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## COMMENTARY



Commentary on: How to overcome taxonomical problems in the study of Internet use disorders and what to do with “smartphone addiction”? (Montag et al. 2019)

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# Two-dimensional taxonomy of internet addiction and assessment of smartphone addiction with diagnostic criteria and mobile apps

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## ABSTRACT

A recent review by Montag et al. raised a taxonomical argument about internet addiction. We propose a two-dimensional taxonomy of internet addiction by both the device and the content as the solution. For the assessment of smartphone addiction, measurements should be based on functional impairment and validated by diagnostic criteria rather than solely on self-reported questionnaires. We detail the potential of mobile applications (apps) to improve the assessment of smartphone addiction. App-generated indicators could fulfill the unmet need of assessment of smartphone addiction and facilitate future assessment and treatment planning of smartphone addiction.

## PROPOSED TWO-DIMENSIONAL TAXONOMY OF INTERNET ADDICTION

Ever since the rise of smartphone use in recent years, researchers have identified unique behavioral patterns of smartphone addiction, which differs from non-mobile internet addiction or computer-based internet gaming disorder (Lin et al., 2016). On the other hand, problematic smartphone users overlap with some individuals with non-mobile internet addiction (Liu, Lin, Pan, & Lin, 2016; Pan, Chiu, & Lin, 2019). Smartphone addiction and non-mobile internet addiction share similar symptoms and psychopathology. Therefore, the taxonomy of internet addiction is the subject of ongoing debate. Montag et al. suggested that two steps should be taken into consideration in the assessment of internet addiction: first, to specify the content or preferred online application and, second, to classify the devices as predominantly mobile or predominantly non-mobile use (Montag, Wegmann, Sariyska, Demetrovics, & Brand, 2019). Herein, we propose a two-dimensional taxonomy of internet addiction using both the device and the content (Fig. 1). Similar to the classification by Montag et al., internet addiction is divided into mobile and non-mobile device use. For the other dimension, we suggest distinguishing gaming disorder from generalized internet addiction rather than a preference for any specific type of application, such as social networking or pornography use disorders (Montag et al. 2019). This principle follows the classification of internet gaming disorder in the current Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association, 2013) and gaming disorder in the International Classification of Diseases, 11th Revision (ICD-11) (WHO, 2019). Gaming should be especially specified among all types of internet and electronic device usage. Compared to our classification of gaming and generalized internet use (Fig. 1), Montag et al.

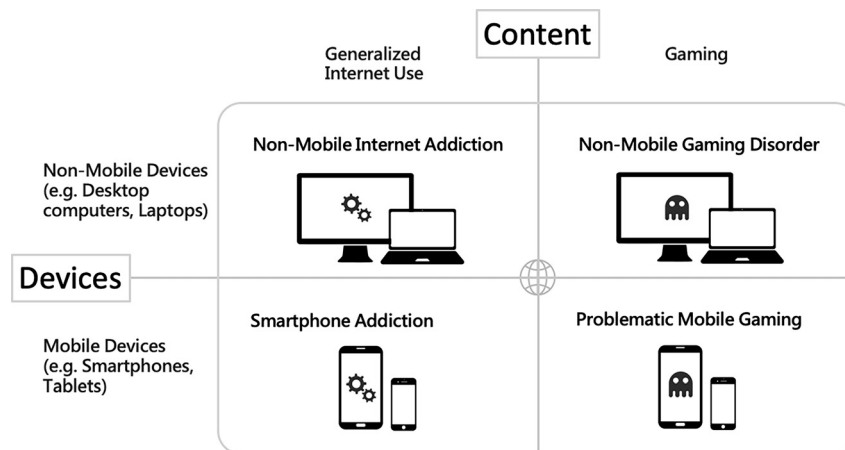


Fig. 1. Two-dimensional taxonomy of internet use disorder. The two-dimensional taxonomy classifies internet addiction by both device and content. In the device dimension, internet addiction is classified into non-mobile internet addiction and smartphone addiction, based on different behavior patterns. In the other dimension of content, gaming is differentiated from generalized internet use

(2019) specified each preferred online application based on the assumptions that specific usage motives and needs, anticipated rewards lead to preference of specific content. However, not all content resulted in significant clinical implications. For example, the use of social networking services on smartphones might present the healthy form rather than pathological form of smartphone use (Montag, Lachmann, Herrlich, & Zweig, 2019). Among all types of internet addiction, only gaming is specifically identified in DSM-5 and ICD-11; whether content apart from gaming could result in significant clinical problems remains controversial. Among all content, only gaming increased risk of smartphone addiction (Liu et al., 2016). In addition, the studies of other types than gaming of internet addiction showed the high heterogeneity (Pan, Chiu, & Lin, 2020).

Based on different behavioral patterns and the extent of clinical significance, both the device and content should be considered in the assessment of internet addiction (Fig. 1). Similar to its role in non-mobile internet addiction, gaming is also the most problematic content in smartphone addiction (Liu et al., 2016). However, the nature of multiple-app usage makes the symptoms of smartphone gaming addiction somewhat different from the symptoms of internet gaming disorder. Smartphone gaming allows the player to connect with other players not only via the gaming app itself but also in combination with other social networking apps. These apps then promote the games to the public, aggravating the addictive behaviors. A recent systemic review of epidemiology of internet addiction showed that since 2013, when internet gaming disorder was listed in research criteria of the current version of DSM-5 (American Psychiatric Association, 2013), scientific publications on non-specific, generalized internet addiction have somewhat declined. However, with the rise of smartphone use in recent years, generalized internet addiction regained attention in the research of smartphone addiction (Pan et al., 2020). Previous studies suggested that the characteristics of smartphone addiction were similar to those of generalized internet use disorder in the DSM-5 (Lin et al., 2016) rather than those of a specific

internet gaming disorder (Lin et al., 2015; Lin, Chiang, Lin, Chang, et al., 2016; Lin et al., 2017). The portability of mobile devices results in frequent, short-duration use among multiple apps, which is more similar to generalized internet addiction, not specific to a particular content, especially gaming. However, few studies have focused on smartphone gaming (Liu et al., 2016; Pan et al., 2019) and further research is needed.

The other essential dimension is to differentiate behavioral patterns of mobile and non-mobile devices (Fig. 1). The accessibility of mobile device results in frequent, short-duration use, different from the symptoms of non-mobile internet addiction. Problematic smartphone users presented recurrent failure to resist the impulse to use the smartphone (swipe), which resulted in physically hazardous or significant negative impacts on daily life (Lin et al., 2016). Previous studies showed that phone-related distraction increased the risk of road crashes (Gjorgjievski et al., 2020; Kim, Min, Kim, & Min, 2017; Klauer et al., 2014). Frequent, short-duration compulsive smartphone use also resulted in significant impairment in personal, social, occupational, or other important areas of functioning (Lin et al., 2016). These typical features of “phubbers” (i.e., problematic smartphone users) are different from those of “homebodies,” (i.e., problematic non-mobile internet users) and even those of “hikikomori,” who present extreme social withdrawal and usually excessive internet use.

## MEASUREMENTS OF SMARTPHONE ADDICTION SHOULD BE BASED ON FUNCTIONAL IMPAIRMENT AND VALIDATED BY DIAGNOSTIC CRITERIA RATHER THAN SOLELY ON SELF-REPORTED QUESTIONNAIRES

The self-reported questionnaire is the most used measurement for smartphone addiction, which reflects a

taxonomical conceptualization. Several self-reported questionnaires have been developed to assess smartphone addiction (Hawi, Samaha, & Griffiths, 2019; Kim, Lee, Lee, Nam, & Chung, 2014; Kwon, Kim, Cho, & Yang, 2013; Kwon, Lee, et al., 2013; Y.-H. Lin et al., 2014; Y. H. Lin, Pan, Lin, & Chen, 2017; Pan, Chiu, & Lin, 2019). However, different self-reported questionnaires among studies of smartphone addiction have found various prevalences and cutoff points. Therefore, self-reported questionnaires validated by the diagnostic criteria of structured interview are necessary to conceptualize smartphone addiction. Only a few scales have been validated by diagnostic criteria, such as the Smartphone Addiction Inventory (Y. H. Lin, Pan, et al., 2017; Y.-H. Lin et al., 2014) and Problematic Mobile Gaming Questionnaire (Pan et al., 2019), which also provided the cutoff points corresponding to clinical diagnosis. However, the Smartphone Addiction Proneness Scale was validated by the self-reported Mental Health Problems Scale and Internet Addiction Proneness Scale for Youth (Kim et al., 2014). The Digital Addiction Scale for Children was also validated by the self-reported Internet Gaming Disorder-20 test, Video Game Dependency Scale, and Game Addiction Scale (Hawi et al., 2019). The Smartphone Addiction Scale (SAS) (Kwon, Lee, et al., 2013) was validated by similar self-reported scales, such as the Visual Analogue Scale, Korean self-diagnostic program for Internet addiction, and Internet Addiction Test. Although the Smartphone Addiction Scale – Short Version (SAS-SV) was validated by self-reported questionnaires and clinical psychologist interviews with symptoms of tolerance, withdrawal, and daily-life disturbance (Kwon, Kim, et al., 2013), the interviews were neither based on diagnostic criteria nor relevant to functional impairment. To improve the consistencies in research and clinical assessment, we suggest measurements of smartphone addiction should be based on functional impairment and validated by diagnostic criteria rather than solely on self-reported questionnaires.

Symptoms and functional impairment of smartphone addiction are always simultaneously evaluated by diagnostic criteria. The strict measurement of smartphone addiction should be validated by diagnostic criteria as a provisional gold standard. The only diagnostic criteria for smartphone addiction (Lin et al., 2016) systemically evaluate four domains of the functional impairment: (1) physical and psychological problems resulting from excessive smartphone use; (2) smartphone use in physically hazardous situations; (3) impairment of social, school, or job performance; and (4) significant subjective distress. It is noteworthy that compared to non-mobile internet addiction, the portability of smartphones dampens the severity of functional impairment associated with smartphone addiction but instead influences multiple domains of an individual's daily life. As newly identified addictive behaviors emerge, functional impairment should be determined by two or more criteria in order to minimize the probability of over-diagnosis.

In the assessment of smartphone addiction, functional impairment might be more clinically relevant than specifying the content/preferred online application (Montag

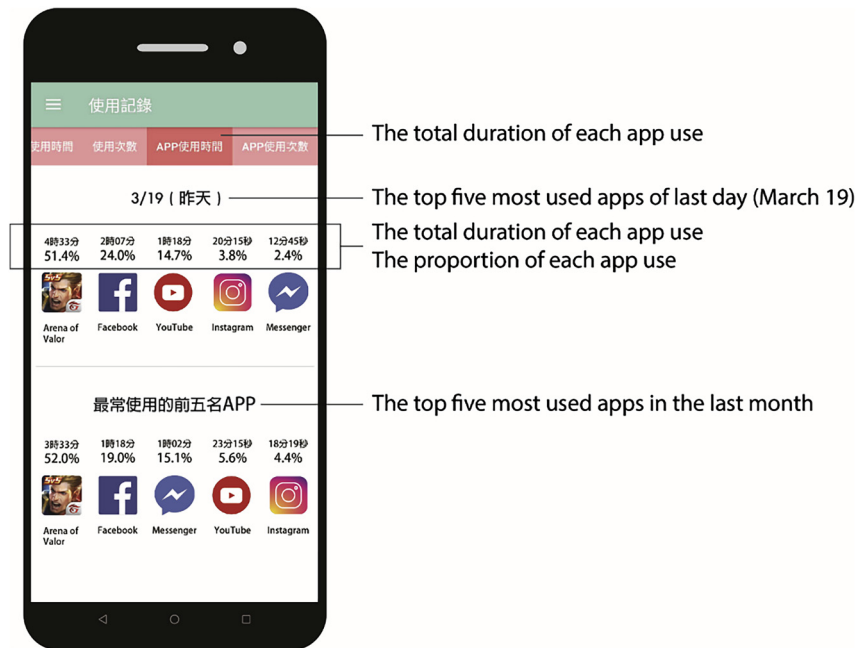
et al., 2019). Functional impairment is a necessary component in the diagnostic criteria of mental illness (American Psychiatric Association, 2013; WHO, 2019). The presence of functional impairment is critical to distinguishing clinical disorders from normal variations (Jablensky, 2016) and avoiding over-diagnosis. Functional impairment in smartphone addiction is characterized by distraction through frequent, short-duration use, with impaired control resulting from the portability of smartphones. For example, texting, using the internet, and reaching for the phone increase the risk of a motor vehicle crash or near-crash (Klauer et al., 2014). Among all smartphone tasks, gaming was the most distracting, decreasing accuracy and increasing the number of missed stimuli during walking (Mourra et al., 2020). Excessive smartphone use also has had physiological consequences, such as poorer sleep quality (Demirci, Akgönül, & Akpınar, 2015), reduced total sleep time, delayed circadian rhythm (Lin et al., 2019), and musculoskeletal symptoms in the neck and shoulder region (Toh, Coenen, Howie, & Straker, 2017).

## APP-GENERATED INDICATORS COULD FULFILL UNMET NEED FOR THE ASSESSMENT OF SMARTPHONE ADDICTION

The feasibility is questionable to specify the content or the preferred app usage in the assessment of internet addiction (Montag et al., 2019) by self-reports. Our previous study found that smartphone users find it very difficult to recall their exact use of each app. More specifically, smartphone-use patterns could be classified into only three groups: gaming predominant, gaming with multiple apps, and multiple apps without gaming (Liu et al., 2016). Therefore, mobile applications that objectively record actual smartphone use without active data entry by smartphone users are necessary to improve the accuracy of assessing smartphone addiction (Ryding & Kuss, 2020). We suggest that classifications of smartphone addiction should be based on the distribution of each app use, instead of on categorical taxonomy by the content of internet use (Montag et al., 2019). Fig. 2 shows an example of a smartphone user's problematic multiple-app use pattern. Although gaming accounts for 52.0% of the total usage, social networking (Facebook, Instagram, and Messenger) still accounts for 38.5%, which reveals that multiple apps are part of smartphone addiction. Thus, such a user's behavioral pattern would be better delineated by a dimensional approach (that examines the distribution of each app use) than a categorical approach (that looks at types, such as gaming or social networking).

Frequency and duration are two fundamental indicators of smartphone addiction. However, estimating frequent and short-duration smartphone-use patterns is very difficult when depending solely upon self-reported questionnaires. Smartphone addiction as assessed by psychiatrists' diagnoses and self-reported questionnaires (Shin & Dey, 2013) has been associated with app-recorded excessive frequency rather than duration of smartphone use (Lin et al., 2015).





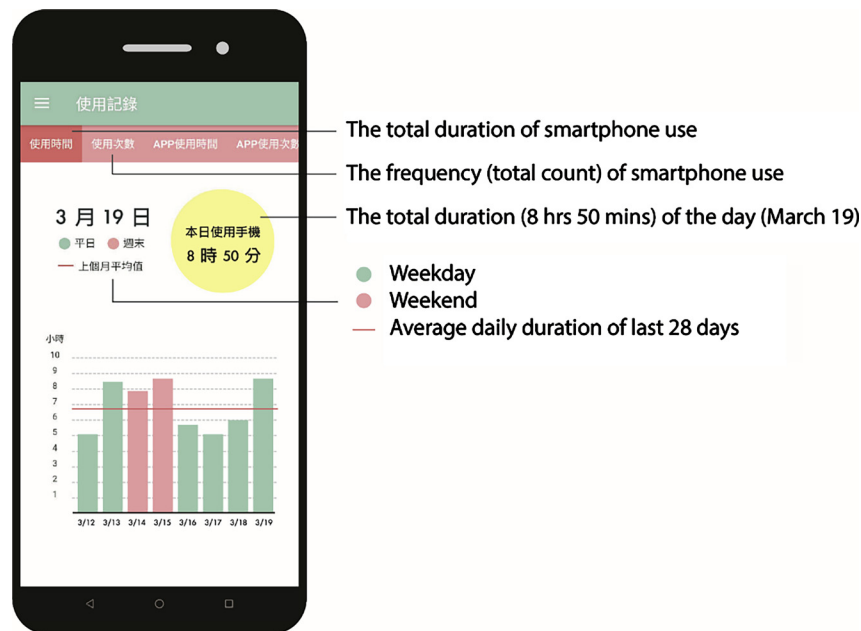
*Fig. 2.* Screenshot of the “Know Addiction” app user interface, which displays the time spent on each app. This is a screenshot of the “Know Addiction” app user interface from a problematic smartphone user. This app operates in the background and records the screen-on and screen-off timestamps of each app, thus measuring usage. The upper part of the screenshot shows the five most-used apps of the previous day (March 19), including the total duration and proportion of each app use. The lower part of the screenshot shows the five most-used apps of the past four weeks-long period (February 21 to March 19), including the total duration and proportion of each app use. The most-used apps on March 19 were somewhat different from the ranking of the past four months-long period (February 21 to March 19). The third to fifth most-used apps on March 19 were Youtube, Instagram, and Messenger, respectively, while the third to fifth most-used apps over the previous month were Messenger, Youtube, and Instagram, respectively, which reveals fluctuations in mobile apps’ usage

Nevertheless, it is conceivable that smartphone users are unable to recall their counts of smartphone-use episodes within a day. A previous study showed that 16.5% of college students’ smartphone use was too frequent to estimate its total duration; and the other 83.5% of smartphone users inaccurately estimated time spent on smartphones per week, even with the assistance of psychiatrists’ structural interviews (Lin et al., 2015). Two studies have shown significant differences between self-reports and app-recorded time spent on smartphone use (Lin et al., 2015; Montag et al., 2015). In addition, smartphone users with more actual smartphone use would underestimate their use to a greater extent due to “time distortion” effects; the extent of such underestimations has been found to be associated with smartphone addiction (Lin et al., 2015).

Apps objectively record the actual smartphone use and could delineate the extent of excessive use, that is the total duration and the frequency of smartphone use (Fig. 3), as well as specify the distribution of each app’s usage (Fig. 2). The app-generated data could provide real time record and high temporal resolution to even minute. In addition, the subtle shifts in patterns of increasing smartphone use can provide early warning signs of deteriorating excessive smartphone addiction. Data on these patterns can be used to alert people to the need for self-management before the patterns—and the associated symptoms—become more severe (Fig. 3). Therefore, the app-generated data serves as a useful tool for long-term follow-up and is sensitive to

prevent the relapse among excessive smartphone users. In addition, the app-generated indicators could explore more behavioral patterns and detail the symptoms of smartphone addiction. The smartphone use episodes (recorded as screen-on to screen-off) and the notification timestamps provide an opportunity to distinguish between users’ proactive and reactive use (Lin et al., 2019; Pan, Lin, Chiu, Lin, & Lin, 2019). App-generated indicators of use/non-use reciprocity were validated to reflect the compulsive symptoms of problematic smartphone use (Lin et al., 2017; Pan et al., 2019). By analysis of empirical mode decomposition, indicators such as trends of frequency, duration, and median use were calculated and tested according to a psychiatrist’s assessment of tolerance symptom, which was defined as spending more and more time engaged in smartphone use. Findings revealed that the trends of daily median duration were significant in terms of identifying tolerance symptom and the trends of frequency were associated to psychiatrist’s diagnosis of smartphone addiction (Lin et al., 2015).

App-generated indicators have the potential to address some of the long-standing challenges associated with collecting data on human behaviors. Previous assessments in mental-health care and research have relied almost exclusively on self-reporting, which resulted in subjective data and burdensome collection. In addition, assessments are conducted so infrequently that they do not provide insights into the temporal dynamics of symptoms, which are crucial for both diagnosis and treatment planning. App-generated



**Fig. 3.** Screenshot of app user interface of smartphone use. This screenshot of the “Know Addiction” app user interface shows the weekly summary of the daily time spent on the smartphone. In the yellow circle is the total duration (8 h 50 min) for the day (March 19), while the lower part of the screenshot reveals the total duration of each day of the past week. The smartphone’s usage varied between weekdays (in green) and the weekend (in pink). This app continuously collects data without active data entry by the smartphone users and provides the average daily duration of the past 28 days (February 21 to March 19) of the user. This average appears as a red horizontal line and serves as a personalized reference of the average time spent on the smartphone (6 h 50 min)

data could delineate the time course of smartphone addiction, provide real-time records, and supply high temporal resolution, even to the second (Pan et al., 2019), while self-reported questionnaires typically record the time only in weeks or months. Therefore, by building apps that continuously collect objective information on behavior in the context of people’s real lives, the resulting app-generated data serves as a useful tool for long-term follow-up and relapse prevention among excessive smartphone users.

## CONCLUSION

We proposed a two-dimensional taxonomy of internet addiction that uses both the device and content based on different behavioral patterns and raises the relevance to clinical significance. Although previous studies of smartphone addiction were mostly assessed by self-reported questionnaires, the measurement of smartphone addiction should be based on functional impairment and validated by diagnostic criteria to improve the consistency of both research and clinical assessment. App-generated indicators could fulfill the unmet need for real-time assessment with high temporal resolution, and empower smartphone users by giving them actionable insights into patterns of behavior that might otherwise have remained unseen.

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