



Tracing 20 years of research on problematic use of the internet and social media: Theoretical models, assessment tools, and an agenda for future work

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ABSTRACT

Over the past two decades, there has been increasing interest in the impact of internet use and growing concern about whether problematic use of the internet (PUI) constitutes an addiction. Despite the growing number of studies investigating PUI and PUI subtypes, its conceptualization and inclusion in a classification system have not been possible yet. Several models aimed at inspiring clinical research and practice have proposed possible mechanisms involved in PUI and problematic use of social media, and multiple self-report instruments have been sequentially developed. The diversity of theoretical models and instruments currently hinders standardized assessment procedures across studies and, in turn, their comparability. The purpose of the present overview is to highlight the current conceptualization and assessment of both PUI and problematic use of social media, in order to critically discuss the existing fragmentation in the field and the need to achieve conceptual convergence. Two suggestions for future directions are also provided, i.e., define diagnostic criteria by bottom-up and top-down processes and develop a psychobiological hypothesis including the description of higher-order mechanisms involved in PUI and not other psychopathological conditions (e.g., the multiple available internet-related cues and outcomes that may lead to parallel forms of associative learning; probabilities of obtaining internet-related reinforcements; and intrinsic motivation processes).

1. Introduction

Over the past two decades, there has been increasing interest in the impact of internet use, both at individual and societal levels. By January 2021, more than 4.5 billion people globally were using the internet [1]. Therefore, it is not surprising that much attention has been placed on how, how much, why, and with which consequences individuals use the internet. Importantly, there is growing concern about problematic use of the internet (PUI) and whether PUI constitutes an addiction.

In the present manuscript we will use PUI to refer to all internet-related behaviors that are potentially addictive; i.e., where there is diminished control over online engagement that is typically perceived as rewarding and that is continued despite experiencing negative consequences that include impairment in important domains of a person's life

[2]. Specifically, such behaviors may include online gaming, gambling, shopping, pornography viewing, email checking, instant messaging, and social media use [3]. Despite some similarities with other forms of dysfunctional internet use (e.g., cyberbullying) [4–6], PIU as defined here will not include repeated aggressive, intentional online behaviors targeting individuals, as these behaviors appear linked to different psychological patterns [7,8].

Internet gaming disorder (IGD), characterized by distress related to poorly controlled video-gaming online, has recently been included in Section III of the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as a possible condition warranting future study [9]. Although available data at the time did not lead to inclusion of IGD in the main text of the DSM-5, additional research has since supported its inclusion, consistent with gaming disorder being introduced in

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ICD-11 [10].

Research has identified some negative effects related to both specific PUI-related content/applications and PUI forms; i.e., predominantly mobile vs. predominantly non-mobile [11,12]. Specifically, using the internet by smartphone has been linked to risk of accidents and injuries while walking, which have been reported as emerging public health concerns [13,14]. Regarding specific content, social media use warrants consideration. Problematic use of social media (PUSM) may represent a new public health concern sharing features with psychoactive substance use disorder [15], and may be considered an “other specified disorder due to addictive behaviors” [16].

Several models aimed at inspiring clinical research and practice have posited mechanisms involved in PUI and PUI subtypes (e.g., PUSM), and multiple self-report instruments have been consequentially developed to assess PUI [17]. The diversity of theoretical models and instruments reflects the absence of agreement about PUI conceptualization and hinders standardized assessment procedures across studies and, in turn, their comparability. Most theoretical models of PUI to date have been tested only partially, and few self-report instruments have been validated in different languages and cultural contexts. The purpose of the present overview is to highlight the current conceptualization and assessment of both generalized PUI and PUSM, in order to critically discuss the existing fragmentation in the field and the need to achieve conceptual convergence (see Fig. 1). Suggestions for future directions are also provided and discussed.

2. Striving for an answer: What is (and what is not) problematic use of the internet (PUI)?

Despite the growing number of studies investigating PUI, there is not yet an agreement on the conceptualization of psychological problems related to internet use [18,19]. The reasons for this lack of consensus can be found in existing research gaps and controversies surrounding internet-related behaviors. The extent to which PUI constitutes a psychopathological condition remains under discussion, with some researchers proposing that the internet may work as a vehicle for expressing an individual’s addictive/interfering focus on specific behaviors (e.g., gaming, pornography), which represent the “true” problematic focus [20–22]. From this perspective, PUI may be considered as an addiction *on* the Internet, being content-specific and perhaps occurring even in the absence of internet access [21–23], and PUI may be considered more appropriately as an aspect of other conditions; e.g., gambling disorder [9,10,24].

However, some researchers have considered PUI as a specific psychopathological entity that shares core components with addictive behaviors and impulse control disorders (ICDs) (e.g., [14,19–28,30]). However, animal models and clinical studies suggest that behavioral addictions, including gambling disorder, compulsive sex, compulsive buying, and PUI, differ from ICDs, particularly as defined in the group of “Disruptive, impulse control and conduct disorders” in the DSM-5 [32–35]. This latter view suggests that PUI shares more characteristics with addictive behaviors, including craving, tolerance, and withdrawal [36,37], than with ICDs. In this context, PUI has been described as an addiction *to* the internet, characterized by a general, multidimensional

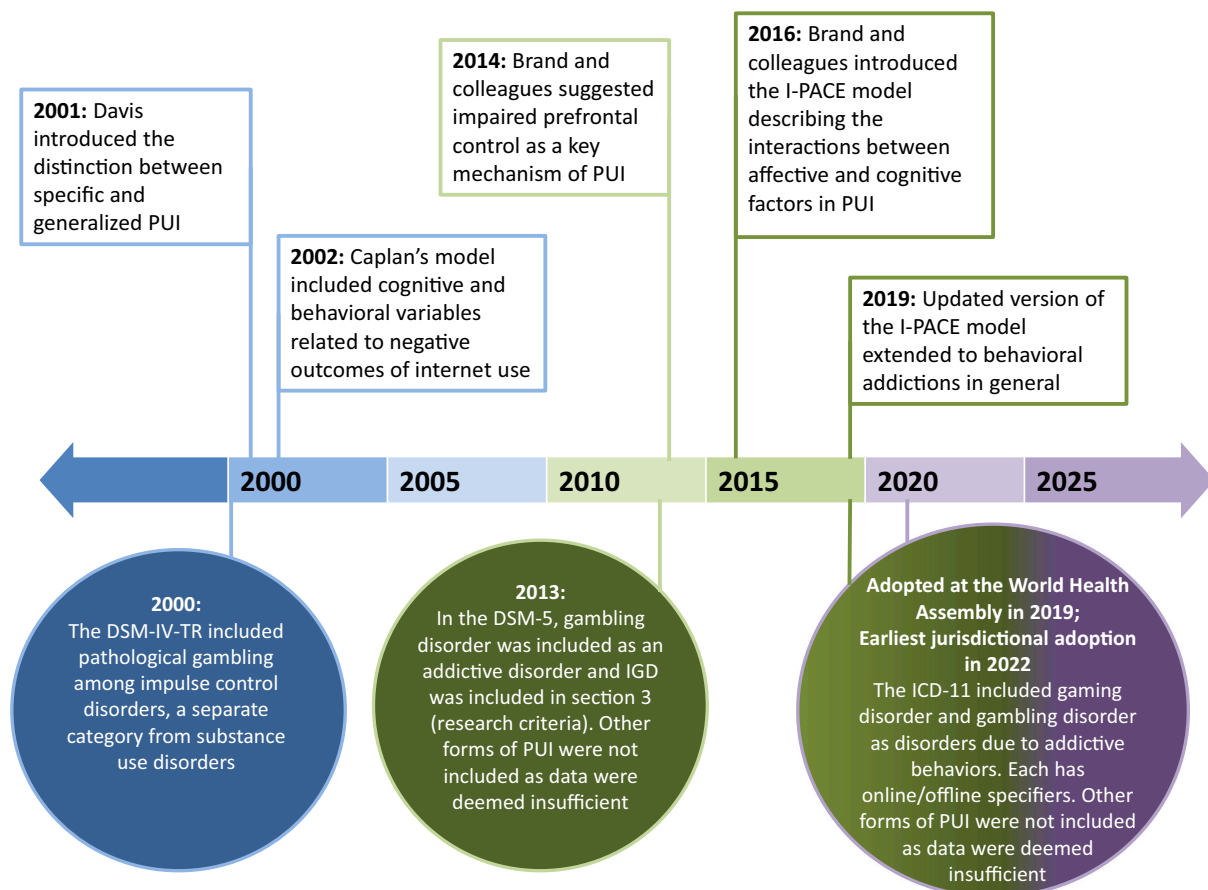


Fig. 1. Major milestones in the field of research on problematic use of the internet (PUI). I-PACE = Interaction of Person-Affect-Cognition-Execution; DSM-IV-TR = Diagnostic and statistical manual of mental disorders (4th edition, text revision); DSM-5 = Diagnostic and statistical manual of mental disorders (5th edition); IGD = internet gaming disorder; ICD-11 = International Classification of Diseases, 11th edition.

overuse of the internet leading to distress or functional impairment. Such usage may mainly relate to social aspects of the internet; i.e., reinforcement obtained by online social interactions may increase desire to stay in virtual social lives [21].

Whether to conceptualize PUI as a disorder (and as an addiction) remains debated. Research findings support both similarities and differences between PUI, gambling disorder, and substance use disorders [38]. Indeed, research is at an early stage, often with study limitations including small sample sizes [39]. The existing debates about PUI have slowed convergence efforts regarding formal criteria and classification [40].

2.1. Which diagnostic criteria might define PUI?

More than 20 years ago, Ivan Goldberg [41], based on the diagnosis of psychoactive substance use dependence, described the diagnostic criteria for internet overuse that included tolerance (i.e., increased time progressively spent on the internet to achieve similar satisfaction, or decreasing satisfaction with similar online durations), withdrawal (e.g., voluntary or involuntary typing movements of the fingers, irritability in the setting of cessation), preoccupation (e.g., obsessive thinking about what is happening on the internet, dreams or fantasies about the internet), spending much time in activities related to internet use, and reducing important occupational, social, or recreational activities because of use of the internet [42]. Subsequently, researchers have proposed criteria for PUI [29,31,36,43–46]. In 2008, four diagnostic criteria were proposed for a diagnosis of PUI as an addictive behavior: (i) internet overuse associated with a neglect of basic motivations and a loss of time; (ii) withdrawal (i.e., depressive feelings, increasing tension or anger when internet use is not feasible); (iii) tolerance (i.e., the need over time to get better computer equipment or engage in more hours of use to achieve similar satisfaction); and (iv) negative consequences (i.e., lying, arguments, fatigue, poor school or vocational achievement, and social isolation) [36]. One year later, Ko and colleagues confirmed the diagnostic accuracy of nine criteria they had developed in 2005 [47,48]. These could be summarized under Block's criteria structure [36] and included repeated failure to resist the urge to use the internet; preoccupation with internet activities; spending more time online than intended; persistent desire and/or fruitless attempts to reduce the use of the internet; excessive effort spent on activities necessary to obtain access to the internet; excessive time spent online; tolerance: a significant increase in the duration of internet use required to reach satisfaction; withdrawal symptoms; persevered internet use despite knowledge of having a chronic psychological/physical problem likely provoked or aggravated by internet use; recurrent internet use resulting in failure to accomplish important role responsibilities at school and home, impaired social life, and behaviors that violate school rules or laws. However, the accuracy of the above criteria was tested in a cohort of 216 Taiwanese students, and limited generalizability was observed [48].

Of note, considering the clinical relevance and demand for focused treatment and preventive programs [49], the World Health Organization (WHO) included both offline and online gaming in the ICD-11. Moreover, as described above, the American Psychiatric Association (APA) included research criteria for IGD in section 3 (the research appendix) of the fifth edition of the DSM and noted that more studies are needed, both with respect to online gaming as well as more general internet use, in order to confirm and/or update the proposed criteria [9,50]. The inclusion of IGD in the DSM-5 was based upon more than 250 published studies that highlighted negative consequences (including death [51]) of excessive gaming on affected individuals' lives across cultures [52]. Based on the findings of the few studies that compared specific types of internet use, internet gaming emerged as a distinct problematic behavior compared to other problematic internet-related activities (e.g., social media use). As a consequence, it was decided to recommend only IGD to be included in Section 3 of the DSM-5. Regarding other PUI subtypes, it was decided to not include them because of limited evidence, fewer

documented negative consequences on the lives of affected individuals, or the lack of a clear alignment with SUDs [50]. As for the ICD-11, similar to the DSM-5, it was concluded that at the time there were insufficient data for formal inclusion of PUI subtypes different from online gaming or online gambling. Of note, the majority of psychobiological models of PUI highlighted the presence of alterations in cognitive processes (e.g., disadvantageous decision-making, impaired impulse control) supporting three nosological approaches, i.e., addictive, impulsive, or compulsive, making the classification of PUI subtypes difficult [53]. Further studies allowing a better understanding of nuanced relationships among different altered neurobiological or cognitive domains could provide insight into mechanisms underlying PUI and possibly help guide its nosological status in a classification system of mental disorders.

To date, given the existing evidence of the similarities among addictive behavioral patterns, researchers are considering other internet-related activities besides gaming for inclusion in diagnostic systems [16,54–57]. Increasingly more studies are reporting serious negative consequences of PUI, such as poorer academic performance, absenteeism and inefficiency in the workplace, interference with personal functioning, isolation, and mental health concerns including anxiety and mood disorders, thus highlighting the need to better understand and characterize PUI [3,47,58,59]. Considering recent data and the relevance for public health, identifying the diagnostic criteria for PUI, including PUI subtypes, should be a main aim of research communities to improve across-study reliability and develop effective treatment approaches and prevention measures [60].

2.2. Current models and proposed mechanisms for PUI

Current debates regarding PUI conceptualization and definition have historical roots. As PUI was first termed *internet addiction* [29], researchers have debated different facets of and factors contributing to PUI.

In 2001, Davis introduced the distinction between specific (SPIU) and generalized pathological internet use (GPIU) [21]. GPIU and SPIU may be viewed as addiction *to* the internet versus *on* the internet, respectively [44,61]. Given the interest in characterizing GPIU rather than SPIU, Davis proposed a cognitive-behavioral model of PUI [21]. The model assumes that an individual's psychopathology acts as a distal necessary trigger of GPIU symptoms and promotes the development of maladaptive internet-related cognitions (e.g., ruminations about excessive internet use, diminished self-efficacy, and poor self-appraisal). Maladaptive cognitions associated with internet usage would in turn act as proximal sufficient generators of both GPIU and SPIU symptoms and generate impaired impulse control, ultimately leading to negative consequences related to internet usage [21].

In 2002, Caplan described problematic behaviors associated with internet use as internet addiction, highlighting key aspects of addiction [62]. Individuals with internet addiction would attribute greater salience to internet-related activities, feel urges to use the internet, be preoccupied when offline, experience mood changes, feelings of tolerance and withdrawal when diminishing internet use, and encounter conflict and relapses to problematic internet use [62]. As a revision of Davis' model, Caplan [23] model of GPIU includes some cognitive/behavioral variables related to negative outcomes associated with internet use. Specifically, the preference for online social interactions would lead to a higher likelihood of communicating through a computer to reduce the distress triggered by face-to-face social interactions. When utilizing online interactions for mood-regulation purposes, such behaviors would be linked to defective self-regulation, as reflected in internet-related obsessive thoughts and compulsive use of the internet. Such poor or impaired self-regulation would in turn generate negative consequences in the lives of individuals [23].

In 2014, the development and maintenance of GPIU and SPIU were described in a model based on the cognitive-behavioral model of GPIU

[21] and a model of nonpathological internet use and specific types of internet addiction [63]. Here, impaired functioning of prefrontal control mechanisms would be associated with defective self-regulation and coping strategies, that would lead individuals to turn to the online world. Reinforcement from internet-related activities (i.e., coping with negative affect) would favor internet-related expectations (e.g., that using the internet would increase positive mood or decrease negative mood), making internet-related behaviors a primary means of coping with negative affect [63]. Thus, individuals would exhibit cyclical behaviors in which online activities increase attention given to maladaptive cognitions (both general and internet-related), which then would be reinforced by internet use. Brand et al. stressed the importance of enhancing prefrontal control processes during treatment, in order to improve monitoring and controlling situational triggers, which would be fundamental for bringing internet usage under control [63].

The theoretical model described by Brand et al. [63] highlights the connection between PUI and mechanisms underlying addictive behaviors, where deficient prefrontal control processes are a main factor involved in the development, progression and maintenance of addictive behaviors [64,65]. Among all the processes in which they are involved, prefrontal control processes have been described to be fundamental in the top-down guidance/regulation of goal-directed behavior [66,67]. Such processes have been proposed as key factors involved in the transition from voluntary/goal-directed actions (with an appraisal of action consequences) to habitual actions (seemingly automatic and uncontrolled) that is at the basis of addictive behaviors [68,69]. This transition would reflect a parallel transition in neurobiological mechanisms, i.e., from prefrontal cortical to striatal control over behavior, and from ventral to more dorsal striatal subregions. The ability/tendency to inhibit urges to engage in shorter-term pleasurable and longer-term maladaptive behaviors is thought to reflect the proper functioning of top-down control of conditioned responses that both predict reward and drive motivations to engage in addictive behaviors [70–72].

The modulation of these complex behavioral patterns has been proposed to arise from the activities of six interacting circuits [73]: reward/saliency (nucleus accumbens and ventral pallidum); memory/learning-conditioning/habits (amygdala and hippocampus); inhibitory control/executive functions (dorsolateral prefrontal cortex, orbitofrontal cortex, inferior frontal cortex, and anterior cingulate cortex); motivation/drive (orbitofrontal cortex, subcallosal cortex, dorsal striatum, and motor cortex); interoception (involved in the awareness of craving; insula and anterior cingulate cortex); and aversion avoidance/stress reactivity (habenula and amygdala). In this model, balanced neural activity within these circuits results in proper inhibitory control and adaptive decision-making, whereas enhanced expectation values of drugs or specific behaviors (e.g., internet gaming) in reward, motivation, and memory circuits result in overcoming the activity of control circuits, with consequential consummatory behaviors, craving, and relapse [70,73–75]. These circuits also interact with those involved in mood regulation, stress reactivity, and interoception [73,75]. Interestingly, the transition to PUI has also been proposed to mainly arise from the interaction between learning/reward processes and altered stress/mood regulation/interceptive awareness mechanisms [2,75–78].

Mechanisms proposed to underlie addictive behaviors and PUI have been modeled in the Interaction of Person-Affect-Cognition-Execution (I-PACE) model of addictive behaviors [79,80]. The I-PACE model has proposed a framework for the affective-cognitive factor interactions involved in PUI. PUI may develop due to interactions between psychological and neurobiological predisposing variables (e.g., impulsivity, anxiety, depression, general distress) and moderating variables (e.g., coping style, self-regulatory capacities, and internet-related attentional and cognitive biases), and mediating variables, including cue-reactivity/craving and reduced inhibitory control. The resulting repetitive and habitual internet-related behaviors become less gratifying and more compensatory over time [79]. Specifically, Brand et al. [79] have suggested that during the process of becoming addicted to a specific

behavior, relationships between exaggerated cue-reactivity/craving feelings and reduced inhibitory-control processes lead to the formation of habitual (addictive) behaviors. Neurally, this would be reflected in the imbalance between the activity of fronto-striatal circuits (i.e., dorsolateral PFC, ventral striatum, and amygdala) during the early stages of problematic behavior, and the dominance of dorsal striatum activity during later stages of addiction.

In its first formulation, the I-PACE model was developed as a theoretical process model for SPIU [80]. In the model, internet-related cognitive biases and coping styles would moderate associations between predisposing factors and PUI characteristics. Moreover, coping styles and cognitive biases would be influenced by the presence of psychopathological disorders and personality characteristics. A moderated mediation effect between predisposing factors and internet-related cognitive biases and coping styles was also proposed. Cognitive and affective responses to situational stimuli (e.g., cue-reactivity, craving) would be mediating variables and be mainly influenced by internet-related cognitive biases and coping styles. They would develop via conditioning processes governed by reinforcement (both positive and negative) and would reduce inhibitory control, which in turn, would lead to increased likelihoods choosing to use specific internet applications [80].

The updated I-PACE model includes three main revisions of the first version: a more refined definition of the predisposing variables involved in different types of addictive behaviors, an update of the core cycle of addictive processes, and a distinction between stages (early, later) of addictive processes and the related variables (moderating, mediating) [79]. The I-PACE model is theoretical and aims at inspiring and guiding clinical research and practice. However, the purported mechanisms are still incompletely understood. Also, studies on the full continuum of severity of PUI are lacking, further hindering nuanced analyses of how different processes may be differently involved in PUI stages. Furthermore, cross-sectional studies, which are the majority in this research field, do not allow exploring longitudinal relationships between affective-cognitive alterations and PUI, making it difficult to understand whether these alterations are risk factors or consequences of PUI. Filling these gaps will be important in better defining and investigating the precise affective and cognitive processes involved in the stages of PUI development and, most importantly, to reveal suitable targets for prevention and treatment and improve public health and clinical care [2].

2.3. From concepts to measures: Assessing PUI

Many different self-report instruments have been developed and used to assess PUI [81–83]. The following paragraph provides a brief description of the most widely used instruments that have been validated (at least) in English [17] (see Table 1).

Almost all available instruments assessing PUI have been developed following the DSM-IV criteria for pathological gambling and/or substance dependence [84], the cognitive-behavioral model of GPIU [21], and the component model of behavioral addictions (arguing that all addictions share common components; e.g., salience, tolerance, withdrawal, mood modification, conflict, and relapse [17,85]).

The most widely employed instrument is the Internet Addiction Test (IAT) [29]. In its first formulation (i.e., the Internet Addiction Diagnostic Questionnaire; IADQ [29]), it included 8 items reflecting the criteria for pathological gambling modified to the context of PUI. Based on the cut-off for pathological gambling (i.e., meeting five or more diagnostic criteria), 60% of the 396 participants included in the IADQ validation study were classified as dependent on the internet and reported more adverse consequences of internet usage. Moreover, those who were classified as dependent reported engaging in different online activities and more interactive internet functions, such as chat rooms and news-groups, as compared with non-dependent individuals. Interestingly, the duration of internet access was shorter for dependent than for non-dependent individuals, suggesting that “internet addiction” may relate

Table 1
Characteristics of self-report instruments assessing problematic use of the internet.

Instrument	Construct and subscales	N° of items	Scoring	Cut-off
Internet Addiction Diagnostic Questionnaire (IADQ) [29]	Pathological or addictive use of the internet	8 items with yes/no responses	Total number of endorsed questions	Endorsing five or more questions over a 6-month period = dependent on the internet
Internet Addiction Test (IAT) [29]	Six factors proposed to be at the basis of problematic use of the internet, i.e., compromised social and individual quality of life, careers, time control, and excitatory/compensatory usage of the internet	20 items on a 6-point Likert scale ranging from 0 (“does not apply”) to 5 (“always”)	Sum of items	A score of 70 or higher = internet use may be causing significant problems
Internet Related Problem Scale (IRPS) [88]	Six-factor structure proposed to be at the basis of problematic use of the internet, i.e., salience, mood enhancement, negative consequences, productivity, loss of control, and lack of information	20 items on a 10-point Likert scale ranging from 1 (“not true at all”) to 10 (“extremely true”)	Sum of items	No cut-off scores
Online Cognition Scale (OCS) [91]	Four-factor structure proposed to be at the basis of problematic use of the internet, i.e., loneliness/depression, diminished impulse control, social comfort, and distraction	36 items on a 7-point Likert scale ranging from 1 (“absolutely disagree”) to 7 (“absolutely agree”)	Sum of items	No cut-off scores
Compulsive Internet Use Scale (CIUS) [94]	Compulsive internet use, it is based on the criteria for substance dependence and obsessive-compulsive disorder	14 items on a 5-point Likert scale ranging from 0 (“never”) to 4 (“very often”)	Sum of items	No cut-off scores
Generalized Problematic Internet Use Scale 2 (GPIUS2) [23]	Four-factor structure proposed to be at the basis of generalized problematic internet use, i.e., preference for online social interaction, mood regulation, deficient self-regulation, and negative outcomes	15 items on a 8-point Likert scale ranging from 1 (“definitely disagree”) to 8 (“definitely agree”)	Sum of items	No cut-off scores
Problematic Internet Use Questionnaire-Short Form (PIUQ-SF-6) [99]	Three-factor structure proposed to be at the basis of problematic use of the internet, i.e., obsession, neglect, control	6 items on a 5-point Likert scale ranging from 1 (“never”) to 5 (“always/almost always”)		A score of 15 or higher = people at high risk of developing problematic use of the internet

more to the type of online activity and not to the amount of time spent online [29].

Based on the results obtained using the IADQ, the IAT was then developed as a more comprehensive 20-item instrument (the 8 items of the IADQ plus 12 new items) to assess PUI [29]. The IAT allows assessing i) among those already identified as having PUI, the specific area in which PUI has impacted the individual's life; ii) in cases in which the presence of PUI is not certain, whether Young's criteria for internet addiction [31] are met, and the consequences of internet-related behavior on the individual's life. Moreover, people who believe that someone may have PUI are recommended to use the IAT to assess the individual. A score of 70 or higher suggests that internet use may be causing significant problems. The IAT and its many different versions have been translated into several languages and used widely in different populations. While it has been described as an instrument with a generally acceptable internal consistency [82,86,87], psychometric studies also brought controversial results regarding its factor structure and other characteristics. Moreover, considering the changes in internet use its language is also outdated.

The Internet Related Problem Scale (IRPS) [88] is a 20-item scale, based on the DSM-IV criteria for substance abuse in the context of PUI, including factors such as tolerance, craving, and negative impact of internet use. The first validation of the scale [88] has been conducted on a small sample of participants ($n = 50$); however, this preliminary study showed the IRPS to have a moderate internal consistency; i.e., the questions were moderately homogenous and associated with the construct of internet addiction. The construct validity was also supported by significant correlations between IRPS scores and time spent online and the Minnesota Multiphasic Personality Inventory-2 scores [89]. The IRPS has been further tested on a sample of 79 participants, showing a six-factor structure reflecting salience, mood enhancement, negative consequences, productivity, loss of control, and lack of information. The internal consistency and concurrent validity of all factors were good, and salience was the most reliable subscale [90]. However,

the study had limitations including the small sample size and sex imbalance (more than 80% of participants were women) [90].

The Online Cognition Scale (OCS) [91] was developed focusing on cognition-related rather than behavior-related PUI features. The OCS adapted items from measures assessing procrastination, depression, impulsivity, and pathological gambling. This questionnaire is the operationalization of a cognitive-behavioral model of GPIU [21], that is based on the idea that maladaptive internet-related cognitions act as proximal precipitants of PUI symptoms, leading to poor impulse control that generates negative consequences related to internet use. The OCS is a 36-item questionnaire that provides a global measure of PUI. It was tested for the first time on a sample of 211 undergraduate students and showed a four-factor structure involving loneliness/depression, diminished impulse control, social comfort, and distraction. Although the first validation study did not report any analysis of the internal factor structure [92], the psychometric qualities of the questionnaire have been ascertained [82,91,93].

The Compulsive Internet Use Scale (CIUS) [94] is a 14-item scale developed to assess compulsive internet use. It is based on the criteria for substance dependence and obsessive-compulsive disorder [84], the findings on behavioral addictions [95], and clinical interviews with people who self-declared having internet addiction. The scale has been validated using three different samples and the one-factor structure provided factorial invariance across time, sex, age, and heavy vs. non-heavy internet use, with reported high reliability and concurrent and construct validity [94].

The Generalized Problematic Internet Use Scale 2 (GPIUS2) [23] was developed to revise and update the first version of the Generalized Problematic Internet Use Scale (GPIUS) [62]. The GPIUS was designed to assess both cognitive and behavioral dimensions of GPIU, including their negative outcomes on the individual's life. This first version included seven dimensions: i) mood alteration, i.e., internet use to regulate negative moods; ii) social benefits perceived when using the internet; iii) social control, i.e., the perception of controlling individual

self-presentation during online social interactions; iv) withdrawal; v) compulsive use; vi) excessive time online, and vii) negative outcomes including personal, social, and professional problems due to internet use. Based on findings from studies on the combination of the social benefits and social control factors into a single dimension, on the Preference for Online Social Interaction (POSI) [96] and compulsive internet use and cognitive preoccupation as both symptoms of deficient self-regulation [77,97], the GPIUS was updated. The main changes to the instrument were the inclusion of a subscale that operationalizes POSI and two first-order sub-scales that, taken together, constitute deficient self-regulation. Thus, the GPIUS2 includes four constructs: i) POSI; ii) mood regulation; iii) deficient self-regulation that includes compulsive use and cognitive preoccupation subscales; and, iv) negative outcomes. The GPIUS2 consists of 15 items that assess the separate sub-dimensions and an overall composite index [23]. The GPIUS2 has been described as an adequate measure of GPIU cognitions, behaviors, and outcomes [98].

The Problematic Internet Use Questionnaire-Short Form (PIUQ-SF-6) [99], is a 6-item version of the Problematic Internet Use Questionnaire (PIUQ) [100]. The PIUQ is originally developed for an 18-item scale and then validated in several countries and languages [99–102]. A nine-item version of the PIUQ is also available. It includes three factors, i.e., obsession (symptoms of withdrawal and obsessive thinking about the internet), neglect (neglect of responsibilities and everyday activities), and control (difficulties in controlling internet use). The PIUQ-SF-6 contains two items from each of the three factors. Scores range from 6 to 30, with higher scores indicating more severe PUI. In contrast to many other instruments, the cut-off scores of the different versions of PIUQ are suggested on empirical bases. The short version has been developed to obtain a measure of PUI brief enough to be useful in time-limited surveys. A cut-off score of 15 (out of 30) is suggested to differentiate between people at high versus low risk of developing PUI.

Despite all of the self-report instruments described above that have been tested at least once and provided satisfactory validity and reliability indices, the criterion validity was not assessed and therefore existing instruments do not allow for discerning overuse from problematic use of clinical relevance [83]. To differentiate between non-problematic and problematic use of the internet, clinical and control groups should be assessed and strict selection criteria be used to detect PUI (e.g. a score of 70 or higher on IAT, [29,83]). Additional tests of reliability have been also recommended to improve the predictive value of current self-report instruments [83]. Moreover, the differences in theoretical models/diagnostic criteria upon which self-report instruments are based may lead to assessments of constructs that only partially overlap. This, in turn, makes study comparisons difficult. Finally, the majority of the assessment tools for PIU have been typically validated on young adults and adolescents, with less research of PIU measures in older adults. Often young adults and adolescents are included together in a single sample, rather than considered separately to investigate possible group differences. Furthermore, direct comparison of these two age groups with one another and with adults is lacking [103]. Future studies considering age-related differences in the assessment of PUI and PUI in general are needed.

3. A focus on problematic use of social media use (PUSM)

With the growth of internet use, research has increasingly focused on the degree to which the types of behaviors performed on the internet may become problematic [104]. Recently, research has focused on PUSM.

Use of social media began in 1979 with Usenet, an online discussion system where individuals could post and share public messages [105]. Today, social media (SM; e.g., Instagram, Facebook, YouTube, Twitter) are used by billions of people worldwide, and are transforming communication, social interaction, and learning. SM are internet-based applications where individuals have a personal profile, visible lists of online friends/connections, and the possibility to update their content or

view others' updated posts [106]. Although it has been proposed that being involved in online social interaction has the potential to increase subjective well-being [106], multiple studies suggest that using SM can become problematic [107]. It has been argued that excessive online behaviors and constant connections are associated with poor social skills, reduced sustained attention, and impaired abilities/tendencies to retain information, leaving people challenged when engaging in meaningful conversations [108]. Individuals using SM excessively have been described as “alone together”: always connected via technology, but isolated [108]. SM use has been also shown to, at times, adversely affect psychological well-being [109], and for some people become an addictive behavior [110].

Similar to PUI, a consensus on the conceptualization of PUSM as a behavioral addiction has not been reached yet. However, it has been proposed that using SM in a compulsive or poorly controlled way has some key elements in common with behavioral and substance addictions, i.e., salience, mood modification, conflict, tolerance, withdrawal, and relapse [110–115], and has negative consequences on personal and occupational functioning [116].

Behavioral addictions have been defined as problematic behavior persisting despite its negative consequences [117]. Similar to what has been argued for PUI, in the case of PUSM, several specific behaviors can generate short-term rewards, and it can be difficult to distinguish individuals who develop a PUSM based on the reinforcers obtained from using SM per se (e.g., for online social interaction, viewing updated posts) from those who develop PUSM based on the reinforcers obtained from participating in other activities available on SM (e.g., gaming [118]). Moreover, given that this research field is still in its infancy, studies investigating PUSM suffer from methodological concerns; e.g., the lack of reliable prevalence estimates of PUSM, small and unrepresentative samples [54], and the absence of diagnostic criteria. Such concerns have led to considerable heterogeneity in assessment tools and varying questionnaire thresholds employed to assess PUSM, thus making generalizations and cross-study comparisons difficult [15,110]. Accordingly, developing criteria that are clinically sensitive to identify individuals with PUSM is required for making a reliable and valid diagnosis in terms of identification of research samples, treatment development, and treatment delivery.

The understanding and the conceptualization of PUSM is also made challenging by the existing gaps in some important fields of clinical research. There are relatively few studies investigating the psychophysiological mechanisms underlying this problematic behavior, with most theoretical models arising from mainly psychosocial research.

Although researchers have extensively used the behavioral addiction conceptual framework to define PUSM, controversies about the traditional conceptualization of behavioral addictions have emerged, with some disagreeing with this view and suggesting the possibility of an “overpathologization” of new habitual behaviors [119].

While the existence of PUSM as an addictive behavior is debatable, the evidence that a small percentage of SM users experience negative consequences because of their online behavior is well documented [116]. The need for future research aimed at clarifying the conceptual nature of PUI and its underlying mechanisms is particularly warranted for PUSM. To increase our understanding of these phenomena, research should focus on the presence of specific symptoms of addiction beyond the negative consequences of PUSM only, select large representative samples to increase the validity of the results, and include psychophysiological indices to investigate the underlying psychobiological mechanisms [110].

3.1. Current models and proposed mechanisms for PUSM

Biopsychosocial frameworks in models of addictions [85,120] posit that multiple and interacting biopsychosocial antecedents, manifestations, and consequences within and among behavioral and substance-related patterns of excessive engagement reflect an underlying

addiction syndrome. As a consequence, the symptoms of PUSM are viewed as similar to those of other behavioral addictions and substance use disorders (SUDs), and include *salience*, referring to the experience that a specific behavior becomes an extremely important activity in the person's life and dominates their thinking, feelings and behaviors; *mood modification*, referring to the subjective experiences that people report as a consequence of engaging in the specific behavior (e.g. a tranquillizing and/or distressing feeling); *tolerance*, referring to the process whereby increasing amounts of the specific behavior are required to achieve the former reinforcing effects (or same amount generates fewer/smaller effects); *withdrawal symptoms*, referring to unpleasant feelings and/or physical effects which occur when the specific behavior is ceased or suddenly reduced; *conflict*, referring to struggles between the addicted individual and other people (interpersonal conflict) or within the individuals themselves (intrapsychic), which are related to the specific behavior; and *relapse*, referring to the tendency to reinstate the specific behavior after its cessation (even after many years).

PUSM has been also described as arising from the positive reinforcement that SM generate, which may promote habit formation, that in turn may result in maladaptive psychological dependency on SM use [121]. This hypothesis has been formulated by integrating three overarching theoretical perspectives: i) the cognitive-behavioral model [21], ii) the social skill model [122], and iii) the socio-cognitive model of dysregulated media use [77]. According to the cognitive-behavioral model, some people who use the internet (e.g., SM) may develop distorted cognitions which are amplified by environmental factors (e.g., social isolation), and lead to the development of maladaptive/obsessive patterns of use [21]. The social skill model suggests that people who use the internet and have poor self-presentational skills are especially likely to prefer online social interaction to face-to-face communication. Online social interaction would favor compulsive internet use and related negative outcomes [122]. Lastly, the socio-cognitive model of dysregulated use suggests that the expectation of positive outcomes, combined with poor self-efficacy and self-regulation, favors compulsive SM use [77].

Based on these three models and the definition of general technology addiction, PUSM has been described as a condition occurring when SM use is considered by the individual as an important (or even exclusive) mechanism to relieve stress, loneliness, or depression [123]. Here, SM use is viewed as a self-medication strategy that favors an addictive use by providing continuous rewards (e.g., self-efficacy, satisfaction) and helping individuals escape their dysphoric mood states.

The Dual-System Theory in the context of PUSM [124] is based on the assumption that human behavior is controlled by two structurally and conceptually distinct brain systems: an impulsive, automatic, and reflexive (reactive) brain system (System 1), and a controlled, inhibitory, and reflective (prudent) brain system (System 2 [124,125]). While System 1 generates impulses to perform (or avoid) a specific behavior, System 2 determines whether impulsion and behavior are consistent with one's long-term goals, and modulates behavior to achieve those goals [126]. PUSM would reflect an imbalance between these two systems, involving strong cognitive-emotional preoccupation with SM use and weak cognitive-behavioral control over SM use.

Bandura's reciprocal determinism model within the social cognitive theory [127] has also been used to describe PUSM [116,128]. The model consists of triadic factors (i.e., person, behavior, and environment) that interactively influence each other [127]. The reciprocal determinism concept proposes that the individual's behavior changes by how the environment is perceived and how that individual, in turn, interacts with the environment. From this perspective, individuals with PUSM would not only be affected by their environment (e.g., social influence) but also by their SM-related problematic behaviors that, in turn, influence their environment.

To our knowledge, the only model that includes the psychobiological mechanisms that are thought to underlie PUSM is the I-PACE model of addictive behaviors [79,80]. Overall, it is generally accepted that the

etiology of PUSM involves a combination of biological, psychological, and social factors [15,85,120,129,130]. Although several models of PUSM have been proposed, there are still many research gaps regarding the mechanisms underlying the development and maintenance of SM-related problematic behaviors. Reasons for these gaps may also be found in the lack of psychophysiological and behavioral studies aimed at testing specific predictions of the theoretical models and thus, the mechanisms underlying PUSM.

3.2. Assessing PUSM

Similarly to PUI, a consensus regarding the diagnostic criteria for PUSM has not been achieved [60]. However, different self-report instruments have been developed and used to assess PUSM [15]. The following provides a brief description of the instruments that are most widely used at present (see Table 2).

The Addictive Tendencies Scale (ATS [131]) is based on the addiction theory and includes three items from other scales assessing addictive tendencies in the use of text messages and instant messaging services [132]. Items are rated on a 7-point scale. Higher ratings indicate higher addictive tendencies. The three items measure salience ("One of the first things I do each morning is log onto a social networking internet site (e.g., MySpace or Facebook)"); poor control ("I find it hard to control my use of a social networking site (e.g. MySpace or Facebook)"); and withdrawal ("I feel lost when I cannot access my social networking site (e.g., MySpace or Facebook)"). Although these three aspects have been central in the characterization of addiction, addiction has been frequently described as involving six core components: salience, mood modification, tolerance, withdrawal, conflict, and relapse [85,114]. Moreover, the psychometric qualities of the ATS for PUSM require further assessment.

The Bergen Facebook Addiction Scale (BFAS [114]) assesses the six proposed components of addiction [85]. The BFAS includes 18 items, three for each of the six components of addiction [85]: salience, mood modification, tolerance, withdrawal, conflict, and relapse. Each item is scored on a 5-point scale. Higher scores indicate a higher level of PUSM. This questionnaire has been translated into several languages and is arguably the most psychometrically robust scale to assess PUSM.

Both the ATS and the BFAS have been criticized because they examine problematic use of one specific commercial SM (i.e., Facebook) rather than the activity itself (i.e., SM use [118]). The BFAS does not differentiate between addiction *on* Facebook (e.g., playing Farmville) from addiction *to* Facebook. Moreover, concerns have been raised given that they are based on diagnostic criteria for gaming or gambling disorders, and problematic Facebook use may be more similar to PUI than to gaming or gambling disorders [133,134].

Similar to the BFAS, in the Bergen Social Media Addiction Scale (BSMAS) 'Facebook' has been replaced with 'Social Media' [135,136], with social media being defined as "Facebook, Twitter, Instagram and the like" in the instructions. This scale has been implemented as a consequence of the debate about considering addiction to one particular commercial company's service (i.e., Facebook) as representative of SM activity [118].

The E-Communication Addiction Scale [137] includes 22 items scored on a five-point Likert scale. The scale provides a measure of four aspects of PUSM: poor self-control (cognitive), e-communication use in extraordinary places, worries, and control difficulty (behavioral). The scale has high internal consistency and reliability for assessing addiction to e-communication across different levels of severity, ranging from very low to very high [15,137].

The Social Media Use Questionnaire (SMUQ [138]) assesses levels of problematic use of social media and includes nine items (e.g., "I struggle to stay in places where I will not be able to access social media", "I spend a large proportion of the day using social media") based on criteria for DSM-5 gambling disorder [9], the IAT [29], and the Fagerstrom test for nicotine dependence [139]. Items are rated on a 5-point Likert scale. The

Table 2
Characteristics of self-report instruments assessing problematic use of social media.

Instrument	Construct and subscales	N° of items	Scoring	Cut-off
Addictive Tendencies Scale (ATS) [131]	Levels of addictive tendencies toward social media	8 items on a 7-point Likert scale ranging from 1 (“strongly disagree”) to 7 (“strongly agree”)	Sum of items	No cut-off scores
The Bergen Facebook Addiction Scale (BFAS) [114] and Bergen Social Media Addiction Scale (BSMAS) [135,136]	Six-factor structure proposed to be at the basis of Facebook/social media addiction, i.e., salience, mood modification, tolerance, withdrawal, conflict, and relapse	18 items on a 5-point Likert scale ranging from 1 (“very rarely”) to 5 (“very often”)	Sum of items	No cut-off scores
E-Communication Addiction Scale [137]	Four-factor structure proposed to be at the basis of problematic use of social media, i.e., poor self-control, e-communication use in extraordinary places, worries, and control difficulty	22 items on a 5-point Likert scale	Mean of items	Score ranges: 4.20–5.00: very high 3.40–4.19: high 2.60–3.39: medium 1.80–2.59: low 1.00–1.79: very low
Social Media Use Questionnaire (SMUQ) [138]	Two-factor structure proposed to be at the basis of problematic use of social media, i.e., withdrawal and compulsion	9 items on a 5-point Likert scale ranging from 0 (“never”) to 4 (“always”)	Sum of items	No cut-off scores
Facebook Dependence Questionnaire (FDQ) [140]	Pathological or addictive use of Facebook	8 items with yes/no responses	Total number of endorsed questions	Endorsing five or more questions over a 6-months period = dependent on the internet
Social Networking Addiction Scale (SNWAS) [121]	Core components of social media addiction: psychological salience, symptoms of conflict, relapse, and reinstatement	5 items on a 7-point Likert scale ranging from 1 (“completely agree”) to 7 (“completely disagree”)	Sum of items	No cut-off scores
Problematic Facebook Use Scale [133]	Four-factor structure proposed to be at the basis of generalized problematic Facebook use, i.e., preference for online social interaction, mood regulation, deficient self-regulation, and negative outcomes	15 items on an 8-point Likert scale ranging from 1 (“definitely disagree”) to 8 (“definitely agree”)	Sum of items	No cut-off scores

SMUQ includes two factors (i.e., withdrawal and compulsion) and has high internal consistency [138].

The Facebook Dependence Questionnaire (FDQ [140]) consists of an adapted version of a questionnaire on internet addiction [141] to the context of Facebook addiction. The FDQ includes 8 two-choice questions (yes/no) focused on worries, concerns, satisfaction, time of use and efforts to reduce use, and control. The endorsement of five out of eight questions indicates addiction to Facebook use [140].

The Social Networking Addiction Scale (SNWAS [121]) is a five-item scale where respondents are asked to answer based on their experience with their most frequently used SM. It is adapted from short versions of Charlton and Danforth’s engagement vs. addiction questionnaire [92,142]. The original questionnaires [92,142] assessed computer-related addiction symptoms in the context of massive multiplayer gaming based on Brown’s conceptualization of addictive behaviors [143]. However, the authors argued that online games and SM share similar characteristics, such as filling social gaps in people’s lives, enhancing individuals’ social visibility, and creating a sense of immersion. Thus, the scale may be used to assess core components of different technology-related addictions: symptoms of conflict, relapse and reinstatement, and psychological salience [121].

The Problematic Facebook Use Scale (PFUS) [133] includes 15 items rated on an 8-point scale (1 = “definitely disagree”, 8 = “definitely agree”) adapted from the GPIUS2 [23]. The PFUS is based on the belief that a theory specifically developed for PUI can provide the basis for the development of a reliable measure to assess problematic Facebook use. Because the GPIU and GPIUS2 have been described as rational bases for conceptualizing and measuring problematic Facebook use, the word “internet” used in the GPIUS 2 has been replaced with the word “Facebook” where indicated in the PFUS. The PFUS has five subscales assessing POSI, mood regulation, cognitive preoccupation, compulsive

use, and negative outcomes. POSI refers to the belief that one is safer, more confident, and more comfortable with online than with face-to-face social interactions (e.g., “Online social interaction is more comfortable for me than face-to-face interaction”). Mood regulation refers to a cognitive symptom of PFU and reflects the motivation to use Facebook to regulate mood (e.g., “I have used Facebook to make myself feel better when I was down”). Cognitive preoccupation refers to obsessive thought patterns about using Facebook (e.g., “When I haven’t been on Facebook for some time, I become preoccupied with the thought of going on Facebook”). Compulsive use refers to poor self-regulation over Facebook use (e.g., “I have difficulty controlling the amount of time I spend on Facebook”). Negative outcomes refer to the extent to which a person experiences personal and social problems resulting from Facebook use (e.g., “My Facebook use has made it difficult for me to manage my life”). The total score ranges from 15 to 120, with higher scores indicating higher levels of PFU. The scale has shown good psychometric properties [133,144,145].

The short description of some of the self-report instruments currently used to assess PUSM highlights two critical features: the different theoretical frameworks on which they are based on and inconsistencies regarding dimensional perspectives on PUSM. These problems complicate cross-study comparisons and limit the reliability of current epidemiological research on SM-related problematic behavior. Taken together, the use of different conceptualizations and different assessment instruments calls into question the construct validity of PUSM, similar to what has been discussed for PUI [15].

4. What future goals should research pursue?

In the setting of theoretical debates regarding whether it is appropriate to consider PUI and PUSM as addictive behaviors, the main aim of

this manuscript was to review theoretical models and assessment tools proposed to conceptualize and measure these problematic behaviors. We have highlighted several main issues and now propose future research directions to address current controversies and methodological shortcomings.

The lack of consensus on how to conceptualize and identify general and specific PUI is reflected in the multiple existing theoretical models, whose differences in part reflect varying definitions and classifications of PUI (e.g., as an addiction or as an impulse control disorder; as an addiction to the internet or as an addiction on the internet). Differences are exacerbated by the subsequent implementation of assessment tools based on varying PUI conceptualizations, arguably slowing the advancement of knowledge by systematic research involving replication and comparisons of the results. For example, the growing research field on problematic use of smartphones has recently led to the formulation and testing of a theoretical framework that accounts for multiple forms and etiologies of problematic use of smartphones [7,146,147]. Although problematic use of smartphones may represent a unique problematic behavior, it has been argued that an appropriate approach when addressing smartphone-related problematic behaviors would involve focusing on the behavior (accessing the internet by smartphone) and not on the device only [12]. This suggests that the large body of data collected over the years on problematic use of smartphones could have been used, at least in part, to improve current knowledge regarding PUI. However, the lack of a clear conceptualization of PUI and identification of core symptomatology for a diagnosis has led to investigating possible “different kinds of PUI” across studies, with consequent difficulties in comparing and replicating results. The opportunity for understanding psycho-physiological mechanisms that underlie PUI is related to this issue. A standardized and reliable diagnosis is important for a reliable identification of PUI and its subtypes (e.g., PUSM) that, in turn, facilitates cross-study comparisons. In the case of gambling disorder, having standardized and reliable diagnoses across studies has promoted the more precise investigations into prevention and treatment approaches and the psycho-physiological mechanisms and processes underlying the disorder, despite heterogeneities relating to forms of gambling (e.g., on cards, sports, lotteries, machines) [148].

With respect to future research directions, we propose two main areas and goals to help address current controversies:

1) Define diagnostic criteria: The DSM-5 in the Differential Diagnosis section of IGD suggested that “[...] *future research on other excessive uses of the internet would need to follow similar guidelines as suggested herein*” [9] p.798, referring to the need to conduct epidemiological studies to determine the prevalence, clinical course, possible genetic influence, and potential biological factors based on, for example, brain imaging data and avoid the use of multiple different questionnaires, criteria, and thresholds. Similarly, we argue that an agreement on the diagnostic criteria, even before formal inclusion in a classification system, is important. Diagnostic criteria should be formulated by bottom-up and top-down processes: starting from the available empirical data, criteria should be informed by the clinical literature on PUI ([149,150] showing symptoms, behaviors, and comorbidities characterizing individuals whose internet use severely compromises significant relationships, jobs, or educational or career opportunities (bottom-up process). At the same time, diagnostic criteria may be inspired by those of IGD (top-down process), given IGD can be considered one PUI subtype. Thus, characterizing a higher-order category of PUI, similar to what happens for other higher-order categories of psychopathology (e.g., the higher-order category of SUD rather than the sub-category of alcohol use disorder), would allow studying specific characteristics that would differentiate PUI (and each PUI subtype) from other potential conditions (e.g., gambling, compulsive buying). Such diagnostic criteria constitute an important if not necessarily starting point to be confirmed or revised by comparable studies assessing prevalence,

clinical course, and genetic and other biological factors of the same phenomenon.

2) Some theoretical models proposed over the past twenty years appear somewhat outdated by more recent technological progress in the context of internet environments; e.g., the model proposed by Davis [21] seems to capture several aspects of PUSM, such as the POSI, rather than other PUI subtypes. At the time in which Davis proposed his model, SM were at early developmental stages, fewer in number and not yet characterized by multiple interfaces and interaction possibilities offered in more recent years. It is therefore evident that to describe and characterize PUI, a comprehensive model is needed, that would conceptualize higher-order mechanisms shared by different PUI subtypes. The I-PACE model takes this perspective; however, it conceptualizes behavioral addictions in general. In order to clarify PUI and its underlying mechanisms, theoretical hypotheses on PUI development are necessary. Such hypotheses should include the description of higher-order mechanisms involved in PUIs and not other psychopathological conditions (e.g., gambling, affective disorders). These mechanisms have a role also in other addictive behaviors but may be predominant in PUI [11]. These may include: i) multiple available visual (e.g., colored graphical app interfaces), auditory (e.g., the sounds of notifications), and tactile cues (e.g., touch screen) to which individuals may be exposed and the multiplicity of internet outcomes (which may elicit subjective motivational/affective responses based on perceptual features) that may lead to parallel forms of associative learning that contribute significantly to the maintenance of internet-related Pavlovian responses [151]; ii) the magnitude of the influences that conditioned internet cues may have on individuals’ online behaviors through real and/or subjective probabilities of receiving internet-related reinforcements [152]; and, iii) novel material generated in the internet environment that may intrinsically motivate individuals [153]. These specific potential PUI mechanisms may underlie all PUIs including PUSM, IGD, compulsive online shopping and compulsive sexual behaviors like problematic pornography use. It could be argued that some of the above-mentioned PUIs reflect an addiction on the internet rather than to the internet. However, it may be hypothesized that some specific aspects of the internet environment may make some online behaviors different and “more addictive” than the similar behaviors manifested offline. For example, in contrast with “offline” shopping, online shopping offers hundreds of buying options at any given time together with a seemingly continuous flow of ad-hoc advertisements and sales. Moreover, buyers typically receive purchased goods after a delay, which may increase craving and expectancy. Considering the above, a question that may be asked involves questioning whether people who may be addicted to online shopping are those who may also be addicted to offline shopping. If the answer is no, it would be important to characterize how online behaviors differ from their offline counterpart and, at the same time, how they operate similarly.

5. Conclusions

Despite the growing number of studies investigating PUI and PUI subtypes, its conceptualization and inclusion in a classification system have not been possible yet. The inclusion of PUI in the nosology together with IGD, gambling disorder, and SUD may contribute to improving public health, primarily by the development of prevention and management protocols. Several models aimed at inspiring clinical research and practice have proposed possible mechanisms involved in PUI and PUSM, and multiple self-report instruments have been consequentially developed. The diversity of the theoretical models and instruments currently hinders standardized assessment procedures across studies and, in turn, their comparability. Here, we propose two main areas and goals to help address current controversies: 1) define diagnostic criteria by bottom-up and top-down processes and 2) develop a psychobiological

hypothesis including the description of higher-order mechanisms involved in PUIs and not other psychopathological conditions (e.g., gambling, affective disorders). These mechanisms may include the multiple available internet-related cues and outcomes that may lead to parallel forms of associative learning; real and/or subjective probabilities of obtaining internet-related reinforcements; and novel material generated in the internet environment that may intrinsically motivate individuals.

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References

- [1] Digital. Hootsuite & we are social (Global) 2021. <https://wearesocial.com/blog/2021/01/digital-2021-the-latest-insights-into-the-state-of-digital>; 2021 (accessed April 11, 2021).
- [2] Antons S, Brand M, Potenza MN. Neurobiology of cue-reactivity, craving, and inhibitory control in non-substance addictive behaviors. *J Neurosci* 2020;415:116952. <https://doi.org/10.1016/j.jns.2020.116952>.
- [3] Ioannidis K, Treder MS, Chamberlain SR, Kiraly F, Redden SA, Stein DJ, et al. Problematic internet use as an age-related multifaceted problem: evidence from a two-site survey. *Addict Behav* 2018;81:157–66. <https://doi.org/10.1016/j.addbeh.2018.02.017>.
- [4] Stodt B, Wegmann E, Brand M. Predicting dysfunctional internet use: the role of age, conscientiousness, and internet literacy in internet addiction and cyberbullying. *Int J Cyber Behav Psychol Learn* 2016;6:28–43. <https://doi.org/10.4018/IJCBPL.2016100103>.
- [5] Gámez-Guadix M, Borrajo E, Almendros C. Risky online behaviors among adolescents: longitudinal relations among problematic internet use, cyberbullying perpetration, and meeting strangers online. *J Behav Addict* 2016;5:100–7. <https://doi.org/10.1556/2006.5.2016.013>.
- [6] Kircaburun K, Kokkinos CM, Demetrovics Z, Király O, Griffiths MD, Çolak TS. Problematic online behaviors among adolescents and emerging adults: associations between cyberbullying perpetration, problematic social media use, and psychosocial factors. *Int J Ment Health Addict* 2019;17:891–908. <https://doi.org/10.1007/s11469-018-9894-8>.
- [7] Billieux J, Maurage P, Lopez-Fernandez O, Kuss DJ, Griffiths MD. Can disordered mobile phone use be considered a behavioral addiction? An update on current evidence and a comprehensive model for future research. *Curr Addict Rep* 2015; 2:156–62. <https://doi.org/10.1007/s40429-015-0054-y>.
- [8] Slonje R, Smith PK, Frisén A. The nature of cyberbullying, and strategies for prevention. *Comput Hum Behav* 2013;29:26–32. <https://doi.org/10.1016/j.chb.2012.05.024>.
- [9] American Psychiatric Association. Diagnostic and statistical manual of mental disorders vol. 25. Washington: American Psychiatric Association; 2013. <https://doi.org/10.1176/appi.books.9780890425596>.
- [10] World Health Organization. International classification of diseases for mortality and morbidity statistics. 11th ed. 2018 (ICD-11 MMS) 2018 version. Webpage <https://icd.who.int/>.
- [11] Moretta T, Chen S, Potenza MN. Mobile and non-mobile internet use disorder: specific risks and possible shared Pavlovian conditioning processes. *J Behav Addict* 2020;9:938–41. <https://doi.org/10.1556/2006.2020.00077>.
- [12] Montag C, Wegmann E, Sariyska R, Demetrovics Z, Brand M. How to overcome taxonomical problems in the study of internet use disorders and what to do with “smartphone addiction”? *J Behav Addict* 2021;9:908–14. <https://doi.org/10.1556/2006.8.2019.59>.
- [13] Nemme HE, White KM. Texting while driving: psychosocial influences on young people’s texting intentions and behaviour. *Accid Anal Prev* 2010;42:1257–65. <https://doi.org/10.1016/j.aap.2010.01.019>.
- [14] Gary CS, Lakhiani C, DeFazio MV, Masden DL, Song DH. Smartphone use during ambulation and pedestrian trauma. *J Trauma Acute Care Surg* 2018;85:1092–101. <https://doi.org/10.1097/TA.0000000000002051>.
- [15] Kuss D, Griffiths MD. Social networking sites and addiction: ten lessons learned. *Int J Environ Res Public Health* 2017;14:311. <https://doi.org/10.3390/ijerph14030311>.
- [16] Brand M, H-Jü Rumpf, Demetrovics Z, Müller A, Stark R, King DL, et al. Which conditions should be considered as disorders in the International Classification of Diseases (ICD-11) designation of “other specified disorders due to addictive behaviors”? *J Behav Addict* 2020. <https://doi.org/10.1556/2006.2020.00035>.
- [17] Király O, Nagygyörgy K, Koronczai B, Griffiths MD, Demetrovics Z. Assessment of problematic internet use and online video gaming. In: *Ment. Heal. Digit. Age*. Oxford University Press; 2015. p. 46–68. <https://doi.org/10.1093/med/9780199380183.003.0003>.
- [18] Chamberlain SR, Lochner C, Stein DJ, Goudriaan AE, van Holst RJ, Zohar J, et al. Behavioural addiction—a rising tide? *Eur Neuropsychopharmacol* 2016;26:841–55. <https://doi.org/10.1016/j.euroneuro.2015.08.013>.
- [19] Kardefelt-Winther D. Conceptualizing internet use disorders: addiction or coping process? *Psychiatry Clin Neurosci* 2017;71:459–66. <https://doi.org/10.1111/pcn.12413>.
- [20] Yellowlees PM, Marks S. Problematic internet use or internet addiction? *Comput Hum Behav* 2007;23:1447–53. <https://doi.org/10.1016/j.chb.2005.05.004>.
- [21] Davis RA. A cognitive-behavioral model of pathological internet use. *Comput Hum Behav* 2001;17:187–95. [https://doi.org/10.1016/S0747-5632\(00\)00041-8](https://doi.org/10.1016/S0747-5632(00)00041-8).
- [22] Griffiths MD. Does internet and computer “addiction” exist? Some case study evidence. *CyberPsychol Behav* 2000;3:211–8. <https://doi.org/10.1089/109493100316067>.
- [23] Caplan SE. Theory and measurement of generalized problematic internet use: a two-step approach. *Comput Hum Behav* 2010;26:1089–97. <https://doi.org/10.1016/j.chb.2010.03.012>.
- [24] Shaffer HJ, Hall MN, Vander Bilt J. “Computer addiction”: a critical consideration. *Am J Orthopsychiatry* 2000;70:162–8. <https://doi.org/10.1037/h0087741>.
- [25] Potenza MN. Should addictive disorders include non-substance-related conditions? *Addiction* 2006;101:142–51. <https://doi.org/10.1111/j.1360-0443.2006.01591.x>.
- [26] Cheever NA, Moreno MA, Rosen LD. When does internet and smartphone use become a problem?. In: *Technol. Adolesc. Ment. Heal. Cham: Springer International Publishing*; 2018. p. 121–31. https://doi.org/10.1007/978-3-319-69638-6_10.
- [27] Shapira NA, Goldsmith TD, Keck PE, Khosla J, McElroy SL. Psychiatric features of individuals with problematic internet use. *J Affect Disord* 2000;57:267–72. [https://doi.org/10.1016/S0165-0327\(99\)00107-X](https://doi.org/10.1016/S0165-0327(99)00107-X).
- [28] Shapira NA, Lessig MC, Goldsmith TD, Szabo ST, Lazortiz M, Gold MS, et al. Problematic internet use: proposed classification and diagnostic criteria. *Depress Anxiety* 2003;17:207–16. <https://doi.org/10.1002/da.10094>.
- [29] Young K. Internet addiction: the emergence of a new clinical disorder. *CyberPsychol Behav* 1998;1:237–44. <https://doi.org/10.1089/cpb.1998.1.237>.
- [30] Fu K-W, Chan WSC, Wong PWC, Yip PSF. Internet addiction: prevalence, discriminant validity and correlates among adolescents in Hong Kong. *Br J Psychiatry* 2010;196:486–92. <https://doi.org/10.1192/bjp.bp.109.075002>.
- [31] Young K. *Caught in the net : How to recognize the signs of internet addiction—and a winning strategy for recovery*. New York: J. Wiley & Sons; 1998.
- [32] Black DW. Behavioural addictions as a way to classify behaviours. *Can J Psychiatry* 2013;58:249–51. <https://doi.org/10.1177/070674371305800501>.
- [33] Clark L, Limbrick-Oldfield EH. Disordered gambling: a behavioral addiction. *Curr Opin Neurobiol* 2013;23:655–9. <https://doi.org/10.1016/j.conb.2013.01.004>.
- [34] Karim R, Chaudhri P. Behavioral addictions: an overview. *J Psychoactive Drugs* 2012;44:5–17. <https://doi.org/10.1080/02791072.2012.662859>.
- [35] van Holst RJ, van den Brink W, Veltman DJ, Goudriaan AE. Why gamblers fail to win: a review of cognitive and neuroimaging findings in pathological gambling. *Neurosci Biobehav Rev* 2010;34:87–107. <https://doi.org/10.1016/j.neubiorev.2009.07.007>.
- [36] Block JJ. Issues for DSM-V: internet addiction. *Am J Psychiatry* 2008;165:306–7. <https://doi.org/10.1176/appi.ajp.2007.07101556>.

- [37] Ko C-H, Yen J-Y, Yen C, Chen C, Weng C, Chen C-C. The association between internet addiction and problematic alcohol use in adolescents: the problem behavior model. *CyberPsychol Behav* 2008;11:571–6. <https://doi.org/10.1089/cpb.2007.0199>.
- [38] Weinstein A, Lejoyeux M. Internet addiction or excessive internet use. *Am J Drug Alcohol Abuse* 2010;36:277–83. <https://doi.org/10.3109/00952990.2010.491880>.
- [39] Banz BC, Yip SW, Yau YHC, Potenza MN. Behavioral addictions in addiction medicine. In: *Prog. Brain Res. vol. 223*. Elsevier; 2016. p. 311–28. <https://doi.org/10.1016/bs.pbr.2015.08.003>.
- [40] Strittmatter E, Kaess M, Parzer P, Fischer G, Carli V, Hoven CW, et al. Pathological internet use among adolescents: comparing gamers and non-gamers. *Psychiatry Res* 2015;228:128–35. <https://doi.org/10.1016/j.psychres.2015.04.029>.
- [41] Goldberg I. Internet addiction disorder: Diagnostic criteria. <http://users.rider.edu/~suler/psyber/supportgp.html>; 1995 (accessed July 5, 2019).
- [42] Thurlow C, Lengel LB, Tomic A. *Computer mediated communication: social interaction and the Internet* 256; 2004.
- [43] Beard KW, Wolf EM. Modification in the proposed diagnostic criteria for internet addiction. *CyberPsychol Behav* 2001;4:377–83. <https://doi.org/10.1089/109493101300210286>.
- [44] Widyanto L, Griffiths MD. 'Internet addiction': a critical review. *Int J Ment Health Addict* 2006;4:31–51. <https://doi.org/10.1007/s11469-006-9009-9>.
- [45] Tao R, Huang X, Wang J, Zhang H, Zhang Y, Li M. Proposed diagnostic criteria for internet addiction. *Addiction* 2010;105:556–64. <https://doi.org/10.1111/j.1360-0443.2009.02828.x>.
- [46] Young K. Psychology of computer use: XL. Addictive use of the internet: a case that breaks the stereotype. *Psychol Rep* 1996;79:899–902. <https://doi.org/10.2466/pr0.1996.79.3.899>.
- [47] Ko C-H, Yen J-Y, Chen C-C, Chen S-H, Yen C-F. Proposed diagnostic criteria of internet addiction for adolescents. *J Nerv Ment Dis* 2005;193:728–33. <https://doi.org/10.1097/01.nmd.0000185891.13719.54>.
- [48] Ko C-H, Yen J-Y, Chen S-H, Yang M-J, Lin H-C, Yen C-F. Proposed diagnostic criteria and the screening and diagnosing tool of internet addiction in college students. *Compr Psychiatry* 2009;50:378–84. <https://doi.org/10.1016/j.comppsych.2007.05.019>.
- [49] Rumpf H-J, Achab S, Billieux J, Bowden-Jones H, Carragher N, Demetrovics Z, et al. Including gaming disorder in the ICD-11: the need to do so from a clinical and public health perspective. *J Behav Addict* 2018;7:556–61. <https://doi.org/10.1556/2006.7.2018.59>.
- [50] Petry NM, Rehbein F, Gentile DA, Lemmens JS, Rumpf H-J, Mölle T, et al. An international consensus for assessing internet gaming disorder using the new DSM-5 approach. *Addiction* 2014;109:1399–406. <https://doi.org/10.1111/add.12457>.
- [51] Reuters. Online addict dies after "marathon" session. <https://www.reuters.com/article/us-china-internet-addiction/online-addict-dies-after-marathon-session-id-USPEK26772020070228>; 2007 (accessed July 5, 2019).
- [52] Chuang Y-C. Massively multiplayer online role-playing game-induced seizures: ANeglected health problem in internet addiction. *CyberPsychol Behav* 2006;9:451–6. <https://doi.org/10.1089/cpb.2006.9.451>.
- [53] Chamberlain SR, Redden SA, Leppink E, Grant JE. Problematic internet use in gamblers: impact on clinical and cognitive measures. *CNS Spectr* 2017;22:495–503. <https://doi.org/10.1017/S1092852917000037>.
- [54] Kuss D, Griffiths MD. Online social networking and addiction—a review of the psychological literature. *Int J Environ Res Public Health* 2011;8:3528–52. <https://doi.org/10.3390/ijerph8093528>.
- [55] Rumpf H-J, Vermulst AA, Bischof A, Kastirke N, Gürtler D, Bischof G, et al. Occurrence of internet addiction in a general population sample: a latent class analysis. *Eur Addict Res* 2014;20:159–66. <https://doi.org/10.1159/000354321>.
- [56] van Rooij AJ, Schoenmakers TM, van de Eijnden RJJM, van de Mheen D. Compulsive internet use: the role of online gaming and other internet applications. *J Adolesc Health* 2010;47:51–7. <https://doi.org/10.1016/j.jadohealth.2009.12.021>.
- [57] Besser B, Loerbroks L, Bischof G, Bischof A, Rumpf H-J. Performance of the DSM-5-based criteria for internet addiction: a factor analytical examination of three samples. *J Behav Addict* 2019;8:288–94. <https://doi.org/10.1556/2006.8.2019.19>.
- [58] Derbyshire KL, Lust KA, Schreiber LRN, Odlaug BL, Christenson GA, Golden DJ, et al. Problematic internet use and associated risks in a college sample. *Compr Psychiatry* 2013;54:415–22. <https://doi.org/10.1016/j.comppsych.2012.11.003>.
- [59] Ho RC, Zhang MWB, Tsang TY, Toh AH, Pan F, Lu Y, et al. The association between internet addiction and psychiatric co-morbidity: a meta-analysis. *BMC Psychiatry* 2014;14:183. <https://doi.org/10.1186/1471-244X-14-183>.
- [60] Kuss D, Lopez-Fernandez O. Internet addiction and problematic internet use: a systematic review of clinical research. *World J Psychiatry* 2016;6:143. <https://doi.org/10.5498/wjp.v6.i1.143>.
- [61] Widyanto L, Griffiths MD. CHAPTER 6 internet addiction : does it really exist ? (Revisited). In: *Psychol. internet*. Academic Press; 2007. p. 141–63.
- [62] Caplan SE. Problematic internet use and psychosocial well-being: development of a theory-based cognitive-behavioral measurement instrument. *Comput Hum Behav* 2002;18:553–75. [https://doi.org/10.1016/S0747-5632\(02\)00004-3](https://doi.org/10.1016/S0747-5632(02)00004-3).
- [63] Brand M, Young K, Laier C. Prefrontal control and internet addiction: a theoretical model and review of neuropsychological and neuroimaging findings. *Front Hum Neurosci* 2014;8:375. <https://doi.org/10.3389/fnhum.2014.00375>.
- [64] Robinson TE, Berridge KC. *Addiction*. *Annu Rev Psychol* 2003;54:25–53. <https://doi.org/10.1146/annurev.psych.54.101601.145237>.
- [65] Cerniglia L, Zoratto F, Cimino S, Laviola G, Ammaniti M, Adriani W. Internet addiction in adolescence: neurobiological, psychosocial and clinical issues. *Neurosci Biobehav Rev* 2017;76:174–84. <https://doi.org/10.1016/j.neubiorev.2016.12.024>.
- [66] Pezzullo G, Rigoli F, Friston KJ. Hierarchical active inference: a theory of motivated control. *Trends Cogn Sci* 2018;22:294–306. <https://doi.org/10.1016/j.tics.2018.01.009>.
- [67] Buschman TJ, Miller EK. Goal-direction and top-down control. *Philos Trans R Soc B Biol Sci* 2014;369:20130471. <https://doi.org/10.1098/rstb.2013.0471>.
- [68] Everitt BJ, Robbins TW. Neural systems of reinforcement for drug addiction: from actions to habits to compulsion. *Nat Neurosci* 2005;8:1481–9. <https://doi.org/10.1038/nn1579>.
- [69] Everitt BJ, Dickinson A, Robbins TW. The neuropsychological basis of addictive behaviour. *Brain Res Rev* 2001;36:129–38. [https://doi.org/10.1016/S0165-0173\(01\)00088-1](https://doi.org/10.1016/S0165-0173(01)00088-1).
- [70] Volkow ND, Wang G-J, Fowler JS, Tomasi D, Telang F. Addiction: beyond dopamine reward circuitry. *Proc Natl Acad Sci* 2011;108:15037–42. <https://doi.org/10.1073/pnas.1010654108>.
- [71] Starcke K, Antons S, Trotske P, Brand M. Cue-reactivity in behavioral addictions: a meta-analysis and methodological considerations. *J Behav Addict* 2018;7:227–38. <https://doi.org/10.1556/2006.7.2018.39>.
- [72] Lee RSC, Hoppenbrouwers S, Franken I. A systematic Meta-review of impulsivity and compulsivity in addictive behaviors. *Neuropsychol Rev* 2019;29:14–26. <https://doi.org/10.1007/s11065-019-09402-x>.
- [73] Volkow ND, Baler RD. Addiction science: uncovering neurobiological complexity. *Neuropharmacol* 2014;76:235–49. <https://doi.org/10.1016/j.neuropharm.2013.05.007>.
- [74] Bickel WK, Mellis AM, Snider SE, Athamneh LN, Stein JS, Pope DA. 21st century neurobehavioral theories of decision making in addiction: review and evaluation. *Pharmacol Biochem Behav* 2018;164:4–21. <https://doi.org/10.1016/j.pbb.2017.09.009>.
- [75] Wei L, Zhang S, Turel O, Bechara A, He Q. A tripartite neurocognitive model of internet gaming disorder. *Front Psych* 2017;8:285. <https://doi.org/10.3389/fpsy.2017.00285>.
- [76] LaRose R. The problem of media habits. *Commun Theory* 2010;20:194–222. <https://doi.org/10.1111/j.1468-2885.2010.01360.x>.
- [77] LaRose R, Lin CA, Eastin MS. Unregulated internet usage: addiction, habit, or deficient self-regulation? *Media Psychol* 2003;5:225–53. https://doi.org/10.1207/S1532785XMEP0503_01.
- [78] LaRose R. The psychology of interactive media habits. In: *Handb. Psychol. Commun. Technol*. Wiley; 2015. p. 365–83. <https://doi.org/10.1002/9781118426456.ch16>.
- [79] Brand M, Wegmann E, Stark R, Müller A, Wölfling K, Robbins TW, et al. The interaction of person-affect-cognition-execution (I-PACE) model for addictive behaviors: update, generalization to addictive behaviors beyond internet-use disorders, and specification of the process character of addictive behaviors. *Neurosci Biobehav Rev* 2019;104:1–10. <https://doi.org/10.1016/j.neubiorev.2019.06.032>.
- [80] Brand M, Young K, Laier C, Wölfling K, Potenza MN. Integrating psychological and neurobiological considerations regarding the development and maintenance of specific internet-use disorders: an interaction of person-affect-cognition-execution (I-PACE) model. *Neurosci Biobehav Rev* 2016;71:252–66. <https://doi.org/10.1016/j.neubiorev.2016.08.033>.
- [81] Beard KW. Internet addiction: a review of current assessment techniques and potential assessment questions. *CyberPsychol Behav* 2005;8:7–14. <https://doi.org/10.1089/cpb.2005.8.7>.
- [82] Laconi S, Rodgers RF, Chabrol H. The measurement of internet addiction: a critical review of existing scales and their psychometric properties. *Comput Hum Behav* 2014;41:190–202. <https://doi.org/10.1016/j.chb.2014.09.026>.
- [83] Lortie CL, Guittion MJ. Internet addiction assessment tools: dimensional structure and methodological status. *Addiction* 2013;108:1207–16. <https://doi.org/10.1111/add.12202>.
- [84] *American Psychiatric Association. Diagnostic and statistical manual of mental disorders*. 4th ed. 2000. DSM-IV-TR. doi:10.1176/dsm10.1176/appi.books.9780890420249.dsm-iv-tr.
- [85] Griffiths MD. A 'components' model of addiction within a biopsychosocial framework. *J Subst Use* 2005;10:191–7. <https://doi.org/10.1080/14659890500114359>.
- [86] Widyanto L, McMurrin M. The psychometric properties of the internet addiction test. *CyberPsychol Behav* 2004;7:443–50. <https://doi.org/10.1089/cpb.2004.7.443>.
- [87] Moon SJ, Hwang JS, Kim JY, Shin AL, Bae SM, Kim JW. Psychometric properties of the internet addiction test: a systematic review and Meta-analysis. *Cyberpsychol Behav Soc Netw* 2018;21:473–84. <https://doi.org/10.1089/cyber.2018.0154>.
- [88] Armstrong L, Phillips JG, Saling LL. Potential determinants of heavier internet usage. *Int J Hum Comput Stud* 2000;53:537–50. <https://doi.org/10.1006/ijhc.2000.0400>.
- [89] *Hathaway SR, McKinley J. Minnesota multiphasic personality inventory: Manual for administration and scoring*. New York: The Psychological Corporation; 1951.
- [90] Widyanto L, Griffiths MD, Brunsden V, McMurrin M. The psychometric properties of the internet related problem scale: a pilot study. *Int J Ment Health Addict* 2008;6:205–13. <https://doi.org/10.1007/s11469-007-9120-6>.
- [91] Davis RA, Flett GL, Besser A. Validation of a new scale for measuring problematic internet use: implications for pre-employment screening. *CyberPsychol Behav* 2002. <https://doi.org/10.1089/109493102760275581>.

- [92] Charlton JP, Danforth IDW. Distinguishing addiction and high engagement in the context of online game playing. *Comput Hum Behav* 2007;23:1531–48. <https://doi.org/10.1016/j.chb.2005.07.002>.
- [93] Ozcan NK, Buzlu S. An assistive tool in determining problematic internet use: validity and reliability of the “online cognition scale” in a sample of university students. *J Depend* 2005;6:19–26.
- [94] Meerkerk G-J, Van Den Eijnden RJJM, Vermulst AA, Garretsen HFL. The compulsive internet use scale (CIUS): some psychometric properties. *CyberPsychol Behav* 2009;12:1–6. <https://doi.org/10.1089/cpb.2008.0181>.
- [95] Griffiths MD. Internet addiction: fact or fiction? *Psychologist* 1999;12:246–51.
- [96] Caplan SE. Preference for online social interaction. *Commun Res* 2003;30:625–48. <https://doi.org/10.1177/0093650203257842>.
- [97] LaRose R. On the negative effects of E-commerce: a Sociocognitive exploration of unregulated on-line buying. *J Comput Commun* 2006;6. <https://doi.org/10.1111/j.1083-6101.2001.tb00120.x>. 0–0.
- [98] Fioravanti G, Primi C, Casale S. Psychometric evaluation of the generalized problematic internet use scale 2 in an Italian sample. *Cyberpsychol Behav Soc Netw* 2013;16:761–6. <https://doi.org/10.1089/cyber.2012.0429>.
- [99] Demetrovics Z, Király O, Koronczai B, Griffiths MD, Nagygyörgy K, Elekes Z, et al. Psychometric properties of the problematic internet use questionnaire short-form (PIUQ-SF-6) in a nationally representative sample of adolescents. *PLoS One* 2016;11:e0159409. <https://doi.org/10.1371/journal.pone.0159409>.
- [100] Demetrovics Z, Szeredi B, Rózsa S. The three-factor model of internet addiction: the development of the problematic internet use questionnaire. *Behav Res Methods* 2008;40:563–74. <https://doi.org/10.3758/BRM.40.2.563>.
- [101] Koronczai B, Urbán R, Kőkönyei G, Paksi B, Papp K, Kun B, et al. Confirmation of the three-factor model of problematic internet use on off-line adolescent and adult samples. *Cyberpsychol Behav Soc Netw* 2011;14:657–64. <https://doi.org/10.1089/cyber.2010.0345>.
- [102] Mazhari S. Association between problematic internet use and impulse control disorders among Iranian university students. *Cyberpsychol Behav Soc Netw* 2012;15:270–3. <https://doi.org/10.1089/cyber.2011.0548>.
- [103] M'hiri K, Costanza A. Problematic internet use in older adults, A critical review of the literature. *J Addict Res Ther* 2015;06:1000253. <https://doi.org/10.4172/2155-6105.1000253>.
- [104] Potenza MN. Clinical neuropsychiatric considerations regarding nonsubstance or behavioral addictions. *Dialogues Clin Neurosci* 2017;19:281–91.
- [105] Kaplan AM, Haenlein M. Users of the world, unite! The challenges and opportunities of social media. *Bus Horiz* 2010;53:59–68. <https://doi.org/10.1016/j.bushor.2009.09.003>.
- [106] Verdun P, Ybarra O, Résibois M, Jonides J, Kross E. Do social network sites enhance or undermine subjective well-being? A critical review. *Soc Issues Policy Rev* 2017;11:274–302. <https://doi.org/10.1111/sipr.12033>.
- [107] Ryan T, Chester A, Reece J, Xenos S. A qualitative exploration of facebook addiction: working toward construct validity. *Addicta Turkish J Addict* 2016;3. <https://doi.org/10.15805/addicta.2016.3.0004>.
- [108] Fernández Pedemonte D, Turkle Sherry. Alone together: why we expect more from technology and less from each other? *Austral Comun* 2012;1:210–2. <https://doi.org/10.26422/aucom.2012.0102.fer>.
- [109] Yuen EK, Koterba EA, Stasio MJ, Patrick RB, Gangi C, Ash P, et al. The effects of Facebook on mood in emerging adults. *Psychol Pop Media Cult* 2019;8:198–206. <https://doi.org/10.1037/ppm0000178>.
- [110] Griffiths MD, Kuss D, Demetrovics Z. Social networking addiction. In: *Behav. Addict.* Elsevier; 2014. p. 119–41. <https://doi.org/10.1016/B978-0-12-407724-9.00006-9>.
- [111] Griffiths MD. The biopsychosocial approach to addiction. *Psyke & Logos* 2005;26:9–26.
- [112] Andreassen CS. Online social network site addiction: a comprehensive review. *Curr Addict Rep* 2015;2:175–84. <https://doi.org/10.1007/s40429-015-0056-9>.
- [113] Andreassen CS, Pallesen S. Social network site addiction - an overview. *Curr Pharm Des* 2014;20:4053–61. <https://doi.org/10.2174/13816128113199990616>.
- [114] Andreassen CS, Torsheim T, Brunborg GS, Pallesen S. Development of a Facebook addiction scale. *Psychol Rep* 2012;110:501–17. <https://doi.org/10.2466/02.09.18.PR0.110.2.501-517>.
- [115] Hormes JM, Kearns B, Timko CA. Craving Facebook? Behavioral addiction to online social networking and its association with emotion regulation deficits. *Addiction* 2014;109:2079–88. <https://doi.org/10.1111/add.12713>.
- [116] Moqbel M, Kock N. Unveiling the dark side of social networking sites: personal and work-related consequences of social networking site addiction. *Inf Manage* 2018. <https://doi.org/10.1016/j.im.2017.05.001>.
- [117] Grant JE, Potenza MN, Weinstein A, Gorelick DA. Introduction to behavioral addictions. *Am J Drug Alcohol Abuse* 2010;36:233–41. <https://doi.org/10.3109/00952990.2010.491884>.
- [118] Griffiths MD. Facebook addiction: concerns, criticism, and recommendations—a response to Andreassen and colleagues. *Psychol Rep* 2012;110:518–20. <https://doi.org/10.2466/01.07.18.PR0.110.2.518-520>.
- [119] Pontes HM, Taylor M, Stavropoulos V. Beyond “Facebook addiction”: the role of cognitive-related factors and psychiatric distress in social networking site addiction. *Cyberpsychol Behav Soc Netw* 2018;21:240–7. <https://doi.org/10.1089/cyber.2017.0609>.
- [120] Shaffer HJ, LaPlante DA, LaBrie RA, Kidman RC, Donato AN, Stanton MV. Toward a syndrome model of addiction: multiple expressions, common etiology. *Harv Rev Psychiatry* 2004;12:367–74. <https://doi.org/10.1080/106732204090905705>.
- [121] Turel O, Serenko A. The benefits and dangers of enjoyment with social networking websites. *Eur J Inf Syst* 2012;21:512–28. <https://doi.org/10.1057/ejis.2012.1>.
- [122] Caplan SE. A social skill account of problematic internet use. *J Commun* 2005;55:721–36. <https://doi.org/10.1093/joc/55.4.721>.
- [123] Xu H, Tan BCYY. Why do I keep checking facebook: effects of message characteristics on the formation of social network services addiction. In: *Int. Conf. Inf. Syst.* vol. 1. ICIS; 2012. p. 812–23. 2012.
- [124] Turel O, Qahri-Saremi H. Problematic use of social networking sites: antecedents and consequence from a dual-system theory perspective. *J Manag Inf Syst* 2016;33:1087–116. <https://doi.org/10.1080/07421222.2016.1267529>.
- [125] Evans JSBT. Dual-processing accounts of reasoning, judgment, and social cognition. *Annu Rev Psychol* 2008;59:255–78. <https://doi.org/10.1146/annurev.psych.59.103006.093629>.
- [126] Turel O, Bechara A. A triadic reflective-impulsive-interceptive awareness model of general and impulsive information system use: behavioral tests of neuro-cognitive theory. *Front Psychol* 2016;7. <https://doi.org/10.3389/fpsyg.2016.00601>.
- [127] Bandura A. Social foundations of thought and action. In: *Heal. Psychol. Read.* 1 Oliver's Yard, 55 City Road, London EC1Y 1SP United Kingdom: SAGE Publications Ltd; 1986. p. 94–106. <https://doi.org/10.4135/9781446221129.n6>.
- [128] LaRose R, Eastin MS. A social cognitive theory of internet uses and gratifications: toward a new model of media attendance. *J Broadcast Electron Media* 2004;48:358–77. https://doi.org/10.1207/s15506878jebem4803_2.
- [129] Rosenberg KP, Feder LC. Behavioral addictions. Elsevier; 2014. <https://doi.org/10.1016/C2012-0-02731-7>.
- [130] D Griffiths M. Social Networking Addiction: Emerging Themes and Issues. *J Addict Res Ther* 2013;04. <https://doi.org/10.4172/2155-6105.1000e118>.
- [131] Wilson K, Fornasier S, White KM. Psychological predictors of young adults' use of social networking sites. *Cyberpsychol Behav Soc Netw* 2010;13:173–7. <https://doi.org/10.1089/cyber.2009.0094>.
- [132] Ehrenberg A, Juckes S, White KM, Walsh SP. Personality and self-esteem as predictors of young people's technology use. *CyberPsychol Behav* 2008;11:739–41. <https://doi.org/10.1089/cpb.2008.0030>.
- [133] Marino C, Vieno A, Altoè G, Spada MM. Factorial validity of the problematic facebook use scale for adolescents and young adults. *J Behav Addict* 2017;6:5–10. <https://doi.org/10.1556/2006.6.2017.004>.
- [134] Ryan T, Chester A, Reece J, Xenos S. The uses and abuses of Facebook: a review of Facebook addiction. *J Behav Addict* 2014;3:133–48. <https://doi.org/10.1556/JBA.3.2014.016>.
- [135] Andreassen CS, Pallesen S, Griffiths MD. The relationship between addictive use of social media, narcissism, and self-esteem: findings from a large national survey. *Addict Behav* 2017;64:287–93. <https://doi.org/10.1016/j.addbeh.2016.03.006>.
- [136] Bányaí F, Zsila Á, Király O, Maraz A, Elekes Z, Griffiths MD, et al. Problematic social media use: results from a large-scale nationally representative adolescent sample. *PLoS One* 2017;12:e0169839. <https://doi.org/10.1371/journal.pone.0169839>.
- [137] Latif H, Uçkun CG, Gökçaya Ö, Demir B. Perspectives of generation 2000 and their parents on E-communication addiction in Turkey; 2016. p. 51–61.
- [138] Xanidis N, Brignell CM. The association between the use of social network sites, sleep quality and cognitive function during the day. *Comput Hum Behav* 2016;55:121–6. <https://doi.org/10.1016/j.chb.2015.09.004>.
- [139] Heatherton TF, Kozlowski LT, Frecker RC, Fagerstrom K-O. The Fagerstrom test for nicotine dependence: a revision of the Fagerstrom tolerance questionnaire. *Addiction* 1991;86:1119–27. <https://doi.org/10.1111/j.1360-0443.1991.tb01879.x>.
- [140] Wolniczak I, Cáceres-DelAguila JA, Palma-Ardiles G, Arroyo KJ, Solís-Visscher R, Paredes-Yauri S, et al. Association between facebook dependence and poor sleep quality: a study in a sample of undergraduate students in Peru. *PLoS One* 2013;8:e59087. <https://doi.org/10.1371/journal.pone.0059087>.
- [141] Echeburúa E. Adicciones... sin drogas? Las nuevas adicciones. 2009.
- [142] Charlton JP, Danforth IDW. Validating the distinction between computer addiction and engagement: online game playing and personality. *Behav Inf Technol* 2010;29:601–13. <https://doi.org/10.1080/01449290903401978>.
- [143] Brown R. A theoretical model of the Behavioural addictions—applied to offending. *Addict Crime* 1997;13–65.
- [144] Moretta T, Buodo G. Modeling problematic facebook use: highlighting the role of mood regulation and preference for online social interaction. *Addict Behav* 2018;87:214–21. <https://doi.org/10.1016/j.addbeh.2018.07.014>.
- [145] Assunção RS, Matos PM. The generalized problematic internet use scale 2: validation and test of the model to Facebook use. *J Adolesc* 2017;54:51–9. <https://doi.org/10.1016/j.adolescence.2016.11.007>.
- [146] Billieux J. Problematic use of the Mobile phone: a literature review and a pathways model. *Curr Psychiatry Rev* 2012. <https://doi.org/10.2174/157340012803520522>.
- [147] Canale N, Moretta T, Pancani L, Buodo G, Vieno A, Dalmaso M, et al. A test of the pathway model of problematic smartphone use. *J Behav Addict* 2021. <https://doi.org/10.1556/2006.2020.00103>.
- [148] Potenza MN, Balodis IM, Derevensky J, Grant JE, Petry NM, Verdejo-Garcia A, et al. Gambling disorder. *Nat Rev Dis Primers* 2019;5:51. <https://doi.org/10.1038/s41572-019-0099-7>.
- [149] Bostwick JM, Bucci JA. Internet sex addiction treated with naltrexone. *Mayo Clin Proc* 2008;83:226–30. <https://doi.org/10.4065/83.2.226>.
- [150] Pies R. Should DSM-V designate “internet addiction” a mental disorder? *Psychiatry (Edgmont)* 2009;6:31–7.

- [151] Vogel V, Kollei I, Duka T, Snagowski J, Brand M, Müller A, et al. Pavlovian-to-instrumental transfer: a new paradigm to assess pathological mechanisms with regard to the use of internet applications. *Behav Brain Res* 2018;347:8–16. <https://doi.org/10.1016/j.bbr.2018.03.009>.
- [152] Zhang S, Mano H, Ganesh G, Robbins T, Seymour B. Dissociable learning processes underlie human pain conditioning. *Curr Biol* 2016;26:52–8. <https://doi.org/10.1016/j.cub.2015.10.066>.
- [153] Tokunaga RS. Engagement with novel virtual environments: the role of perceived novelty and flow in the development of the deficient self-regulation of internet use and media habits. *Hum Commun Res* 2013;39:365–93. <https://doi.org/10.1111/hcre.12008>.