartphone addiction, where the two labels are frequently used interchangeably. However, the "addiction" part appears in many publications, whether or not authors consider the conceptualization of smartphone-related problematic behavior as a behavioral addiction (Busch & McCarthy, 2021).

The authors of the I-PACE model suggest that the official classification should include the general term for internet-use disorder, which can be further specified concerning a primary problematic application. However, an individual's problematic (addictive) behavior may involve a mixture of activities or applications, not just a single one (Brand et al., 2016). Furthermore, the I-PACE model soon proved useful for various other behaviors, such as gambling, gaming, shopping, and compulsive sexual behavior, smartphone addiction, including behavioral and substance-use disorders (Brand et al., 2019; Elhai et al., 2020; Mehmood et al., 2021). Flayelle and colleagues (2022) see the model as an improvement in behavioral addiction research. I believe that this theoretical framework can lead to, as said by Griffiths (2019), unifying substance and behavioral addictions in terms of conceptualization, definition, and diagnostic criteria.

4.7.3 Pathways Model of Problematic Smartphone Use

Back in 2015, given the purported lack of evidence for withdrawal, tolerance, and impulse control as solid characteristics of smartphone addiction, Billieux, and colleagues, including the author of the components model of addiction, came up with a theoretical framework based on then well-established evidence, and named it the *pathway model* of *problematic smartphone use* (Billieux et al., 2015a). This model sees problematic smartphone use as multidimensional, and addictive use is just one aspect of it, and the other two problematic uses are banned use and risky use (Billieux et al., 2015a). Furthermore, as the name of the model suggests, there are at least three pathways or mechanisms that can lead to problematic smartphone use, and those being an excessive reassurance pathway, an impulsive-antisocial pathway, and an extraversion pathway (Billieux et al., 2015a). The model also takes into consideration the core personality traits and internalized psychopathology, certain mobile applications or uses, which results in various elusive behaviors related to smartphone use, such as addictive use, prohibited or inappropriate use, and finally, dangerous use (using phone while driving, unsafe online behavior). The findings did not support the extraversion pathway on at least two occasions (Canale et al., 2021; Pivetta et al., 2019). This is contrary to the theoretical assumptions, but authors also leave the possibility that the dangerous use was related exclusively to sensation seeking and not the extraversion personality dimension, and this path could possibly be renamed to sensation seeking path, which leads to the dangerous use of smartphones (Canale et al., 2021; Pivetta et al., 2019).

The model has some empirical support and is often used as a framework when studying PSU. It is obvious that the authors of the model, by "problematic," do not strictly mean addictive use, but antisocial (prohibited) and dangerous (risky) use as well. However, the model relied on data obtained using scales that were heavily criticized for their validity. Namely, many of the instruments intended to measure PSU could actually measure the individual's own relationship with an object (in this case, a smartphone), which could be a proxy for broader personality traits, such as impulsivity or anxiety, not necessarily related specifically to smartphones, or any other technology for that matter (Ellis, 2019).

4.8 Measuring Problematic Smartphone Use

Over time, many tools intended to assess the risk of SA were developed under various names, with most relying on something other than a specific theoretical background (Harris, Regan, et al., 2020). Similarly, they adapted the substance use disorder criteria, gambling disorder, or internet addiction (Flayelle et al., 2022). The first two were used as a starting point since they were officially recognized as addictions, and the latter, IA, had its measurement scale back in 1998 (Young, 1998). Before the appearance of smartphones, or at least before their wide usage, instruments were measuring problematic mobile phone use (e.g., Bianchi & Philips, 2005).

The psychometric tools for assessing SA were heavily criticized as the construct itself. Their validity was questioned, especially when contrasting them with objective measures of smartphone use, whether the duration of use, frequency of checking, or the amount of usage of particular applications, all measured by the device itself (e.g., Ellis et al., 2019). However, in the line of what has been said that frequent use does not equate to problematic use, the objective measures, despite being useful, do not catch the reasons or motives for an individual's overall use of smartphones (e.g., Horwood & Anglim, 2021). On the other hand, another question concerning the validity of SA tests is whether they indeed measure the SA (PSU or whatever the construct is named) or they measure the various psychological problems, where the SA is just one of the manifestations, a maladaptive coping, or a defense mechanism (Billieux et al., 2015a; Flayelle et al., 2022; Harris, Regan, et al., 2020; Lingiardi & McWilliams, 2017). Another, but not less critical point is similar to the criticism of the construct itself, where some researchers argue that the diagnostic criteria for behavioral addictions or problematic behaviors, including SA, are "being recycled" in the way that the test items are constructed based on the criteria of an already established disorder and then apply to a behavior of the interest. For example, a scale targeting SA is built based on DSM criteria for gambling disorder, where just the wording is adapted to suit problematic smartphone use. The Discussion section describes such a "confirmatory approach" in more detail (Flayelle et al., 2022). Nevertheless, self-rating PSU was compared to other-rating PSU, indicating the similarities between the two, and although concluding that both assessment methods have their shortcomings, the self-rating scales can be valid for assessing the PSU (Horwood & Anglim, 2021).

A comprehensive review of PSU scales by Harris, Regan, et al. (2020) sheds light on the challenges in this field. The review examined 71 instruments, including those related to classical mobile phones dating back to 2004. Notably, it included the Brief Smartphone Addiction Scale (BSAS; Csibi et al., 2016) and SABAS (Csibi et al., 2018), which are essentially the same scale, with the former being the original Hungarian version and the latter a well-known English adaptation. The review concludes with the observation that there is a lack of consistent conceptualization of PSU, leading to the development of numerous, more or less redundant instruments. It also highlights the unsatisfactory reliability of many of the published scales as a detected problem (Harris, Regan, et al., 2020).

Without instruments based on a solid theoretical background, we found that the SABAS is optimal for operationalizing SA. It differs from most other instruments by being utterly shorter, based on the components model of addiction (Griffiths, 2005), where each item corresponds with one core component, and being relatively new, thus requiring continual psychometric properties inspections. An instrument based on the components model of addiction was published in 2016 in Turkey, named the Mobile Addiction Scale (MAS; Fidan, 2016), the same year the Hungarian version of SABAS was first published (Csibi et al., 2016). However, the MAS scale did not "take off," and it is notably longer than the SABAS. Another independently developed instrument under a similar name – the Arabic Mobile Addiction Scale, was published in 2021 and based on the components model of addiction (AMAS; Abojedi et al., 2021).

Nevertheless, again, this tool also has yet to be widely used, and it is comprised of 32 items, which makes it markedly longer than SABAS. Lastly, the Mobile Phone Involvement Questionnaire (MPIQ; Walsh et al., 2010) was based on the components model as well, but on earlier Brown's version (Brown, 1993, 1997 as cited in Walsh et al., 2010), not the revised version proposed later by Griffiths (2005), as incorrectly noted in Harris, Regan, et al., 2020. For the discussion on crucial differences between the two versions of models, see Griffiths, 2019.

Smartphone Addiction Scale – Short Version (SAS-SV; Kwon et al., 2013), perhaps the most used scale for this purpose, was adapted to the Serbian language in 2021 when the first research of this dissertation was already published (Nikolić et al., 2022). In addition, the structure of the adapted SAS-SV was not validated with confirmatory factor analysis. The SABAS was used on a Serbian-speaking population (Sojević et al., 2018), but its proper translation nor adequate qualities were presented. In the myriads of instruments designed to assess PSU, finding one that would be ample for studying the Serbian-speaking population was difficult. One of the criticisms of the PSU scales was the lack of evidence for internal consistency and test-retest reliability of many of the scales (Harris, Regan, et al., 2020). Indeed, since temporal stability indicators of scales were more challenging to find in the published literature, the critical task for us was to investigate the test-retest reliability of the SABAS scale in one of our studies.

5 Cyberchondria

Cyberchondria is a morbidity stemming from technological evolution and, thus, it is a relatively new dysfunction, whose research started around a decade ago (e.g., Loos, 2013; Starcevic & Berle, 2013). It is not completely clear how that term came up, but it is believed that it first appeared in the news as an amalgam of *cyber* and *hypochondriasis* (Loos, 2013; Vismara et al., 2020). From its name, one could guess what cyberchondria means. The diagnostic entity of hypochondriasis was removed from the DSM-5 (APA, 2013), and the new diagnoses that ought to replace hypochondriasis are somatic symptom disorder and illness anxiety disorder. Although the word *hypochondriasis* perhaps became attached to a negative and somewhat pejorative connotation over time, the term still remained in the ICD-11 classification (WHO, 2019). To be fair, the term cyberchondria was coined even before the fifth edition of the DSM was published (so, while the hypochondriasis officially existed in the DSM), which explains the *hypochondriasis* part. The *cyber* part is related to the specific technology, that is, the internet, or more specifically, searching things on the internet via a search engine (the verb googling is often used since Google may be the most popular search engine, at least outside East Asia).

Recently, cyberchondria has been defined as "a pattern of excessive searching on the internet for medical or health-related information…" (Vismara et al., 2020, p. 7). The core features of cyberchondria are compulsiveness, worsening of distress or anxiety over time, and preoccupation with searching, which conflicts with other activities and has negative consequences (Vismara et al., 2020). Despite still not being a diagnosable condition, that is, it is not officially included in either ICD or DSM, Cyberchondria is recognized early on as significant for healthcare professionals (Aiken et al., 2012; Vismara et al., 2020).

5.1 The Beginnings

It is believed that the term was first used by journalists to describe this phenomenon in the early era of the internet, in the mid-late nineties and early 2000s (Loos, 2013; Zofnass, 2007). However, it was not long before it caught the interest of social science researchers. For example, an article from 2003 recognizes the potential damage that internet resources can cause to mental health when it comes to searching for symptoms online. Despite the initial good intentions of early websites containing medical information and seeing an advantage on the internet when it comes to dealing with not-so-significant symptoms, the potential shortcomings were pointed out.

Early articles discussed the potential positive and negative effects of the availability and abundance of medical information online. A negative consequence can be anxiety followed by information search due to difficulty judging the reliability of the information found. Nevertheless, the internet contained not only websites with health articles but also a place where people shared their experiences and communicated their concerns with others, feeling relief. This is one of the positive effects related to online health information reported by the participants (Lewis, 2006).

Similarly, an article from the same year (2006) discusses the increasing search for medical information online in the US, acknowledging the varying quality and credibility of information. Despite the attempts to regulate the posting of health information online, this gave modest results, with the internet being a rather decentralized technology. Again, authors agree that the searching can be beneficial for an individual, especially a well-informed one, but also emphasize the danger of vulnerable individuals, especially adolescents, searching for information online and ending up anxious about certain symptoms (Smith et al., 2006). Again, the potential exploitation of such individuals was noted, in the sense that a scared person becomes susceptible to spending money on e-health services or medications without the actual need (Smith et al., 2006). A 2002 survey reported that 93% of participants from the US and French population believed that online health-related information is credible, understandable, and of high quality (Schmidt, 2002). However, the website is not available anymore, so the validity of the survey is difficult to check. That was a serious issue since the author analyzed the web places offering cures for cancers doing the shipping of medications that should only be prescribed face-to-face. The vulnerable population was discussed again, but this time, the damage done to them by the websites with unverified information, besides being taken advantage of in a financial way, was getting a false hope and engaging in treatment that would potentially be fatal for them (Johnson & Davison, 2004; Schmidt, 2002).

The point is, although the problems related to health information on the internet and the harm it can cause were recognized early on, the construct of cyberchondria was still not very well defined and was used rather colloquially (e.g., Johnson & Davison, 2004; Schmidt, 2002). In the early 2000s, the term was used in scientific publications, but no comprehensive exploration of cyberchondria took place, nor was it the focus of the articles. Sometime later, the researchers became more interested in the phenomenon, developing possible models and mechanisms for its formation and maintenance.

As mentioned earlier, the availability of health information online has its own benefits. However, cyberchondria behavior carries a certain public health and cost burden. We will see in the next subsection's examples that people experiencing cyberchondria often utilize healthcare services excessively (Vismara et al., 2020). Furthermore, health anxiety and somatoform disorders have indirectly increased healthcare costs in the EU and the UK. Cyberchondria is related to more frequent visits to a physician, and people with cyberchondria often seek different clinics and specialists due to their increased mistrust of medical professionals (Vismara et al., 2020). There are estimations that in the US, the unnecessary healthcare cost due to somatization symptoms is even higher (Harding et al., 2008). However, the entire effect cannot be attributed to health anxiety, hypochondriasis (illness anxiety disorder), or cyberchondria, but those conditions certainly have their part in this problem.

5.2 Existing Conditions Conceptually Close to Cyberchondria

A valid question to ask is, how is cyberchondria different from the well-known hypochondriasis, except that it includes the internet? Also, is cyberchondria a well-founded and clinically relevant construct? Or is it just a form of health anxiety or hypochondriasis (or, in DSM-5 terms, illness anxiety disorder)? If this construct is truly distinct from other similar conditions, does it represent a public health burden, and would a person seek professional help because of a person's excessive online health information search that had become unbearable? Studies in the past decade have tried to answer these questions.

First, it would be useful to make a clear distinction between these mentioned and rather similar constructs, namely hypochondriasis, health anxiety, illness anxiety disorder, somatic symptom disorder, and cyberchondria. The APA Dictionary of Clinical Psychology from 2013 defines the somewhat old-fashioned term hypochondria as a subclinical condition of excessive and groundless belief in one's bad health. The condition, if severe enough to cause dysfunction, can be diagnosed as *hypochondriasis* (VandenBos, 2013). However, the possible transition to a diagnosis of hypochondriasis is stated for the commonly used term – *health anxiety*, which is "excessive or inappropriate anxiety about one's health, based on misinterpretation of symptoms… as indicative of serious illness" (VandenBos, 2013, p.268). Health anxiety is common among physically healthy individuals, and it is not a long-lasting condition, but in severe cases, the diagnostic criteria for hypochondriasis, according to DSM-IV-TR, for example, can be met (Aiken et al., 2012; VandenBos, 2013, p.268). In DSM-IV-TR, hypochondriasis was classified under the somatoform disorders, and it was used to denote "preoccupation with the fear or belief that one has a serious physical disease based on the incorrect and unrealistic interpretation of bodily symptoms" (VandenBos, 2013, p. 284).

The term was abandoned in DSM-5 (APA, 2013), where the persons previously diagnosed with hypochondriasis could now be considered to have an *illness anxiety disorder* or *somatic symptom disorder*. The key difference between the two is that in somatic symptom disorder, some physical symptoms are present but cannot be clearly explained by a medical condition or other mental disorder. The distress, as well as preoccupation, is heightened by experiencing medical symptoms. On the other hand, in illness anxiety disorder, there are no actual physical symptoms, or if they are present, they are slight. Still, the person suffering from it is in fear and anxiety of having or getting a serious illness and is preoccupied with those kinds of thoughts. One of the criteria in the DSM-5 is disproportionate health-related behaviors such as frequent checking of one's own body for symptoms (DSM-5; APA, 2013). Hypochondriasis is still a diagnostic category in ICD-11 placed under obsessive-compulsive or related disorder rather than in the somatoform group (ICD-11; WHO, 2019). Yet, it is defined similarly as a continuing preoccupation with or fear of having a deadly disease. The condition includes misinterpretations of otherwise common body sensations, excessive behaviors related to health, increased distress, and diminished functioning in different areas of life (ICD-11; WHO, 2019). The section "Inclusions" in ICD lists *hypochondriacal neurosis*, *nosophobia*, and *illness anxiety disorder*. This section usually includes optional diagnostic terms or alternative names, which would, in this case, be an *illness anxiety disorder*. However, the "inclusions" may contain different conditions that are related to the primary category but are not sub-categories themselves. Lastly, it is important to point out that the illness anxiety disorder, as defined in DMS-V (APA, 2013), centers on an excessive concern about having or developing a severe and undiagnosed medical condition. Still, in hypochondriasis, the explicit criterion is a lack of response to reassurance (Black & Grant, 2014).

I felt the need to briefly remind the readers about the meaning of these terms (hypochondriasis, somatic symptom disorder, illness anxiety disorder, and health anxiety), as they frequently appear in articles concerning cyberchondria without going too much into their conceptual distinctions or similarities. This is understandable given the explained changes in diagnostic categorization of the conditions, especially the changes from DSM-IV-TR and DSM-5, and the differences in the ICD-11 and DSM-5 terminology (APA, 2000, 2013; WHO, 2013). An important note to keep in mind is that neither health anxiety nor cyberchondria are included as official diagnosable mental disorders in any of the two classification systems. Cyberchondria has been viewed as an expression of hypochondriasis (e.g., Brown et al., 2020; Doherty-Torstrick et al., 2016; Jokić-Begić & Bagarić, 2020; Keller et al., 2008; Thakur et al., 2020) or an expression of health anxiety (e.g., Brown et al., 2020; Doherty-Torstrick et al., 2016; Jokić-Begić & Bagarić, 2020), interceded by the internet, but it is good to keep in mind which terms represent the official diagnoses and which do not.

5.3 Models and Mechanisms

In the last decade, mechanisms for developing and maintaining cyberchondria have been proposed, focusing on different constructs. These can be seen as predisposing, risk, or vulnerability factors. For example, low self-esteem has been found to positively predict cyberchondria, mediated by obsessive-compulsive symptoms and health anxiety (Bajcar & Babiak, 2021). The authors, however, pointed out, and tested formally as well, that it is plausible that the cyberchondria predicts the mentioned variables and that the relationship between these dimensions can operate as a loop (Bajcar & Babiak, 2021).

Next, the constructs of anxiety sensitivity and intolerance to uncertainty (IU) have also been related to cyberchondria (Fergus, 2013; Norr et al., 2015). Anxiety sensitivity refers to an individual's proneness to interpret bodily sensations that are anxiety-related as a sign of looming harm. The authors describe it as a "fear of fear" (Norr et al., 2015, p. 65). An uncomfortable bodily symptom can be interpreted by a person as a clear sign of a serious disease rather than just an unpleasant sensation (Norr et al., 2015). Earlier, it was shown that anxiety sensitivity is indeed positively related to different anxiety disorders, including health anxiety. Anxiety sensitivity, as discussed below, is composed of three subdimensions – cognitive, physical, and social concerns (Norr et al., 2015).

Intolerance to uncertainty (IU) is defined as a cognitive bias where people perceive the chance of a negative event as intolerable and menacing, regardless of the likelihood of its occurrence (Carleton et al., 2007; Norr et al., 2015). Intolerance of uncertainty is a transdiagnostic construct; that is, it appears in various anxious disorders (Norr et al., 2015). The two aspects of the IU are prospective IU and inhibitory IU. The former refers to a cognitive component, where a person perceives a threat regardless of how uncertain it is to happen in the future. The latter refers to a behavioral component, namely the symptoms resulting from facing uncertainty (Norr et al., 2015). However, the IU can be considered a unitary construct as well and used as such. It is credible to propose the IU as a risk factor, or at least a factor associated with cyberchondria, due to its robust relations with anxiety-related disorders. The relatedness of the IU and cyberchondria was first examined by Fergus (2013), and Norr and Albanesse (2015) included the anxiety sensitivity in the model, expecting that it would positively predict cyberchondria, together with the two subdimensions of the IU, adjusted for the health anxiety (Norr et al., 2015). The positive prospective IU was not significantly related to the cyberchondria, but the inhibitory IU was, together with anxiety sensitivity and health anxiety. The correlation between inhibitory rather than prospective IU and cyberchondria was also found in other studies (e.g., Zangoulechi et al., 2018). Anxiety sensitivity and IU became especially relevant to cyberchondria in the coronavirus pandemic (Wu et al., 2021). Of course, due to the cross-sectional nature of the study by Wu and colleagues (2021), no strong causal conclusions could be made.

The anxiety sensitivity appeared to be a stronger predictor of cyberchondria than the IU, where only the inhibitory IU remained relevant to the cyberchondria prediction. Authors note the overlap of the two constructs – anxiety sensitivity and the IU; however, where the common aspect they share is the anxiety associated with the unknown (Fergus, 2015). One of the mechanisms examined is a partial mediation of affective responses between IU and cyberchondria, with affective responses denoting negative feelings that can be triggered by IU (Zheng et al., 2020).

However, the relationship between anxiety sensitivity and IU components with cyberchondria appeared to be not so clear, at least at first. In a subsequent study, the aspects of anxiety sensitivity and the IU were not significant predictors after accounting for the effects of age, gender, physical health, health anxiety, and negative affect. Nonetheless, one of the three aspects of metacognitive beliefs, specifically uncontrollable thoughts, was positively related, with a moderate effect, after adjusting for all other variables (Fergus & Spada, 2017). Metacognitive beliefs are here used in the context of health anxiety. The idea of the possible role of metacognition in developing/maintaining cyberchondria stemmed from the metacognitive model of problematic internet use (Fergus & Spada, 2017, 2018). Since PIU and cyberchondria are closely related (Fergus & Dolan, 2014; Fergus & Spada, 2017; Starcevic et al., 2019, 2020), it was reasonable to assume the relation between metacognitive beliefs and cyberchondria. Even though the other two subdimensions of metacognitive beliefs – biased thinking and negative thoughts were not statistically significant predictors of cyberchondria, the authors concluded that the results sported the metacognitive mechanism of cyberchondria (Fergus & Spada, 2017). The authors proposed the possibility that initially, the catalyst for the onset of cyberchondria may be the metacognitive beliefs (most strongly – the uncontrollability of thoughts), rather than the health anxiety, since in previous studies, including a longitudinal one, it was shown that individuals without high levels of initial health anxiety developed cyberchondria over time (Te Poel et al., 2016). Not much later, the conceptualization of cyberchondria was updated by adding the metacognitive element into the conceptualization (Afrin et al., 2022; Fergus & Spada, 2018; Marino et al., 2020; Starcevic et al., 2020).

In short, metacognitive beliefs about the usefulness of health-related thoughts, like the person thinking about their own health, will help them more efficiently cope with anxiety when encountering the triggers associated with health (Marino et al., 2020). On the other hand, beliefs about the danger of health-related thoughts refer to the belief that if one worries about illness, the illness will more likely happen. But how does this fuel the cyberchondria in contrast to the previous kind of metacognitive belief? A person initially searches for health information online believing in the benefits of such behavior, thinking that if he or she does not "complete" the search, the thoughts about a dangerous illness will not go away (Marino et al., 2020).

The amount of information on the internet is growing constantly and exponentially, and although it is extremely difficult to quantify it, there are some approximations (Statista, 2023). The data indexed on popular search engines like Google and Bing is easily accessible. There were estimated to be more than four and a half billion (around 60% of the world's population) active internet users in the world in 2021. What would become important later for this thesis is that it is also estimated that 92.6 percent of users access the internet through mobile devices (Lambert, 2024).

As briefly discussed previously, the medical information found online can benefit both individuals and the public (Vismara et al., 2020). As noted before, vulnerable populations especially are at risk of developing anxiety after searching health-related topics on the internet. Still, an otherwise unsusceptible person can become overwhelmed with the contradicting, unclear, inaccurate, or vague information found online about certain symptoms (Vismara et al., 2020). Many articles found online tend to focus on relatively rare serious diseases, which are likely to catch the reader's attention and facilitate further searching and acquiring information about serious illnesses that are linked to relatively common and often harmless or no very serious symptoms (White & Horvitz, 2009; Vismara et al., 2020). A simple search of a symptom "headache" can lead a person to a text that lists the headache as one of the symptoms of a brain tumor, which then leads to a further search of "headaches in tumor" and so on, increasing the anxiety by connecting this relatively rare condition with a common sensation, such as headache (Aiken et al., 2012; White & Horvitz, 2009).

Starcevic later elaborated on this pattern of behavior, named *escalation* by White and Horvitz, in his model of cyberchondria (Starcevic & Berle, 2013). Both White and Horvitz and later Starcevic indicated that besides the escalation, that is, increased anxiety, the online health information search can result in reassurance or in terminating the browsing session. In the explanation by Starcevic, reassurance occurs when the anxiety level is decreased, and further, browsing is not followed by growing distress (Starcevic & Berle, 2013). White and Horvitz called this scenario *non*-escalation (White & Horvitz, 2009). Abandoning the search session is called avoidance of *further search by Starcevic, and it basically represents the avoidance behavior that is the result of the increased anxiety after the* initial search (Starcevic & Berle, 2013).

The theoretical model of Starcevic and Berle (2013) was further developed and integrated by Brown and colleagues (Brown et al., 2020). They decided to primarily use the term *online health research* (OHR) since, in their opinion, the term "cyberchondria" has been conceptualized in different ways. However, it was later pointed out that the terminology confusion cannot be overcome by ignoring the term under scrutiny (Starcevic, 2020). Anyway, they place a stronger emphasis on the possibility that OHR precedes health anxiety (Brown et al., 2020). The literature review resulted in a "hybrid" model that borrowed some aspects from other existing psychopathology models and incorporated them with the model of cyberchondria by Starcevic and Berle (2013).

This new model distinguishes *normal OHR* from *pathological OHR*. The pathological OHR can be further divided into what the authors called *problematic* OHR and *compulsive OHR*. The former denotes a safety behavior appearing with health anxiety, and it maintains the preoccupation with bodily symptoms and the possibility of getting a serious disease (Brown et al., 2020). The compulsive OHR would be equivalent to cyberchondria, and it signifies the perception of OHR as distressing, difficult to control, and compulsive. Here, the focus is not primarily on a health threat and fear of developing a disease but on "the internet use itself and its impact and implication for the person's mental and physical state…" (Brown et al., 2020, p. 14). However, Starcevic doubts the strong distinctiveness of the problematic and the compulsive OHR and posits the possibility that cyberchondria might contain both kinds of OHR. It can be related to problematic internet use (PIU) as well as hypochondriasis/health anxiety (Starcevic, 2020). Indeed, the strong relationship between cyberchondria and PIU has been shown several times (Starcevic et al., 2019), and the behavioral pattern that both constructs share is compulsion, repetitiveness, and preoccupation with online activity, followed by a feeling of loss of control and difficulty of stopping it (Starcevic, 2020).

Zheng and colleagues (2021) proposed another theoretical model for cyberchondria by incorporating the existing knowledge. The model explains the possible mechanism of the development of cyberchondria, or more precisely, the emergence of online health search behavior in the first stage and the transition from a normal online health information search to cyberchondria in the second stage. The emergence of OHS is influenced by cognitive, emotional, and socio-cultural factors (Zheng et al., 2021). The predictors of OHS include perceived health threat, information insufficiency, online health information seeking, informational subjective norms, and source beliefs. The second stage includes health anxiety and negative metacognitive beliefs, or transition from a normal OHS to cyberchondria when the searches were repeatedly perceived as unsatisfactory (i.e., no reassurance happened), as was described by Starcevic and Berle (2013). This model emphasizes that cyberchondria develops when the internet is used for symptom-checking (Zheng et al., 2021).

5.4 Cyberchondria in the Age of COVID-19

It was mentioned that there was a substantial increase in online health information research (OHR) and cyberchondriatic behaviors during the COVID-19 pandemic. Naturally, the research on the fear of COVID-19, the psychological impact of the pandemic, curfews, and other measures began almost immediately. It was not only the OHR that was increased but also the general problematic internet use, especially certain activities on the internet, such as gaming, gambling, and social networking (Starcevic, Schimmenti, et al., 2020). The general crisis all over the globe helped with the uncertainty and questionable trustworthiness of the information, as well as the difficulty dealing with the information overload, which could lead to the onset of cyberchondria, even among people with no prior amplified health anxiety (Keller et al., 2008; Starcevic, Schimmenti, et al., 2020). Starcevic, Schimmenti, et al., 2020 described the model in more detail. Maybe for the first time in history, we faced an *infodemic* due to unprecedented accessibility and internet speed (Jokic-Begic et al., 2020).

People rely on social media during crises, as described in the example of Twitter and the San Francisco earthquake. However, in the case of COVID-19, it was shown that relying on social media as a source of information led to both increased cyberchondria and information overload (Farooq et al., 2020). Of course, at the beginning of the 2000s, there were far fewer Twitter and internet users than today, and the COVID-19 situation was much more ambiguous than the earthquake situation.

The disturbing news and images overwhelmed the internet. Social media fueled the fear of the new disease even before it appeared in a given country, and much fake news and misinformation was disseminated at tremendous speed (Hadlington et al., 2023; Zhou et al., 2021). The people turned to the internet for reassurance. Still, because of the factors mentioned above (among probably many more), many of them fell into a vicious circle of cyberchondria (Jokic-Begic et al., 2020; Starcevic, Schimmenti, et al., 2020). This problem was recognized by the WHO as well, and the recommendations to fight the infodemic were given (Laato et al., 2020). Information overload was recognized as a significant contributor to cyberchondria even long before the coronavirus pandemic due to the very nature of the internet (White & Horvitz, 2009). However, in the context of the pandemic, a person's trust in online information, the perceived severity of the threat, and the sharing of unverified information online influenced cyberchondria (Laato et al., 2020;

Zheng et al., 2023). Older people prone to cyberchondria tend to take false information as truth and continue searching according to the miscalculated information (Xiang et al., 2023).

Considering the individual subdimensions of cyberchondria, a study showed that cyberchondria's distress and compulsion aspects increased during the pandemic, while the reassurance decreased (Infanti et al., 2023). Imposing the curfew seems to have boosted anxiety safety behaviors and cyberchondria (Jokic-Begic et al., 2020). As for COVID-related anxiety, cyberchondria and health anxiety could be considered risk factors, while the perception of being informed about the pandemic and healthy emotion regulation could be considered protective factors (Jungmann & Witthöft, 2020). Many other studies investigated the specific characteristics of cyberchondria during the pandemic (e.g., Ciułkowicz et al., 2022; Mestre-Bach & Potenza, 2023; Vismara et al., 2020, 2021, 2022; Wu et al., 2021). I found it is important to draw attention to the COVID-19 pandemic context, since all of the data in studies presented in this dissertation was collected from 2020 to 2022, that is, during the pandemic, which had a significant global impact on internet/smartphone use, especially cyberchondria.

An interesting study was conducted on a sample from the population of Serbia, where the importance of the general conspiracy mentality for using pseudoscientific practices (PSP) to prevent COVID-19 was shown. In short, the psychotic-like experience of disintegration was positively related to PSP and negatively to adherence to suggested COVID-19 prevention measures. The mediators of the relationship between disintegration and PSP were thinking styles and conspiracy mentality (Lazarević et al., 2021). The cognitive styles were experiential and rational, and the disintegrations denote the psychotic-like experiences among the non-clinical population, such as paranoia, magical thinking, mania, etcetera (Knezevic et al., 2017).

It was also expected that there would be a rise in various *conspiracy theories* surrounding COVID-19 due to the mentioned unfamiliarity, uncertainty, and information overload related to the pandemic. The connection between the conspiracy theories related to COVID-19 and the adherence to precaution measures and increased use of PSPs has been shown in several studies (Imhoff & Lamberty, 2020; Čavojová et al., 2020; Teovanović et al., 2021), including the opposite direction of the conspiracy beliefs and trust in institutions and adoption of official regulations about COVID-19 (Pummerer et al., 2022; van Mulukom et al., 2022). The lack of control drives both generic and COVID-related conspiracy theories and pseudoscientific beliefs (Šrol et al., 2021).

Furthermore, a study conducted after the pandemic officially ended in Poland showed a positive relationship between cyberchondria severity and utilizing different complementary/alternative medicine (CAM) products or practices (Jędrzejewska et al., 2024), and this relationship was also shown in other studies (e.g., Lamberty & Imhoff, 2018). Complementary or alternative medicine uses methods of unknown (untested) effect or no meaningful effect, which can have both health and financial consequences (Lobato et al., 2014). However, we did not analyze the individual CAM practices but investigated them as a whole. Therefore, we do not imply their effectiveness or harmfulness compared to the conventional medicine recognized in our country – Serbia. A similar could be said for pseudoscientific practices (PSPs) in the sense that we make no judgments about their usefulness. The word "questionable health practices" in our second study's title might be too indicative of CAM/PSP being labeled bad or good.

5.5 Cyberchondria as a Behavioral Addiction

So far, we have shown that cyberchondria has characteristics of obsessive-compulsive disorder and disorders from the anxiety spectrum. Constructs and behaviors included in the genesis and maintenance of cyberchondria are metacognitions, rituals, and difficulty in reacting to stop signals related to online searches (Marino et al., 2020). Furthermore, low self-esteem and pain catastrophizing were proposed as vulnerability factors. The sheer quantity, as well as the qualities of medical information online, such as ambiguity, play an important role in stimulating cyberchondria behavior through information overload and increasing uncertainty. In other words, the internet is often not a good place to look for reassurance regarding health (Volpe et al., 2015).

Since cyberchondria is a repetitive activity performed exclusively on the internet (regardless of the device), the strong connection with problematic internet use (i.e., internet addiction) is strong. Cyberchondria is sometimes classified among "Internet-related psychopathology," together with other problematic activities such as cybersuicide, cyberbullying, cyberstalking, online shopping, online gaming, and cybersex (Starcevic & Aboujaoude, 2015b; Volpe et al., 2015). In the time of writing the article, in 2015, Starcevic and Aboujaoude noted the caveats of classifying all these technology-related problematic behaviors as new technology (internet) addiction diagnoses without previously examining a possible primary, already existing psychopathology in an individual who expresses through various online activities, including compulsive health information search (Flayelle et al., 2022; Starcevic & Aboujaoude, 2015b). However, later in 2020, as already mentioned, cyberchondria was proposed as a clinically relevant and distinct syndrome (Vismara et al., 2020).

The debate is still ongoing concerning the conceptualization of the mentioned aberrant technology-related behaviors as *behavioral addictions*. Brown and colleagues hinted that OHR could be looked at as a behavioral addiction, as compulsive or problematic internet use (Brown et al., 2020; Khazaal et al., 2021). It was also hinted to Starcevic that cyberchondria might be considered an addictive activity (Starcevic & Aboujaoude, 2015a). Various researchers assumed that cyberchondria could have addictive characteristics or even be considered an addictive disorder due to its link to PIU (internet addiction). This idea has been formally conceptualized through the Interaction of the Person-Affect-Cognition-Execution model, which attempts to explain the addictive processes (I-PACE; Brand et al., 2019) in the context of specific internet behaviors and disorders. However, more empirical evidence is needed to categorize cyberchondria as behavioral addiction (Mestre-Bach & Potenza, 2023).

6 Study 1: Psychometric Properties of the Serbian Smartphone Application-Based Addiction Scale (SABAS) and Validation of the English Version Among Non-native English Speakers[1]

6.1 Introduction

6.1.1 Problematic Smartphone Use and Smartphone Addiction

Smartphone addiction (SA) and problematic smartphone use (PSU) have been recognised as an important and clinically relevant area for research and a growing public health concern (Lopez-Fernandez et al., 2017). Although SA and PSU are frequently used as synonyms (Busch & McCarthy, 2021), some scholars prefer the use of PSU because it does not imply the addictive nature of this behaviour and does not contain diagnostic labelling (Panova & Carbonell, 2018). Irrespective of terminology, it should be noted that although SA has not yet been considered as a formal diagnostic disorder in Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013) criteria for smartphone addiction have been suggested (Y.-H. Lin et al., 2016).

Problematic smartphone use in its most extreme form can be defined as "a behavioral addiction including the core components of addictive behaviours, such as cognitive salience, loss of control, mood modification, tolerance, withdrawal, conflict, and relapse" (Billieux et al., 2015a, p. 157). These components come from the *addiction components model* that posits that all addictions, whether substance-based or behaviour-based, consist of these key components (Griffiths, 2005). In the context of PSU, salience refers to the cognitive, emotional, and affective dominance of smartphone use in an individual's life. Mood modification refers to engaging in smartphone use for its arousing or calming effect, including avoidant coping mechanisms (e.g., Cho, 2020). Tolerance indicates the need to increase the frequency and duration of smartphone use over time to

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[1] Vujić, A., Volarov, M., Latas, M., Griffiths, M. D., & Szabo, A. (2023). Psychometric Properties of the Serbian Smartphone Application-Based Addiction Scale (SABAS) and Validation of the English Version Among Non-native English Speakers. *International Journal of Mental Health and Addiction*. https://doi.org/10.1007/s11469-023-01013-1. All authors have consented to include the article in the dissertation.

reach the effects that the same behaviour induced previously. Withdrawal refers to negative psychophysiological symptoms that occur when activity is stopped or abruptly decreased. Conflict denotes conflicts resulting from smartphone use, which can be intra- or interpersonal (e.g., a conflict with family members and/or occupational/educational activities due to smartphone use). Lastly, relapse refers to the rapid recurrence of previous patterns of smartphone use after a period of abstinence to the same or even higher intensity than before (Griffiths, 2005).

Recent authors consider PSU and SA to represent two different points on the same continuum, with SA lying at the upper end (a conceptualisation that is in line with McMurran's idea [1994] of the severe use-to-abuse spectrum). This differentiation between PSU and SA may be necessary because all smartphone addicts are problematic smartphone users, but not all problematic smartphone users are addicted to smartphones (Griffiths, 2016). In addition, Griffiths and others claim that the resulting detrimental consequences of behaviour distinguish addiction from excessive nonpathological behaviour (Griffiths, 2005; Szabo & Demetrovics, 2022).

For example, those who use their smartphones excessively tend to report higher levels of depression, anxiety, stress (Elhai et al., 2017), and sleep disturbances (Sohn et al., 2019; Thomée et al., 2011). Additionally, PSU can result from poor coping mechanisms where individuals use their smartphones as a distraction from negative feelings and experiences (Cho, 2020). Finally, PSU can put individuals in life-threatening situations, such as those caused by using a smartphone while driving (Barkana et al., 2004; White et al., 2004). Although the present study focuses on validating the Serbian translation of the SABAS, which contains the term "addiction" in it, the authors perceive the SABAS as a measure of problematic behaviour that could put individuals at risk for SA. In fact, increasing scores on this instrument can be conceptualised as representing a higher PSU and therefore a higher risk of – or susceptibility to – smartphone addiction.

6.1.2 The Assessment Of Smartphone Addiction/Problematic Smartphone Use

To date, numerous instruments assessing SA/PSU have been developed (e.g., Problematic Mobile Phone Use Questionnaire [PMPUQ]; Billieux et al., 2008; Smartphone Addiction Scale [SAS]; Kwon et al., 2013; Smartphone Addiction Inventory [SPAI]; Y.-H. Lin et al., 2014), but many of those do not have any theoretical framework underpinning the items. For example, many scales have content derived from DSM criteria for gambling or substance use disorders (Flayelle et al., 2022; Harris, Regan, et al., 2020), suffer from specific shortcomings, as pointed out in previous reviews (Ellis et al., 2019; Harris, Regan, et al., 2020), and do not have satisfactory reliability, and their test-retest reliability often remains unreported (Harris, Regan, et al., 2020). Also, scales that assess SA/PSU usually correlate weakly with objectively measured rapid phone checking, which could be closely related to behavioural addiction (Ellis et al., 2019).

In general, most of these instruments are poor predictors of the objective indices of technology use in terms of patterns of use (such as phone checking and notification receiving) and usage frequency (Ellis et al., 2019). However, it could also be argued that a poor correlation between SA/PSU and use frequency exists because frequent use does not always mean problematic/addictive use (Emanuel et al., 2015). On the one hand, an individual can spend an extended amount of time using a smartphone, but their activities may be focused on fulfilling a concrete (e.g., a work-related) task, and therefore less interfering with everyday life (see De-Sola Gutiérrez et al., 2016; Tossell et al., 2015). On the other hand, an individual can use a smartphone maladaptively as a coping mechanism for a particular underlying psychological problem or need (Kardefelt-Winther, 2014, 2017).

The development of SABAS items was grounded by adapting six items from the Exercise Addiction Inventory (Griffiths, Szabo, & Terry, 2005) to fit PSU/SA, with each item representing one component of the addiction. According to Yu and Sussman (2020), items from the Smartphone Addiction Inventory (SPAI; Y.-H. Lin et al., 2014) and the Korean Smartphone Addiction Proneness Scale for Youth (SAPS; Kim et al., 2014) could also probably assess the components of addiction from Griffiths' model. However, unlike SABAS, these scales were not explicitly derived from the components model, rather they were either based on the DSM-5 (APA, 2013) criteria or on previous scales and findings and have considerably more items than the SABAS.

Originally developed in Hungarian as a screening tool for SA in children (Csibi et al., 2016), the SABAS has subsequently been validated on adult population samples in different languages, such as English (Csibi et al., 2018; Mason et al., 2022), Chinese (Chen et al., 2020; Yam et al., 2019), Italian (Soraci et al., 2021), Persian (C.-Y. Lin et al., 2019), Turkish (Gökler & Bulut, 2019), Bangla (Islam et al., 2021), Indonesian (Nurmala et al., 2022), and Arabic (Vally & Alowais, 2022). The English version has been used previously in studies where participants were not strictly native English speakers (e.g., Csibi et al., 2018). The results of these studies have suggested the unidimensionality of the scale, as well as good reliability and validity. However, some findings have questioned its temporal stability (Harris, Regan, et al., 2020). To date, no studies have examined the characteristics of the Serbian version of the scale. A Serbian translation of the SABAS was used in one study in the Serbian language (Sojević et al., 2018). However, the psychometric properties (apart from Cronbach's α) were not presented. Additionally, the translation procedure did not include a back translation process, and the study was conducted exclusively on university students. Therefore, in this study, the SABAS was retranslated using back translation procedure and validated using a sample from the general Serbian population.

6.1.3 The Present Study

The present study comprised two studies. The goal of Study 1 was to evaluate the factor structure of the SABAS translated into the Serbian language, including item analysis, convergent validity, and test-retest reliability. The goal of Study 2 was to evaluate the English version of the SABAS completed by English-speaking Serbian participants and to compare it with the Serbian version. The Serbian SABAS was expected to have a one-factor structure and there would be good (i) internal consistency, (ii) test-retest reliability, and (iii) convergent validity, divergent validity, and (as a consequence) good construct validity. More specifically, it was expected that there would be a strong positive correlation between the SABAS and the short version of the Smartphone Addiction Scale (SAS-SV) scores, as both scales assess the same construct. It was also expected that there would be a moderate positive correlation of the SABAS score with depression and anxiety, based on previously published research (e.g., Elhai, et al., 2017), as well as a moderate positive correlation with entertainment use (van Deursen et al., 2015; Zhang et al., 2014), and a positive relationship with smartphone use duration (Haug et al., 2015). Lastly, we expected that there would be a positive relationship between the SABAS scores and the two aspects of worry (i.e., severity and control). This is because worry is closely related to the aforementioned symptoms of anxiety and depression and has been directly investigated in the context of SA/PSU (Elhai et al., 2019).

To get some insight into the divergent validity of the SABAS, the study compared the correlation of the SABAS scores with 'entertainment smartphone use' and with 'productive smartphone use'. It was expected that there would be a significantly stronger relationship between SABAS and entertainment use than with productive use. This is based on the aforementioned findings that the use of smartphones for entertainment is related to the problematic use of smartphones, whereas focused use on concrete tasks and productive goals (such as education and the achievement of social connectedness) is not related to PSU and can have positive psychosocial effects (see De-Sola Gutiérrez et al., 2016; Horwood & Anglim, 2019). The study also examined the ability of the SABAS to differentiate between low and high-average smartphone use. It was expected that the high-use group would have significantly higher scores on the SABAS than the low-use groups (Tosseell et al., 2015). Finally, the participants were classified into 'normal to mild' and 'moderate to extremely severe' anxiety and depression groups, respectively, and their differentiation concerning their SABAS scores was tested. It was expected that the 'moderate to extremely severe' group in both anxiety and depression would have significantly higher scores on SABAS than the 'normal to mild' groups.

Study 2 examined whether the English version of the SABAS scale could also be used to screen the risk of SA among non-native English speakers, in this case, among participants whose first language was Serbian but who reported having a good command of English. It was expected that the English SABAS would have good psychometric properties, including internal consistency and unidimensionality.

6.1.4 Part 1: Method

6.1.4.1 Sample and Procedure

A convenience sample was recruited from the general Serbian population using social media (e.g., Facebook) and instant messaging applications (e.g., Viber, WhatsApp), which were used to provide a link to the survey. Participants were required to be 18 years or older and smartphone users. Data were collected in two phases. Data from the first phase (T1) were collected at the end of January 2022 using the Qualtrics platform (Qualtrics, 2022). In total, 600 participants completed the survey in T1 (M_{age} = 39.82 years, *SD* = 10.87; 57.93% female). There were no missing data values. During data cleaning, one participant was identified as being under 18 years of age and was therefore excluded. The final sample comprised 599 participants. More than a third of the participants had a university or college degree (41.40%), 23.37% had a master’s degree, and 5.51% had a Ph.D. Approximately a quarter of the participants had graduated from high school (23.04%), and 6.34% were university or college students at the time of data collection. Two participants only finished elementary school.

For those who agreed to participate in the second phase of Study 1, a survey link was automatically sent to an individual (via Qualtrics) three weeks after they completed the first phase to collect retest data (T2 data). The responses were matched using an ID code that the participants generated themselves. A total of 377 participants initially agreed to participate in the retest, although only 201 participants completed it. Since not all T2 data matched the T1 data due to invalid ID codes, only 189 responses provided valid test and retest data (62.43% female).

6.1.4.2 Ethics

Informed consent was obtained from all participants included in the study. Ethical permission for the study was obtained from the first author’s university Research Ethics Board (2021/608). Participation was completely anonymous and voluntary. Those who agreed to participate in the retest were presented with the General Data Protection Regulation (GDPR) document because they had to provide their email address. No material compensation was provided for participating in the study. Participants were informed that they could withdraw from participation without any consequences.

6.1.4.3 Instruments

Smartphone use questions. Participants were asked to estimate their daily use of smartphones on a typical weekday and a typical weekend in hours (similar to Kwon et al. [2013] and Nikolic et al. [2022]). Prior to conducting *t*-tests where "high" and "low" smartphone use groups were compared to the SABAS scores, weekday use was multiplied by five, and weekend use was multiplied by 2, the two products were added up and divided by seven, to get the daily average time spent on smartphones. In addition, two questions were asked to assess the frequency of smartphone use for specific purposes (i.e., entertainment, boredom, leisure), as well as the use of smartphones to fulfil concrete tasks (i.e., work, finances, and communication). The answers were given on a scale from 1 (almost never) to 7 (almost always) See Appendix A for the actual questions.

Smartphone Application-Based Addiction Scale (SABAS; Csibi et al., 2018). The six-item Serbian version of the SABAS was used to assess the risk of smartphone addiction (SA). The translating procedure was broadly based on the protocol suggested by Beaton et al. (2000). More specifically, the SABAS items were translated from English to Serbian by a certified English language teacher and an English language and literature graduate. The authors compiled a single version from these two translations, then back-translated to English by a third bilingual individual who had not previously seen the original items. The meaning of the elements in the back-translated version did not substantially change from the original version. Finally, the authors made slight changes according to their expertise and created a final version of the Serbian SABAS. Items are rated on a six-point response scale from 1 (strongly disagree) to 6 (strongly agree), and a higher score on the scale (out of 36) indicates a greater risk of SA. The SABAS items in Serbian and English language are shown in Appendix B.

Smartphone Addiction Scale Short Version (SAS-SV; Kwon et al., 2013; Serbian version: Nikolic et al., 2022). The ten-item Serbian translation of the short version of the SAS was used to assess the risk of smartphone addiction. Items are rated on a six-point response scale from 1 (strongly disagree) to 6 (strongly agree). Cronbach's alpha of the SAS-SV scale in the present study was very good ($\alpha = .88$).

Depression Anxiety Stress Scale (DASS-21; Lovibond & Lovibond, 1995; Serbian version: Jovanovic et al., 2014). This instrument is a 21-item measure typically used to assess symptoms of depression, anxiety, and stress, in both clinical and nonclinical settings. In the present study, only the depression and anxiety subscales were used, comprising 14 items (seven items each). Participants are instructed to rate the presence of symptoms they experienced during the last seven days, using a four-point response scale from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). Cronbach's alpha of the two subscales in the present study were very good (depression: $\alpha = .88$; anxiety: $\alpha = .81$).

Worry. Two questions were formulated for the purpose of the present study to assess two components of worry (i.e., Hirsch & Mathews, 2012; Hirsch et al., 2013), namely, worry severity ("On a scale from 1 to 5, indicate how much you usually worry") and perceived control over worrying (e.g., "I feel like I usually do not have control over how much I worry"). The items were rated on five-point response scales, with higher scores indicating higher intensity of worry and the lower perceived control over worry, respectively.

6.1.4.4 Data Analysis

Both exploratory factor analysis (EFA), with principal axis factoring (a recommended method when multivariate normality is violated [Costello & Osburne, 2005]), and confirmatory factor analysis (CFA) were performed on two randomly selected subsamples, using a pseudorandom number generator to select the cases from the data. Each subsample consisted of approximately 50% of the sample. The number of factors in EFA was determined using minimum rank parallel analysis, the Guttman-Kaiser criterion, and the scree diagram. Loadings >.50 were considered acceptable (Hair et al., 2010). The model fit in CFA was considered acceptable if $\chi 2$ was insignificant, and the comparative fit index (CFI) and the Tucker-Lewis index (TLI) were >.90, and the root mean square error of approximation (RMSEA) and the standardised root mean square residual (SRMR) were <.08 (Hu & Bentler, 1999). Parameters were estimated using robust maximum likelihood (MLR) due to the nonnormal multivariate distribution of the items.

The mean inter-item correlation (MIC) squared multiple correlations (SMC), and corrected item-total correlations were calculated as a measure of item discrimination. The corrected item-total correlation and SMC both represent how well an item is related to the rest of the items. Corrected item-total correlation should be >.30 (Field et al., 2012), and for SMC values >.20 can be considered acceptable (see Dinić, 2019). Finally, Cronbach's α if the item is deleted, was computed. Additionally, convergent validity was assessed using Pearson's correlation coefficient *r*. Divergent validity was assessed by testing the difference in the correlations between the SABAS score and entertainment use and productive use, using the test of dependent correlations difference (Steiger, 1980). The internal consistency of the SABAS was assessed with Cronbach's α and ωtotal. The composite reliability (CR) and the average variance extracted (AVE) were also computed. Test-retest reliability was determined with the r and intra-class correlation coefficient (*ICC*, two-way mixed effects, single measure, absolute agreement). An *ICC* of .75 indicates good test-retest reliability (Koo & Li, 2016). To examine the ability of the scale to discriminate between "normal to mild" and "moderate to extremely severe" levels of anxiety/depression, *t*-tests with SABAS score as the outcome measure used.

Regarding depression, participants were classified into the first group if they scored ≤13 ("normal to mild") points and into the second group if their score was >14 ("moderate to extremely severe"). As for anxiety, the cut-off for the first group was ≤9 ("normal to mild"), and for the second group was >10 ("moderate to extremely severe"). These scores are comparable to the scores obtained with DASS-42, since they were multiplied by two (Lovibond & Lovibond, 1995). Furthermore, a *t*-test was used to test the difference between the "low" average weekly smartphone use group, which comprised 151 participants (25% of the lowest scores on average smartphone use) and the "high" smartphone use group (25% of the highest scores on average smartphone use), which comprised 160 participants. Finally, to check for the gender differences among variables, a series of *t*-tests was used with adjusted significance levels, and Cohen's *d* measures of effect size.

Data were analysed in R programming language (R Core Team, 2021) using "tidyverse" (Wickham et al., 2019), "lavaan" (Rosseel, 2012), "psych" (Revelle, 2022), "rstatix" (Kassambara, 2021), "dlookr" (Ryu, 2022), "irr" (Gamer & Lemon, 2019), "semTools" (Jorgensen et al., 2021), "semPlot" (Epskamp, 2022), "stringdist" (van der Loo, 2014), "fuzzyjoin", "EFA.MRFA" (Navarro-Gonzalez & Lorenzo-Seva, 2021), "mvnormalTest" (Zhang et al., 2020), "MVN" (Korkmaz et al., 2014), and "diffcor" (Blötner, 2022) packages. The data, including the test-retest data and the R analysis code, are available upon request from the corresponding author.

6.1.5 Part 1: Results

6.1.5.1 Descriptive Statistics

The descriptive statistics, along with the gender differences, are shown in Table 6.1. Gender differences were found in SABAS scores, anxiety, and worry severity, with females scoring higher than males on all three scales. Considering the univariate distribution, the SABAS scores were right-skewed. Still, their distribution did not significantly deviate from the normal distribution since the skewness and kurtosis values were within the acceptable range of ±1.0 (George & Mallery, 2020). Anxiety and depression scores were highly right-skewed, meaning that only a small number of participants exhibited higher scores on the two scales. This is to be expected since the sample was drawn from a non-clinical population. As for multivariate normality of the SABAS items, both Mardia's test (multivariate skewness was 330.91, $p < .001$, and multivariate kurtosis was 4.70, $p < .001$) and Henze-Zirkler test ($HZ = 4.96$, p < .001) indicated the violation of this assumption. No multicollinearity among SABAS items was found, since no inter-item correlation was >.80, and the determinant of the item correlation matrix was 0.164, and therefore greater than 0.00001 (Field et al., 2012).

Table 6.1

Descriptive statistics of the total sample (N = 599), male subsample (n = 252) and female subsample (n = 347) with mean differences and effect sizes

Scale	Total		Males		Females		*t* (*df*)	*d*
	M	*SD*	*M*	*SD*	*M*	*SD*		
SABAS	15.77	5.67	15.06	5.79	16.28	5.53	-2.59(526)*	-0.21
SAS-SV	22.33	8.76	21.80	9.17	22.71	8.45	-1.23(514)	-0.10
Entertainment	5.10	1.39	5.07	1.39	5.13	1.39	-0.52(542)	-0.04
Productive	5.74	1.33	5.63	1.42	5.82	1.26	-1.61(501)	-0.13
Weekday use	3.89	2.40	3.90	2.43	3.88	2.38	0.08(534)	0.01
Weekend use	4.47	3.02	4.52	3.19	4.44	2.89	0.32(501)	0.03
Anxiety	2.90	3.10	2.44	2.76	3.24	3.28	-3.27(584)**	-0.27
Depression	3.39	3.84	3.29	3.80	3.46	3.88	-0.55(547)	-0.05
Worry severity	3.29	1.00	3.11	0.97	3.43	1.00	-3.87(551)**	-0.32
Worry control	2.57	1.22	2.47	1.18	2.65	1.24	-1.81(558)	-0.15

Note. *p*-values were adjusted using Benjamini-Hochberg method. *M* = mean score; *SD* = standard deviation; *d* = Cohen's *d* effect size. SABAS = Smartphone Application-Based Addiction Scale; SAS-SV = Smartphone Addiction Scale – Short Version; Entertainment = entertainment use of smartphones; Productive = productive use of smartphone.
*$p < .05$. **$p < .01$.

6.1.5.2 The structure of the SABAS

The sample was randomly split, and 300 participants were included in the EFA. The Kaiser-Meyer-Olkin coefficient was good (*KMO* = .81), and the Bartlett's sphericity test was significant, $\chi^2(15) = 507.38$, $p < .001$, suggesting that the data were adequate for factor analysis (Field et al., 2012). The minimum rank parallel analysis, the Guttman-Kaiser criterion, and visual inspection of the scree diagram indicated that only one factor should be extracted. The single factor explained 41.3% of the variance of the original data. All loadings in the pattern matrix were >.50, except for Item 1, which was >.40.

The CFA was conducted on the second half of the sample (*N* = 299). Six items loaded onto a single factor, representing smartphone addiction. However, several problems emerged during both the global and local model fit inspection. The model fit was as follows: $\chi^2(9) = 41.95$, p < .001, CFI = .928, TLI = .881, RMSEA = .122, and SRMR = .046. The χ^2 fit index is highly dependent on sample size, so it was no surprise that it was significant for this model. The CFI and SRMR showed an acceptable fit. Still, TLI and RMSEA were not in an acceptable range, which raised concerns. One reason for this could be the sample size, but in the CFA, the sample was not too small. Furthermore, models with small degrees of freedom tend to have an inflated RMSEA (Kenny et al., 2015). On the other hand, the TLI is largely dependent on the size of the correlations between the observed variables in the model. However, it could not be determined whether this caused the TLI to be below the threshold. Therefore, the analysis relied on inspection of local misfit and modification indices. Item 1 had high standardised residuals with other items, all z > |2| (except with Item 4). The standardised residuals of Item 4 with Items 5 and 6 were also high. In contrast, SRMR still indicated an acceptable discrepancy between observed and model-implied covariance. Modification indices suggested that allowing the errors of Items 1 and 5 and Items 4 and 6 to correlate would improve the model fit.

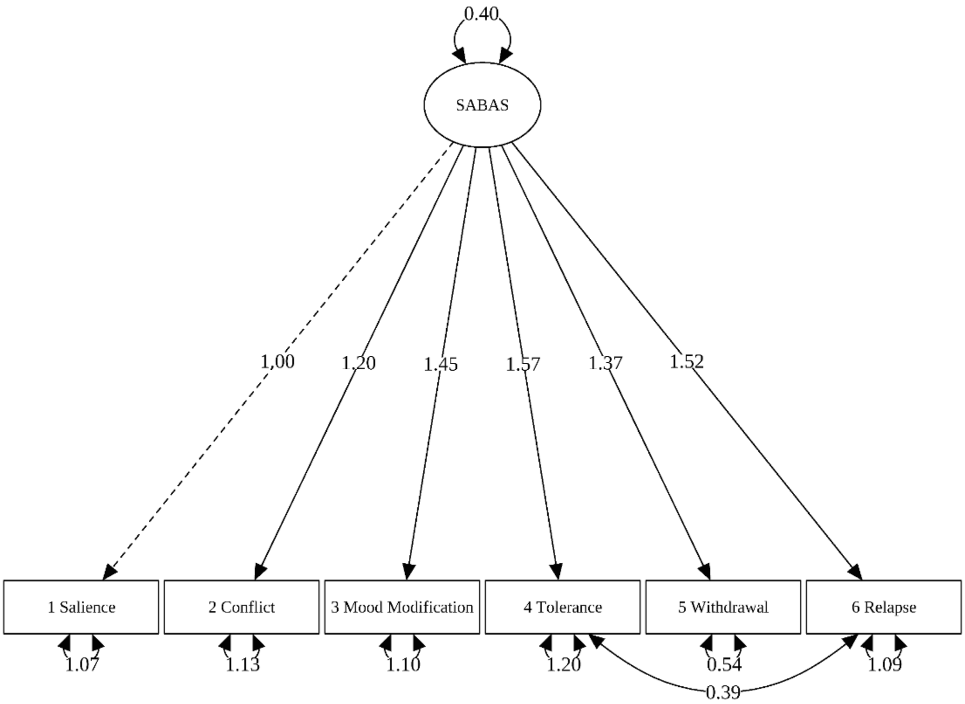

Figure 6.1. Serbian SABAS Modified Model with Unstandardised Coefficients.

The modification index (MI) was highest for the correlated errors of Item 1 and Item 5 (MI = 21.04). The next highest MI was for Item 4 and Item 6 pairing (MI = 20.23). In addition, the expected parameter change (EPC) was the highest for this pair of items. Therefore, the model was modified by allowing the errors of items 4 and 6 to correlate since they could be mutually more related than the other items. They seemed to reflect increased smartphone use over time, followed by reduced control over smartphone use. The correlation of the two items' errors was r = .34. Table 6.2 shows standardised loadings and commonalities of EFA, and standardised loadings and R^2 of the modified CFA model. The fit indices of the modified model were: $\chi^2(8) = 25.53$, p = .001, CFI = .961, TLI = .926, RMSEA = .096, and SRMR = .042. The modified model, with unstandardized parameters, is presented in Figure 6.1.

Table 6.2

Results of the exploratory factor analysis and modified model of the confirmatory factor analysis of items in the Smartphone Application-Based Addiction Scale

Item	Addiction component	EFA (N = 300)		CFA (N = 299)		
		Std. loading	Communality	Std. loading	*S.E.*	R^2
1	Salience	.44	.19	.52	-	.27
2	Conflict	.54	.29	.58	.15	.34
3	Mood modification	.66	.44	.66	.23	.43
4	Tolerance	.73	.54	.67	.23	.45
5	Withdrawal	.65	.42	.76	.14	.58
6	Relapse	.78	.60	.68	.22	.46

Note. All parameters in the CFA were significant at $p < .001$. Std. loading = standardised loading; *S.E.* = Standard error.

All standardised loadings were >.50 in the modified model, satisfying previously established criteria (Hair et al., 2010). Item 1, reflecting the salience aspect of addiction, performed weakly since it had the lowest loadings in both EFA and CFA, communality, and the proportion of explained variance by the latent factor. Nevertheless, it was concluded that the unidimensionality of the Serbian translation of the SABAS was supported.

6.1.5.3 Item Analysis and Reliability of the Serbian SABAS

Item 1 had the lowest corrected item-total correlation while still being acceptably high. Item 1 and Item 2 had the SMC, indicating that those two were less correlated with the remaining items. The mean average response on items was 2.63 (*SD* = 0.94), which is lower than the theoretical mean (*M* = 3.5). This finding means that, in general, participants tended to agree less with the items. Item 5 appeared to be the "most difficult", and Item 4 the "easiest" (Table 6.3). However, "the easiest" item on the scale had the average response closest to the theoretical mean. The internal consistency of SABAS was characterised as "very good", with the Cronbach’s alpha being $\alpha = .81$ and $\omega_{total} = .81$. The MIC was .41, which lies in the range from .20 to .50, suggesting that the scale was homogenous (Clark & Watson, 1995). Average variance extracted (AVE) calculated for the 299 participants from the T1 sample (a subsample used to carry out CFA) was .45, while it was .44 for the whole sample (*N* = 599) which suggests that the item variance was not well explained by the SA latent variable. The CR was .82 (*N* = 299), indicating good internal consistency (Fornell & Larcker, 1981; Lam, 2012).

Table 6.3

Inter-item correlations and item statistics of the Smartphone Application-Based Addiction Scale (N = 599)

Item	Correlation					*M*	*SD*	Item-total	*SMC*	α if deleted
	1	2	3	4	5					
1	1					2.44	1.18	.42	.22	.81
2	.32	1				2.22	1.35	.50	.25	.79
3	.23	.35	1			3.15	1.40	.57	.38	.78
4	.32	.40	.54	1		3.25	1.50	.65	.48	.76
5	.42	.38	.47	.42	1	2.11	1.12	.62	.42	.77
6	.30	.39	.48	.61	.54	2.60	1.35	.66	.48	.76

Note. All correlations were significant at $p < .001$ (adjusted using the Benjamini-Hochberg method). Item-total = corrected item-total correlation; *SMC* = squared multiple correlation; α if deleted = α if item is removed from the scale.

The test-retest reliability was assessed with 189 participants, as described in the Method section. The intra-class coefficient suggests good reliability, *ICC* (3,1) = .795, 95% CI [.731, .844], $F(188, 149) = 9.1$, $p < .001$. Pearson correlation between SABAS scores at T1 and T2 was $r = .803$, $p < .001$, 95% CI [.745, .848], again indicating good test-retest reliability of the scale.

6.1.5.4 Convergent and Divergent Validity of the Serbian SABAS

To examine the convergent validity of SABAS, correlations with SAS-SV, anxiety, depression, entertainment use, and worry aspects were calculated (Table 6.4). As expected, the SABAS had the highest correlation with the SAS-SV, indicating that the two scales shared approximately 62% variance. Next, SABAS score and entertainment smartphone use correlated strongly and positively, while the correlation with productive use was much lower, although still significant. The correlations of the SABAS score with hours used during a typical weekend and a typical weekday were positive and moderate, with the relationship slightly higher with the duration of smartphone use during the weekend. The correlations between SABAS scores and anxiety and depression scores were also positive and moderate. As expected, the correlation of SABAS scores with worry severity and perceived control over worry was somewhat lower and could be described as low and positive. In addition, SABAS and SAS-SV scores showed a very similar pattern of correlations with other measures. The scores on the SABAS correlated significantly higher with entertainment smartphone use, than with productive use (Z = 8.90, p < .001).

Table 6.4

Pearson correlations of Smartphone Application-Based Addiction Scale, Smartphone Addiction Scale–Short Version, smartphone duration use, and purpose of use, anxiety, depression, and aspects of worry (N = 599)

	1	2	3	4	5	6	7	8	9
1 SABAS	1								
2 SAS-SV	$.79^{***}$	1							
3 Weekday	$.33^{***}$	$.40^{***}$	1						
4 Weekend	$.39^{***}$	$.44^{***}$	$.64^{***}$	1					
5 Entertainment	$.52^{***}$	$.53^{***}$	$.44^{***}$	$.47^{***}$	1				
6 Productive	$.16^{***}$	$.15^{***}$	$.21^{***}$	$.19^{***}$	$.40^{***}$	1			
7 Anxiety	$.31^{***}$	$.35^{***}$	$.18^{***}$	$.20^{***}$	$.23^{***}$	.03	1		
8 Depression	$.29^{***}$	$.28^{***}$	$.09^{*}$	$.10^{*}$	$.16^{***}$	-.06	$.71^{***}$	1	
9 Worry severity	$.20^{***}$	$.22^{***}$	$.14^{***}$	$.14^{**}$	$.23^{***}$	$.11^{**}$	$.43^{***}$	$.35^{***}$	1
10 Worry control	$.24^{***}$	$.28^{***}$	.07	$.09^{*}$	$.21^{***}$	.02	$.52^{***}$	$.49^{***}$	$.67^{***}$

Note. *p*-values were adjusted using the Benjamini-Hochberg method; SABAS = Smartphone Application-Based Addiction Scale; SAS-SV = Smartphone Addiction Scale – Short Version; Entertainment = entertainment use of smartphones; Productive = productive use of a smartphone; Worry severity = the excessiveness of worrying; Worry control = perceived control over worrying.

Moderate differences in SABAS scores were observed between the two anxiety and depression groups (Lovibond & Lovibond, 1995). "Normal to mild" depression group (N = 498) had a mean score of 15.10 (SD = 5.51) on the SABAS, which was significantly lower compared to the "moderate to extremely severe" group (N = 101), which had a mean score of 18.80 (SD = 5.48), $t(144) = 6.14$, $p < .001$, $d = 0.67$. As for anxiety, the first group (N = 457), had a mean score of 15.0 (SD = 5.56) on average, while the second group (N = 142) had a mean score of 18.30 (SD = 5.24), which were also significantly different, $t(247) = 6.55$, $p < .001$, $d = 0.62$. Additionally, the "high" smartphone use group (N = 160), had a mean SABAS score of 18.5 (SD = 5.67), which was significantly higher than the "low" smartphone use group (N = 151) average of 12.7 (SD = 4.93), $t(307) = 9.71$, $p < .001$, with a large effect size, $d = 1.10$.

6.1.6 Part 1: Discussion

Analysis showed that the structure of the SABAS is unidimensional, based on both EFA and CFA analyses. The global fit of the Serbian SABAS was somewhat weak, and a modification needed to be imposed. Errors in Item 4 ("Over time, I fiddle around more and more with my smartphone.") and Item 6 ("If I try to cut the time I use my smartphone, I manage to do so for a while, but then I end up using it as much or more than before.") were allowed to correlate since there is a specific similarity in the content of both items. The similarity of the content between the two items may be more obvious in the Serbian version of the scale. They corresponded with the tolerance and relapse aspects of the addiction, and both items might reflect the decreasing control over smartphone use over time. It should also be noted that in the Arabic study of the SABAS, two pairs of item errors were allowed to correlate (Items 2 and 5, and Items 5 and 6) to improve the fit, and the authors concluded that the unidimensionality was supported (Vally & Alowais, 2022).

The latent variable of smartphone addiction explained the most variance in Item 5, referring to withdrawal symptoms, followed by relapse, tolerance, and mood modification. Exploratory factor analysis indicated that smartphone addiction was best defined by relapse, tolerance, and mood modification, followed by withdrawal. The results of both EFA and CFA suggest that salience and conflict components play a less significant role in defining the construct. It is possible that these two items do not reflect impairing aspects of smartphone use, as do items referring to withdrawal or relapse, for example. Thinking about a smartphone as a particularly important thing in one's life could be considered commonplace nowadays since it makes a broad range of activities possible or much easier to perform. This is not necessarily related to functional impairment.

Similarly, conflicts that arise from because of an individual's smartphone use could be rare nowadays, since peers, elders, and younger individuals use smartphones often in their social circles. If conflicts caused by smartphone use occur, they are probably not very serious or damaging to an individual. The results further suggest that in the Serbian version, there is a considerable covariance between tolerance and relapse that the latent factor could not explain, which resulted in allowing residuals of the items to covary.

Despite the need for model modification, SABAS appears to be a short, reliable, and valid measure for screening the risk of smartphone addiction (i.e., problematic smartphone use). The Serbian translation of the SABAS showed good psychometric properties, including internal consistency, test-retest reliability, homogeneity, and convergent validity. There is also some evidence supporting divergent validity, primarily reflected in a stronger relationship of the SABAS with entertainment use than with productive use. As expected and consistent with previous studies, the SABAS score was closely related to the SAS-SV total score, which is a valid and reliable measure of SA (Harris, McCredie, et al., 2020).

Furthermore, in line with expectations and the results of previous studies (e.g., Elhai et al., 2017), SABAS scores were moderately and positively related to anxiety and depression, supporting the convergent validity of the scale. The difference in SABAS scores between the lower and higher anxiety/depression groups could be in line with the compensatory internet use theory (Kardefelt-Winther, 2014). Individuals may engage in internet use (or, in this case, smartphone use) to relieve negative moods, and if the motivation to use a certain technology is rooted in escaping real-life problems or compensating for unmet needs, an individual would likely increase the use of technology, for the compensation to take effect (Kardefelt-Winther, 2014). Unfortunately, this coping style maintains and aggravates emotional problems, which can lead to SA/PSU.

Next, correlations of weekday and weekend use in hours with SABAS were similar to correlations of those measures with the SAS-SV in the present study as well as in previous studies (e.g., Nikolic et al., 2022). The moderate strength of the relationship between SA/PSU and the duration of use supports the aforementioned assumption that the frequency or duration of use is not crucial in determining the SA/PSU. Despite this result, in accord with the previous findings, individuals with higher smartphone use also had higher SABAS scores (Tossell et al., 2015), suggesting the scale's ability to discriminate between low and heavy smartphone users. Finally, females had a slightly more pronounced risk of smartphone addiction than men, concurring with findings of previous studies (e.g., De-Sola Gutiérrez et al., 2016).

6.1.7 Part 2: Method

6.1.7.1 Participants

The English SABAS data were originally collected for the study on hedonic smartphone use (reference is temporarily withdrawn for anonymity). Data initially contained 410 responses collected online from English-speaking participants from various countries, but the majority were from Serbia (*N* = 335, 81.7%), and only these data were included in the study. Therefore, the English language was not the participants' native language, but they were required to have a good command of English to participate in the research. In addition, participants were required to be smartphone users and be at least 18 years old. The mean age of this sample was 32.73 years (*SD* = 11.09), and the additional demographic characteristics are presented in Table 6.5. The participants were recruited online, using Qualtrics (Qualtrics, 2022) platform, by sharing the link to the questionnaire on various social networks.

Table 6.5

Demographic characteristics of the sample in Study 2 (N = 335)

Variable	Category	%
Gender	Male	24.78
	Female	75.22
Living with a spouse	With spouse	52.84
	Without spouse	47.16

Variable	Category	%
Education	High school	24.18
	Postgraduate	17.31
	University	58.51
Health	Excellent	20.90
	Good	56.72
	Average	17.91
	Below average	4.18
	Poor	0.30
Living area	Metropolitan area	17.31
	Large town	54.33
	Small town	21.79
	Village	6.57

6.1.7.2 Instruments

Smartphone Application-Based Addiction Scale (SABAS; Csibi et al., 2018). This was the original English version of the scale (see full description in Study 1).

6.1.7.3 Data Analysis

Apart from the descriptive statistics and item correlations, the analysis included CFA with MLR estimation, followed by item analysis, which included the calculation of Cronbach α, ω total, CR, MIC, and AVE. It was expected that among the non-native English speakers, the English SABAS would show a unidimensional structure, good internal consistency, and acceptable AVE and MIC values.

6.1.8 Part 2: Results

6.1.8.1 Confirmatory Factor Analysis and the Reliability of the English SABAS

Table 6.6 shows the raw and standardised loadings and R^2 of the English SABAS CFA model. A single-factor model showed an excellent global fit, $\chi^2(9) = 12.56$, $p = .184$, CFI = .990, TLI = .984, RMSEA = .036, SRMR = .026. Items 4, 3, and 6 had the highest loadings, while Item 2 (conflict) and Item 1 (salience) had the lowest loading and therefore did not meet the rule of being >.50, although all standardised loadings were >.40. Mardia's test indicated significant multivariate skewness of the data (154.16, $p < .001$), but not kurtosis (0.2416, $p = .809$). Henze-Zirkler test suggested that the data did not have a multivariate normal distribution ($HZ = 2.48$, $p < .001$).

Table 6.6

Factor loadings from confirmatory factor analysis of the English version of the Smartphone Application-Based Addiction Scale

Item	Addiction component	Loading	*S.E.*	*z*-value	Std. loading	R^2
1	Salience	1	-	-	.492	.242
2	Conflict	0.895	0.145	6.176	.466	.218
3	Mood modification	1.686	0.222	7.610	.717	.515
4	Tolerance	1.549	0.201	7.705	.719	.517
5	Withdrawal	1.030	0.142	7.258	.515	.265
6	Relapse	1.404	0.195	7.201	.616	.379

Note. All loadings were significant at $p < .001$; *S.E.* = standard error; Std. loading = standardised loading.

The English SABAS had a low AVE (.37), while the CR was .76. It should be noted that the participants in Sample 1 ($N = 599$) who completed the Serbian SABAS and the participants in Sample 2 ($N = 335$) who completed the original English SABAS were different in several aspects. The Study 1 sample was significantly older than Study 2 sample, $t(680) = 9.44$, $p < .001$, $d = 0.65$. The effect size could be characterised as medium (Cohen, 1988). Importantly, participants who completed the English SABAS had significantly higher scores, $t(707) = 2.53$, $p = .011$, with the effect size being very small, $d = 0.17$.

The reliability of English SABAS was α = .76 (ω_{total} = .76), CR = .77, and a MIC = .35. The average response on items was 2.79 (*SD* = 0.92). There were no extremely high or low item-total correlations. The most endorsed items were Item 4 (tolerance), Item 3 (mood modification), and Item 6 (relapse). The least endorsed item was Item 2 (conflict). Item correlations and item statistics are shown in Table 6.7.

Table 6.7

English Smartphone Application-Based Addiction Scale, inter-item correlations and item statistics (N = 335)

Item	Correlation					*M*	*SD*	Item-total	*SMC*	α if deleted
	1	2	3	4	5					
1	1					2.56	1.30	.44	.20	.74
2	.28	1				2.11	1.23	.42	.18	.75
3	.32	.29	1			3.15	1.50	.59	.38	.70
4	.36	.32	.54	1		3.24	1.38	.59	.38	.70
5	.33	.25	.39	.32	1	2.56	1.28	.46	.22	.74
6	.27	.34	.44	.44	.31	3.10	1.46	.53	.29	.72

Note. All correlations were significant at $p < .001$ (adjusted using the Benjamini-Hochberg method). Item-total = corrected item-total correlation; *SMC* = squared multiple correlation; α if deleted = α if item is removed from the scale.

6.1.8.2 Part 2: Discussion

The English version of SABAS showed acceptable psychometric properties when completed by non-native English language speakers from Serbia. Although it had a slightly weaker internal consistency, was less homogenous, and had lower factor loadings in CFA compared to the Serbian SABAS, the English SABAS showed better overall model fit, undoubtedly supporting the unidimensional structure of the scale. However, less than 40% of the item variance was captured by the construct, leaving considerable variance that can be accounted for by error. The reliability of the scale was considered acceptable. Unlike the Serbian SABAS, the latent variable of ‘smartphone addiction’ in the English SABAS explained the largest amount of variability in Item 4 ("Over time, I fiddle around more and more with my smartphone."), representing tolerance, and Item 3 ("Preoccupying myself with my smartphone is a way of changing my mood, I get a buzz, or I can escape or get away, if I need to."), representing mood modification. It is concluded that, with some caution, the English version of SABAS could be used for quick screening for the risk of smartphone addiction among English speakers whose first language is Serbian.

6.2 General discussion for Study 2

The first study evaluated the psychometric properties of the Serbian version of SABAS. The SABAS was translated into the Serbian language since, to the authors’ knowledge, regarding PSU, only the SAS-SV was previously back-translated, evaluated, and published (Nikolic et al., 2022). The SABAS differs from SAS-SV because it is based on the components model of addiction, has a transparent theoretical background, and is shorter than the SAS-SV. Therefore, the SABAS validation in the Serbian language is an asset to the Serbian research community.

It is concluded that the results of the present study supported the unidimensionality Serbian SABAS, as well as having good psychometric properties, which is in accordance with previous validations of SABAS in English and other languages (Chen et al., 2020; Csibi et al., 2018; Gökler & Bulut, 2019; Islam et al., 2021; Lin et al., 2019; Nurmala et al., 2022; Soraci et al., 2021; Vally & Alowais, 2022; Yam et al., 2019). This short instrument allows a researcher to assess smartphone addiction, defined by six components of addiction (Griffiths, 2005).

The second study examined whether English SABAS could be used to screen for SA among individuals from the Serbian population. For this purpose, a subset of the data used in a previous study was also used here. Internal consistency was higher in the Serbian SABAS than in the English SABAS in Study 2, and the former generally showed better psychometric properties than the English version. This finding was expected since in Study 2 the participants did not complete the scale in their native language. Overall findings suggest that Serbian SABAS should be preferred for assessing PSU/SA among individuals who speak Serbian as their first language, but the English version can be used in circumstances where the instrument is administered to English-speaking Serbian participants, for example, in cross-cultural studies.

6.3 Limitations and Future Directions

Given the limitations of the two studies, the findings should be treated with caution. For instance, a convenience sample was used, and the data were collected online. Therefore, self-selection bias may be present. Next, only 31.5% of participants took part in the retest due to not giving consent for participation, giving an incorrect ID code, or simply due to not responding. Lastly, in Study 1, the divergent validity of the Serbian version of the SABAS was assessed mainly by comparing the relationship of the SABAS with entertainment and productive use. Future research should consider this and administer a measure that is theoretically completely unrelated to smartphone addiction, as well as thoroughly evaluate the criterion validity of the SABAS.

As for Study 2, a convenience online sample was also used. Additionally, English language proficiency was not controlled, although it was explicitly required in the recruitment text. In other words, how the participants specifically understood the items is not known. Next, in Study 2, the AVE was low, indicating the low average reliability of the English SABAS items when administered to non-native English speakers. This should be considered in future use of the English SABAS on non-native English-speaking populations. Finally, the test-retest reliability should also be evaluated on the English version.

The main practical value of the present study is the translation and validation of a theoretically-based measure that can be used for the screening of the risk of smartphone addiction among the Serbian population. Smartphone addiction has the potential to be a diagnostic entity. Therefore, having a brief psychometrically robust validated instrument would be of great importance for practitioners and researchers. The present study also showed that the English version of the SABAS can be used to appraise the risk of smartphone addiction among non-native English speakers from the Serbian population, which could potentially generalize to populations from other cultures as well, making it a useful tool for future cross-cultural studies.

7 Study 2: Hedonic Use, Stress, and Life Satisfaction as Predictors of Smartphone Addiction[2]

7.1 Introduction

Smartphones are affordable and nowadays universally used portable technological devices with access to the Internet. The estimated number of smartphone users worldwide in 2021 is >3.8 billion, which means that nearly half of the global population owns a smartphone. This number has doubled since 2015 (O'Dea, 2021). In many parts of the world, smartphones have become an everyday necessity (Y. K. Lee et al., 2014). People benefit from smartphone use via its wide range of appli- cations that serve various functions, many of which can directly affect a person's well-being and life satisfaction. Indeed, smartphone use can positively impact subjective well-being through applications that allow users to obtain health-related information, attention, help, and social support (Bert et al., 2014; Kang & Jung, 2014). In addition, it could improve travel experiences by making tourists better oriented feel more confident, and connected (D. Wang et al., 2016).

However, smartphone use may have negative aspects because some individuals could become overly preoccupied with it at the expense of social relations, work, study, or other important life obligations. As a result, these individuals might exhibit problematic smartphone use (PSU), a primary contemporary health concern. According to the pathway model, different patterns of smartphone use can lead to different types of PSU. Addictive use is only one of them (Billieux et al., 2015; Canale et al., 2021; Pivetta et al., 2019). This research report focuses on smartphone addiction (SA) and conceptualizes it as a component of PSU, characterized by symptoms of salience, conflict, mood alteration, withdrawal symptoms, tolerance, and relapse following the components model of addictions (Griffiths, 2005). Further, it also considers it a form of 'Internet addiction' because one cannot be addicted to a smartphone per se, but to its applications, most of which connect to the Internet (Griffiths & Szabo, 2014).

[2] Vujić, A., & Szabo, A. (2022). Hedonic use, stress, and life satisfaction as predictors of smartphone addiction. *Addictive Behaviors Reports, 15*, 100411. https://doi.org/10.1016/j.abrep.2022.100411https://doi.org/10.1016/j.abrep.2022.100411. All authors have consented to include the article in the dissertation.

Smartphone addiction as a form of PSU could have harmful effects on physical (Inal et al., 2015; Park et al., 2015) and psychological health. For example, the SA is positively related to anxiety and depression symptoms (Chłoń-Domińczak et al., 2014; Gao et al., 2017; Hawi & Samaha, 2017; Kim et al., 2019; Rozgonjuk et al., 2018; Vahedi & Saiphoo, 2018), although this association may be inconsistent (e.g., Kuss et al., 2018). Further, PSU is also related to a decrease in sleep quality (Demirci et al., 2015), dysfunctional emotional regulation (Yildiz, 2017), lower work productivity, poorer academic performance (Duke & Montag, 2017; Hawi & Samaha, 2016; Lepp et al., 2015; Samaha & Hawi, 2016), and lower subjective well-being or quality of life (Koç & Turan, 2020; Li et al., 2020; Samaha & Hawi, 2016). A connection between PSU and increased perceived stress also exists (Elhai, Dvorak, et al., 2017; Samaha & Hawi, 2016; Shen & Wang, 2019; J. L. Wang et al., 2015).

Some scholars suggest that excessive smartphone use should be referred to as "problematic use" to avoid classifying it as a diagnostic entity, such as addiction (Panova & Carbonell, 2018; Tossell et al., 2015). Hence, to avoid terminological confusion, we use the term smartphone addiction to refer to an aspect of PSU rather than to a kind of behavioral addiction diagnosis, similar to Tossell et al. (2015). This term may be the most appropriate because excessive use, defined as frequent and voluminous, can imply addictive use (Lin et al., 2015). However, excessive use cannot always be considered addictive. Therefore, the context in which smartphones are used plays a vital role in developing SA.

The purposes of smartphone use vary. For example, Van Deursen et al. (2015) examined social and process use, renamed by Horwood and Anglim (2018) as "entertainment use". Social use predicted SA directly, while process use directly predicted habitual use and indirectly affected addictive use (Van Deursen et al., 2015). Another study supported these findings by showing that entertainment use is associated with PSU and anxiety (Elhai, Levine, et al., 2017). In this case, entertainment use, in addition to entertainment, relaxation, pastime, and gathering information, also refers to escaping from real-life problems or monotonous daily routines. The social use tackles the purpose of forming and maintaining social contacts and interactions via the smartphone without explicitly implying escapism or maladaptive coping elements (Van Deursen et al., 2015). In related research, coping motives (mood regulation, pastime), and perceived enjoyment predicted SA, while social and information- seeking motives were not significant predictors (Chen et al., 2017; Zhang et al., 2014). Other studies also revealed the role of entertainment and escapism in PSU and specifically SA (Panova & Lleras, 2016; Shen & Wang, 2019; J. L. Wang et al., 2015). As some results suggested a moderation effect of perceived stress on the relationship between entertainment use and smartphone addiction (e.g., Wang et al., 2015), we assumed that perceived stress might explain at least one part of the relationship between hedonic smartphone use and SA. In other words, in addition to that hedonic use might influence SA directly, there might be an indirect effect, through perceived stress. This mediation effect would be in accordance with the compensatory Internet use theory (Kardefelt-Winther, 2014a).

Compensatory Internet use theory states that different motivations accompanied by psychosocial difficulties lead to negative consequences of Internet use, such as online gaming and social networking. One of these motivations could be escapism – the tendency to avoid real-life problems and alleviate negative emotions using activities on the Internet or entertainment. Therefore, it is possible that the relationship between hedonic motivation and SA is partly explained by the stress an individual is facing by testing the indirect effect of the motivation (i.e., hedonic use) through perceived stress. Such incentives can lead to adverse outcomes when someone experiences particular psychosocial hardship (Kardefelt-Winther, 2014a, 2014b). According to the theory, problematic Internet use is seen not as compulsive or addictive behavior but rather as a compensatory behavior that may have both positive and negative consequences. The theory serves as a framework for researching SA/PSU.

We use the terms utilitarian and hedonic (use) to describe two principal smartphone usage types. Utilitarian use refers to smartphone use that serves living activities and necessities such as banking, reading e-mails, using location services, communicating, etc. On the other hand, smartphone use also has a hedonic value when the need for instant gratification drives its use. Such gratification stems from pleasure or joy derived from watching videos, playing games, watching pornography, online shopping, unwinding, self-distracting from a stressful situation, etc. (Linnhoff & Smith, 2017).

Indeed, perceived stress is positively related to SA (Chiu, 2014; Cho et al., 2017; Samaha & Hawi, 2016; Sebastian et al., 2020; Vahedi & Saiphoo, 2018; J. L. Wang et al., 2015; Zhai et al., 2020). However, longitudinal studies suggest that the relationship between SA and stress may be inconsistent. For example, a longitudinal study found no direct effect of excessive smartphone use on stress (Karsay et al., 2019). In accord with this report, another longitudinal work could not connect heightened stress to increased nomophobia after six months (Wolfers et al., 2020). Furthermore, unlike Internet addiction, another study showed that SA could not significantly predict stress, depression, anxiety, and suicidal tendencies in a regression model, although it correlated substantially with these constructs (Wan Ismail et al., 2020). A note on this conclusion is that SA cannot be separated from Internet addiction, as discussed earlier, because smartphones are merely devices used for accessing Internet-based applications.

While practical smartphone use can positively impact subjective well-being, a recent study showed that overuse and SA negatively predicted satisfaction with life (Koç & Turan, 2020). Furthermore, excessive smartphone use appears to be associated with dissatisfaction with life (Linnhoff & Smith, 2017). However, it is not easy to establish causality in this relationship. For example, a negative relationship could exist between SA and quality of life (Li et al., 2020). In contrast, Horwood and Anglim (2019) showed that satisfaction with life was not related to PSU, but entertainment use was positively associated ($r = .64$) with it.

Another study reported no significant relationship between SA and satisfaction with life, although the authors revealed an indirect effect of SA on it through perceived stress and academic performance (Samaha & Hawi, 2016). Yang and colleagues found no significant effect of PSU on life satisfaction in one of their models (Yang et al., 2019). One could argue that smartphone use type (purpose) and aspects of subjective well- being are essential in studying the relationship between these two constructs. The relationship between well-being and PSU could be reciprocal, so that low personal well-being might cause perceived or actual PSU (Horwood & Anglim, 2019). This proposition stems from reports that dispositional traits, such as neuroticism, can increase SA (Horwood & Anglim, 2018, 2019). Low self-esteem was also related to SA (Koç & Turan, 2020). Based on these findings, being a component of well-being, we conjecture that low satisfaction with life could increase SA. In addition, based on the findings from Samaha & Hawi 2016, we sought to examine the mediation role of perceived stress between satisfaction with life and SA. In other words, the relationship where low life satisfaction is related to increased SA could be partially explained by the presence of a high amount of perceived stress, which would again be in line with the compensatory Internet use theory (Kardefelt-Winther, 2014a).

Some studies reported that women exhibit greater SA or PSU than men (Linnhoff & Smith, 2017; Lopez-Fernandez et al., 2017; Moreno- Guerrero et al., 2020; Van Deursen et al., 2015), but contrary evidence also exists (Mitchell & Hussain, 2018). Therefore, the possible gender differences in SA are equivocal. As for age, some studies found a negative relationship between age and PSU or the SA (Mitchell & Hussain, 2018; Roser et al., 2016). A study examining a large sample also provided relatively solid evidence for preschool children and young adults who reported the highest level of SA (Csibi et al., 2019). However, this inverse relationship cannot be consistently demonstrated (Moreno-Guerrero et al., 2020; Kuss et al., 2018). Based on the bulk of the extant literature, we conjecture that women exhibit a greater SA than men and that age is negatively related to SA.

We believe that this study will contribute to a better understanding of the relationship between hedonic smartphone use and SA. Unlike the study by Wang et al. (2015), where the moderation of perceived stress on the relation between entertainment/escapism motive and SA was examined, we have used the structural equation model inspecting the mediation effects of perceived stress. Previous studies used samples of Chinese college students (Chen et al., 2017; Shen & Wang, 2019; Wang et al., 2015). In this study, we examined a sample of adults from different segments and age groups of a mainly European population, making the results more generalizable. Furthermore, we tried to keep the operationalization of the hedonic use as simple as possible by assessing it with a single item, asking the participants to express them- selves in terms of percentage of overall use. Another research used a regression analysis to examine the predictive power of different application categories on SA and life satisfaction (Linnhoff & Smith, 2017). However, as these authors point out, a particular application can belong to more than one category since it can be used for different motives. Therefore, we abandoned this approach and asked the participants about their appraisal of the hedonic motive for smartphone use, not particular applications or application categories. Finally, not examined in past works, we tested the proposition of Horwood and Anglim (2019) to obtain insight into how satisfaction with life might affect the SA.

The objectives of the current study are to test the research hypotheses that perceived stress and the hedonic use of smartphones are positive predictors of SA, and that satisfaction with life will negatively predict SA. Furthermore, we expect positive indirect effect of hedonic use on SA, through perceived stress, and a negative indirect effect of satisfaction with life on SA, through perceived stress. We also propose that age is a negative predictor of SA. Finally, as mentioned above, we conjecture that women exhibit higher SA than men. The conceptual model is shown in Figure 5.1.

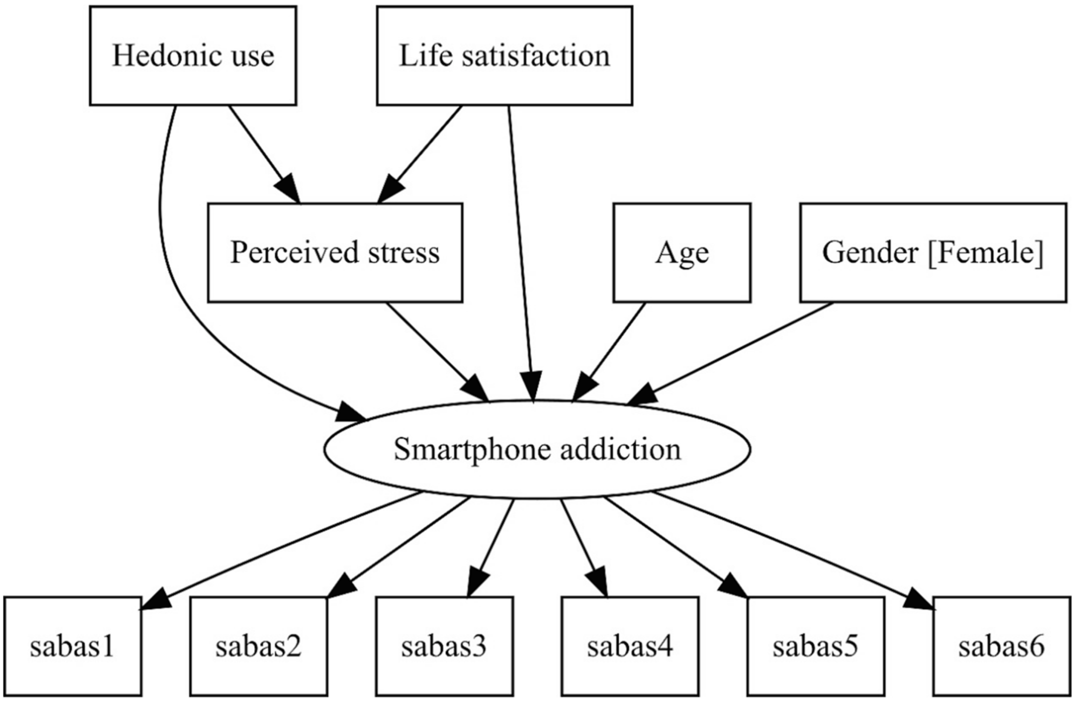

Figure 5.1. A conceptual model.

7.2 Method

7.2.1 Participants

Participants were 410 adult volunteers, of whom 300 (73.2%) were women aged between 18 and 77 years, *M* = 32.32, *Mdn* = 30 (*SD* = 10.85). Initially, there were 469 respondents, but we have removed incomplete responses. Additionally, we also removed data obtained from two participants who did not use a smartphone. Twenty-four (23.9%) percent of the final sample completed high school, 56.3% had a university, and 19.8% had postgraduate degrees. They completed the study in English. Having a good mastery of English was explicitly required in the call for participants posted on various social media (see Procedure section).

7.2.2 Ethics

The Research Ethics Board of the Faculty of Education and Psychology at ELTE Eötvös Loránd University granted ethical clearance (Certificate Number 2020/306) for the current study. All participants read and consented to anonymous participation by answering with "Yes" to the question if they were willing to participate.

7.2.3 Materials

Demographic questions asked participants their gender, age, and education level. In addition, two single-item frequency scales asked the percent of time participants access the Internet via smartphones and the percent of the time they use their devices for utilitarian and hedonic purposes. Finally, we collected responses to three questionnaires described below. It took approximately eight to ten minutes to complete all the questionnaires.

Smartphone Application-Based Addiction Scale. (SABAS; Csibi et al., 2018). The SABAS is a six-item, one-dimensional instrument intended to assess addiction symptoms related to smartphone application use based on the components model of addiction (Griffiths, 2005). It is rated on a six-point Likert scale (ranging from 1 = strongly disagree to 6 = strongly agree). The SABAS has been validated in several languages, including Hungarian (Csibi et al., 2016), English (Csibi et al., 2018), and Chinese, 2020 (Leung et al., 2020; Yam et al., 2019). The reported reliability of the English version was good (Cronbach's alpha α = .81). In the current study, the internal reliability of the SABAS was .75.

Perceived Stress Scale (PSS-4; Cohen et al., 1983). This scale assesses perceived stress in the past month. It is rated on a 5-point Likert scale (1 = never to 5 = very often). The reliability of PSS-4 in previous research ranged from Cronbach's α = .67 to .82 (E. H. Lee, 2012). In the current study, the internal reliability of the PSS-4 was.74.

Satisfaction With Life Scale (SWLS; Diener et al., 1985). This instrument is a five-item tool rated on a 7-point Likert scale, ranging from (1 = strongly disagree to 7 = strongly agree). The initially reported internal consistency of the scale was α = .87 (Diener et al., 1985). In the current study, the internal reliability of the SWLS was .85.

Device type for Internet access. Participants were required to report their best estimate of the percent (time) that they use various devices to access the Internet. The devices listed were smartphones, tablets, desktop computers, and laptop computers. The percentages needed to add up to 100%.

Hedonic and Utilitarian Use. Participants reported their best estimate of the percent of time they use their smartphones for hedonic purposes (including entertainment, surfing on social media, playing games, etc.). They also estimated the percent of time spent with utilitarian purposes (studying, work, e-banking, paying bills, participating in online work/study meetings, etc.). These percentages had to add up to 100. Since the two forms of use are mutually exclusive, we only analyzed hedonic use on the utilitarian-hedonic continuum. These two questions referred to the overall use in general. We note that although the question was phrased using the ’percentage of time’ term, these are not actual percentages calculated from the frequency of use, but simply self- reported use. Therefore, this scale is no different than the Likert scale, and it is treated as interval, given the large amount of answer points.

7.2.4 Procedure

Respondents participated in the current study by anonymously filling out questionnaires on the Qualtrics research platform (Qualtrics, 2017), having a unique uniform resource locator (URL). Call for participants was posted on various social networking sites, such as Facebook, Twitter, LinkedIn, and applications such as WhatsApp and Instagram. Participation in the research was anonymous, with no material compensation offered to the participants, who could withdraw from the study at any time without consequences. Before proceeding with the data analyses, we checked the data validity by examining the minimum duration of completion (realistically enough time), meeting the criteria for participation (aged 18 years or over and user of a smartphone), and the answers’ completeness.

7.2.5 Data analysis

Data were analyzed using IBM SPSS 27 (IBM Corp., 2020) and R version 3.6.2 (R Core Team, 2021). Structural equation modeling (SEM) was performed with the ’lavaan’ and ’lavaanPlot’ packages (Lishinski, 2021; Rosseel, 2012). The hypotheses were tested in a single structural model. A latent variable represented SA: all six SABAS items loaded on a single factor. Perceived stress and satisfaction with life were entered as average scores of the respective items and hedonic use as a single item, divided by 10 to lower the variance range (Kline, 2016). The guidelines for good model fit indices were: for RMSEA .06, for CFI and TLI .90, and for SRMR < 0.08 (Hooper et al., 2008).

7.3 Results

7.3.1 Descriptive measures

Cronbach's alpha and McDonald's omega coefficients were computed on 412 cases. Reliabilities for SABAS ($\alpha = .75$, $\omega = .76$) and PSS-4 ($\alpha = .74$, $\omega = .72$) are acceptable, while for SWLS ($\alpha = .85$, $\omega = .85$) is excellent. The descriptive statistics of the scales are shown in Table 5.1. Table 5.1 shows the zero-order correlation coefficients between the continuous variables used in the analysis. As for smartphone use, 7.28% of the participants reported low (0–20% of the time) frequency of smartphone use as a means to access the Internet relative to tablets, desktop computers, and laptop computers, including the two participants who reported no use of smartphone at all. Next, 16.02% reported medium–low frequency (20–40%), 28.88% reported medium frequency (40–60%), 30.83% high frequency (60–80%), and finally 16.99% reported very high frequency for using a smartphone to access the Internet (80–100%).

Table 5.1

Descriptive statistics of the various measures and items

	M	*Mdn*	*SD*	skewness	kurtosis
Perceived stress	2.69	2.75	0.75	0.21	-0.08
Life satisfaction	4.59	4.80	1.22	-0.51	-0.28
Smartphone addiction (SA)	2.81	2.67	0.91	0.24	-0.47
Hedonic Use	56.11	60.00	25.00	-0.10	-0.75
SABAS item 1	2.64	2.00	1.37	0.51	-0.81
SABAS item 2	2.12	2.00	1.23	1.16	0.57
SABAS item 3	3.18	3.00	1.49	-0.01	-1.29
SABAS item 4	3.30	3.00	1.39	0.04	-1.04
SABAS item 5	2.58	2.00	1.26	0.57	-0.63
SABAS item 6	3.07	3.00	1.44	0.29	-1.11

Note. *M* = mean. *Mdn* = Median. *SD* = standard deviation. SABAS 1 to SABAS 6 are the items of the SABAS questionnaire.

As seen in Table 5.2, SA shows the strongest positive correlation with perceived stress, followed by hedonic use, and a negative correlation with satisfaction with life. The highest correlation emerged between perceived stress and satisfaction with life.

Table 5.2

Zero-order correlation coefficients between age, perceived stress, satisfaction with life, hedonic smartphone use, and smartphone addiction

	1	2	3	4	5
1 Age	-				
2 Perceived stress	-.07	-			
3 Life satisfaction	.01	$-.56^{***}$	-		
4 Smartphone addiction (SA)	$.10^{*}$	$.31^{***}$	$-.23^{***}$	-	
5 Hedonic use	$-.22^{**}$	$.15^{**}$	$-.12^{*}$	$.23^{***}$	-

Note. **p* < .05. ***p* < .01. ****p* < .001.

7.3.2 Structural equation model

There was a single latent variable (smartphone addiction) in the structural model, with six indicator variables (i.e., six SABAS items) and five manifest variables: age, gender, hedonic use, life satisfaction, and perceived stress. The model was fitted using the maximum likelihood (ML) estimation, with bootstrapped standard errors, and showed a good global fit, $\chi^2(36) = 58.06$, $p = .011$; CFI = .970, TLI = .954, RMSEA[90% CI] = .039 [0.019, 0.056], SRMR = .037. Although the chi-square test statistic was significant, this is due to great sensitivity to the sample size. Bootstrapping ($n = 2000$) was performed to obtain 95% confidence intervals of the parameters, based on the adjusted bootstrap percentile method. The model diagram is presented in Figure 5.2.

Gender, perceived stress, and hedonic use were significant predictors of SA. As the gender variable was coded 0 = males, 1 = females, it means that being a female positively predicted the SA. Perceived stress and hedonic use also predicted the outcome in a positive direction. Next, perceived stress was positively predicted by hedonic use and negatively by life satisfaction.

Although the direct effect of satisfaction with life on SA was not significant, there was a significant negative indirect effect of satisfaction with life on SA through perceived stress. An indirect effect of hedonic use on SA was not significant, but the confidence interval did not include zero, despite the lower bound being very close to zero. The regression coefficients with confidence intervals are shown in Table 5.3. All variables explained 18.1% of the variance of smartphone addiction, while satisfaction with life and hedonic use explained 32.4% of the variance in perceived stress.

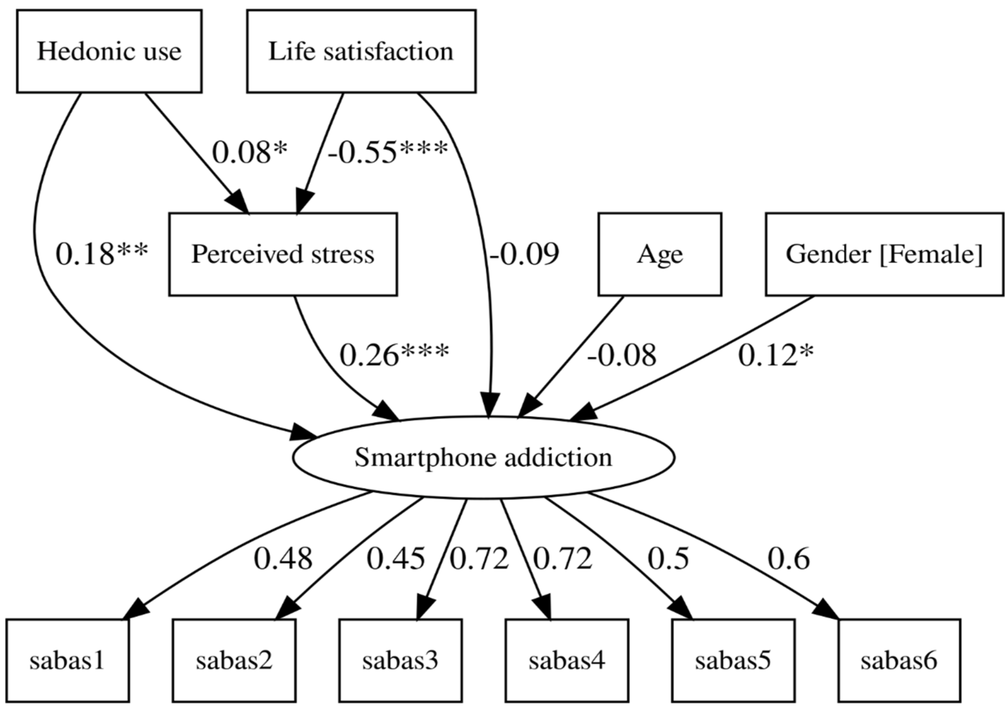

Figure. 5.2. Path diagram of the hypothesized model, with standardized path coefficients

Note. Uniqueness, disturbance, and covariance arrows are omitted from the diagram for the sake of clarity. All exogenous variables are allowed to covary. Standardized regression coefficients (next to the arrows going to perceived stress variable and smartphone addiction factor) and factor loadings (next to the arrows going from smartphone addiction factor to individual SABAS items) are presented. All factor loadings are significant. *p < .05, **p < .01, ***p < .001.

Table 5.3

Unstandardized regression coefficients, with standard errors, z-values, significance, and confidence intervals of the coefficient.

Parameters			*B*	*SE*	*Z*	*p*	95% CI	
							LL	UL
Direct effects								
	Smartphone addiction (SA)							
		Hedonic use	0.046	0.015	3.023	0.003	0.017	0.078
		Life satisfaction	-0.051	0.041	-1.278	0.201	-0.127	0.026
		Stress	0.233	0.067	3.48	0.001	0.106	0.368
		Age	-0.005	0.004	-1.406	0.16	-0.012	0.002
		Gender [Femalel	0.176	0.085	2.067	0.039	0.01	0.349
	Stress							
		Hedonic use	0.025	0.012	2.054	0.04	0.001	0.048
		Life satisfaction	-0.337	0.026	-13.069	<0.001	-0.386	-0.284
Indirect effects								
	Smartphone addiction (SA)							
		Hedonic use	0.006	0.003	1.651	0.099	0.001	0.013
		Life satisfaction	-0.079	0.023	-3.478	0.001	-0.125	-0.036
Covariances								
	Hedonic use							

Parameters		*B*	*SE*	*Z*	*p*	95% CI	
						LL	UL
	Life satisfaction	-0.368	0.161	-2.288	0.022	-0.688	-0.043
	Gender [Female]	0.095	0.055	1.735	0.083	-0.012	0.204
	Age	-6.062	1.465	-4.139	<0.001	-9.047	-3.419
Life satisfaction							
	Gender [Female]	0.053	0.027	1.967	0.049	0.002	0.111
	Age	0.159	0.641	0.248	0.804	-1.067	1.439
Gender [Female]							
	Age	0.455	0.209	2.175	0.03	0.046	0.857

Note. *B* = unstandardized coefficient. *SE* = standard error of the coefficient. *z* = z-test value. *p* = p-value. *CI* = bias-corrected confidence interval. *LL* = lower limit of the confidence interval. *UL* = upper limit of confidence interval.

7.4 Discussion

This cross-sectional study reveals that hedonic smartphone use pre- dicts the SA. This finding supports two previous reports that higher entertainment-oriented smartphone use will more likely lead to PSU or SA than non-entertainment or utilitarian use (Jeong et al., 2016; S. J. Lee et al., 2016). One possible explanation could be based on the uses and gratification theory (Katz et al., 1973), which states that people choose which content to consume based on their personal needs. For example, hedonic needs can involve socialization, mood regulation, sexual gratification, or entertainment (Shen & Wang, 2019). A common feature of most, if not all, addictions is that when an instant reward is accessible, it is easier for an individual to become addicted to the behavior (S. J. Lee et al., 2016). According to the compensatory Internet use theory, problematic Internet use, being directly related to and inseparable from PSU, comes from maladaptive coping. For example, a person uses the Internet/smartphone to escape real-life problems or relieve stress (Kardefelt-Winther, 2014a). Hedonic smartphone use can be a route of escape yielding pain relief (or distraction from a problem, uncontrollable situation, distress) through gratification, via watching videos, pornography, playing various games, listening to music, using social networks, and gathering information through social media and news, related to SA. Overall, supporting the results of previous research, this study confirms hedonic smartphone use as a predictor of SA.

We also found that perceived stress is a predictor of the risk of SA. This finding also supports previous reports (Samaha & Hawi, 2016; J. L. Wang et al., 2015). It may also be related to the compensatory Internet use theory. Individuals who consider their situation unmanageable will need to use smartphones to escape or alleviate stress. In this case, a higher stress level may trigger increased smartphone use.

The results further suggest that perceived stress can explain a part of the relationship between hedonic use and SA since there was an indirect effect of hedonic use on SA through perceived stress. However, it should be noted that the effect was not statistically significant, but the confidence interval indicated that some effect might be present. Nonetheless, if the effect exists, it appears to be very small. This finding implies that other factors could also mediate the relationship between hedonic use and SA. For example, the use of smartphones for hedonic purposes may lead to increased stress. Using a smartphone for entertainment may harm productivity and daily life, such as a person not fulfilling obligations and tasks at all or in time, leading to increased perceived stress (the perceived stress is conceptualized as a feeling of the lack of control over life events). In turn, perceived stress may lead to greater SA since the smartphone is used as a tool to alleviate negative emotions. However, the interrelation of use motivation, perceived stress, life satisfaction, and SA is most likely reciprocal (Horwood & Anglim, 2019; Samaha & Hawi, 2016).

Satisfaction with life did not predict SA directly, with all other variables included. In other words, no direct effect emerged, but there was an indirect effect of satisfaction with life on SA through perceived stress. These results suggest that the perceived stress may explain the relationship between life satisfaction and SA. People dissatisfied with their lives may experience more perceived stress and engage in maladaptive smartphone use to cope with the distress and negative affect or escape real-life problems and distressing thoughts, thus increasing SA.

In our study, the age of the participants did not predict the risk of SA. This finding contrasts some previous findings (Hussain et al., 2017; Mitchell & Hussain, 2018; Roser et al., 2016), but is in line with others (e.g., Kuss et al., 2018). However, the current results reveal a small but statistically significant negative correlation between age and

SA and a stronger negative correlation with hedonic use. In both cases, the shared variance, however, is too small to be considered meaningful. Further- more, unlike the study by Csibi et al. (2019) that tested children as young as three (3) years old, our results are based on an adult sample aged 18 years and older. Perhaps a broader age range could have produced a more accurate picture of the relationship between age and SA than the heterogeneous sample of adults studied here.

In accord with previous research, our study supports the findings that the female gender is a predictor of SA. This finding has often been re- ported when investigating gender differences regarding SA (Linnhoff & Smith, 2017; Lopez-Fernandez et al., 2017), but some studies could not confirm this connection (Mitchell & Hussain, 2018). An explanation could be that there are different motives for smartphone use in women and men. For example, escapism was found to be higher in women than men (Linnhoff & Smith, 2017). Furthermore, women showed a greater tendency to develop habitual or addictive smartphone use through the more prominent social use and social stress (van Deursen, et al., 2015). Thus, the current results need further scrutiny to identify the factors associated with frequently reported gender differences related to SA.

This study contributed to a better understanding of mutual relations between hedonic use purpose, perceived stress, satisfaction with life, age, gender, and smartphone addiction. First, we used a short, valid, and reliable scale, SABAS, which is based on the ’components model of addiction.’ In contrast, most previous studies were based on other, not necessarily theory-driven, instruments. Next, we have further confirmed the principal postulations of the compensatory Internet use theory (Kardefelt-Winther, 2014a) on a primarily Western and wide age group sample in contrast to Chinese students examined in similar studies. Most importantly, we showed that the simple, single-item operationalization of the smartphone use purpose could be adopted. The subjective appraisal of what the participants believe to be utilitarian or hedonic purpose may be more accurate than asking them the (estimated) frequency of specific application use and then posteriorly classifying these into the respective categories because some applications might satisfy both purposes.

7.4.1 Limitations

This study has limitations that call for caution in interpreting the results. First, this study relied on a convenience sample, and the data were collected online, leaving the possibility of self-selection bias. Second, the questionnaires were in English, and we did not control for the language proficiency of the respondents. Third, the cross-sectional design limits the drawing of causal conclusions. Fourth, based on the small variances explained by the predictors (a little less than one-fifth), it is likely that a considerable proportion of variance in SA is attributable to other factors. These factors may include personality traits, various morbidities, chronic use, and psychopathological characteristics (e.g., Elhai et al., 2017; Shen & Wang, 2019; van Deursen et al., 2015). Therefore, future research should also include these critical factors in the model, which might lead to a greater amount of explained variance in SA. Fifth, an important limitation of our work is that despite asking participants for the percent of the time of accessing the Internet via smartphones, when we examined the answers related to Internet-based application use, we assumed that such access occurred exclusively via smartphones, which may not be the case. Hence, future studies should control for smartphone-based hedonic Internet use. Finally, estimates of the percent of the time for hedonic use may only be approximate due to memory bias.

7.5 Conclusions

This study demonstrated that hedonic smartphone use and perceived stress are directly associated with SA. Additionally, satisfaction with life negatively affected SA through its relationship with perceived stress. Finally, the female gender was a direct positive predictor of SA. There was a weak correlation between age, SA, and hedonic smartphone use in this study, but age did not emerge as a predictor of SA. The practical implication of these results is that treatments aimed at the symptoms of SA should assess life stress and the purpose of smartphone use while considering the gender and life satisfaction of the affected person. We also suggest that researchers allow their participants to appraise what they consider hedonic or utilitarian smartphone use because measuring application use frequency or duration could be erroneous since numerous applications fulfill both purposes.

8 Study 3: Are Cyberchondria and Intolerance of Uncertainty Related to Smartphone Addiction?[3]

8.1 Introduction

8.1.1 Smartphone Addiction — Definition and Conceptual Dilemmas

Smartphone addiction (SA) is "…a compulsive pattern of smartphone usage which can result in negative consequences that impair the daily functioning of the user" (Busch & McCarthy, 2021, p. 2). In the current study, we use Griffiths' (2005) components model of addiction as a framework. Based on this model, SA is "… a behavioral addiction including the core components of addictive behaviors, such as cognitive salience, loss of control, mood modification, tolerance, withdrawal, conflict, and relapse" (Billieux et al., 2015a, 2015b, 2015c, p. 157; Griffiths, 2005). However, SA is a controversial term among researchers because there is increasing criticism of pathologizing components of the modern lifestyle and labeling problematic smartphone use (PSU) as a behavioral addiction (Billieux et al., 2015a; Billieux, et al., 2015b; Billieux, et al., 2015c; Flayelle et al., 2022; Kardefelt-Winther, 2017; Panova & Carbonell, 2018). Although some novel results support the view that PSU/SA is a behavioral problem that has brain abnormality correlates (e.g., Zou et al., 2022), we agree that it is too early to consider this phenomenon a non-substance addiction, like gambling disorder. However, we decided to use the term SA to denote PSU for easier comparison with other studies. Smartphone addiction and PSU are commonly used in literature as synonyms (Busch & McCarthy, 2021), and SA can often be found in the names of the measurement tools that tend to measure PSU (Tossell et al., 2015). To sum up, even though we use the term SA in the current study, we refer only to a possible "risk" for addiction rather than a diagnosable behavioral addiction. This approach aligns with the idea that problematic use and addiction lie on the same continuum, where inappropriate use can turn into addictive use, similar to what has been suggested for problematic gambling and gambling addiction (Griffiths, 2016).

Despite their excellent functionality, smartphones are of limited use without an internet connection (Montag & Reuter, 2017). Therefore, there have been proposals to

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[3] Vujić, A., Volarov, M., Latas, M., Demetrovics, Z., Kiraly, O., & Szabo, A. (2023). Are cyberchondria and intolerance of uncertainty related to smartphone addiction? *International Journal of Mental Health and Addiction*. https://doi.org/10.1007/s11469-023-01054-6. All authors have consented to include the article in the dissertation.

rename the SA construct as "internet use disorder, predominantly mobile," to emphasize the problem- atic internet activities performed via smartphone (Montag et al., 2021). This term shows how problematic internet use (PIU), and SA/PSU are often difficult to distinguish. However, smartphones have distinctive features (such as portability, constant connectedness, and compact size) that can uniquely impact behaviors performed on the internet. Those smartphone features make people more susceptible to developing an "addictive" behavior (see Barnes et al., 2019; Panova & Carbonell, 2018). Finally, it is worth mentioning that when researching behaviors related to PSU or the internet, regardless of the terminology, the focus should not be solely on the frequency of use but on the activities a person per- forms on the internet and on the motives that mainly drive such behaviors (Griffiths & Szabo, 2014; Pontes et al., 2015).

8.1.2 Smartphone Addiction and Mental Health Problems: Relationship and Causality

Smartphone addiction is related to anxiety, depression, perceived stress (Elhai, Dvorak, et al., 2017; Elhai, Levine et al., 2017), loneliness, social phobia (Bian & Leung, 2015), sleep quality (Stanković et al., 2021), and poorer academic performance (Hawi & Samaha, 2016). A newer study suggests that the relationship between general distress and PSU could be indirect, through expectations of smartphone use and metacognitive beliefs (Casale, et al., 2021). In addition, excessive smartphone use is related to negative physical health outcomes, such as craniocervical problems (Kee et al., 2016; Park et al., 2015) and somatization problems (Winkler et al., 2020). Establishing the causality between PSU and poor mental health outcomes is difficult because both directions seem possible. On the one hand, psychopathological problems can lead to excessive smartphone use (e.g., if a smartphone serves as a means of maladaptive coping such as distraction or excessive reassurance seeking). Therefore, the association between psychological problems and SA can be explained from a compensatory technology use perspective (Kardefelt-Winther, 2014). To be precise, excessive smartphone use can manifest in a maladaptive coping style, where a person tends to compensate for the underlying psychosocial problems by using a smartphone (Billieux, et al., 2015a; Billieux et al., 2015a; Billieux et al., 2015c; Kardefelt-Winther, 2017; Panova & Carbonell, 2018).

On the other hand, highly increased technology use can cause various problems with mental health, such as prolonged stress, depression, and sleep disruption. These dysfunc- tions are due to exposure to stressful content or comparing with people on social media who seem much happier and more successful (Elhai, Dvorak, et al., 2017; Elhai, Levine et al., 2017; Vogel et al., 2015). Also, a reciprocal relationship between mental health problems and SA is possible. For example, individuals could use smartphones to alleviate negative moods or to avoid real-life problems (Elhai, Dvorak, et al., 2017; Elhai, Levine et al., 2017; Wang et al., 2015). This form of coping corresponds to the mood modification component of SA that reflects the change in mood (arousing or calming) that people experience as a direct consequence of using a smart- phone (Csibi et al., 2021; Griffiths, 2005; Zhang et al., 2014). However, the increased use can lead to more anxious and/or depressive states because smartphone-related activities performed to diminish or avoid negative emotions can be seen as a form of experiential avoidance (see Elhai, Dvorak, et al., 2017; Elhai, Levine et al., 2017). While experiential avoidance as a coping strat- egy can produce positive short-term effects (captured by the mood modification component), they keep the person away from problem-focused, goal-oriented activities, which harms one’s mental health in the long run (Hayes et al., 2016).

8.1.3 Can Cyberchondria Predict Smartphone Addiction?

Behaviors related to cyberchondria have become particularly relevant since the surfacing of COVID-19 (Varma et al., 2021). Indeed, 60 publications on the Web of Science in November 2022 discussed the relationship between cyberchondria and coronavirus. Cyberchondria relates to searching for health information online to decrease distress or anxiety (Starcevic & Berle, 2013). Still, it increases anxiety levels, leading to more online searches, which becomes difficult to stop (Starcevic & Berle, 2013). Therefore, cyberchondria is closely related to health anxiety, illness anxiety disorder, obsessive–compulsive disorder, and PIU (Starcevic, 2020; Starcevic et al., 2019). However, cyberchondria has recently been recognized as a distinct and clinically relevant construct — a compulsive syndrome-like behavior related to adverse psychosocial outcomes (Vismara et al., 2020). The Cyberchondria Severity Scale (CCS) recognizes four distinct facets: compulsion, reassurance, distress, and excessiveness (McElroy et al., 2019). Network analysis indicated that each dimension measured by CSS played an equally important role in conceptualizing the construct (Starcevic et al., 2019). However, the Short Cyberchondria Scale (SCS) is unidimensional; its items refer to what the authors believed to be the core component of cyberchondria characterized by excessive online health information search and the associated distress (Jokić-Begić et al., 2019).

Previous studies showed that cyberchondria is related to compulsive internet use (Khazaal et al., 2021), or what was called PIU in Starcevic et al. (2019), or internet addiction (Ivanova & Karabeliova, 2020). Compulsion and distress domains of cyberchondria were most strongly related to compulsive internet use, linked to online search for health information (Khazaal et al., 2021). Given the robust relationship between cyberchondria and PIU (Starcevic et al., 2019), it is plausible to assume a positive relationship between cyberchondria and smartphone addiction. A person who exhibits cyberchondria-related behaviors, i.e., compulsive, and excessive online health information search, which is difficult to stop, will use a smartphone to access the information online to decrease anxiety. However, if the wanted reassurance was not achieved, a person would enter a "vicious circle" as the nature of cyberchondria suggests, and they will end up with higher levels of anxiety than before the search, leading to even more reassurance seeking online (Schenkel et al., 2021; Starcevic & Berle, 2013). One reason for this would be the characteristics of the information on the internet, which can be unpredictable and unreliable (Starcevic & Berle, 2013; Starcevic et al., 2020), as well as information overload (Laato et al., 2020). In short, the need for repeated reassurance leads to excessive internet use (i.e., via smartphones), which can turn into excessive smartphone use and, ultimately, addictive use.

Unfortunately, only a few studies investigated the direct relationship between PSU/SA and cyberchondria (e.g., Köse & Murat, 2021; Yam et al., 2021). However, a moderate-high correlation emerged between cyberchondria and PSU/SA, $r = 0.60$ (Köse & Murat, 2021). Also, cyberchondria was a moderating and mediating variable between PSU/SA and fear of COVID-19 (Yam et al., 2021).

It is plausible that smartphones can facilitate cyberchondria-related behaviors due to their portability and practicality. Additionally, a study showed that most online health searches (i.e., cyberchondria-related behaviors) are associated with internet use during the night-time (Kanganolli & Praveen, 2020), where it is likely that such online search is done via smartphone (for example, while lying in bed). Smartphones also allow the health-anx- ious person to search for health information while commuting to work or on the worksite and in other places where it would be impossible to use a desktop computer.

Using a smartphone as a tool to access the internet to alleviate health-related anxiety and distress can lead to problematic use, which interferes with daily life activities and increases anxiety even more.

Our research explores the relationship between cyberchondria and SA in the healthy population (individuals without chronic diseases). This delimitation was applied because illness could foster a search for online health information and lead to cyberchondria. This link was especially considerable during the COVID-19 pandemic when this study was conducted (see Arsenakis et al., 2021; Vismara et al., 2021).

8.1.4 Intolerance of Uncertainty and Its Relation to Smartphone Addiction

Intolerance of uncertainty (IU) is "an individual’s dispositional incapacity to endure the aversive response triggered by the perceived absence of the salient, key, or sufficient information, and sustained by the associated perception of uncertainty" (Carleton, 2016, p. 31). Intolerance of uncertainty includes behavioral (e.g., inhibition or excessive collecting of information), cognitive (e.g., irrational beliefs about uncertainty), and emotional (e.g., being upset and frustrated) reactions to uncertain situations (Bottesi et al., 2020; Freeston et al., 1994). Many studies suggested that IU is a transdiagnostic risk factor for anxiety and mood disorders (Mahoney & McEvoy, 2012; McEvoy & Mahoney, 2012). Although IU is typically seen as a correlate of internalizing mental disorders, there is evidence that IU is also related to the symptoms of externalizing psychopathology (e.g., Sadeh & Bredemeier, 2021). It seems that IU is correlated with worry, rumination, and compulsive behaviors, but also with substance (ab)use and other risky/impulsive behaviors (Carleton, 2016; Freeston et al., 1994; Kraemer et al., 2015; Mihić et al., 2014; Oglesby et al., 2014; Sadeh & Bredemeier, 2021). For example, according to Sadeh and Bredemeier (2021), individuals with higher IU were likelier to engage in risky behaviors to reduce or avoid distress rather than to experience a pleasure. Similarly, in other studies, IU was found to be related to coping motives for alcohol use (Kraemer et al., 2015; Oglesby et al., 2014).

Based on the results of one meta-analysis, the level of IU was positively related to the use of the internet and mobile phones (Carleton et al., 2019). Smartphones can serve as a "safety blanket" since they increase reassurance possibilities through constant connectivity, disabling an individual from learning to tolerate uncertainty (Carleton et al., 2019). The intensified reassurance actions can catalyze increased perceived uncertainty, which leads to elevated anxiety (see Carleton, et al., 2019). This path is similar to the mechanism where cyberchondria, as a reassurance-seeking behavior, brings only short-lived relief from distress but increases anxiety in the long run (Carleton et al., 2019; Norr et al., 2015; Starcevic & Berle, 2013). Negative reinforcement makes an individual more likely to per- sist in reassurance-seeking (Carleton, et al., 2019; Salkovskis, et al., 2003; Tang et al., 2007).

Based on the compensatory internet use theory (Kardefelt-Winther, 2014), individuals with higher intolerance of uncertainty may experience anxious feelings more frequently, making them excessively use the smartphone to cope with the anxiety. This phenomenon is similar to the idea that stems from previous findings that suggest people with increased IU tend to consume more alcohol to deal with distress (Rozgonjuk et al., 2019). However, this kind of coping does not necessarily need to be reflected in reassurance-seeking online but also in different forms of avoidant behaviors, that include activities performed via smartphone. Accordingly, IU was positively related to PSU/SA and non-social smart- phone use (Rozgonjuk et al., 2019), which was named "process use" (van Deursen et al., 2015), "entertainment use" (Horwood & Anglim, 2019), or "hedonic use" (Vujić & Szabo, 2022). Non-social use also mediated the relationship between IU and PSU/SA (Rozgonjuk et al., 2019). In addition, IU predicted nomophobia, a construct closely related to SA, and it mediated the relationship between differentiating self and nomophobia (Ercengiz et al., 2020). Nonetheless, clear causal direction could not be determined. That is, it is not sure if increased use of smartphones (and the internet) leads to higher anxiety through perceived uncertainty or if increased IU makes an individual prone to excessive smartphone/internet use and ultimately to SA.

Moreover, IU was proposed as a transdiagnostic risk factor underpinning various mental health problems (Mahoney & McEvoy, 2012; McEvoy & Mahoney, 2012), including cyberchondria (possibly due to its relationship with anxiety and depression Carleton, 2016; Norr et al., 2015). Cyberchondria may develop through IU when a person with difficulties in facing uncertainty endeavors to reduce the uncertainty about symptoms of physical illness. A search for health information online may serve as a reassurance seeking, i.e., an attempt to decrease anxiety, which, if it fails, leads to even greater anxiety and further searching (Fergus, 2013; Norr et al., 2015).

Individuals with higher IU would be more motivated to engage in smartphone use to reduce distress, putting themselves at risk of developing PSU/SA. A similar process was described in the context of distress (in)tolerance (see Elhai et al., 2018). We posit that the motivation to use smartphones in people with increased IU and cyberchondria is analogous but with one specific difference. That is, in the context of both elevated IU and cyberchondria, people might use smartphones as a means to reassure themselves, i.e., to decrease anxiety by resolving uncertainty. However, in the context of trait IU, the uncertainty could be related to any life circumstances. In contrast, in the context of cyberchondria, this uncertainty is more specifically related to health symptoms. Therefore, we wanted to examine whether those specificities related to cyberchondria have an incremental predictive power when predicting SA, compared to the IU.

Also, since it has been shown that IU was related to externalizing symptoms, it is plausible to assume that it will be associated with SA. Lastly, we expect a moderate positive rela- tionship between depression, anxiety symptoms, and SA, with their effect decreasing after including IU and cyberchondria in the model (Elhai, Dvorak, et al., 2017; Elhai, Levine et al., 2017), after accounting for age, gender, the purpose of smartphone use, and average daily smartphone use.

8.1.5 Aim and Hypotheses

The present study aimed to further investigate the IU and cyberchondria as two potentially important constructs in explaining SA. Our main hypotheses were that cyberchondria will have a unique contribution to predicting SA, in a positive direction after IU is already included in the model since it has been suggested that cyberchondria is a distinct construct from other closely related constructs and it is related to PIU and SA/PSU (Köse & Murat, 2021; Starcevic et al., 2019). In addition, since the IU is a trait-like construct (Carleton, 2016), unlike cyberchondria, a potential nosological category, the IU was entered into the model first. Next, we expected the IU to be positively related to SA (Rozgonjuk et al., 2019), over and above depression and anxiety symptoms.

8.2 Method

8.2.1 Participants

This study used data gathered in another study that dealt with the Serbian adaptation of the Smartphone Application-Based Addiction Scale (Csibi et al., 2018; Vujić, Volarov, Latas, Griffiths, & Szabo, 2023), where a convenience sample was collected online by sharing the link to the questionnaire on various social networks and messaging applications. Participants needed to be over 18 years old, smartphone users, and fluent in Serbian. In this study, the responses from people with a chronic disease (n = 128) were filtered out since the target population had to be chronic disease free. Therefore, this study is based on 471 participants, 260 women (55.2%) and 211 men (44.8%). The average age of the participants was M = 38.67 (SD = 10.41). Most participants had finished college or university (41.2%), 23.8% had master's degrees, 5.31% had a Ph.D. or higher, and 22.5% graduated from high school. Two participants had primary school education, while 6.79% were studying at the university at the time of data collection. The participants rated their financial situation as follows: 7.22% as very good, 36.70% as good, 47.60% as average, 7.43% as poor, and 1.06% as very poor.

8.2.2 Materials

Demographic Questions. Participants were asked about their gender, age, level of education, and current financial status.

Questions About the Daily Use of Smartphones. Participants were required to estimate their daily smartphone (SP) use in hours on a typical workday and weekend. First, a unique variable of smartphone use was computed by multiplying typical daily use over workdays by five and multiplying the use over the weekend by two. Then the sum of the two was divided by seven.

In the case of extreme responses (two in the dataset), the highest value of the weekday and weekend use was substituted with the next highest value plus one before computing the mean, as Field et al. (2012) suggested. Namely, an extreme value of 24-h use on weekends was replaced by 21 (the next highest value plus one), and similarly, 23-h use on workdays was replaced by 17. We believe that the transformation was justified since we found it unrealistic that someone uses a smartphone 24 or 23 h a day. Yet, we avoided deleting the extreme values because those answers reflect the participants' very high daily smartphone use.

Smartphone Use Purpose Questions. Two questions were used to assess two broad purposes of smartphone use, namely entertainment/leisure and productive use. The first was "How often do you use your smartphone for fun, out of boredom or habit (e.g., watching videos, scrolling through social media, listening to music, surfing the internet, etc.)?" and the second was "How often do you use your smartphone to fulfill a certain task (e.g., communicating with friends and family, paying bills, navigation, using a smartphone for work or for study purposes." Both questions were answered on a 7-point Likert scale, from 1 = almost never to 7 = almost always.

Smartphone Application-Based Addiction Scale (SABAS; Csibi et al., 2018; Validation Study of the Serbian Translation of the Scale Can Be Found in *Vujić, Volarov, Latas, Griffiths, & Szabo, 2023)*. This is a 6-item scale based on a components model of addiction (Griffiths, 2005). Each item refers to one of the components; however, the total score is used to operationalize smartphone addiction. The response scale is Likert type (1 = strongly disagree to 6 = strongly agree). The reliability of the instrument in the form of Cronbach's α, and McDonald's ω total in this study was α = .82 (ω = .82), practically the same as in the English version evaluation study, where it was α = .81 (Csibi et al., 2018).

Short Cyberchondria Scale (SCS; Jokić-Begić et al., 2019). This brief scale is constructed to measure the core features of cyberchondria. Sample items include "After searching for health information, I feel frightened," and "Once I start searching for health information, I find it difficult to stop." It was previously adapted from the Croatian language and validated into Serbian (Vujić et al., 2022) but was also used in English (Farooq et al., 2020). It is a reliable scale with good psychometric characteristics. The respondents answer on a 5-point scale (1 = I totally disagree, 5 = I totally agree). The reliability of the scale in this study was α = .86 (ω = .86), similar to another study, where it was α = .82 (Vujić et al., 2022).

Intolerance of Uncertainty Scale (IUS-11; Mihić et al., 2014). This short version was constructed directly from the full English version of IUS (Freeston et al., 1994), and not by translating the short English version, which contains 12 items (Carleton et al., 2007). For the Serbian language, the 11 items appeared to be optimal. Sample items include "When it's time to act, uncertainty paralyzes me" and "One should always look ahead to avoid surprises." The instrument showed good psychometric properties (Mihić et al., 2014). It can measure two dimensions of IU, inhibitory anxiety (IA, "Uncertainty makes my life intolerable") and prospective anxiety (PA, "Unforeseen events upset me greatly"); however, the total score can be computed to represent general IU (Mihić et al., 2014; Renjan, 2016). The response format is a 5-point Likert (1 = not at all characteristic of me, 5 = entirely characteristic of me). In this study, the total score was used. The internal consistency of the whole scale was α = .91 (ω = .91) in this study.

Depression Anxiety Stress Scale (DASS-21; Jovanović et al., 2014; Lovibond & Lovibond, 1995). The DASS-21 depression and anxiety scales were used, each containing seven items with the 4-point Likert response scale (0 = did not apply to me at all, 3 = applied to me very much or most of the time), asking participants to rate their feelings in the past week. The depression scale depicts depressive symptoms such as anhedonia and dysphoria, while the anxiety scale portrays anxious symptoms defined as arousal, physical symptoms, and subjective uneasiness. In the current work, Cronbach's alpha of the depression scale was α = .86 (ω = .87), and anxiety was α = .80 (ω = .81).

8.2.3 Procedure

Data were collected online, using the Qualtrics platform, for the study on adapting the Serbian version of SABAS, at the beginning of 2022 (see Vujić, Volarov, Latas, Griffiths, & Szabo, 2023). The original study from which these data came from obtained ethical approval from the Research Ethics Board of the first author's university (2020/306).

8.2.4 Data Analysis

In the correlational analysis, we used the Pearson correlation coefficient, where the *p*-values were corrected via the Benjamini–Hochberg method, controlling the false discovery rate, in our case, the rate of .05 (Benjamini & Hochberg, 1995). Therefore, all adjusted *p*-values below .05 were considered significant. Next, we used hierarchical multiple regression analysis, with smartphone addiction as the outcome variable. A composite score was computed using depression and anxiety symptoms scales from the DASS-21 questionnaire by taking the mean of the scores of the two scales. That was done due to their substantially high correlation to avoid potential multicollinearity problems in the regression model. Furthermore, calculating the total DASS-21 score is possible, representing general distress. Since we had not administered the stress scale, we decided to make a composite score with only anxiety and depression. The composite was named depression and anxiety symptoms.

There were five regression steps, and the authors determined the order of the inclusion of the variables. In the first step, gender and age were entered. The second step included entertainment and productive use frequency, as well as the average duration of smartphone use. In the third step, the composite score of the depression and anxiety scale was entered. In the fourth step, intolerance of uncertainty was added, and in the fifth step, cyberchondria was added, making it eight predictors overall. Data were analyzed using the R programming language (R Core Team, 2022), including "tidyverse" (Wickham et al., 2019), "psych" (Revelle, 2022),"sjPlot" (Lüdecke, 2021), "lm.beta" (Behrendt, 2023), "haven" (Wickham et al., 2022), "broom" (Robinson et al., 2023), "dlookr" (Ryu, 2022), "janitor" (Firke, 2023), "car" (Fox & Weisberg, 2019), "MASS" (Venables & Ripley, 2002), "robustbase" (Maechler et al., 2022), and "lmtest" (Zeileis & Torsten, 2002) packages.

8.3 Results

8.3.1 Descriptive Statistics

Descriptive statistics are shown in Table 8.1. It should be noted that daily smartphone use in hours and depression had notably skewed distributions. Since the sample was taken from the general population and with people suffering from chronic diseases excluded, it was expected that most depression and anxiety symptoms scores would be low.

Table 8.2 shows the Pearson correlation between the variables. Smartphone addiction had the highest correlation with entertainment use purpose, followed by correlations with intolerance of uncertainty, daily smartphone use, and cyberchondria. These correlations were moderate and positive.

Table 8.1

Descriptive statistics

Variable	*M*	*SD*	*IQR*	*Skew*	*Kurt*	*Min*	*Mdn*	*Max*
Smartphone addiction	15.69	5.74	8	0.32	− 0.50	6	15	33
Entertainment use	5.05	1.39	2	− 0.34	− 0.41	1	5	7
Productive use	5.77	1.34	2	− 1.08	0.58	1	6	7
Average SP use per day (h)	4.01	2.37	2.43	1.62	3.79	0.5	3.57	17.14
Anxiety	2.59	2.88	4	1.69	3.86	0	2	20
Depression	3.12	3.54	3.50	1.71	3.29	0	2	20

Variable	*M*	*SD*	*IQR*	*Skew*	*Kurt*	*Min*	*Mdn*	*Max*
DA symptoms	2.86	2.93	3.50	1.76	3.79	0	2	18
Intolerance of uncertainty	23.34	8.00	11	0.88	0.44	11	22	52
Cyberchondria	8.42	3.83	6	0.73	− 0.08	4	8	20

Note. *M* = mean; *SD* = standard deviation; *IQR* = interquartile range; *Skew* = skewness; *Kurt* = kurtosis; *Min* = minimum; *Mdn* = median; *Max* = maximum; *DA symptoms* = depression, and anxiety symptoms composite.

8.3.2 Regression Analysis

Inspection of the VIF values indicated no danger of multicollinearity in the hierarchical regression since all were < 2, while usually, VIF < 5 is considered problematic (Sheather, 2009). Visual inspection of the final model residual distribution indicates no violation of normality assumptions. No cases with the Cook's distance greater than one would be considered highly influential (Field et al., 2012). We should note that due to a possible slight violation of the homoscedasticity assumption and 11 multivariate outliers (detected via Mahalanobis distance and studentized residuals), we decided to run a robust regression model and a model with the heteroscedasticity consistent standard errors, with all predictors, included. However, no substantial differences in estimates, standard errors, and corresponding *t*-values were found in comparison to the regular regression model. Namely, the predictors that were significant at .05 level remained significant in both the robust model and the model with adjusted standard errors. Therefore, the same conclusion could be drawn from robust and non-robust models, indicating that the mentioned issues did not notably bias the results.

Table 8.2

Pearson correlation coefficients

Variable	1	2	3	4	5	6	7	8
1 Age	1							
2 Smartphone Addiction	− .11*	1						
3 Entertainment use	− .26***	.55***	1					
4 Productive use	.01	.20***	.38***	1				

Variable	1	2	3	4	5	6	7	8
5 Average SP use per day (h)	− .18***	.35***	.48***	.22***	1			
6 DA symptoms	− .15**	.30***	.21***	-.02	.16**	1		
7 Intolerance of uncertainty	− .01	.34***	.19***	.10*	.08	.49***	1	
8 Cyberchondria	-.16*	.31***	.17***	-.02	.14**	.38***	.38***	1

Note. The *p*-values were adjusted for multiple tests using the Benjamini–Hochberg method; DA = symptoms, depression, and anxiety symptoms composite.

$*p < .05$, $**p < .01$, $***p < .001$

All five models had a significant *F*-value, and each subsequent step significantly improved the model. This finding indicates that each block of variables substantially improved the explanation of smartphone addiction. Since intolerance of uncertainty and cyberchondria were entered individually at the fourth and fifth steps, both variables uniquely contributed to predicting smartphone addiction, over and above depression and anxiety symptoms, and while controlling for daily smartphone use, the purpose of use, gender, and age. The cyberchondria that was included as the last predictor had a somewhat weaker effect than IU. According to standardized coefficients, the effects of IU and cyberchondria could be described as minor. The final model explained nearly 40% of the outcome variance. In the final model, significant predictors were entertainment use, intolerance of uncertainty, cyberchondria, and the duration of daily use of smartphones, all predicting smartphone addiction in a positive direction, as expected. Standardized estimates indicate that the effect of entertainment use was much more significant than the effects of IU and cyberchondria (Table 8.3).

Table 8.3

Results of hierarchical regression analysis with smartphone addiction as the outcome

Predictors	Model 1		Model 2		Model 3		Model 4		Model 5	
	b	β	*b*	β	*b*	β	*b*	β	b	β
Constant	17.58***	-	3.15*	-	2.25	-	0.43	-	−0.86	-
Gender (female)	1.25*	.11	1.05*	.09	0.85	.07	0.89*	.08	0.75	.07

Predictors	Model 1		Model 2		Model 3		Model 4		Model 5	
	b	β	*b*	β	*b*	β	*b*	β	b	β
Age	− 0.07**	− .12	0.02	.04	0.03	.06	0.02	.04	0.03	.05
Entertainment use			2.12***	.51	1.97***	.48	1.88***	.45	1.86***	.45
Productive use			− 0.13	−.03	− 0.04	− .01	− 0.11	− .03	− 0.07	− .02
Average SP use per day (h)			0.30**	.12	0.27*	.11	0.29**	.12	0.27**	.11
DA symptoms					0.36***	.18	0.16	.08	0.10	.05
Intolerance of uncertainty							0.15***	.21	0.12***	.17
Cyberchon-dria									0.21***	.14
R^2/adj. R^2	.024/.020				.325/.318				.355/.347	
Δ*F*	5.84***				77.45***				23.68***	

Note. *b* = unstandardized coefficient; β = standardized coefficient; adj. R^2 = adjusted squared multiple correlation; Δ*F* = change in the *F* statistic; DA symptoms = depression, and anxiety symptoms composite.

**p* < .05, ***p* < .01, ****p* < .001

In the final model, gender was no longer a significant predictor, although its *p*-value was close to the threshold, *p* = .07, indicating somewhat higher scores on smartphone addiction in women than in men. We note that the mean score on SABAS for women was *M* = 16.20 (*SD* = 5.56), and for men *M* = 15.06 (*SD* = 5.90).

The use of smartphones for productive purposes was not significant, despite its moderate and positive correlation with SA. Depression and anxiety symptoms were no longer significant after entering intolerance of uncertainty in the model. In summary, the model explained a substantial proportion of variance of smartphone addiction, with entertainment use, IU, cyberchondria, and smartphone daily use duration being significant predictors. Model 5 regression estimates with 95% confidence intervals are presented in Figure 8.1 in the Appendix.

8.4 Discussion

This study investigated the relationship between cyberchondria, IU, and PSU. Hierarchical linear regression results suggest that cyberchondria uniquely affects PSU, over and above anxiety and depression symptoms, and IU, with age, gender, purpose (entertainment use and productivity use), and duration of smartphone use accounted for. The results supported our hypotheses that both IU and cyberchondria will have a positive relationship with SA and that each will contribute uniquely to explaining SA. That is, people with higher IU, as well as cyberchondria, may be more likely to engage in PSU and potentially develop SA. However, concluding causal relationships would require a different longitudinal or experimental study design rather than a cross-sectional one. We should also note that a bidirectional relationship between the investigated constructs is possible. These findings align with previous research, which suggested the connection between IU (Rozgonjuk et al., 2019) and cyberchondria (Köse & Murat, 2021) on the one hand and SA on the other. It is also worth mentioning that the strongest predictor of SA in the model was entertainment use purpose, while productivity use purpose was not significant. This finding also agrees with previous research reports (van Deursen et al., 2015; Wang et al., 2015).

The relationship between IU and SA suggests that IU is a core aspect of different psychopathologies or maladaptive behaviors (Carleton, 2016; Carleton et al., 2019; Mahoney & McEvoy, 2012; McEvoy & Mahoney, 2012). Intolerance of uncertainty can promote maladaptive coping in the shape of SA (Rozgonjuk et al., 2019) because some people tend to resolve the uncertainty and reduce distress related to it by any means (e.g., reassurance-seeking behaviors or excessive collecting of information). However, increased smartphone use could actually produce the opposite effects, leading to higher IU. Smartphones provide the possibility of constant reassurance (e.g., that a family member arrived home safely; that the partner is not cheating, etc.), but the perpetual availability of "safety cues" eventually can increase anxiety and deprive distress tolerance, leading to the rise of perceived uncertainty (Carleton et al., 2019). In other words, the maladaptive coping reflected in smartphone overuse could possibly maintain the aversive emotions. Most activities performed using a smartphone cannot actually reduce the uncertainty and negative emotions accompanied by it, no matter how much information a person gathers. However, this coping strategy can bring some temporary relief in some situations, which only reinforces this dysfunctional coping strategy, bringing negative outcomes in the long run. These negative outcomes are inevitable because reassurance-seeking as a safety behavior prevents people from testing their irrational beliefs about uncertainty in reality and from learning to tolerate uncertainty (Carleton et al., 2019). Aside from reassurance-seeking, avoiding uncertainty-related negative feelings is the other way to cope with uncertainty-related negative feelings. The usage of smartphones for both reassurance-seeking and avoiding facing uncertainty can be explained from the compensatory internet use theory perspective. According to the theory, the internet, or smartphone platforms, can be used as a coping strategy with negative outcomes. In other words, activities such as playing games or scrolling through social media can be used to escape real-life problems or reduce stress (Kardefelt-Winther, 2014). For example, individuals who use smartphones as a coping tool can increase entertainment activities on their devices when they want to distract themselves from negative emotions and ongoing real-life problems (Wang et al., 2015). A practical implication of the findings is that if one of the primary motivations of an individual to overuse, a smartphone is the reduction of uncertainty, then an intervention aiming to increase the ability to tolerate uncertainty and decrease biased interpretation of uncertainties could be implemented to help a person deal with the PSU/SA (see Oglesby et al., 2017). This intervention could also be a treatment of choice based on our finding that symptoms of depression and anxiety were no longer significant after including IU in the model but also based on the existing knowledge that IU underpins various emotional and behavioral problems (Mahoney & McEvoy, 2012; McEvoy & Mahoney, 2012). Finally, Qiu and colleagues (Qiu et al., 2023) have also recently recognized that targeting IU in therapy could be a preventive measure for PSU/SA.

Results also suggested that, despite both IU and cyberchondria having a similar proposed underlying motivation for smartphone use, namely, reducing the uncertainty, the cyberchondria had a unique contribution to predicting SA, above and beyond IU. The uncertainty in the context of the IU could be related to any aspect of life. In contrast, in the context of cyberchondria, uncertainty is specifically related to health symptoms, which a person tends to reduce. Additionally, in cyberchondria, the tendency to reduce uncertainty and self-reassure includes, by definition, searching for health information online, which can be performed via smartphone (among other devices). Accordingly, the behavioral aspect of the connection between cyberchondria and SA is more obvious than it is in the case of the IU and SA relationship, where IU can have various behavioral expressions, with smartphone overuse/SA being only one of them.

Nevertheless, a smartphone is only an instrument or a medium through which certain activity is performed, and the results must be interpreted with this in mind. The excessive use of smartphones, and therefore SA, may reflect an underlying compulsion (for example, online shopping, gaming, watching videos, scrolling through social media) which serves as a way of dealing with distress and anxiety. A previous study showed that individuals "deliberately engage in specific activities with specific content…" (Pontes et al., 2015, p. 23), so if they were unable to access their chosen activities, they would stop going online completely, or they would substantially decrease their time spent online (Pontes et al., 2015).

The average time participants spent using the smartphone during the day is quite similar to what was reported in other studies, including the Serbian one (Kwon et al., 2013; Nikolic et al., 2022). Contrary to what was hypothesized, depression and anxiety symptoms were not significant predictors of SA (although the *p*-value was close to the threshold of 0.05), after including IU in the model despite DA symptoms being moderately correlated with SA. The nonsignificance of DA symptoms as predictors might be due to the substantial overlapping of the variance in DA symptoms and IU, which explains the SA variance. The insignificant effect of age is consistent with some previous studies (Elhai, Dvorak, et al., 2017; Elhai, Levine et al., 2017; Kuss et al., 2018; Moreno-Guerrero et al., 2020) but also in contradiction with others (Csibi et al., 2021; De-Sola Gutiérrez et al., 2016; Mitchell & Hussain, 2018; van Deursen et al., 2015). The relation between age and SA seems highly dependent on the sample, consisting of high school or university students, participants from the general population with different age ranges, etc. Another possible reason for the non-significant effect of age could be the non-linear relation between age and SA, for which a linear model would not be appropriate. However, the investigation of this relationship was not the focus of this report. Some studies showed greater problematic smartphone use in women (De-Sola Gutiérrez et al., 2016; Lopez-Fernandez et al., 2017; van Deursen et al., 2015), while others did not show gender differences (Mitchell & Hussain, 2018). It is also possible that the sample age structure plays a role in these diffusing findings.

8.4.1 Limitations and Future Directions

The first limitation of the study is its cross-sectional design, which does not allow us to conclude anything about causality in the relationship between IU, cyberchondria, and SA. Therefore, future studies should consider a longitudinal design to overcome this shortcoming. Second, a convenient online sample was tested in this study, and it was not representative of the Serbian general population since the self-selection bias in this sample could be present. Therefore, subsequent studies should use random sampling to collect a more representative sample. Furthermore, to isolate the potential unique variance SA in its relationship with IU and cyberchondria, a measure of PIU (or IA) should be included in the model, which has not been done in this study, to have a more detailed insight into whether the smartphone as a medium facilitates cyberchondria. Next, a self-report of smartphone screen time could be biased; thus, a more objective measure could be a better alternative in assessing daily smartphone use duration (for example, using a smartphone application for obtain the usage data or using the data provided by the smartphone operating system). Finally, the study is based on a Serbian sample which means its cross-cultural generalizability is questionable. Despite these limitations, we hope this research will encourage further investigation of the problematic use of technology and cyberchondria, its diathesis, and connection with psychopathological consequences.

9 Study 4: Cyberchondria and Questionable Health Practices: The Mediation Role of Conspiracy Mentality[4]

9.1 Introduction

9.1.1 Cyberchondria and its Correlates

Cyberchondria is a repetitive pattern of excessive search for health-related information on the Internet with the purpose of relieving distress or anxiety (Starcevic & Berle, 2013). Unlike the "classical reassurance seeking", where an individual can actually achieve a decrease in anxiety, in cyberchondria, the levels of anxiety, distress, and possibly confusion are higher than before the online information search (Starcevic, 2017; Starcevic & Berle, 2013). In a recent review, cyberchondria was determined as a "transdiagnostic compulsive behavioral syndrome", due to it being related to various groups of disorders such as anxiety, behavioral, and obsessive-compulsive and related disorders (Vismara et al., 2020).

There are several proposed vulnerability factors and mechanisms of the development and maintenance of cyberchondria. For example, low self-esteem could be a risk factor for various dysfunctional behaviors, including problematic use of technology such as the Internet and smartphones, as well as cyberchondria. However, these dysfunctionalities could also result in decreased self-esteem (Bajcar & Babiak, 2019). Next, metacognitive beliefs (e.g., "Worrying about an illness is likely to make it happen" or "Dwelling on thoughts of illness is uncontrollable") or some of their dimensions seem to be related to cyberchondria (Fergus & Spada, 2017, 2018). Other mechanisms include pain catastrophizing (Gibler et al., 2019), intolerance to uncertainty (Fergus, 2013, 2015; Norr, Albanese, et al., 2015), and anxiety sensitivity (Fergus, 2015; Norr, Albanese, et al., 2015). However, not all relevant studies have found a relationship between intolerance to uncertainty and anxiety sensitivity on the one side and cyberchondria on the other (Fergus & Spada, 2017). Clinical or subclinical constructs that are most strongly related to cyberchondria are health anxiety (Baumgartner & Hartmann, 2011; Fergus & Russell, 2016; McMullan et al., 2019), obsessive-compulsive symptoms (Fergus &

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Russell, 2016; Norr, Oglesby, et al., 2015) and problematic Internet use (PIU; Durak Batıgün et al., 2020). Yet, cyberchondria appears to be distinct enough from these closely related constructs (Fergus & Russell, 2016; Mathes et al., 2018; Starcevic et al., 2019).

9.1.2 Measuring Cyberchondria

There are several proposed measures of cyberchondria, with the two briefest tools being the 12-item Cyberchondria Severity Scale (CSS-12; McElroy et al., 2019) and the Short Cyberchondria Scale (SCS; Jokić-Begić, 2019). Items from the original 33-item CSS (McElroy & Shevlin, 2013) were developed based on a review of the existing literature on cyberchondria and conceptually similar constructs. They should reflect the multidimensional structure of cyberchondria, including both anxiety and excessive searching behaviors. The final solution suggested five factors: compulsion, distress, excessiveness, reassurance, and mistrust of medical professionals, with the latter showing poor validity. Therefore, the short form of CSS (CSS-12; McElroy et al., 2019) consists of only four factors.

On the other hand, the authors of the SCS believe that the original CSS is too long and perhaps contains items that are not strictly relevant to cyberchondria. Hence, they sought to develop a valid, reliable, and short scale that would capture the essential features of cyberchondria – excessiveness, reassurance seeking, and distress. After a thorough analysis, only four items that capture the negative consequences of online health information search were retained (Jokić-Begić et al., 2019). In this research, we intended to examine the psychometric properties of Serbian adaptations of both brief tools and determine their similarities and differences.

9.1.3 Cyberchondria Amid the COVID-19 Pandemic

Cyberchondria has been explored in the context of the coronavirus crisis (Farooq et al., 2020; Jokic-Begic et al., 2020; Jungmann & Witthöft, 2020; Maftei & Holman, 2020; Seyed Hashemi et al., 2020; Starcevic et al., 2020; Zheng & Tandoc, 2020). Specifically, the current pandemic is accompanied by high levels of uncertainty and fear, which could lead to a considerable increase in online health information search, as well as cyberchondria (Farooq et al., 2020). For example, it has been suggested that both PIU and cyberchondria are directly and indirectly related to the fear or anxiety related to COVID-19 (Jungmann & Witthöft, 2020; Seyed Hashemi et al., 2020). Furthermore, according to a recently proposed model, fear, uncertainty, and information overload related to the COVID-19 pandemic play a significant role in the development of cyberchondria (Starcevic et al., 2020). Compulsive online search for symptoms not only increases anxiety, but may also lead to other risks, such as choosing to self-medicate for an illness that one does not have or taking a medication or herbal remedy that may have side effects or no effect at all. Moreover, much of the health information available online is not complete. Thus, we could assume that in uncertain situations such as the COVID-19 pandemic, people with greater cyberchondria may resort to questionable health practices to prevent infection. What remains unknown is the mechanism through which cyberchondria could lead to a greater use of problematic health practices.

One of the mechanisms could be the tendency toward conspirative thinking. It has been suggested that individuals with this tendency are more likely to approve of complementary/alternative medicine (CAM) treatments and the use of pseudoscientific practices (PSP) with the aim of preventing a coronavirus infection (Lamberty & Imhoff, 2018; Pennycook et al., 2015; Pummerer et al., 2021; Teovanović et al., 2021). Furthermore, believing in conspiracy theories is a form of dealing with something uncertain and unfamiliar and it is related to the disapproval of science (Lewandowski et al., 2013; Sadeghiyeh et al., 2020). Therefore, we find it relevant to investigate the mediation role of conspiracy mentality in relations between cyberchondria and questionable health practices in the context of COVID-19, as well as in the general context.

9.1.4 Objectives and Hypotheses

This research had two objectives. The first was to explore the psychometric properties of Serbian adaptations of the 12-item Cyberchondria Severity Scale (CSS-12; McElroy et al., 2019) and the Short Cyberchondria Scale (SCS; Jokić-Begić et al., 2019). Therefore, we strived to examine and compare the characteristics and performance of the SCS and the short form of the CSS. More precisely, we tested the factor structure, convergent validity, and reliability of the scales. We expected acceptable fit indices of the originally proposed four-factor model of the CSS-12, a bifactor model, and the single-factor model of the SCS. We further anticipated moderate to high positive correlations with health anxiety, internet addiction, and obsessive-compulsive symptoms and a negative correlation with self-esteem.

The second objective was to explore the prediction of questionable health practices (CAM and PSP related to COVID-19) based on cyberchondria. Additionally, we tested the mediation role of conspiracy mentality in these relations. We expected that cyberchondria would positively predict the use of both CAM and PSP and that these relations would be mediated by conspiracy mentality.

9.2 Method

9.2.1 Participants and Procedure

The sample included 511 participants (73.6% women), aged from 18 to 77 (*M* = 41.37, *Mdn* = 41, *SD* = 10.95). More than half of the participants (52.5%) had a college or university degree or more, 42.10% finished only high school, 2.35% finished only primary school, and 3.13% were university or college students. On a scale from 1 (very poor) to 5 (excellent), participants rated their health status as 4.03 (*SD* = 0.90) on average. Men were under-represented in the sample. However, the average age of the overall sample, as well as women and men separately, roughly resembled the estimated averages in the Serbian population (Statistical Office of the Republic of Serbia, 2020, 2021). Additionally, there was a higher proportion of highly educated people in the sample, compared to the Serbian population, where around 11% of people have an academic degree (Social Inclusion and Poverty Reduction Unit, 2013). In summary, the sample was convenient and not representative of the Serbian adult population. Therefore, the generalizability of the results must be taken with caution.

The study was approved by the Ethics Committee of the Department of Psychology, Faculty of Philosophy, University of Novi Sad (Code: 202102111130_SPhQ). Data were collected online, over the course of March 2021, using the Qualtrics platform. The link to the set of questionnaires was shared via social networks.

9.2.2 Measurement

The Serbian Adaptation of the Cyberchondria Severity Scale (CSS-12; McElroy et al., 2019, for the Serbian adaptation, see Supplement). Based on the Croatian adaptation of the CSS (Jokić-Begić et al., 2019), we selected 12 items for the CSS-12 and adapted them to the Serbian language, given the similarities between the two languages. The CSS-12 has four subscales: Excessiveness (repeated search for health information on the Internet), Distress (the increase in anxiety, distress, and uneasiness after performing an online health information search), Reassurance (the need for seeking reassurance from health specialists as a result of distress caused by online health information search), and Compulsion (the interference of online health information search with other online or offline activities, e.g., professional and social). Participants answered on a 5-point Likert scale (from 1 = never to 5 = always). According to the authors, the best model of the scale is a bifactor model. Thus, they recommend using the total score of all 12 items.

The Serbian Adaptation of the Short Cyberchondria Scale (SCS; Jokić-Begić et al., 2019, for the Serbian adaptation, see Supplement). The SCS is a 4-item scale that measures general cyberchondria, covering negative affective reactions related to online health information search. The response format is a 5-point Likert scale (from 1 = I totally disagree to 5 = I totally agree).

The Complementary–Alternative Medicine (CAM) Questionnaire. This questionnaire was developed for the purpose of this study. It consists of five items measuring the frequency of use of various preventive and/or healing methods that could be classified as CAM (phytotherapy, bioenergetic medicine, dietotherapy, chiropractic, and acupuncture), regardless of the current COVID-19 situation. Responses are given on a 5-point Likert scale (from 1 = never or very rarely to 5 = very often).

The Pseudoscientific Practices Scale (PSPS; Teovanović et al., 2021). This scale measures people's use of the most common pseudoscientific practices as preventive measures against coronavirus infection (such as consuming large amounts of garlic, drinking water every 15 minutes, and taking colloidal silver). In this study, participants reported the use of such practices during the previous 3 months. Although the content somewhat overlaps with the CAM questionnaire, it specifically captures the use of certain unproven methods as coronavirus infection prevention measures. The response format is a 5-point Likert scale (from 1 = never to 5 = very often).

The Conspiracy Mentality Questionnaire (CMQ; Bruder et al., 2013, for the Serbian adaptation, see Lukić et al., 2019). This 5-item questionnaire measures a generic propensity for conspiracist ideation and assesses the person's general susceptibility to explaining various events using conspiracy theories. The participants answered using a 5-point Likert scale (from 1 = I totally disagree to 5 = I totally agree).

The Internet Addiction Test (IAT; Widyanto & McMurran, 2004; for the Serbian adaptation, see Dukanac et al., 2016). This 20-item measure assesses problematic Internet use. In this study, the total score of all 20 items was used. The response format is a 5-point Likert scale (from 1 = almost never to 5 = always).

The Obsessing Scale from the Obsessive-Compulsive Inventory – Revised (OCI-R, Foa et al., 2002, for the Serbian adaptation, see Purić et al., 2018). The scale comprises 3 items that assess difficulty in controlling intruding thoughts that cause distress. The response format is a 5-point Likert scale (from 1 = not at all to 5 = extremely).

The Health Anxiety Questionnaire (HAQ; Lucock & Morley, 1996, for the Serbian adaptation, see Supplement). We adapted the Croatian version of the HAQ (Jokić-Begić et al., 2019) to the Serbian language. We used the total score of all 21 items to measure health anxiety. The response format is a 4-point Likert scale (from 1 = not at all or rarely to 4 = most of the time).

The Single-Item Self-Esteem Scale (SISE; Robins et al., 2001). We measured self-esteem using a single item ('I have high self-esteem' or 'Imam visoko samopoštovanje' in Serbian) to which participants could respond from 1 = not very true of me to 7 = very true of me.

Means, standard deviations, and alpha reliabilities of all scales are shown in Table 2. All variables had good internal consistencies, with the CAM questionnaire demonstrating the lowest, but still acceptable value. For all scales and subscales, the scores were calculated by summing the items.

9.2.3 Data Analysis

First, a confirmatory factor analysis (CFA) of the proposed models for the CSS-12 and the SCS was performed in the R software (R Core Team, 2021), v. 3.6.2, using the 'lavaan' package (Rosseel, 2012) in order to test their factor structure. Due to the violation of the multivariate normality assumption of CSS-12 and SCS items, an ML estimator with robust standard errors (MLR) was used. A model fit was considered acceptable if the CFI and the TLI $\geq .90$ and the RMSEA and the SRMR $\leq .08$ and good if the CFI and the TLI $\geq .95$ and the RMSEA and the SRMR $\leq .05$ (Hu & Bentler, 1999).

Several CSS-12 structures were tested: 1) a single-factor model, 2) a four-factor model, 3) a hierarchical model, 4) a classical bifactor model with 4 specific factors, and 5) the asymmetrical bifactor model (more specifically, the bifactor S-1 model). Since a single-level sampling process often results in data that are not suitable for the traditional bifactor model (e.g., fixed instead of random, mutually interchangeable indicators or facets, see Burns et al., 2020), bifactor models often result in anomalous results (e.g., negative variance). Therefore, the bifactor S-1 model was proposed as an alternative. In this model, one domain (subscale or facet) is chosen as the reference domain, so the items belonging to it only load on the general factor, which would represent the common true score variance of the underlying reference domain. Thus, there is one specific factor fewer than in the traditional bifactor model. Importantly, the specific factors in this model are allowed to correlate, while the general and specific factors are orthogonal, as in the traditional bifactor model. By applying this approach, the meaning of the general factor would not change by changing the indicators and models would result in interpretable factors and a non-anomalous solution (for details, see Eid et al., 2017). The choice of the reference domain is somewhat arbitrary and it should be based on a theory and ease of interpretation (Burns et al., 2020). In the case of the CSS-12, Compulsion was chosen as a reference factor, since it represents the interference of cyberchondria with the person's professional, social, and everyday activities and its content differs most from the content of the other three factors.

Second, correlations between the CSS-12, the SCS, and other measures were examined in order to test the convergent validity of the two scales. The profile similarity between the two scales was calculated as Cronbach and Gleser's (1953) *D* statistics, which are based on Euclidean distances. Therefore, lower values indicated greater profile similarity and *D* could be interpreted as Cohen's *d* (Cohen, 1988), with values .20 indicating small, .50 medium, and .80 large dissimilarities.

Third, the mediation models were run using the PROCESS macro, v.3.4.1 (Hayes, 2018) in SPSS software (IBM Corp., 2020). In both models, cyberchondria was the predictor, operationalized as a score on the first extracted principal component of both CSS-12 and SCS sum scores (see the Supplemental material), and conspiracy mentality was the mediator. In the first model, the outcome variable was PSP, while in the second model, the outcome variable was CAM use. Unstandardized coefficients (*b*) with 95% percentile bootstrap confidence intervals (with 5,000 bootstrap samples) were reported along with standardized (β) coefficients. Due to the high skewness and kurtosis, CAM and HAQ variables were normalized using the Rankit transformation.

9.3 Results

9.3.1 Factor Structure of Serbian Adaptations of the CSS-12 and the SCS

Fit indices of all tested models are presented in Table 7.1. The single-factor model exhibited a poor fit, while the fit of the four-factor model was good. The hierarchical model did not show an acceptable fit, but after the inspection of modification indices, it was clear that the first-order factors of Distress and Compulsion on the one hand and Reassurance and Excessiveness on the other might have to be correlated in order to improve the fit. In fact, the inter-factor correlations of Distress-Compulsion and Reassurance-Excessiveness were above .70.

The traditional bifactor model exhibited an anomalous result with a negative variance of item 9 as well as a non-significant loading of item 4 on the specific factor of Distress. It appears that this specific factor did not have a clear meaning. However, the bifactor S-1 model with Compulsion as the reference domain showed the best fit of all models, including the models where each of the other three domains served as the reference domain. The three specific factors (Excessiveness, Distress, and Reassurance) correlated significantly and moderately (.49 - .69). We should note that item 1 from the specific factor of Excessiveness did not load significantly on the general factor.

Table 7.1

The Fit Indices of the Proposed CSS-12 Models

Model	χ^2(df)	CFI	TLI	RMSEA	SRMR
Single-factor	589.829(54)	.712	.648	.160	.103
Four-factor	164.251(48)	.941	.919	.077	.052
Hierarchical	234.618(50)	.908	.878	.094	.077
Bifactor*	171.118(42)	.934	.896	.087	.068
Bifactor S-1	81.511(42)	.980	.968	.048	.027

Note. Robust fit indices were used. *The model had a negative variance. CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual.

In the case of the SCS, the CFA showed an excellent fit with caution that it could reflect an overfit ($\chi^2(2) = 1.65$, $p = .44$, CFI = 1.00, TLI = 1.00, RMSEA = .000, SRMR = .008). The CFI of 1 and the TLI of even >1 could be expected in a very simple model such as this one, where the χ^2 is not significant. Additional item statistics for CSS-12 and SCS items and detailed CFA parameters (including bifactor S-1 model) for both scales can be found in the Supplemental material.

9.3.2 Validity Correlations of Serbian Adaptations of the CSS-12 and the SCS

The CSS-12 and the SCS demonstrated similar patterns of correlation with other measures (Table 7.2). Unsurprisingly, both scales most strongly correlated with each other, with the correlation being moderate. The next strongest correlations of the two scales were with health anxiety, followed by Internet addiction and obsessing, supporting their convergent validity. The relationship between the two cyberchondria scales and self-esteem was negative, as expected. Furthermore, high profile similarity was obtained between the two scales ($D = 0.03$).

The total CSS-12 scale, its subscales, and the SCS showed good alpha reliabilities, presented in Table 2. Additionally, omega total coefficients were: for the total CSS-12 ($\omega = .86$), for Excessiveness and Distress ($\omega = .82$), for Reassurance ($\omega = .74$), for Compulsion ($\omega = .73$), and for the SCS ($\omega = .84$).

Table 7.2

Means, Standard Deviations, Internal Consistencies, and Zero-Order Correlations

Scale	*M* (*SD*)	α	E	D	R	C	CSS	SCS	PSP	CAM	CM	HA	IA	O
E	8.08 (2.83)	.81	1											
D	6.04 (2.84)	.81	.51***	1										
R	6.13 (2.53)	.71	.56***	.47***	1									

C	4.25 (2.17)	.72	.24***	.58***	.26***	1								
CSS	24.77 (7.95)	.86	.78***	.85***	.76***	.65***	1							
SCS	8.40 (3.59)	.82	.44***	.69***	.38***	.49***	.66***	1						
PSP	23.67 (7.31)	.81	.11*	.16***	.19***	.08	.18***	.17***	1					
CAM	10.43 (3.60)	.70	.08	.09	.17***	.04	.13**	.10*	.47***	1				
CM	18.66 (3.94)	.82	.03	.09*	.03	.11*	.08	.13**	.25***	.12*	1			
HA	32.16 (9.43)	.94	.41***	.58***	.40***	.32***	.57***	.51***	.15***	.13**	.08	1		
IA	37.30 (11.95)	.92	.35***	.36***	.27***	.30***	.42***	.33***	.11*	.08	.08	.37***	1	
O	5.61 (2.65)	.88	.29***	.39***	.18***	.28***	.38***	.37***	.09	.13**	.07	.52***	.36***	1
SE	4.83 (1.73)	-	-.11*	-.13**	-.03	-.10*	-.12*	-.09*	.04	.06	.06	-.12*	-.09	-.21***

Note. *p*-values were adjusted via the False Discovery Rate (FDR) method. No notable changes in significance levels occurred after the adjustment. *M* = mean; *SD* = standard deviation; E = Excessiveness; D = Distress; R = Reassurance; C = Compulsion; CSS = Cyberchondria Severity Scale (CSS-12); SCS = Short Cyberchondria Scale; PSP = Pseudoscientific practices; CAM = Complementary/Alternative medicine; CM = Conspiracy Mentality; HA = Health anxiety; IA = Internet addiction; O = Obsessing; SE = Self-esteem.

*$p < .05$. **$p < .01$. ***$p < .001$.

9.3.3 Mediation Analyses

The results of mediation analyses showed a significant direct effect of cyberchondria on pseudoscientific practices related to COVID-19, $b = 1.181$, 95%CI [0.570, 1.792], with the standardized coefficient $\beta = .162$, as well as an indirect effect through conspiracy mentality (b = 0.182, 95%CI [0.025, 0.364], β = .025). Regarding the second model, cyberchondria had a significant direct effect on CAM: b = 0.109, 95%CI [0.026, 0.193], β = .114, as well as an indirect effect, although the lower level of CI was very close to zero (b = 0.011, 95% CI [.001, .026], β = .011). Figure 3.2 and Figure 3.3 in the Supplemental material illustrate the two mediation models.

9.4 Discussion

The first aim of this study was to explore the psychometric properties of Serbian adaptations of two brief cyberchondria measures, the CSS-12 and the SCS. First, the factor structure was explored. For the SCS, the one-factor model showed an excellent model fit and scores on all items showed good alpha reliability. For the CSS-12, the bifactor S-1 model showed the best fit, which allowed for the use of the total score as well as the subscale scores. In previous research (McElroy et al., 2019), the traditional bifactor model showed the best model fit, but alternative bifactor models were not tested. However, the traditional bifactor model exhibited an anomalous result in our research, reflecting problems in the specific factor of Distress. Thus, the bifactor S-1 model arose as the best solution that prevents an anomalous result. Within this model, based on the domain's distinctiveness from other domains, we choose the Compulsion subscale as the reference domain. Thus, the general factor represented the level of compulsion in cyberchondria, and the remaining three specific factors were deviations of each factor's scores from the expected values, which were based on compulsion intensity. Although some authors have suggested that the bifactor S-1 model facilitates the interpretation of the results by suggesting a clear interpretation of the general factor and its relation to the s-factors (e.g., Burns et al., 2019), the model has also been criticized. For example, Willoughby (2020) raised concern about the application of bifactor S-1 models, pointing out that they cannot be used to determine the 'overall propensity' of the construct, since both the general factor and specific factors have different meanings than they have in a traditional bifactor model (Willoughby, 2020). Apart from differences between the bifactor models, the results showed that subscales as specific factors contained substantial true score variance, independent of the general reference factor. Likewise, the general factor contained substantial true score variance, independent of specific factors. This further supports the use of both total and subscale scores on the CSS-12. As for the hierarchical model, modification indices suggest that the second-order factor could not explain a certain amount of variance shared by the first-order factor pairs (Excessiveness – Reassurance and Distress – Compulsion).

Scores on all items and the subscales of Excessiveness, Distress, Reassurance, and Compulsion showed good alpha reliability, which is in line with previous studies (McElroy et al., 2019; Zheng et al., 2020, 2021). According to McElroy, the domains of Excessiveness and Compulsion capture excessive behavior related to cyberchondria, while Distress and Reassurance are more related to worrying and the need to be reassured about medical concerns (McElroy, et al., 2019). In this study however, Distress and Compulsion showed high mutual correlations, followed by correlations between Excessiveness and Reassurance, while Compulsion showed moderate correlations with Reassurance and Excessiveness. Correlations between factors in the four-factor model in our research were much higher than correlations between the same factors in the 33-item version of the scale (McElroy et al., 2019).

Both scales showed the expected relations with convergent validity measures, which is consistent with previous findings (e.g., Jokić-Begić et al., 2019; McElroy et al., 2019). Health anxiety was the dominant correlate of cyberchondria. However, in light of previous findings (Starcevic et al., 2019), it is important to note that the correlation between them is not sufficiently high to conclude that cyberchondria is the same construct as health anxiety. As previously suggested, the affective aspect (i.e., health worry) was the only aspect of health anxiety related to both overall cyberchondria and each of its subdomains. This is not surprising, since individuals engage in online health information search in order to alleviate worry about health (Fergus & Russell, 2016).

Furthermore, the SCS scale showed an excellent model fit and alpha reliability. Both scales showed the expected relations with convergent validity measures, which is consistent with previous findings (e.g., Jokić-Begić et al., 2019; McElroy et al., 2019). The SCS also correlated most strongly with health anxiety. Profile similarity between the CSS-12 and the SCS showed that these scales had very similar patterns of correlation with the used validity measures and that they assessed the same construct.

Second, the results of mediation analyses showed that cyberchondria had both direct effects and indirect effects (through conspiracy mentality) on pseudoscientific practices related to COVID-19 and the use of complementary/alternative medicine treatments in general. An explanation could be that people with high cyberchondria could turn to PSP and/or CAM to lower their anxiety about the disease and regain the sense of control, especially in regards to getting infected with coronavirus. As mentioned before, in cyberchondria, searching for health information online often results in a level of distress that is higher than before the search (Starcevic & Berle, 2013). Therefore, at some point, one could turn to activities other than online searching and visiting various (conventional medicine) clinics. That is, the person could resort to unconventional and unproven prevention methods and treatments. The often contradictory and scarce information provided by official medical sources additionally intensifies the uncertainty, which is already increased in individuals prone to cyberchondria (Wu et al., 2021). This leads them to choose PSP and/or CAM as practical solutions, i.e., straightforward protective behaviors that provide a sense of control and have an 'anxiolytic' effect.

Our results revealed conspiracy mentality as one of the possible mechanisms through which cyberchondria is related to the use of PSP/CAM. In previous studies, COVID-19 conspiracy beliefs strongly correlated with pseudoscientific beliefs and the main predictor of both types of beliefs was not anxiety but a lack of control. This suggests that a lack of control can be seen as a more central factor in adopting conspiracy theories, as it may increase anxiety. Anxiety generates the need to give meaning to a threatening situation and may finally result in adopting conspiracy beliefs (Šrol et al., 2021). Therefore, it could be assumed that the distress associated with cyberchondria makes people more prone to developing a conspiracy mentality and adopting conspiracy beliefs, which are linked to more positive attitudes toward CAM (Lamberty & Imhoff, 2018) and PSP (Teovanović et al., 2020) as tools for maintaining a sense of control over the uncertain situation (see Sadeghiyeh et al., 2020).

The results may indicate a certain generalization, since we demonstrated a relation between a general tendency towards conspirative thinking (not only about COVID-19) and COVID-19-related PSP. Additionally, we asked participants about their actual use of CAM, not only about their attitude towards CAM. In our sample, PSP and CAM obtained higher correlations with conspiracy mentality than with any other variable. Still, we should note that their correlations with conspiracy mentality were relatively low, leaving the possibility that other factors also contribute to health-risk practices.

There are several limitations to this study. First, cyberchondria's indirect effect on CAM through conspiracy mentality was very small. Thus, one might question the actual meaningfulness of this effect. Second, it is possible that self-selection bias was present, since a convenience sample was used, with responses collected online. Third, the cross-sectional nature of the study prevents us from drawing conclusions about the causal relationships between the phenomena. Fourth, almost three quarters of the participants were women, leaving males underrepresented in the sample. Additionally, participants on average reported good physical health, leaving the possibility that they did not have an express need for searching for health-related information. Finally, compared to some previous research, participants in our sample reported somewhat lower total scores on the CSS-12 (Wu et al., 2021; Zheng et al., 2021) and the SCS (Jokić-Begić et al., 2019).

Since the unidimensionality in the Serbian adaptation of the CSS-12 is not completely clear, future research should further examine this problem, using a more representative sample. Further, starting with the full 33-item version of the scale adapted into Serbian might give a different result. Different items from the original instrument might constitute a shorter version of the CSS in Serbian. Regarding the second part of this research, more complex models could be utilized to additionally investigate the paths through which cyberchondria might be connected to PSP/CAM, by adding other important variables such as a lack of control or coronavirus-related anxiety if the problem is examined in the COVID-19 pandemic context.

In sum, the results of our study support the alpha reliability and convergent validity of the Serbian adaptation of both the CSS-12 and the SCS. The CSS-12 could be used as a measure of the four domains of cyberchondria and probably as the total score, but this is to be further examined in the Serbian population. The SCS scale could be used as a general cyberchondria scale, since its four items refer to the core cyberchondria features. Since both total scores showed high profile similarity, the SCS could be used when there is a need for a brief screening of the tendency toward cyberchondria, while the four subscales of the CSS-12 could be used when there is a need to assess cyberchondria as a multidimensional construct. The results further enhance our understanding of health-risk outcomes of cyberchondria and the potential mechanism through which cyberchondria could affect health-risk behaviors. These two brief measures of cyberchondria could be of great importance for practitioners working to improve Serbian public health in the ongoing COVID-19 pandemic. This study can facilitate research of cyberchondria on the Serbian population.

10 General Discussion

10.1 Summary of the Findings

To sum up, Study 2 showed that what we called hedonic use, measured with a single item, which was essentially used for entertainment, pastime, boredom, including searching for random information on the internet via smartphone, is positively associated with smartphone addiction operationalized through SABAS, that is, through the six core components of addiction. Perceived stress, as well as gender, also played a role in predicting the SA, and life satisfaction was negatively related to SA, but only through the perceived stress, and not directly. As discussed previously, the results were interpreted in terms of compensatory internet use theory, where stressed individuals would likely use smartphones to cope with the stress. However, this is not contrary to the possibility of smartphone addiction (or PSU) being an addictive behavior. Hedonic use can correspond to positive reinforcement and perceived stress to negative reinforcement when it comes to their positive association with the SA. This study utilized the English version of the SABAS which might not have been optimal, given that the majority of the participants were non-native English speakers. Then, the idea for the second study emerged – to adapt and validate the SABAS to the Serbian language. We believe this was done successfully, although instrument validation is a long process, not a single study problem.

Study 1 tested the newly back-translated SABAS, and confirmed its unidimensionality, using both exploratory and confirmatory factor analyses. The result of the unidimensional structure is of immense importance since it conforms with the components model of addiction, where there are no "peripheral" components among all six components of addiction. All of them can be related to various sociopsychological problems. Although a single-factor structure was supported, there was a moderate modification in the model, where the tolerance and relapse shared a moderate amount of variance not explained by the smartphone addiction factor. One explanation is the content and the wording of the items, where both contain a characteristic of increasing use over time. Importantly, the temporal stability and internal consistency measures showed that the Serbian SABAS appears to be a reliable tool, and the correlations with the relevant constructs, indicated its validity. The second part of the study showed acceptable psychometric properties of the English SABAS, administered earlier on non-native

English and native Serbian speakers, which gave more confidence in the findings of Study 1.

Study 4 arose from the need for a cyberchondria assessment tool suitable for the Serbian population. Furthermore, cyberchondria, along with SA and internet addiction, is a technology-related problematic and potentially addictive behavior. Besides the CSS-12 instrument, the ultra-short SCS tool was adapted from Croatian as well. However, the validation of CSS-12 and inspection of psychometric properties of SCS was the first part of the study. In order to facilitate the understanding of the mechanism of cyberchondria related to pseudoscientific practices and CAM, given the coronavirus pandemic context. The preliminary results suggested that the CSS-12 should be investigated further, given that in our study, the bifactor structure was not supported and should be used to assess specific dimensions of cyberchondria. Until the structure of CSS-12 is further clarified, the SCS can be appropriate to operationalize the general cyberchondria.

Finally, Study 3 investigated the relationship between cyberchondria and smartphone addiction. Cyberchondria and intolerance of uncertainty (IU) were predictors of primary interest. The main results suggest that cyberchondria predicted smartphone addiction over and above IU, depressive and anxiety symptoms, smartphone use purpose and use frequency, age, and gender. However, the strongest predictor was entertainment use, which corresponds closely to the hedonic use variable from Study 1.

Overall, the results are aligned with the assumptions of compensatory internet use theory (Kardefelt-Winther, 2017) since the perceived stress partly explains the relationship between hedonic (entertainment) use and life satisfaction with SA. Stressed individuals are likely to use smartphones more to alleviate negative emotions or to escape unpleasant reality, which can lead to problematic or addictive use. In addition, people prone to worrying, anxious and depressive symptoms engage in smartphone use to "numb" those adverse emotions. Also, the unidimensionality of the SABAS is in line with the components model of addiction (Griffiths, 2005) since none of the six core components appeared as peripheral, or less important than the rest or uncharacteristic of a disorder (see Amendola, 2023b). Finally, commenting on the overall results in light of the I-PACE model (Brand et al., 2019) is difficult since the model explains the onset and maintenance of an addiction through various personality aspects and processes. However, it is safe to say that our results support the role of psychopathology as a general predisposing factor and motives (i.e., entertainment use) as a specific predisposing factor for the onset and maintenance of an addiction.

10.2 The "Addiction" Framework of Problematic Smartphone Use

We previously noted that the concept of behavioral addiction is still highly debated and without clear consensus among researchers. The main point of the criticism is that possibly any problematic behavior is an "addiction," although it might not be clinically relevant at all. Flayelle and colleagues (Flayelle et al., 2022) as well as several other researchers (Billieux et al., 2015a; Kardefelt-Winther, 2017), call it "the confirmatory approach."

Overpathologization of modern lifestyle, applying diagnostic criteria from substance addiction and gambling disorder to problematic internet/smartphone use, and a priori classifying it as an *addictive behavior* (Billieux et al., 2015b; Flayelle et al., 2022; Kardefelt-Winther, 2017). The picture with smartphones is even blurrier than with problematic internet use. Since smartphones have very distinctive features (accessibility, portability, constant connectedness, plentiful of functionalities), they even become a necessity of everyday life, and as other technologies are integrated into people's personal and professional aspects of life, bringing many benefits. At the same time, this is not the case with drug and alcohol use, and other "behavioral addictions" such as gambling and exercise (Young & de Abreu, 2011). Although aware of their increased use of smartphones, it is important that many young people do not consider distracting from other activities (Emanuel et al., 2015) or even regulate their own behavior when they perceive smartphone usage as maladaptive (Kuss et al., 2018).

For instance, there have been proposals for "milk tea addiction" (Qu et al., 2023), which were criticized soon after (Hugues et al., 2024). Similarly, the "selfitis", or "selfie addiction" (Balakrishnan & Griffiths, 2018) behavior has been recorded in a paper, which was later used as an example of the tendency to "medicalize" problematic behaviors (Starcevic et al., 2018b), or to "overpathologize" everyday behaviors (Billieux, Schimmenti, et al., 2015). Again, this was not left without a response, so one of the authors of the "selfitis paper", refuted the critiques, claiming that it was made clear that no new disorder was discovered nor invented, nor did they claim that the behavior of excessive talking of selfies is a behavioral addiction (Griffiths, 2018). We have a similar stance regarding problematic smartphone use/smartphone addiction; any term could be used as long as it clearly defines what it refers to or what the authors claim it represents. We agree with the further response in this debate; however, rigor in both terminological and conceptual senses is needed to study technology-related behaviors (Starcevic et al., 2018a).

Certain critical points include which term should be used for the behavior regarding smartphone use, whether it should be conceptualized as an addiction or problematic use, compulsive behavior, or behavior related to a maladaptive coping style. Furthermore, another concern is related to the measurement instruments of problematic smartphone use, which were also adopted from the scales that originally measured other conditions (Flayelle et al., 2022). Some authors question the usefulness and validity of the self-report instruments currently used to measure PSU (Connolly et al., 2021; Ellis, 2019; Harris et al., 2020). Furthermore, there is an increasing number of studies in which smartphone use was measured objectively by smartphone use via a smartphone application (e.g., Stanković et al., 2021). However, there are implications that the self-report measures can approximately assess the actual smartphone use and that the self-report usually underestimates the use (Lee et al., 2017). The estimates of mobile phone frequency and duration of use (number of calls or messages) being linked to psychological constructs are considered problematic by some (Ellis, 2019). In addition, scale scores tell very little about the user's actual experience with the smartphone, given the wide variety of activities that can be performed on a smartphone (Ellis, 2019). Questions about individuals' worries related to smartphones may represent more general traits. For example, tools used to assess problematic smartphone use are also likely to detect core features of impulsivity, anxiety, or extraversion (Ellis, 2019). Once technology has become intertwined with daily life, people are less able to accurately report these behaviors, especially when it comes to estimating the number of single interactions in a 24-hour period (Andrews et al., 2015; Ellis, 2019).

The article from 2018 claims that the addiction conceptualization of problematic smartphone use is unfounded (Lanette & Mazmanian, 2018). They also put an emphasis on researching the reasons why behind, that is, motivations for excessive use of smartphones, and focusing towards a more profound understanding of individuals whose smartphone use causes them psychological and social problems. The questions should be *how* and *why* someone uses a smartphone in that particular way and amount (Lanette & Mazmanian, 2018).

Conclusions made in a case study by Körmendi and colleagues (Körmendi et al., 2016) were about the underlying problems, in this case, fear of intimacy but, at the same time, the need for connection and love, led a young female person to use her smartphone excessively, both in group and when alone (Körmendi et al., 2016). She used her phone for various activities, but mostly for social networking. This approach to investigating problematic smartphone/internet use is in accordance with proposals by Billieux and the process framework rather than a confirmatory framework (Flayelle et al., 2022). Interestingly, the authors of this case report do not discard the components model, and what's more, the girl in question fulfills all the criteria for technological addiction, according to the components model of addiction and DSM-5 (APA, 2013) criteria for gambling disorder as well (Körmendi et al., 2016). The report also has a slight psychoanalytic tone, describing the behavior in terms of defense mechanisms, which is not extremely common in this field but is again in consonance with a similar stance of Maté, where behind any addictive behavior, there is a pain within the person, that needs to be escaped (Maté, 2009). The point of this paragraph is that the area of behavioral addiction is extremely complex and can be tackled from different perspectives, which are often not mutually exclusive. For example, the Interaction of Person-Affect-Cognition-Execution model (I-PACE; Brand et al., 2019) and compensatory internet use (Kardefelt-Winther, 2014) models might seem as contradictive at first glance, but that it is not the case (Flayelle et al., 2022). From what was written about Maté's opinions, one could get the impression that his point of view is purely psychoanalytical, but it is not since he spends many pages in his books explaining the neurobiological side of addictions (Maté, 2009). Starcevic correctly noted that there would not be so many controversies around behavioral addictions if their nature was clear and not so complex (Starcevic et al., 2018a).

The potential classification of PSU and cyberchondria problematic behaviors as mental disorders, or even addictions, carries societal problems as well. There is a certain stigma surrounding people who see psychological help, who have been diagnosed with a psychiatric disorder, or worse, who have been hospitalized in a psychiatric institution. The patients themselves are often ashamed to even seek some help, let alone speak about their mental difficulties. We tend to look at diagnosed individuals through the lenses of their diagnosis, which carries prejudice and generalizations and labels them with prototypical characteristics (as laypeople understand them). Of course, the level and type of stigma towards people with mental disorders varies across cultures, but it is still universally present across cultures (Kecmanović, 2010). Giving someone a diagnosis of, say, "smartphone addiction" can lead to unwanted intra- and interpersonal consequences for a person. Addiction (of any kind) can be equated with a person's immorality, lack of will, laziness, selfishness, and similar undesirable traits, and in turn, a person's self-perception can be damaged by the way the others see him/he (Kecmanović, 2010).

The term "addiction" has been typically associated with substance addiction or gambling disorder. Moreover, the very thought of conceptualizing substance use disorder, gambling disorder, and other potentially addictive behaviors mentioned throughout this thesis as "addiction" may seem odd. A "smartphone addiction" would unlikely be life-threatening, such as drug addiction, and is less likely to lead to extreme psychosocial, financial, or family-related problems, such as gambling disorder. On the other hand, recognizing problematic behaviors as addiction, that is, a disease, can benefit an individual in realizing that they need to seek help; the individuals themselves, as well as professionals, would take the condition more seriously and, hopefully, treat it with success (see Kaess et al., 2021; Kuss et al., 2013). This, however, would not solve the broader cultural problem of stigmatization, which would require widespread, comprehensive policy. To paraphrase the words of Kecmanović (2010), setting up a diagnosis is the "necessary evil" since a diagnosis follows a treatment. On the positive side, a study on Serbian medical students and the general population showed some readiness of the society to adopt more positive attitudes towards the mentally ill, and the results were similar to those from Western countries (Jerotić et al., 2019). The authors expressed their optimistic prognosis regarding the destigmatization of psychiatric patients.

10.3 In the Defense of the Components Model and Confirmatory Approach

While the components model sustained criticism, there are very plausible counterarguments to that criticism, specifically to some of its components being "peripheral", that is, not related to the addiction, and that the model served as the blueprint for hyperproduction of various behavioral addictions (Griffiths, 2020). The core components are intended to serve as unifying factors for problematic behaviors, and the problems in the conceptualization of various behaviors most often arise due to psychometric or operationalization reasons (Griffiths, 2020).

Next, the exclusion criteria for problematic behaviors were proposed, to classify a certain problematic behavior as addictive, and to clearly separate excessive, but non-harmful or everyday enthusiastic behaviors from problematic or addictive behaviors (Kardefelt-Winther et al., 2017). This was done, as said many times before, due to concerns about overpathologizing everyday activities (Billieux, Schimmenti, et al., 2015).

In line with the compensatory theory (Kardefelt-Winter, 2014), escapism is one of the exclusion criteria, which means that if escapism is the main motive behind a problematic behavior, this behavior cannot be characterized as addictive. However, Griffiths (2020), as well as the author of this thesis, does not agree with this statement. After all, in the introduction, the view of Maté explained that he sees any addiction (substance or non-substance) as a way for a person to escape their psychological pain, as well as harsh socioeconomic reality (Maté, 2009). Maté primarily worked with the most difficult cases of substance-addicted individuals as described in his book; however, Griffiths' perspective is that substance and behavioral addictions are the same at their core.

The obligation to elaborate on the ongoing debate about behavioral addictions seemed essential to this dissertation, given the studies it includes. Smartphone addiction, or problematic smartphone use, was operationalized exactly using SABAS, which was based on the components model of addiction, that is, six core components – salience, tolerance, mood modification, conflict, and relapse. Therefore, although the components model of addiction has its shortcomings, we still believe it is quite useful due to its simplicity and relatively straightforward operationalizations. We also consider that compensatory internet use theory (Karddefelt-Winter, 2014) is not opposed to the components model and "addiction approach" since, as we said, escapism (or other underlying psychopathological problem) might be the primary motive behind a person's problematic behavior, but that does not mean the behavior cannot be addictive. Similarly to Griffiths (2020), substance addictions do (often) serve as coping strategies and do indeed go in hand with other underlying psychopathologies (Griffiths, 2020).

As for cyberchondria, some indications were described that it also could be considered addictive activity, for the same underlying mechanisms – trying to cope with anxiety and relieve the adverse mood, which in turn can be a consequence of personality traits, fear, current situational factors, psychopathologies, etc. Unlike internet or smartphone addiction, cyberchondria was much less researched in the light of addiction, but its relationship with the internet and smartphone addiction appears to be very strong. We tried to investigate the assumptions that smartphones, due to their specific features, can facilitate behaviors characteristic of cyberchondria, and this was done while also controlling for depressive and anxiety symptoms, as well as intolerance of uncertainty.

10.4 General Limitations and Future Directions

The limitations of each research were listed in a corresponding study section. To summarize, they include using a cross-sectional design, which has disadvantages over longitudinal or experimental studies. The exception is that we had two-point data in Study 1 to calculate the test-retest reliability of the SABAS. Secondly, all studies were conducted online, using convenience samples. This method, while efficient, introduces a possibility of self-selecting bias, which could potentially impact the generalizability of the findings. Thirdly, following the previous limitation, the samples might not represent the Serbian population, but this excludes Study 1, which had a sample of English-speaking participants from various countries. However, in Study 4, when validating cyberchondria instruments, we showed that specific sample characteristics were quite similar to the characteristics of the general Serbian population, such as age and gender structure.

It is important to note that regarding the test-retest (Study 1), the differences in sociodemographic variables among those who agreed to participate in the retest stage and those who did not were not initially reported. These differences, however, provide valuable insights into the characteristics of the participants. First, the two groups did not differ significantly regarding age, financial status, or whether they have a chronic disease. However, significantly more females than expected in the group gave consent for the retest (62%). Next, the two groups did differ significantly regarding the highest education level in the way that among those who agreed to take part in the retest, there were significantly more university students (those who were studying at the time of the research); 58% of students did not agree to take the retest. In other education groups (except primary school, where there were only two participants in total who did not agree to take the retest), there were more those who agreed to take the test for a second time.

Furthermore, the groups had no differences in average weekly smartphone usage. However, the group that agreed to do the retest had a slightly higher score on entertainment and productivity use, with small effect sizes. Although these differences were not drastic, we present them as potential limitations when interpreting the test-retest results and correcting the oversight of not unveiling them in the original text of Study 1. It is important to emphasize that these differences in sociodemographic variables could potentially influence the test-retest results, underscoring the need for their careful consideration in future studies.

10.5 Novelty and Practical Implications

This thesis offers several main novelties. Firstly, the results presented in this thesis illuminate the relationship between cyberchondria and problematic smartphone use. Although tightly related to anxiety, intolerance of uncertainty, and anxiety- and worry-related dimensions, cyberchondria had a unique contribution to predicting problematic smartphone use. To our knowledge, it was the first study investigating the cyberchondria – PSU relationship while adjusting for anxiety, depression, and IU. Secondly, it was also the first study to examine the mechanism of the cyberchondria affecting the engagement of complementary-alternative medicine in general and pseudoscientific practices related to COVID-19 through the dimension of conspiracy mentality. Thirdly, we showed that entertainment and productive use purposes (hedonic and utilitarian use) could be measured relatively simply by a single item, replicating the earlier research results of the positive relatedness of entertainment use and perceived stress and PSU.

Further, regarding the theoretical aspect of the research, our findings can facilitate more in-depth research of the relationship between SA, IU, and cyberchondria, using different methodologies and statistical methods and including possibly important but omitted variables. It would be interesting to investigate the mentioned associations in a more granulated way and provide insight into how these associations could be influenced by including variables, such as health anxiety (closely related to cyberchondria) and internet addiction (closely related to both cyberchondria and smartphone addiction).

Attention should be paid to intolerance of uncertainty when dealing with both cyberchondria and smartphone addiction. It would be easy to say that when treating a person with, say, smartphone addiction, the practitioner should focus on treating the IU. However, this is not the conclusion we can draw from our study or the advice we can give. As we said, we cannot firmly say that the IU causes SA, although we can only assume it since the IU is most likely the causal factor of various anxious disorders. We also cannot say whether cyberchondria is the cause of SA, what one might be tempted to conclude from our Study 3. As mentioned, especially with cyberchondria, relationships with other states and traits can be bidirectional, fueling each other. Establishing causal paths is a difficult task for future research.

Throughout the text, it was discussed how smartphone addiction and cyberchondria might be mutually related. However, the studies did not offer deeper mechanisms of this relationship, where internet addiction might play a crucial role, where a smartphone might serve as a proxy, just like with any other problematic online behavior. Furthermore, underlying psychopathologies may also be a common factor in cyberchondria and smartphone addiction. Nevertheless, Study 3 showed that cyberchondria was uniquely related to smartphone addiction next to the depressive and anxious symptoms and intolerance to uncertainty. With the limited resources, important variables might have been omitted as well, but the topic (association between cyberchondria and SA) is indeed in its infancy.

There are also several practical implications for the overall findings. Firstly, we gave practitioners a brief and useful tool – SABAS, for quick screening for a risk of smartphone addiction, which can help decide whether treatment is needed and which further steps to take. Secondly, the scale also allows the practitioners to assess the component on which an individual gets the highest score, i.e., since the SABAS is based on the components model of addiction, it can easily be gauged which component contributes the most to a person's problematic behavior. This information can also help in deciding the proper treatment steps. For researchers, we gave first insights into the properties of the Serbian SABAS, suggesting its good psychometric characteristics and, importantly, its stability over time. We hope this will facilitate the scarce research on smartphone addiction among the Serbian population. Lastly, we also shed light on the usefulness of the English SABAS on non-native English speakers, which can be helpful in cross-cultural studies.

Regarding cyberchondria, we were the first to offer adaptations in the Serbian language for the two instruments – the CSS-12 and SCS. Both can be useful for practitioners for a quick assessment of the person's cyberchondria-related characteristics, especially in identifying cyberchondria aspects of a person who is suspected of having an illness anxiety disorder, health anxiety, or related problems. If the cyberchondria is pronounced, this can help shape the further treatment of an individual. The CSS-12 is even helpful in detecting one of the four specified subdimensions of cyberchondria, while SCS is a short tool used for quick screening for the core aspects of cyberchondria. As with the SABAS, we hope that our studies will encourage the further validation and improvement of these instruments on the Serbian population and promote the research of cyberchondria among Serbian researchers.

10.6 Conclusion

The four studies presented in this dissertation contributed to the rapidly accumulating knowledge of behavioral addictions, problematic technology-related behaviors, and, more specifically, smartphone addiction and cyberchondria. The final goal of the dissertation has been changing over time, primarily due to the happenings around the COVID-19 pandemic, which had significant psychosocial and socioeconomic consequences, which in turn left a significant impact on the research community. Cyberchondria emerged as an important phenomenon during the pandemic, along with the rise of excessive and problematic technology use, including internet smartphones. Therefore, an idea occurred to combine the research on smartphone addiction with smartphone addiction, conducted chiefly on Serbian samples, to which my research team and I had access. Both phenomena, SA and cyberchondria, have common characteristics, which both candidate them to be classified as behavioral addictions. Both are technology-related behaviors, and both are tightly related to the internet.

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Vujić, A., Volarov, M., Latas, M., Griffiths, M. D., & Szabo, A. (2023). Psychometric Properties of the Serbian Smartphone Application-Based Addiction Scale (SABAS) and Validation of the English Version Among Non-native English Speakers. *International Journal of Mental Health and Addiction*. https://doi.org/10.1007/s11469-023-01013-1

13 Appendices

13.1 Appendix to Study 1

Appendix A

Questions related to the smartphone use purpose

Serbian (as presented in the survey)	
Entertainment	Concrete task
Koliko često koristite telefon za zabavu, iz dosade ili iz navike (npr. gledanje video klipova, provođenje vremena na društvenim mrežama, slušanje muzike, surfovanje po Internetu itd.)? Odgovor označite na skali od 1 do 7.	Koliko često koristite telefon da biste ispunili neki konkretan zadatak (npr. komunikacija sa porodicom i prijateljima, plaćanje računa, navigacija, korišćenje telefona u vezi sa poslom ili učenjem itd.)? Odgovor označite na skali od 1 do 7
English translation	
Entertainment	Concrete task
How often do you use your smartphone for fun, out of boredom or habit (e.g., watching videos, scrolling through social media, listening to music, surfing on the Internet, etc.)? Use the seven-point scale to answer	How often do you use your smartphone to fulfil a certain task (e.g., communication with friends and family, paying bills, navigation, using a smartphone for work or for study purposes etc.)? Use the seven-point scale to answer.

Appendix B

Contents of the Serbian and the English Smartphone Application-Based Addiction Scale items

Item	Component	Serbian	English
1	Salience	Moj telefon mi je najvažnija stvar na svetu.	My smartphone is the most important thing in my life.
2	Conflict	Dešavale su se svađe između mene i moje porodice (ili prijatelja) zbog moje upotrebe telefona.	Conflicts have arisen between me and my family (or friends) because of my smartphone use.

Item	Component	Serbian	English
3	Mood modification	Koristim telefon kako bih popravio/la svoje raspoloženje (to mi pruža trenutno zadovoljstvo ili način da pobegnem od realnosti ili problema).	Preoccupying myself with my smartphone is a way of changing my mood (I get a buzz, or I can escape or get away, if I need to).
4	Tolerance	Kako vreme prolazi, sve više traćim vreme na svom telefonu.	Over time, I fiddle around more and more with my smartphone.
5	Withdrawal	Ako ne mogu da koristim svoj telefon kada hoću, budem nesrećan/a, razdražljiv/a ili promenljivog raspoloženja.	If I cannot use or access my smartphone when I feel like, I feel sad, moody, or irritable.
6	Relapse	Ukoliko pokušam da smanjim vreme provedeno na telefonu, to mi uspe na neko vreme, posle čega počnem da ga koristim isto toliko često ili čak više nego ranije.	If I try to cut the time I use my smartphone, I manage to do so for a while, but then I end up using it as much or more than before.

13.2 Appendix to Study 4

Table 7.3

Component loadings of the CSS-12 scales and SCS scale

Scale	Component loading	Communalities after extraction
CSS Excessiveness	.723	.522
CSS Distress	.879	.772
CSS Reassurance	.694	.481
CSS Compulsion	.668	.446
SCS	.810	.657

Note. CSS = Cyberchondria Severity Scale; SCS = Short Cyberchondria Scale.

In Table 7.4 means, standard deviations, corrected item-total correlations, squared multiple correlation, and Cronbach alpha if item deleted, for CSS-12 and SCS are shown.

Table 7.4

Item statistics of the CSS-2 and SCS items

Tool	Item	*M*	*SD*	Corr. item-total	*SMC*	α if item deleted
CSS						
	1	3.02	1.053	.499	.495	.856
	2	1.77	1.066	.375	.317	.864
	3	2.78	1.170	.562	.499	.852
	4	2.07	1.100	.669	.517	.844
	5	2.77	1.219	.438	.309	.861
	6	2.27	1.088	.681	.549	.843
	7	1.33	0.763	.448	.385	.859
	8	1.79	1.080	.588	.484	.850
	9	2.18	1.146	.684	.593	.843
	10	1.42	0.854	.490	.445	.856
	11	1.45	0.807	.576	.432	.852
	12	1.91	1.103	.557	.467	.852
SCS						
	1	2.61	1.039	.531	.306	.825
	2	2.07	1.168	.776	.645	.711
	3	1.90	1.144	.746	.617	.728
	4	1.82	1.089	.544	.317	.821

Note. CSS = Cyberchondria severity scale; SCS = Short cyberchondria scale; *M* = Mean; *SD* = standard deviation; Corr. item-total = corrected item-total correlation; *SMC* = squared multiple correlation. Average correlation of CSS-12 items was .349, and .532. of SCS items.

In Figure 3.1, the scree plot is presented.

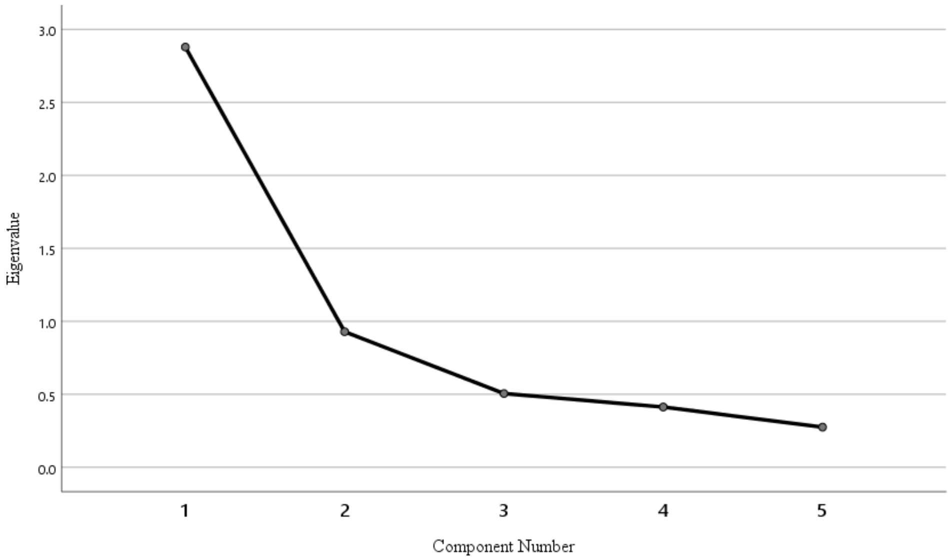

Figure 3.1. Scree plot

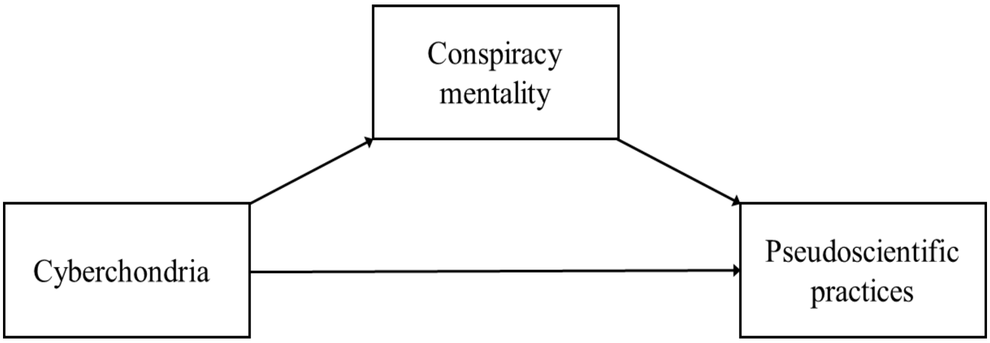

Figure 3.2. Mediation Model 1, with Pseudoscientific Practices as the Outcome

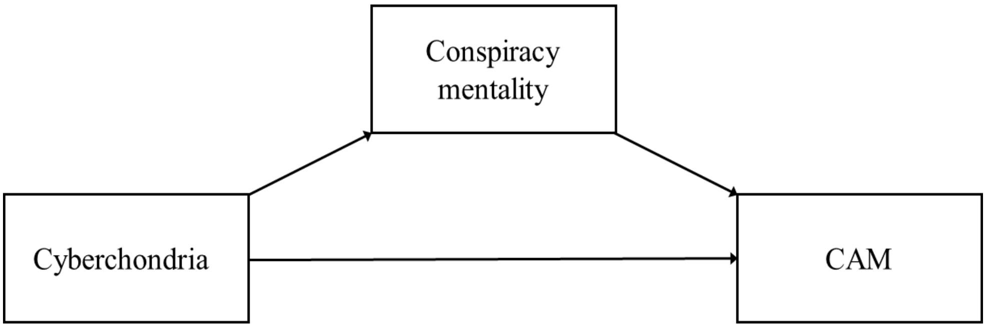

Figure 3.3. Mediation model 2, with CAM as the Outcome

In Table 7.5, the unstandardized and standardized loadings, covariances, and variances of the CSS-12 from the CFA are presented for the four-factor model, along with standard errors, *z*-values, and *p*-values.

Table 7.5

Factor loadings, covariances and variances of the CSS-12 four-factor model

parameter	Estimate	S.E	*z*-value	*p* value	Std.all
Excessiveness =~					
CSS_1	1				.731
CSS_3	1.154	0.061	18.913	<.001	.759
CSS_6	1.149	0.086	13.348	<.001	.813
Distress =~					
CSS_4	1				.740
CSS_8	0.967	0.076	12.67	<.001	.728
CSS_9	1.197	0.081	14.786	<.001	.850
Reassurance =~					
CSS_5	1				.583

parameter	Estimate	S.E	*z*-value	*p* value	Std.all
CSS_11	0.816	0.099	8.221	<.001	.718
CSS_12	1.226	0.100	12.206	<.001	.790
Compulsion =~					
CSS_2	1				.620
CSS_7	0.812	0.084	9.668	<.001	.703
CSS_10	0.974	0.104	9.402	<.001	.753
Covariances:					
Excessiveness ~~					
Distress	0.397	0.054	7.330	<.001	.634
Reassurance	0.386	0.045	8.661	<.001	.707
Compulsion	0.172	0.039	4.379	<.001	.338

Note. S.E. = standard error; Std.all = standardized coefficients.

In Table 7.6, unstandardized and standardized estimates, as well as variances for the SCS are shown.

Table 7.6

Factor loadings, and variances of the SCS items

parameter	Estimate	S.E	*z*-value	*p* value	Std.all
SCS =~					
SCS_1	1				.587
SCS_2	1.730	0.116	14.931	<.001	.904
SCS_3	1.599	0.117	13.624	<.001	.853
SCS_4	1.065	0.116	9.213	<.001	.597
Variances:					
SCS_1	0.707	0.047	15.07	<.001	.655
SCS_2	0.250	0.057	4.418	<.001	.183
SCS_3	0.356	0.064	5.595	<.001	.272
SCS_4	0.761	0.061	12.496	<.001	.643
SCS	0.372	0.052	7.167	<.001	1

Note. S.E. = standard error; Std.all = standardized coefficients.

In Table 7.7, the parameters of the bifactor S-1 model of the CSS-12, are presented. Compulsion is the reference g-factor.

Table 7.7

Factor loadings, covariances and variances of the bifactor S-1 model (CSS-12 items)

parameter	Estimate	S.E	*z*-value	*p* value	Std.all
excessiveness =~					
CSS_1	1				.778
CSS_3	1.069	0.060	17.686	<.001	.749
CSS_6	0.931	0.068	13.633	<.001	.701
distress =~					
CSS_4	1				.674
CSS_8	0.446	0.100	4.463	<.001	.306
CSS_9	0.708	0.091	7.742	<.001	.458
reassurance =~					
CSS_5	1				.588
CSS_11	0.665	0.091	7.345	<.001	.590
CSS_12	1.148	0.114	10.032	<.001	.745
g =~					
CSS_2	1				.591
CSS_7	0.819	0.085	9.619	<.001	.677
CSS_10	1.037	0.103	10.021	<.001	.765
CSS_1	0.156	0.126	1.237	.216	.093
CSS_3	0.355	0.122	2.908	.004	.191
CSS_6	0.680	0.160	4.262	<.001	.394
CSS_4	0.838	0.160	5.249	<.001	.480
CSS_8	1.129	0.155	7.308	<.001	.659
CSS_9	1.246	0.131	9.533	<.001	.685
CSS_5	0.305	0.114	2.677	.007	.158
CSS_11	0.508	0.120	4.245	<.001	.397
CSS_12	0.517	0.133	3.873	<.001	.295
Covariances:					
excessiveness ~~					
distress	0.418	0.058	7.191	<.001	.690
reassurance	0.383	0.052	7.402	<.001	.654
distress ~~					
reassurance	0.259	0.055	4.722	<.001	.490
Variances:					
CSS_1	0.428	0.045	9.496	<.001	.386
CSS_3	0.551	0.056	9.744	<.001	.403
CSS_6	0.417	0.039	10.798	<.001	.353
CSS_4	0.381	0.057	6.666	<.001	.315
CSS_8	0.550	0.064	8.564	<.001	.472
CSS_9	0.421	0.053	7.872	<.001	.321

parameter	Estimate	S.E	*z*-value	*p* value	Std.all
CSS_5	0.934	0.082	11.446	<.001	.630
CSS_11	0.322	0.031	10.457	<.001	.494
CSS_12	0.434	0.063	6.871	<.001	.358
CSS_2	0.738	0.080	9.277	<.001	.650
CSS_7	0.315	0.061	5.200	<.001	.542
CSS_10	0.302	0.049	6.150	<.001	.415
excessiveness	0.670	0.067	9.957	<.001	1
distress	0.549	0.092	5.941	<.001	1
reassurance	0.512	0.078	6.598	<.001	1
g	0.397	0.079	5.012	<.001	1

Note. S.E. = standard error; Std.all = standardized coefficients.

13.3 Appendix to Study 3

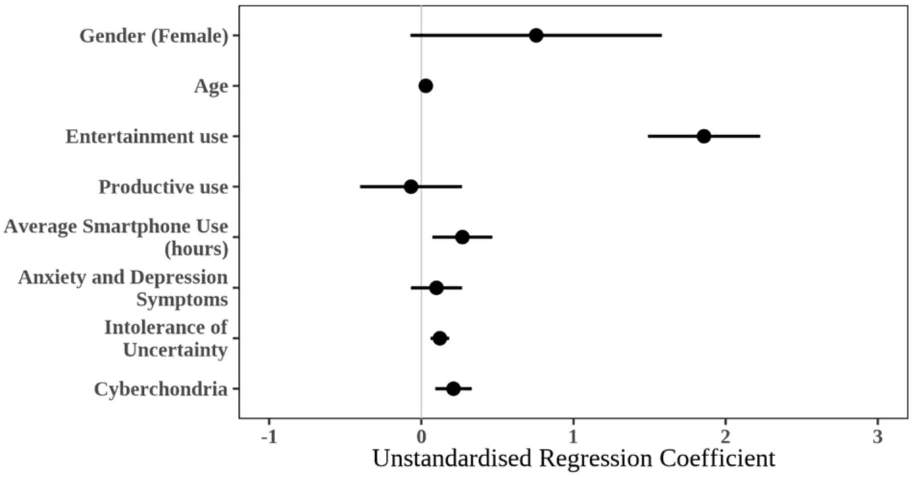

Figure 8.1. The model 5 regression estimates plot with the smartphone addiction as the outcome. Error bars are 95% confidence intervals.