The Psychometrics of Internet Addiction and Internet Gaming Disorder:

A Step Towards Measurement Unification

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Copyright Statement

Statement of Originality

I declare that the work presented in this thesis is, to the best of my knowledge and belief, original and my own work, except as acknowledged in the text. The material (presented as my own) has not been submitted previously, in whole or in part, for a degree at any other institution.

Statement of Contribution to Others

In those cases in which the work presented in this thesis was the product of collaborative efforts, I declare that my contribution was substantial and prominent, involving the development of original ideas, as well as the definition and implementation of subsequent work. Detailed information about my contribution to collaborative work in this thesis is outlined in Appendix I.

Dedication

This work is dedicated to the most important person of my life, my grandmother Emilia.

Moving from Brazil to Portugal at the age of 16 was no easy feat for a rebellious and stubborn teenager. During that time, I really missed my real-life friends from Brazil and was bullied in school for having a Brazilian accent. These events (alongside others) led me to develop a full-blown gaming addiction that lasted for about a decade. In hindsight, I now think that doing this PhD was perhaps an attempt to provide answers to my own past struggles as I had (Un)fortunately, experienced many years of gaming addiction in first-hand. Ironically, after completing my PhD, I got more questions than answers. Nevertheless, if it wasn't for my grandmother, I wouldn't be here now writing these very words. She was my guardian angel and have sacrificed herself to help me in every possible way she could to get me out of my gaming addiction and make me strive in life by means of education and being a better person. I remember when she one day confessed to me that her biggest fear at the peak of my gaming addiction was that *she was constantly afraid of getting home and not finding me alive in my room*. Although I am truly sorry for having made she feel that way back then, everything she has been through has finally been paid off as she left this world knowing that I had finished my MSc degree and have got into the PhD.

So for all these reasons and those I cannot mention, this thesis could not be dedicated to anyone but her, my beloved grandmother that passed away with cancer just before the start of my PhD back in 2013.

Walk on through the wind

Walk on through the rain

Though your dreams be tossed and blown

Walk on, walk on

With hope in your heart

And you'll never walk alone

You you'll never walk alone

(Christine Johnson)

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To a new dawn.

List of Selected Publications

Peer-reviewed Journal Articles

Pontes, H. M., & Griffiths, M. D. (2017). The development and psychometric evaluation of the Internet Disorder Scale (IDS-15). *Addictive Behaviors, 64,* 261-268. doi: 10.1016/j.addbeh.2015.09.003

Pontes, H. M., & Griffiths, M. D. (2016). The development and psychometric properties of the Internet Disorder Scale – Short Form (IDS9-SF). *Addicta: The Turkish Journal on Addictions, 3(2),* 1-16. doi: 10.15805/addicta.2016.3.0102

Pontes, H. M., Macur, M., & Griffiths, M. D. (2016). Internet Gaming Disorder among Slovenian primary schoolchildren: Findings from a nationally representative sample of adolescents. *Journal of Behavioral Addictions, 5*(2), 304-310. doi: 10.1556/2006.5.2016.042

Pontes, H. M., & Griffiths, M. D. (2016). Portuguese validation of the Internet Gaming Disorder Scale–Short-Form. *CyberPsychology, Behavior & Social Networking, 19*(4), 288-293. doi: 10.1089/cyber.2015.0605

Fuster, H., Carbonell, X., **Pontes, H. M.**, & Griffiths, M. D. (2015). Spanish validation of the Internet Gaming Disorder-20 (IGD-20) Test. *Computers in Human Behavior, 56*, 215-224. doi:10.1016/j.chb.2015.11.050

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Peer-reviewed Book Chapters

Pontes, H. M., Kuss, D. J., & Griffiths, M. D. (in press). Psychometric assessment of Internet Gaming Disorder in neuroimaging studies: A systematic review. In C. Montag, & M. Reuter (Eds.), *Internet and Smartphone Addiction: Neuroscientific Approaches*: Springer London.

Pontes, H. M., & Griffiths, M. D. (2015). New concepts, old known issues: The DSM-5 and Internet Gaming Disorder and its assessment. In J. Bishop (Ed.), *Psychological and Social Implications Surrounding Internet and Gaming Addiction* (pp. 16-30). Hershey, PA: Information Science Reference. doi: 10.4018/978-1-4666-8595-6.ch002

[1] Study awarded with the '**2016 Durand Jacobs Award**' by the International Centre for Youth Gambling Problems and High-Risk Behaviors at McGill University (Canada) as the best graduate student paper related to the psychology of addictive behaviours after being selected by a panel of international experts in the field.

Commentary and Editorial Papers

Griffiths, M. D., van Rooij, A. J., Kardefelt-Winther, D., Starcevic, V., Király, O., … **Pontes, H. M.**, … & Demetrovics, Z. (2016). Working towards an international consensus on criteria for assessing Internet Gaming Disorder: a critical commentary on Petry et al. (2014). *Addiction, 111*, 167-178. doi: 10.1111/add.13057

Griffiths, M. D., Kuss, D. J., Billieux, J., & **Pontes, H. M.** (2016). The evolution of Internet addiction: A global perspective. *Addictive Behaviors, 53*, 193-195. doi: 10.1016/j.addbeh.2015.11.001

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Published Conference Proceedings and Presentations

Pontes, H. M. (2016). An overview of the current trends in the assessment of technological addictions: The case of Internet Gaming Disorder. *Paper presented at 3rd International Congress of Technology Addiction, Congress, Istanbul, Turkey.* doi: 10.13140/RG.2.1.5141.0808

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Macur, M., **Pontes, H. M.**, & Griffiths, M. D. (2016). Prevalence rates of Internet Gaming Disorder among Slovenian youth: Findings from a nationally representative study. *Journal of Behavioral Addictions, 5*, Supplement 1, 27-28. doi:10.1556/JBA.5.2015.Suppl.1

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Abstract

Previous research on gaming addiction and Internet addiction (IA) has relied on inconsistent definitions and theoretical frameworks to define these constructs, and has negatively impacted on their assessment. However, the American Psychiatric Association (APA) included 'Internet Gaming Disorder' (IGD) as a tentative disorder in need of further investigation in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5). Following this preliminary recognition of gaming addiction as potential disorder, unification and standardisation in the field in terms of assessment became possible given that the DSM-5 provided a set of official criteria defining IGD that could be implemented in future research. The research in this thesis substantially contributes to knowledge by (i) systematically reviewing the inconsistencies in the psychometric assessment of IGD and IA, (ii) developing a new potentially unifying standardised psychometric assessment framework for both disorders, and (iii) identifying potential risk factors for IGD and IA. A cross-sectional design was employed across all empirical studies (Study 1, N = 1,003; Study 2, N = 1,060; Study 3, N = 1,105; Study 4, N = 1,100), and the data were analysed using structural equation modelling (i.e., measurement model and latent profile analysis), alongside traditional bivariate statistical modelling. The results indicated that, at a theoretical level, the use of inconsistent assessment tools to investigate IGD and IA has hindered progress in the field. At an empirical level, the Internet Gaming Disorder Test (IGD-20 Test) and the Internet Gaming Disorder Scale–Short-Form (IGDS9-SF) were developed to assess IGD, and the Internet Disorder Scale (IDS-15) and the Internet Disorder Scale–Short Form (IDS9-SF) were developed to assess IA based on the IGD conceptualisation provided by the APA in the DSM-5. Overall, the research in this thesis confirms the usefulness of the utilisation of the IGD framework and the

psychometric tools developed as a potential avenue to overcome the shortcomings related to previous heterogeneity issues in the assessment of both IGD and IA.

PART I: INTRODUCTION

CHAPTER 1: Clinical Psychology of Internet Addiction: A Review of its Conceptualisation, Prevalence, Neuronal Processes, and Implications for Treatment[2]

Introduction

Given the ubiquity of the Internet, its evolving nature as a modern tool of society, and issues surrounding its excessive use and abuse by a minority of people, Internet addiction has become an increasingly important topic for dedicated research agendas from several scientific fields including psychology, psychiatry, and neuroscience. Moreover, the number of users of the Internet is ever increasing (Kuss, Griffiths, Karila, & Billieux, 2014). The latest International Telecommunication Union (ITU) report predicted that by the end of 2014, around 44% of the world's households will have Internet access, an increase of approximately 40% in comparison to 2013 (International Telecommunication Union, 2014). Furthermore, it is generally agreed amongst scholars that the phenomenon of Internet addiction was initially reported and described in the psychological literature by both Young (e.g., Young, 1996, 1998b) and Griffiths (e.g., Griffiths, 1996b, 1998), in the 1990s and that technological addictions were under scientific debate and scrutiny since this time, particularly in relation to addictions *on* the Internet as opposed to addictions *to* the Internet (see Griffiths, 1995, 2000b).

Psychological phenomena of any kind, whether addictive or not, usually encompass various complex mechanisms and behavioural properties that are better understood from a biological, psychological, and/or sociological point of view, making it difficult to provide

[2] Most of the material featured in Chapter 1 resulted in the following refereed publication: Pontes, H. M., Kuss, D. J., & Griffiths, M. D. (2015). Clinical psychology of Internet addiction: a review of its conceptualization, prevalence, neuronal processes, and implications for treatment. *Neuroscience and Neuroeconomics, 4*, 11-23. doi:10.2147/NAN.S60982

standalone definitions for such phenomena. Likewise, the very concept of addiction does not have a unique all-encompassing and widely accepted definition (West, 2001), let alone as applied to the concept of Internet addiction. Despite the controversies, Internet addiction has been referred to across the psychological, psychiatric, and neuroscientific literature by the adoption of different terms and nomenclatures such as Internet addiction disorder (OReilly, 1996; Young, 1998b), pathological Internet use (Kandell, 1998), compulsive Internet use (Greenfield, 1999a), virtual addiction (Greenfield, 1999b), compulsive computer use (Black, Belsare, & Schlosser, 1999), pathological Internet use (Davis, 2001), problematic Internet use (Caplan, 2002), among others. For the purpose of this thesis, the term Internet addiction is used for the sake of parsimony and consistency.

Given the extant debates in the field as to whether Internet addiction can stand on its own as a diagnosis (i.e., as a primary disorder) or whether it is a consequence of other existing underlying mental disorders (e.g., depression, anxiety, attention deficit hyperactivity disorder, other impulse control disorders, making it a secondary disorder) (Block, 2008; Pies, 2009), the purpose of this review is to highlight the issue of Internet addiction in terms of (i) the definition and characterisation, (ii) incidence and prevalence rates from robust studies (i.e., those with nationally representative samples), (iii) its associated neuronal processes, and (iv) implications for treatment and prevention, along with patient-specific relevant considerations.

It is envisaged by the present author that by clarifying such specific aspects based on the latest empirical findings and advancements in the field, a better understanding may be obtained for this emerging phenomenon that continues to generate a great deal of debate (Griffiths & Pontes, 2014). Moreover, by reviewing the most recent empirical evidence, the present author argues that Internet addiction can be a serious disorder affecting a minority of people, and can be understood

and conceptualised within a behavioural addictions framework despite the methodological and conceptual limitations usually associated with this phenomenon.

Internet Addiction: A Critical Approach to Definition and Characterisation

Generally speaking, Internet addiction has been characterised by excessive or poorly controlled preoccupation, urges, and/or behaviours regarding Internet use that lead to impairment or distress in several life domains (Weinstein, Feder, Rosenberg, & Dannon, 2014). However, according to Young (1998b), Internet addiction is a problematic behaviour akin to pathological gambling that can be operationally defined as an impulse control disorder not involving the ingestion of psychoactive intoxicants. Following the conceptual framework developed by Young, Pistner, O'Mara, and Buchanan (1999) to understand Internet addiction, five specific types of distinct online addictive behaviours were identified: (i) 'cyber-sexual addiction', (ii) 'cyber-relationship addiction', (iii) 'net compulsions (i.e., obsessive online gambling, shopping, or trading), (iv) 'information overload', and (v) 'computer addiction' (i.e., obsessive computer game playing). Furthermore, and using a similar rationale, Block (2008) defined Internet addiction as a compulsive-impulsive spectrum disorder involving online and/or offline computer usage patterns featuring excessive use, withdrawal symptoms, tolerance, and negative repercussions.

However, as noted above, it has also been argued that the Internet may simply be the means or 'place' where the most commonly reported addictive behaviours occur. In short, the Internet may be just a medium to fuel other addictions as argued theoretically and shown empirically by a number of scholars (Griffiths, 1999, 2000b; Griffiths & Szabo, 2014; Pontes, Szabo, & Griffiths, 2015). Interestingly, new evidence pointing toward the need to make this distinction has been provided from studies in the online gaming field where robust empirical evidence has

demonstrated that Internet addiction is not the same as other more specific addictive behaviours carried out online (i.e., gaming addiction) (Király, Griffiths, et al., 2014), further magnifying the meaningfulness to differentiate between what may be called 'generalised' and 'specific' forms of online addictive behaviours, and also between Internet addiction and gaming addiction as these behaviours are conceptually different (Griffiths & Pontes, 2014; Montag et al., 2014).

Additionally, the lack of formal diagnostic criteria to assess Internet addiction represents another methodological problem since researchers are systematically adopting modified criteria for pathological gambling to investigate Internet addiction (Winkler, Dörsing, Rief, Shen, & Glombiewski, 2013). Although Internet addiction may share some commonalities with other substance-based addictions (Brand, Young, & Laier, 2014; Yen et al., 2008; Zhou et al., 2011), it is unclear to what extent such criteria are useful and suitable to evaluate Internet addiction. Notwithstanding the existing difficulties in understanding and comparing Internet addiction and pathological gambling, recent research provided useful insights on this topic. A recent study by Tonioni et al. (2014) involving two clinical groups (i.e., 31 Internet addicts patients and 11 pathological gamblers) and a control group (i.e., 38 healthy individuals) that aimed to investigate whether Internet addiction patients presented different psychological symptoms, temperamental traits, coping strategies, and relational patterns in comparison to pathological gamblers, concluded that Internet addiction associated with significant more interpersonal impairments. Moreover, temperamental patterns, coping strategies, and social impairments appeared to be different across both disorders. Nonetheless, the similarities between Internet addiction and pathological gambling were essentially in terms of psychopathological symptoms such as depression, anxiety, and global functioning. Although, individuals with Internet addiction and pathological gambling appear to share similar psychological profiles, previous research found no overlap between these two

populations (Dowling & Quirk, 2009), thus it can be concluded that both phenomena are separate disorders (Ko et al., 2010).

Despite the fact that initial conceptualisations of Internet addiction helped advance the current knowledge and understanding of Internet addiction in different aspects and contexts, it has become evident that the field has greatly evolved since then in several ways. As a result of these ongoing changes, behavioural addictions have now recently received official recognition in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) (American Psychiatric Association, 2013). Moreover, Internet addiction can also be characterised as a form of technological addiction (Griffiths, 1995, 1996b, 1998), which is operationally defined as a non-chemical (behavioural) addiction involving excessive human-machine interaction (Griffiths, 1995). In this theoretical framework, technological addictions such as Internet addiction represent a subset of behavioural addictions featuring six core components: (i) salience, (ii) mood modification, (iii) tolerance, (iv) withdrawal, (v) conflict, and (vi) relapse (Griffiths, 2005; Marks, 1990). In-depth descriptions of each of these six core components and how they manifest were provided elsewhere (see Griffiths, 2005). The components model of addiction appears to be a more updated framework for understanding Internet addiction as a behavioural addiction not only conceptually but also empirically, and the extant empirical evidence available appears to support its suitability and applicability to the understanding of Internet addiction. In fact, this framework has previously received empirical support for Internet addiction (Kuss, Shorter, Van Rooij, Griffiths, & Schoenmakers, 2014; Kuss, Shorter, Van Rooij, Van de Mheen, & Griffiths, 2014) and several other behavioural addictions, such as exercise addiction (Terry, Szabo, & Griffiths, 2004), videogame addiction (Fuster, Carbonell, Pontes, & Griffiths, 2016; Pontes, Király, Demetrovics, & Griffiths, 2014), Facebook addiction (Andreassen, Torsheim, Brunborg, &

Pallesen, 2012; Pontes, Andreassen, & Griffiths, 2016) work addiction (Andreassen, Griffiths, Hetland, & Pallesen, 2012), shopping addiction (Andreassen et al., 2015), Tinder addiction (Orosz, Tóth-Király, Bőthe, & Melher, 2016), and even addiction to studying (a precursor to work addiction) (Atroszko, Andreassen, Griffiths, & Pallesen, 2015).

The cognitive-behavioural framework has also inspired several scholars regarding the definition, conceptualisation, and treatment of Internet addiction. One of the most influential cognitive-behavioural approaches was developed by Davis (2001). His model of pathological Internet use (often referred in the literature as problematic Internet use), was the first to clearly differentiate between specific pathological Internet use and generalised pathological Internet use. According to Davis (2001), specific pathological Internet use can be broadly defined as a type of Internet addiction where people are dependent on a specific function or application of the Internet, whereas generalised pathological Internet use relates to a more general, multidimensional overuse behavioural pattern of the Internet. In this model, maladaptive cognitions play an important role in the development and maintenance of pathological Internet use. In order to describe the nature of the cognitive theory of pathological Internet use, Davis (2001) introduced concepts such as distal and proximal contributory causes of pathological Internet use. On one hand, distal causes may include pre-existing psychopathology (e.g., depression, social anxiety, substance dependence, etc.) and behavioural reinforcement (i.e., provided by the Internet itself throughout the experience of new functions and situational cues that contribute to conditioned responses). On the other hand, proximal causes may involve maladaptive cognitions that are seen as a sufficient condition with the potential to lead to both generalised pathological Internet use and specific pathological Internet use and also cause the set of symptoms associated with pathological Internet use.

Davis (2001) argued that generalised pathological Internet use involves spending abnormal amounts of time on the Internet, either wasting time with no direct purpose and/or spending excessive amounts of time in online chat rooms. Thus, procrastination is also assumed to play an important role in both the development and maintenance of generalised pathological Internet use. In this model, symptoms of pathological Internet use primarily derive from maladaptive cognitions. These symptoms relate more to cognitive symptoms and, as such, may include obsessive thoughts about the Internet, diminished impulse control, inability to cease Internet use, as well as a generalised feeling that the Internet is the only place where individuals feel good about themselves (Davis, 2001). Other consequent symptoms may include thinking about the Internet while offline, anticipating future time online, decreasing interest in other activities or hobbies, and social isolation (Davis, 2001).

More recently, several authors have further expanded Davis' cognitive-behavioural theory by incorporating the social-cognitive model of unregulated Internet use developed by LaRose and colleagues (i.e., J Kim, LaRose, & Peng, 2009; LaRose, Eastin, & Gregg, 2001; LaRose, Lin, & Eastin, 2003; LaRose, Mastro, & Eastin, 2001). This new perspective of pathological Internet use (which is referred to problematic Internet use) is not conceptualised as a disease, pathology, or clinical disorder (Pontes, Caplan, & Griffiths, 2016). Rather, the term captures a more common and relatively less severe problem than is suggested by the Internet addiction paradigm (Pontes, Caplan, et al., 2016). Accordingly, problematic Internet use is usually situated by cognitive-behavioural researchers in the middle range of the continuum (of problem severity) and emphasises the mild, benign nature of related negative outcomes (e.g., truancy, foregoing a social event, etc.) (Pontes, Caplan, et al., 2016). Conversely, addiction researchers place Internet addiction at the upper end of the continuum, requiring the experience of serious negative life consequences (e.g.,

divorce, dropping out of school, dismissal from a job, etc.) (Pontes, Caplan, et al., 2016; Tokunaga, 2015).

Despite the efforts to operationalise the cognitive-behavioural theories of Internet addiction (e.g., Caplan, 2002; Caplan, 2010; Haagsma, Caplan, Peters, & Pieterse, 2013), these theories usually lack robust standardised psychometric tools that fully capture the complexity of Internet addiction and it has mostly been considered a more generalised phenomenon. Additionally, new theoretical approaches recently developed based on Davis' (Davis, 2001) cognitive-behavioural model (i.e., Brand et al., 2014) still lack robust operationalisation and valid standardised tests to assess the suitability of such theories in the measurement of Internet addiction.

Notwithstanding such debates, addictive Internet use is considered to be a serious issue by those working in the field, albeit not yet officially recognised as a disorder, and has been described across the literature as being associated with a wide range of co-occurring psychiatric comorbidities alongside an array of dysfunctional behavioural patterns (Banjanin, Banjanin, Dimitrijevic, & Pantic, 2015; Floros, Siomos, Stogiannidou, Giouzepas, & Garyfallos, 2014a, 2014b; Kuss, Griffiths, et al., 2014; Odacı & Çıkrıkçı, 2014). More specifically, Internet addiction has been recently associated with low life satisfaction and low academic performance (Dhir, Chen, & Nieminen, 2015), decreased motivation to study (Reed & Reay, 2015), poorer physical health (Kelley & Gruber, 2013), social anxiety (Weinstein, Dorani, Elhadif, Bukovza, & Yarmulnik, 2015), attention deficit/hyperactivity disorder and depression (Sariyska, Reuter, Lachmann, & Montag, 2015), poorer emotional wellbeing and substance use (Rücker, Akre, Berchtold, & Suris, 2015), impulsivity (Reed, Osborne, Romano, & Truzoli, 2015), cognitive distortions (Lu & Yeo, 2015), deficient self-regulation (Gámez-Guadix, Calvete, Orue, & Las Hayas, 2015), poorer family environment (Chng, Li, Liau, & Khoo, 2015), increased levels of mental distress (Al-Gamal,

Alzayyat, & Ahmad, 2015), and loneliness (Pontes, Griffiths, & Patrão, 2014), among other negative psychological, biological, and neuronal aspects alongside many other problem-behaviours widely described in the literature. Although it is assumed that Internet addiction may result in impaired mental health and can generate further psychiatric comorbidity, this is not to say that the opposite is not possible as Internet addiction can also be a result of a dysfunctional coping mechanism in relation to existing life adversities and impaired mental health.

In a recent systematic literature review conducted by Li, Garland, and Howard (2014), the authors reviewed a total of 42 empirical studies that assessed the family correlates of Internet addiction in adolescents and young adults. According to the authors, virtually all studies reported greater family dysfunction amongst Internet addicted families in comparison to non-Internet addicted families. More specifically, individuals with Internet addiction more often exhibited: greater global dissatisfaction with their families; less organised, cohesive, and adaptable families; greater inter-parental and parent-child conflict; and perceptions of their parents as more punitive, less supportive, warm, and involved. Furthermore, families were significantly more likely to have divorced parents or to be a single-parent family.

Another recent systematic literature review conducted by Lam (2014) examined the possible links between Internet addiction and sleep problems. After reviewing seven studies that met strict inclusion criteria, it was concluded that on the whole, Internet addiction was associated with sleep problems that encompassed subjective insomnia, short sleep duration, and poor sleep quality. The findings also suggested that participants with insomnia were 1.5 times more likely to be addicted to the Internet in comparison with those without sleep problems. Despite the strong evidence found supporting the links between Internet addiction and sleep problems, the author

noted that due to the cross-sectional nature of most studies reviewed, the generalisability of the findings was somewhat limited (Lam, 2014).

As shown by the various existing conceptual approaches to Internet addiction and its characterisation via key correlates, Internet addiction is a relatively recent phenomenon that clearly warrants further investigation, and empirical studies suggest it needs to be taken seriously by psychologists, psychiatrists, and neuroscientists. Although uncertainties still remain regarding its diagnostic and clinical characterisation (Müller, Beutel, & Wölfling, 2014), additional research is still necessary in order to tackle current conceptual and empirical inconsistencies if generalised Internet addiction is to be officially recognised as an official behavioural addiction in the future similarly to other more established behavioural addictions such as 'Gambling Disorder'. However, in order to achieve official status, researchers will have to adopt a more commonly agreed upon definition as to what Internet addiction is, and how it can be conceptualised and operationalised both qualitatively and quantitatively (as well as in clinically diagnostic terms).

Distinguishing Between Internet Addiction and Excessive Internet Use

Distinguishing between Internet addiction and excessive Internet use is crucial given that the overlapping boundaries between the two behaviours. Furthermore, it is generally agreed that although Internet addiction implies excessive Internet use patterns, excessive usage in itself does not necessarily translate into addiction, and that the context of excessive Internet use is also important (Griffiths, 2010a). The differences between excessive Internet use and Internet addiction have been under scientific scrutiny from both empirical and theoretical points of view (Caplan, 2003, 2006; Lee et al., 2014). More recently, Lee et al. (2014) conducted a small-scale study using a sample of 125 male Korean adolescents to investigate the differences between (i) excessive

(termed as Internet abuse in the original study), (ii) addicted, and (iii) non-addicted users by comparing their results using diagnostic interviews and participants' levels of psychiatric comorbidities and other behavioural aspects. Consequently, after grouping the participants using the Internet Addiction Test (IAT) (Young, 1998a) scores and a psychiatric diagnosis, significant differences in psychiatric comorbidities and behavioural aspects were found between excessive and addicted users. More specifically, comorbidity rates were significantly higher in the addicted group than in the excessive group. Moreover, sleep disorders, mood changes, and preoccupation were more prominent in the addicted group. Additionally, while excessive users may not present with all six core criteria of addiction (i.e., salience, mood modification, tolerance, withdrawal, conflict, and relapse) (Griffiths, 2005) and are likely to experience fewer problems related to their Internet use in comparison with addicted users, the latter are usually characterised by significant impairments in several life domains as they continue to use the Internet despite adverse consequences (Chong, Chye, Huan, & Ang, 2014).

From a theoretical point of view, Caplan (2006) argued that excessive Internet use comprises a quantity or degree of online activity that exceeds what a person thinks of as normal, usual, or planned, whereas Internet addiction involves difficulty with impulse control. Caplan (2006) suggested that in many cases where individuals consider their amount of time spent online to be excessive, this excess is perhaps more related to their reliance on the Internet to carry on daily activities (i.e., functional rather than dysfunctional use) than with their psychosocial wellbeing. In this case, many people may report that they use the Internet excessively, however, most of these people use the Internet to obtain positive rather than negative outcomes that are related to their working and/or social lives. Additionally, Caplan (2003) also found that Internet addiction was more related to negative outcomes than excessive Internet use.

Given that the quantity or amount of time spent online by itself does not necessarily indicate problematic behaviour (Caplan, 2006; Griffiths, 2010a), it can be concluded that in order to distinguish between Internet addiction and excessive Internet use, empirical and clinical attention should be paid to the extent of problems Internet use may or may not cause for a user and how the Internet impacts on the user's life in terms of biological, social, and psychological wellbeing. The fact that it is often difficult for users to accurately differentiate the amount of time spent online for educational and/or work-related purposes from that for non-educational/non-work-related purposes may contribute to this inherent difficulty in distinguishing between both excessive and addictive Internet use from the users' perspective (Li, O'Brien, Snyder, & Howard, 2015).

Internet Addiction: Prevalence Estimates

Investigating the incidence and prevalence rates of Internet addiction in the general population is paramount to assess the demand for consulting, treatments, and preventive measures (Wartberg, Kriston, Kammerl, Petersen, & Thomasius, 2015). However, Internet addiction research that attempts to estimate the prevalence rates for Internet addiction is usually faced with several methodological shortcomings. On one hand, there are currently no consensual criteria of Internet addiction, which directly impacts on the adequacy, reliability, and validity of studies using inconsistent diagnostic instruments to assess this phenomenon (Weinstein & Lejoyeux, 2010). On the other hand, despite the difficulties concerning the diagnosis and the heterogeneity of instruments to assess Internet addiction, most studies reporting prevalence rates for Internet addiction usually suffer from sampling selection biases due to systematic use of non-probability sampling techniques (e.g., convenience samples) and over-reliance on specific samples (e.g.,

adolescents or adults) (Rumpf et al., 2014). Consequently, these two issues compromise the validity of most prevalence studies whilst also limiting possible comparisons of prevalence rates across different cultural contexts. In order to mitigate some of the problems related to this aspect of Internet addiction research, this section only presents (see Table 1) findings from studies that recruited participants using probability sampling techniques and/or included nationally representative samples.

Table 1. Main Methodological Features of Studies Reporting Prevalence Rates Using Random and Nationally Representative Samples

Supporting Research	Prevalence	95% C.I.	Time Frame	Country	*Assessment*		*Sample Information*	
					Instrument	**Validated**	**Size**	**Characteristics[a]**
Rücker et al. (2015)	11.7%	[11.4;11.9]	N/S	Switzerland	IAT	Yes	3,067	Nationally representative sample of school-based adolescents
Blinka et al. (2015)	1.4%	[1.3;1.5]	N/S	25 European countries[b]	EIU	No	18,709	Nationally representative sample of community-based adolescents
Evren, Dalbudak, Evren, and Demirci (2014)	15.96%	[15.7;16.1]	3-month	Turkey	BAPINT-SV	No	4,957	Nationally representative sample of school-based adolescents
Ha and Hwang (2014)	2.8%	[2.7;2.8]	N/S	South Korea	KS scale	Yes	56,086	Nationally representative sample of school-based adolescents
Heo, Oh, Subramanian, Kim, and Kawachi (2014)	2.8%	[2.7;2.8]	N/S	South Korea	KS scale	Yes	57,857	Nationally representative sample of school-based adolescents
Kaess et al. (2014)	4.2%	[4.0;4.3]	N/S	11 countries[c]	YDQ	No	11,356	Nationally representative sample of school-based adolescents
Király, Griffiths, et al. (2014)	15.5%	[15.2;15. 7]	N/S	Hungary	PIUQ-6	No	2,073	Nationally representative sample of school-based adolescents
Y Li, Zhang, Lu, Zhang, and Wang (2014)	11.7%	[11.6;11.7]	N/S	China	YDQ	No	24,013	Nationally representative sample of school-based adolescents

I-H Lin et al. (2014)	18.7%	[18.5;18.8]	N/S	Taiwan	CIAS	Yes	9,510	Nationally representative sample of school-based adolescents
Rumpf et al. (2014)	1%	[0.8;1.1]	N/S	Germany	CIUS	Yes	8,132	Nationally representative community-based sample
Tsitsika et al. (2014)	1.2%	[1.0;1.3]	N/S	7 European countries[d]	IAT	Yes	13,284	Random sample of school-based adolescents
Wartberg et al. (2014)	3.2%	[2.8;3.5]	N/S	Germany	CIUS	Yes	1,744	Nationally representative sample of school-based adolescents

Notes: [a] All included studies adopted a cross-sectional design; [b] Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Spain, Sweden, Turkey, and United Kingdom; [c] Austria, Estonia, France, Germany, Hungary, Ireland, Israel, Italy, Romania, Slovenia, and Spain; [d] Greece, Spain, Poland, Germany, Romania, Netherlands, and Turkey.
Abbreviations: **C.I.**: Confidence Interval; **N/S**: Not Specified; **IAT**: Internet Addiction Test; **EIU**: Excessive Internet Use Scale; **BAPINT-SV**: The Addiction Profile Index Internet Addiction Form-Screening Version; **KS scale**: Internet Addiction Proneness Scale; **YDQ**: Young's Diagnostic Questionnaire; **PIUQ-6**: Problematic Internet Use Questionnaire; **CIAS**: Chen Internet Addition Scale; **CIUS**: Compulsive Internet Use Scale.

As shown in Table 1, a total of 12 studies providing epidemiological data were published between January 2014 and February 2015 (i.e., those with nationally representative samples). Interestingly, prevalence rates for Internet addiction ranged from a minimum of 1% in one study (i.e., Rumpf et al., 2014) to a maximum of 18.7% in another (i.e., Lin et al., 2014). While all studies used cross-sectional designs to assess prevalence rates in different countries, significant heterogeneity in the assessment of Internet addiction was found alongside some arbitrariness in terms of the cut-off points adopted to ascertain prevalence rates, even when researchers had used the same instrument. It is worth mentioning that almost half of the studies included (i.e., 5 out of 12) did not assess Internet addiction with a psychometrically validated instrument (i.e., Blinka et al., 2015; Evren et al., 2014; Kaess et al., 2014; Király, Griffiths, et al., 2014; Li et al., 2014). Additionally, with the exception of one study (i.e., Rumpf et al., 2014) all the remaining studies provided data on adolescent samples only, thus hampering the degree of generalisability of extant prevalence rates to other important segments of the general population such as young children and adults.

Regarding the differences in prevalence rates of Internet addiction among males and females, almost half of the studies found a higher prevalence among males (i.e., Evren et al., 2014; Ha & Hwang, 2014; Király, Griffiths, et al., 2014; Li et al., 2014; Tsitsika et al., 2014), while only one study found higher rates in females (i.e., Rücker et al., 2015). Conversely, two studies found no differences at all in terms of prevalence rates across both genders (i.e., Blinka et al., 2015; Rumpf et al., 2014). Furthermore, one study found a higher prevalence of Internet addiction among males in general and also reported that females in female-only schools were more prone to present with Internet addiction (i.e., Heo et al., 2014), while another study concluded that males suffering with depression, anxiety, and peer relationship problems were more likely to exhibit Internet

addiction, whilst females experiencing conduct problems or hyperactivity/inattention were more prone to exhibit Internet addiction (i.e., Kaess et al., 2014).

Additional information on Internet addiction prevalence rates has been provided by recent review studies. For instance, Cheng and Li (2014) conducted a meta-analysis in order to estimate prevalence rates of Internet addiction across several countries by searching for evidence stemming from empirical studies published between 1996 and 2012. In the study, the authors identified 164 Internet addiction prevalence rates published across 80 studies from 31 nations across seven world regions. The results showed a global prevalence of Internet addiction around 6%, with the highest rates found in the Middle East (10.9%) and lower rates found in Northern and Western Europe (2.6%). The authors also reported that poor quality of life was associated with higher prevalence rates of Internet addiction. Although this study was, to the best of the author's knowledge, the first to systematically address the issue of Internet addiction prevalence worldwide, several limitations were present.

Firstly, these results may not be entirely representative of the real prevalence of Internet addiction worldwide since the findings presented by the authors were restricted to reports that only used either Young's Diagnostic Questionnaire (YDQ) (Young, 1998b) or the IAT (Young, 1998a). For this reason, it is possible that reliable prevalence rates reported elsewhere may have been unintentionally omitted due to strict inclusion criteria. Furthermore, findings regarding the psychometric properties of the YDQ are scant in diverse cultural backgrounds as only recently a few studies conducted in Germany have investigated the psychometric properties of the YDQ (Wartberg, Durkee, et al., 2016; Wartberg, Kriston, Kegel, & Thomasius, 2016), and this may have introduced severe biases to the prevalence rates found with this instrument in other non-western European countries. Additionally, Table 1 shows that several prevalence studies were conducted

in 2014 and 2015 using other types of psychometric tools, leading to the conclusion that important and perhaps more reliable prevalence rates may have not been included in the authors' meta-analysis. Secondly, important geographic areas such as Africa were omitted from Cheng, Li 's meta-analysis. Therefore, their findings may not be applicable to all countries. Notwithstanding the issues associated with the lack of consensual conceptualisation, assessment, and shortcomings in terms of existing prevalence rates for Internet addiction, it is relatively safe to conclude Internet addiction affects a minority of individuals across different cultures even though the problem of Internet addiction is not as widespread as it may appear because conservative prevalence rates are systematically reported by the majority of empirical studies.

Internet Addiction and its Associated Neuronal Processes

Over the last 15 years, studies have emerged using neuroscientific techniques to study relevant brain processes, activities, and brain structures associated with both gaming addiction and Internet addiction (Kuss & Griffiths, 2012a; Ninaus et al., 2014). Neuroimaging studies have a number of advantages over self-reports which historically have more commonly been used in Internet addiction research. Neurobiological studies allow researchers to understand how specific changes in the brain can be identified and associated to Internet addiction in a correlational fashion (i.e., not causal), as has been widely documented in substance-related addiction research (Volkow, Fowler, & Wang, 2003).

According to research in substance-related addictions, addiction develops via habituation mechanisms, whereby extended engagement in the addictive behaviour leads to dopamine release in the dopaminergic pathways (Everitt & Robbins, 2005). As a consequence, the individual becomes less sensitive to natural rewards, such as food and sex, and instead seeks the addictive

behaviour (Goldstein & Volkow, 2002; Kalivas & Volkow, 2005), ultimately changing brain chemistry and leading to craving and tolerance (Brebner et al., 2005; Koob & Le Moal, 2008). In periods of abstinence, the lack of dopamine release in the brain leads to withdrawal symptoms which can only be alleviated via reinstatement of the addictive behaviour (Volkow et al., 2003). Research also suggests that engaging in addictive behaviours may result in brain dysfunctions, including prefrontal brain regions (i.e., the orbitofrontal cortex and cingulate gyrus) which are commonly associated with decision-making (Potenza, 2006; Volkow et al., 2003). Emerging research suggests that similar brain activation and changes occur for behavioural addictions, including Internet addiction.

In a systematic review of Internet and gaming addiction, Kuss and Griffiths (2012a) identified 18 studies that used neuroscientific evidence to outline similarities between Internet and gaming addiction and more traditional substance-related addictions in brain functioning, morphometry, and associated behaviours. Since then, a number of additional research papers have been published, in what follows, the studies' results will be presented. Functional magnetic resonance imaging (fMRI) studies have shown that Internet addiction is associated with increased activation of brain areas relevant for reward experience and addiction (Dong, Hu, & Lin, 2013). Specifically, it has been shown that Internet addicts are significantly more sensitive to rewards than controls, and they appear to be less sensitive to the negative consequences of their Internet engagement, including losses in a gambling task. This may explain prolonged engagement in excessive behaviours despite unfavourable repercussions (Dong, Hu, et al., 2013), and indicates excessive Internet use is associated with allostasis, a change in the reward set point (Koob & Le Moal, 2001), which leads the individual to seek the addictive behaviour. Moreover, research suggests that different brain areas are activated in adolescent Internet addicts relative to healthy

controls during a ball-throwing animation (Koob & Le Moal, 2001), including the thalamus, bilateral precentral area, bilateral middle frontal area, and the right temporoparietal junction, indicating that online disembodiment is reflected in the brain activity of Internet addicts in comparison with controls.

Similarly, during extended Internet use, neuroadaptation occurs, which leads to the synchronisation of the brain regions involved in addiction, such as the mesocorticolimbic system (J Liu et al., 2010). Internet addiction has also been found to be associated with lower levels of grey matter and consequent changes in motor control, thinking, motivation, emotions, craving, and decision making (Yuan et al., 2011). Furthermore, research suggests that male Internet addicts have morphometric brain abnormalities, including a significantly lower orbitofrontal cortical thickness in comparison with healthy controls (Hong et al., 2013), decreased right frontal pole grey matter volume, better functional connectivity between their right frontal pole and the left ventral striatum, and a higher amplitude of low-frequency fluctuation in their bilateral ventral striatum, suggesting an impaired ability to focus on long-term goals if distracted (Kühn & Gallinat, 2014).

Studies using electroencephalography (EEG) indicate that individuals with Internet addiction allocate their attention differently than healthy controls, suggesting impaired information processing and response inhibition in Internet addiction (Choi et al., 2013; Dong & Zhou, 2010; Ge et al., 2011; Yu, Zhao, Li, Wang, & Zhou, 2009), leading to impulsive decisions, which may contribute to renewed engagement in the addictive behaviour irrespective of potential negative consequences. These findings have now been replicated using fMRI (Li et al., 2014), showing that when using a go/no-go paradigm, individuals diagnosed with Internet addiction are not able to inhibit their responses relative to healthy controls, and this has been linked to the lack of engaging the former's indirect frontal-basal ganglia pathway. A similar study using the Stroop paradigm

with Internet addicts in comparison with healthy controls has furthermore shown that Internet addicts had stronger 'Stroop effect'-related activity in the anterior and posterior cingulate cortices (Dong, DeVito, Du, & Cui, 2012), supporting the contention that Internet addicts have impaired inhibitory control. A comparable Stroop paradigm study furthermore indicated Internet addicts use more cognitive resources for executive control and attention relative to healthy controls, as identified using fMRI (Dong, Lin, Zhou, & Lu, 2014), suggesting their cognitive flexibility is impaired.

From a neurochemical level, positron emission tomography (PET) research indicates that during gaming, dopamine is released in the striatum, and prolonged engagement in gaming reduces dopamine levels in general (Hou et al., 2012; SH Kim et al., 2011), leading the individual to seek the addictive behaviour in order to overcome withdrawal symptoms.

The cited studies suggest that Internet addiction shares various neurobiological and neurochemical similarities with more traditional substance-related addictions, indicating that addictions should be viewed from a syndrome perspective (Shaffer et al., 2004), including both substance-related addictions and behavioural addictions, such as Internet addiction. The presented evidence furthermore suggests that Internet addiction is worthwhile to be considered for inclusion in the diagnostic manuals, given that our knowledge of this emerging disorder has substantially grown over the last two decades.

Nonetheless, the empirical research in this area comes with a caveat. Many studies do not clearly distinguish between Internet addiction and gaming addiction, making comparisons across studies difficult. Based on the review of these studies, it is suggested that future studies: clearly distinguish between the specific Internet activities that may lead to addiction-related symptoms and problems; assess brain changes longitudinally to outline the progression of Internet addiction

on a neurological level; and specifically use individuals who have been officially diagnosed with Internet addiction by mental healthcare professionals to clearly distinguish between high engagement and pathological Internet use. The knowledge base on Internet addiction and its neurobiological correlates has grown considerably over the last 15 years; however, more research needs to be done in order to address the context of the natural course of Internet addiction. Questions of associated brain changes and consequent changes in behaviour that may require professional treatment need to be addressed longitudinally using further objective measures. Ultimately, this will prove beneficial for healthcare, treatment and insurance providers, and the affected individuals and their significant others.

Implications for Treatment, Prevention, and Patient-specific Considerations

Although Internet addiction is not yet an officially recognised disorder, there is no shortage on the number of studies evidencing its detrimental effects on human health and general functioning (e.g., Banjanin et al., 2015; Chou, Liu, Yang, Yen, & Hu, 2015; Kuss, Griffiths, & Binder, 2013; Kuss, Griffiths, et al., 2014; Reed & Reay, 2015). For this reason, this section briefly describes some of the literature focused on the treatment and prevention of Internet addiction, and also provides useful clinical information from the patients' perspective.

It is now known that all addictions, whether chemical or behavioural, share some specific characteristics that include salience, compulsive use or loss of control, mood modification, alleviation of distress, tolerance, withdrawal, and the continuation of the behaviour or substance consumption despite harmful consequences (Cash, Rae, Steel, & Winkler, 2012). Additionally, addictions may also emerge from the impaired functioning of the reward system (Przepiorka, Blachnio, Miziak, & Czuczwar, 2014).

In a recent meta-analysis, Winkler et al. (2013) examined and compared the short-term and long-term efficacy of both psychological and pharmacological treatments for Internet addiction and also identified treatment moderations in a set of 16 studies that included 17 treatment conditions and 670 patients. After analysing the selected studies, the authors reported that both psychological and pharmacological interventions were effective in treating and reducing symptoms of Internet addiction, time spent online, anxiety, and depression. Furthermore, in terms of the psychological treatments alone, of most studies reviewed, short-term efficacy was deemed to be large and robust, and also maintained over follow-up. Additionally, in terms of the studies that tested the effects of the pharmacological treatments alone, their short-term efficacy was found to be medium-to-large and robust notwithstanding the lack of follow-up data. Winkler et al. (2013) also noted that in studies reporting individual treatments, a higher number of female participants, older patients, or an American sample had larger effect sizes in terms of the outcome variables.

Regardless of the treatment approach, it has been argued by some authors that total abstinence from the Internet should not be the goal of any intervention, and that instead an abstinence from problematic online activities and a regulated use of the activity should be achieved (Cash et al., 2012; Khazaal et al., 2012). However, more empirical evidence is needed in order to validate such claims. In a recent review conducted by Przepiorka et al. (2014) on the existing evidence of cognitive-behavioural therapy and pharmacological treatment of Internet addiction, the authors recommended that clinicians should combine both approaches to treat this phenomenon because this strategy was found to be the most effective method for treating Internet addiction. Furthermore, it was also noted that some of the most used pharmacological interventions for Internet addiction have been extrapolated from other forms of treatments for substance-based addictions. For this reason, there appears to be evidence supporting the efficacy of some drugs in

the treatment of Internet addiction, such as antidepressants (i.e., escitalopram and bupropion), antipsychotics (i.e., olanzapine and quetiapine), opioid receptor antagonists (i.e., naltrexone combined with sertraline), and psychostimulants (i.e., methylphenidate) (Cash et al., 2012; Przepiorka et al., 2014; Winkler et al., 2013). It is also worth noting that many methodological shortcomings are present in studies reporting the pharmacological treatments for Internet addiction as findings from pharmacological treatments of online gaming addiction (rather than generalised Internet addiction) are often reported by these studies.

Nonetheless, in terms of psychological treatments for Internet addiction, one of the most influential models is the cognitive-behavioural therapy. In several studies, this model has been used to treat Internet addiction (Young, 2007, 2013). In this model, the first stage of treatment is focused on the behavioural aspects of the patient, so that at subsequent stages the focus of treatment is gradually shifted toward the development of positive cognitive assumptions (Przepiorka et al., 2014). Furthermore, during therapy, Internet addicts identify false beliefs and learn how to modify them into more adaptive ones (Przepiorka et al., 2014). Additionally, the cognitive-behavioural therapy approach also advocates that patients should monitor their thoughts in order to identify affective and situational triggers associated with their addictive online behaviour (Khazaal et al., 2012). Very often, activities not involving the use of the Internet (e.g., physical activities) are also assessed to facilitate patients' engagement with those activities or to treat specific comorbidities (e.g., social phobia and depression). This approach is based on the idea that physical exercise might compensate for a decrease in dopamine levels due to decreased Internet usage and also that the inclusion of sports exercise may enhance the effectiveness of the intervention (Cash et al., 2012). A more detailed account of several aspects surrounding cognitive-behavioural therapy to treat

Internet addiction has been discussed in greater detail elsewhere (see Khazaal et al., 2012; King, Delfabbro, & Griffiths, 2012; King, Delfabbro, Griffiths, & Gradisar, 2011, 2012).

Specific variations of cognitive-behavioural therapy have also been devised to treat Internet addiction, such as CBT-IA (Young, 2011, 2013). Young (1999) proposed some strategies for the treatment of Internet addiction, including: practicing the opposite (i.e., identifying patients' patterns of Internet use and then helping them disrupt their normal routine of Internet usage and adhering to new time patterns of use to break the online habits); using external stoppers (i.e., real events or activities that prompt patients to disconnect from the Internet); setting goals with regard to the amount of time spent online; abstaining from a particular application that patients are unable to control; using reminder cards that serve as cues to remind the patient of the costs of Internet addiction and the benefits of breaking free from it; developing a personal inventory of activities the patient used to engage in or cannot find the time to engage in due to their excessive usage of the Internet; entering a support group to compensate for the lack of social support; and engaging in family therapy to address relational problems within the family.

Although the cognitive-behavioural therapy model for treating Internet addiction appears to be effective, there are no significant differences between this type of treatment and other psychological treatments aimed at treating Internet addiction (Winkler et al., 2013). For this reason, other treatment approaches might be useful to treat this condition. In light of this, Q-X Liu et al. (2015) conducted a clinical trial that aimed to treat Internet addiction using multifamily group therapy (MFGT) (MFGT involves working with a collection of families, including the families identified patient, in a group setting, combining the advantages of group process with the systems focus of family therapy) in a cohort of 92 participants comprising 46 adolescents with Internet addiction and their parents. Participants were allocated to either the experimental condition (i.e.,

six sessions of MFGT intervention) or a control group (i.e., waiting list). They were then administered structured questionnaires at three time points (i.e., pre-intervention, post-intervention, and 3-month follow up). After analysing the results, the authors concluded that six sessions of MFGT was an effective strategy in reducing Internet addiction-related behaviours in adolescents. Moreover, the authors also noted that the results were maintained after a 3-month period, further concluding that Internet use was partially explained by the satisfaction of their psychological needs and improved parent-adolescent communication and closeness.

As noted by King et al. (2011) in their systematic review on the reporting and methodological quality of Internet addiction treatment studies, almost all studies have several key limitations when analysed with the Consolidating Standards of Reporting Trials (CONSORT) guidelines. The authors also found that the reviewed Internet addiction treatment studies usually present with inconsistencies in the definition and diagnosis of Internet addiction, lack randomisation and blinding techniques, lack adequate controls or other comparison groups, and report insufficient information concerning recruitment dates, sample characteristics, and treatment effect sizes.

Several qualitative studies have provided insights into participants' perspectives and specific considerations regarding excessive and addictive use of the Internet (e.g., Chou, 2001; W Li, O'Brien, et al., 2015; Tsai & Lin, 2003). Li, O'Brien, et al. (2015) conducted a qualitative study involving 27 American university students who had self-identified as intensive Internet users spending at least 25 hours a week online for non-educational or non-work-related activities, and suffered from Internet-related health and/or psychosocial problems. After collecting data from participants over several focus group sessions, the authors found various indicators that pointed out participants' own experiences of excessive and addictive Internet use. More specifically, it was

found that most participants used the Internet for more than 40 hours per week for non-educational or non-work-related reasons, and suffered multiple physical and psychological problems due to intensive Internet use (Li, O'Brien, et al., 2015). Furthermore, participants acknowledged that it was difficult to accurately calculate the total amount of time spent on the Internet per day because of unlimited data plans on mobile devices, making the Internet constantly available, possibly causing participants difficulty distinguishing between the amount of the time spent on the Internet for educational or work-related purposes from that for non-school/work-related purposes (Li, O'Brien, et al., 2015).

Qualitative findings have also suggested that negative emotions (e.g., depressive mood, sadness, and anger), boredom, and stress associated with social-related and work-related obligations can be emotional and situational triggers for excessive Internet use (W Li, O'Brien, et al., 2015). Last but not least, quantitative studies have found that Internet addicts may also experience a variety of adverse consequences related to intensive Internet use, such as decreased academic performance and motivation to study (Jia, 2012; Reed & Reay, 2015), increased substance use (Gámez-Guadix et al., 2015; Rücker et al., 2015), higher incidence of depressive symptoms (Banjanin et al., 2015; Gámez-Guadix, 2014), among other disorders and behavioural problems. Due to the nature of Internet addiction and its potential harmful consequences, it is important that clinicians assess excessive Internet use in their practice while also further examining the nature of Internet use and how it relates to patients' online behaviour in general so that they may have a better insight into specific online behaviours and motivations underpinning excessive and harmful use.

Conclusions

The present review highlights some of the key issues surrounding research on Internet addiction from several standpoints. For this purpose, the definition and characterisation of Internet addiction, its prevalence rates from robust studies (i.e., those with nationally representative samples), its associated neuronal processes, and implications for treatment and prevention, along with patient-specific relevant considerations, were under scrutiny in the present review.

In regards to the definition and characterisation of Internet addiction, it is clear that uncertainties regarding its status and criteria as to what constitutes as Internet addiction have not yet reached consensus in the field (Van Rooij & Prause, 2014). However, continuous efforts from researchers aimed at uncovering the concept's intricacies, aetiology, and natural course will likely help overcome existing debates and controversies about Internet addiction. Ultimately, in order to achieve a scientific consensus, researchers will have to adopt a standard definition of Internet addiction and also put forth a solid theoretical framework that provides sufficient information on the conceptualisation and operationalisation of this phenomenon, both qualitatively and quantitatively, and as well as in clinically diagnostic terms.

The many different understandings and conceptualisations for what appears to be the same phenomenon (i.e., Internet addiction) have generated a lot of confusion and methodological difficulties that have somewhat hindered progress in the field. Such diversity with regard to how to conceptualize and define the concept is perhaps illustrated by the heterogeneity of the prevalence rates for Internet addiction found worldwide. Although the Internet addiction prevalence rates reported in nationally representative samples range from a minimum of 1% (i.e., Rumpf et al., 2014) to a maximum of 18.7% (i.e., Lin et al., 2014), the disparity and discrepancy among rates

are obvious, and therefore put into question the consistency of the assessment and theoretical framework of Internet addiction adopted by researchers.

In terms of the neuronal processes associated with Internet addiction, the extant research provides small, but convincing evidence for a link between biological brain abnormalities in patients addicted to substances and similar brain abnormalities in patients with Internet addiction (Camardese, Leone, Walstra, Janiri, & Guglielmo, 2015). Furthermore, evidence from fMRI studies have identified abnormalities in frontal brain regions (especially the dorsolateral prefrontal cortex) that are believed to be responsible for cognitive control and control of inhibition (Kuss & Griffiths, 2012a; W Li, Li, et al., 2015). Other studies have shown that a number of regions in the cognitive control network, such as the dorsolateral prefrontal cortex, play an important role in substance addiction, suggesting that structural deficits and functional abnormalities in individuals with substance addiction might be similar to those presenting with Internet addiction (e.g., similar behaviour symptoms, such as tolerance, withdrawal, preoccupation, and negative repercussions) (Li, Li, et al., 2015). Despite the fact that research in this area is increasing, questions of associated brain changes and consequent changes in behaviour that may require professional treatment need to be addressed longitudinally using additional objective measures including neuroscientific measures (i.e., fMRI, PET, EEG), but also observational methods used in treatment and healthcare settings and rated by trained observers independent of treatment providers. Ultimately, this will prove beneficial for healthcare, treatment and insurance providers, and the affected individuals and their significant others.

Finally, the fact that behavioural addictions such as Internet addiction share some commonalities with substance-based addictions has profound implications for treating such conditions. To date, treatment for Internet addiction has been essentially provided via

psychological and pharmacological therapy. Moreover, evidence for psychological treatments using cognitive-behavioural therapy seems to be flourishing, although empirical evidence for their efficacy is still sparse, warranting further studies. Additionally, in terms of pharmacological treatments, existing evidence is still extremely limited and insufficient (Camardese et al., 2015). However, if it is assumed that a malfunction of the reward system underlies Internet addiction, it is reasonable to conclude that pharmacological interventions of use in treating other forms of addiction may be potentially useful as a starting point for psychopharmacological research in the area of Internet addiction (Camardese et al., 2015).

It is hoped by the present author that this doctoral thesis will contribute to progress the existing work in the field in a number of ways. At the conceptual level, the this thesis will systematically review key inconsistencies in the psychometric assessment of Internet Gaming Disorder and Internet addiction (Part 1: Introduction: Chapters 1, 2, and 3) to better illustrate how methodological drawbacks and hindrance in research emerged as a result of the adoption of inconsistent and non-standardised assessment tools in the evaluation process of these two behavioural addictions. At the empirical level, a new potentially unifying standardised psychometric assessment framework for both Internet Gaming Disorder and Internet addiction will be developed (Part 2: Empirical Studies: Chapters 4, 5, 6, and 7) as an attempt to promote a unified assessment strategy for both constructs that is capable of bridging the gaps widely reported in the literature with regards to their assessment. The focus of this thesis will be on Internet Gaming Disorder and Internet addiction given that further research on the assessment of these two constructs are needed as these phenomena are growing in terms in societal and clinical acceptance by many stakeholders.

CHAPTER 2: Assessment of Internet Gaming Disorder in Clinical Research: Past and Present Perspectives[3]

Introduction

According to a report by the Entertainment Software Association [ESA] (Entertainment Software Association, 2014), 59% of the entire American population plays videogames, with a mean average of two gamers in each game-playing household. The ESA report also notes that, among US households, 68% play videogames on consoles, 53% play on smartphones, and 41% play on wireless devices. During 2012, playing videogames via smartphones and wireless devices use increased by 22% and 37%, respectively (Entertainment Software Association, 2014). The same report also concluded that the average videogame player is 31 years old, with 52% being male and 48% female (Entertainment Software Association, 2014). Similarly, several academic studies also suggested that the stereotype of an adolescent male gamer as the typical game addicted is no longer the case, since most regular gamers appear to be young adult males (Kuss & Griffiths, 2012c), although the number of women playing casual videogames has risen substantially over the last decade (Griffiths & Lewis, 2011; McLean & Griffiths, 2013). The number of female gamers aged 50 years and older increased by 32% from 2012 to 2013 (Entertainment Software Association, 2014). These numbers illustrate how widespread and prevalent that video gaming has become across most segments of the population.

Given the increased popularity and prevalence of video gaming, researchers in gaming studies, addiction treatment specialists, policy-makers, and the general public have expressed concern that some players may be playing videogames pathologically to an extent that is related

[3] Most of the material featured in Chapter 2 resulted in the following refereed publication: Pontes, H. M., & Griffiths, M. D. (2014). Assessment of Internet Gaming Disorder in clinical research: Past and present perspectives. *Clinical Research and Regulatory Affairs, 31*(2-4), 35-48. doi:10.3109/10601333.2014.962748

to detrimental effects interfering with day-to-day life functioning (Ferguson, Coulson, & Barnett, 2011; Gentile, 2009; Kuss & Griffiths, 2012b; Sublette & Mullan, 2012).

Over the past decade, there has been a significant increase in research examining various behavioural addictions such as addictions *to* and *on* the Internet (Kuss, Griffiths, et al., 2014). In the psychological study of excessive Internet use, the primary object of addiction is the experience that is stimulated by the online material residing online, and/or the interactive experience of gaining access to this material or applications online (Shaffer, Hall, & Vander Bilt, 2000). In respect to the negative detrimental effects caused by the playing of videogames, researchers have adopted a broad range of terminologies to define and conceptualise the phenomenon, including computer game dependence (Griffiths & Hunt, 1998), computer addiction (Young et al., 1999), problem videogame playing (Tejeiro Salguero & Morán, 2002), videogame addiction (Griffiths & Davies, 2005), Internet gaming addiction (Kuss & Griffiths, 2012b), pathological video-game use (Gentile, 2009), problem videogame play (King & Delfabbro, 2009), game addiction (Lemmens, Valkenburg, & Peter, 2009), online gaming addiction (Mehroof & Griffiths, 2010), problematic online game use (MG Kim & Kim, 2010), videogame dependency (Rehbein, Psych, Kleimann, Mediasci, & Mößle, 2010), pathological gaming (Lemmens, Valkenburg, & Peter, 2011), online videogame addiction (Van Rooij, Schoenmakers, Vermulst, Van den Eijnden, & Van de Mheen, 2011), and problematic online gaming (Demetrovics et al., 2012).

All these slightly different terminologies, alongside the use of different non-standardised assessment tools to investigate the phenomenon of gaming addiction, has fostered many debates amongst scholars as to whether the phenomenon is a unique clinical entity (Block, 2008; Petry & O'Brien, 2013; Pies, 2009) and to whether or not 'Internet Addiction Disorder' should have been included as a new disorder in the fifth edition of the *Diagnostic and Statistical Manual of Mental*

Disorders (DSM-5) (American Psychiatric Association, 2013). As a result of these debates, the Substance Use Disorder Work Group recommended that the DSM-5 include Internet Gaming Disorder in Section III ('Emerging Measures and Models') as an area that required further research before possible inclusion in future editions of the DSM (Petry & O'Brien, 2013). Furthermore, researchers in the gaming studies field have noted that empirical evidence is needed to identify the defining features of Internet Gaming Disorder, obtain cross-cultural data on reliability and validity of specific diagnostic criteria, determine prevalence rates in representative epidemiological samples in countries around the world, evaluate its natural history, and examine its associated biological features (Petry & O'Brien, 2013).

Furthermore, the Internet Gaming Disorder classification proposed by the DSM-5 is similar in nature to 'Gambling Disorder' (in the DSM-5). Moreover, the American Psychiatric Association (2013) defined Internet Gaming Disorder as a behaviour that refers to "persistent and recurrent engagement in videogames, often with other players, leading to clinically significant impairments or distress as indicated by five (or more) of the following nine criteria in a 12-month period: (1) preoccupation with games; (2) withdrawal symptoms when gaming is taken away; (3) tolerance, resulting in the need to spend increasing amounts of time engaged in games; (4) unsuccessful attempts to control participation in games; (5) loss of interest in previous hobbies and entertainment as a result of, and with the exception of, games; (6) continued excessive use of games despite knowledge of psychosocial problems; (7) deceiving family members, therapists, or others regarding the amount of gaming; (8) use of games to escape or relieve negative moods; and (9) jeopardising or losing a significant relationship, job, or education or career opportunity because of participation in games (p.795)."

It is also worth noting that the use of the term Internet Gaming Disorder to describe problematic gaming behaviour may limit the concept of Internet Gaming Disorder as the phenomenon also occurs in offline games (e.g., Griffiths, Kuss, & King, 2012; Lemmens & Hendriks, 2016; Pápay, Nagygyörgy, Griffiths, & Demetrovics, 2014; Tejeiro, Espada, Gonzalvez, Christiansen, & Gomez-Vallecillo, 2016). Moreover, Internet Gaming Disorder may also be involved in non-Internet computerised games, although these have been less researched (American Psychiatric Association, 2013). According to Spekman, Konijn, Roelofsma, and Griffiths (2013), within the gaming studies field, it is gaming addiction that generates the most comment, critique, and debate. Therefore, given the variety of potential classification frameworks and assessment approaches for investigating gaming addiction, it is important to review some of the key aspects involved in gaming addiction research and assessment in order to shed some light to the conceptual differences generated in the years prior to the inclusion of Internet Gaming Disorder in the DSM-5.

More specifically, this review will briefly focus on the assessment of gaming addiction while also providing (i) a brief overview of how the field evolved in terms of its historical developments, (ii) present current definitions and frameworks, (iii) some of the latest neurobiological research findings, (iv) a review of psychometric assessment, and (v) a discussion of the emerging trends in the assessment of gaming addiction. For the sake of consistency, the term Internet Gaming Disorder is generally used throughout this review, since this is now the nomenclature recognised by official medical bodies (American Psychiatric Association, 2013), except in those studies that specifically examined problematic offline gaming (typically studies prior to 2000).

Historical Developments

This section briefly examines the development of research into problematic gaming and Internet Gaming Disorder during the 1980s, 1990s, and 2000s as these decades correspond to important transitional periods in the field where several theoretical and conceptual milestones took place.

Early and Modern Perspectives

The release of the first commercial videogames date to the early 1970s and it took approximately 10 years for the first reports of gaming disorder to emerge in the psychological and psychiatric literature (Griffiths et al., 2012). For instance, Ross, Finestone, and Lavin (1982) described three cases of (offline) videogame obsession, whereas Nilles (1982) reported a similar phenomenon described as 'computer catatonia'. A more detailed description of Internet Gaming Disorder was brought forth later by Soper and Miller (1983), where it was observed that 'videogame addiction' was akin to other behavioural addictions and consisted of compulsive behavioural involvement, a lack of interest in other activities, association and friendship circles essentially with other disordered gamers, and physical and mental symptoms when the players attempted to cease the behaviour. In the mid-to-late 1980s, reports by clinicians (e.g., Keepers, 1990; Klein, 1984; Kuczmierczyk, Walley, & Calhoun, 1987) noted that many of the children counselled were seemingly addicted to videogames, as several had skipped classes and spent their lunch money or, alternatively, stole or begged money to get their 'videogame fix' (Klein, 1984, p. 396).

Arguably, the first empirical study published in a refereed journal specifically addressing problematic video gaming – which was viewed back then as a compulsion – was conducted by Egli and Meyers (1984). They investigated whether playing videogames had any perceived

positive or negative impact on players' lives in a sample of 151 participants with ages ranging from 10–20 years. The data collected allowed the authors to develop a psychometric tool comprising a total of 28 questions rated on a 7-point Likert scale to assess gaming compulsion based on the participants' perception of compulsive behaviour. As a result, the authors demonstrated that 13% of the total sample (n = 20) displayed compulsive videogame playing behaviour. Despite using an innovative and modern methodology to assess 'gaming compulsion', the relatively small sample size, alongside the exclusive reliance on participants' perception about their supposedly compulsive behaviour towards game playing, severely limited the generalisability of the authors' findings.

At the end of the 1980s, Shotton (1989) investigated 127 players who self-reported as being 'hooked' on videogames for at least 5 years, with a large proportion of these (n = 75) being measured against two control groups. Despite the results obtained, the author positively portrayed the disordered videogame players as overall highly intelligent, motivated, and achieving people that were often misunderstood by society. After a 5-year follow-up, it was concluded that the young cohort had done well both educationally and professionally. Nevertheless, this study had its own limitations. More specifically, no standardised measure for Internet Gaming Disorder was used, and the only pre-requisite for being considered disordered was the individual's own perception of being 'hooked' on computer games. Despite the methodological shortcoming of these studies' reliance on participants' perception of problematic gaming, more recent empirical research suggested that a person's self-diagnosis of Internet addiction might be indicative of the presence of an addiction, since this measure is highly associated with more standardised measures of Internet addiction (Widyanto, Griffiths, & Brunsden, 2011).

With the exception of the studies carried out by Egli and Meyers (1984) and Shotton (1989), the generality of the published studies from the 1980s were not systematic or empirically based, since they were somewhat observational, anecdotal and/or case studies, based on samples of teenage males and on a particular type of videogame using a particular medium (i.e. arcade videogames) (Griffiths et al., 2012). During the 1990s, the field underwent important changes research-wise. Contrary to the trend established by the studies in the early 1980s, the studies conducted during the 1990s were mainly carried out in the UK and investigated non-arcade videogame playing (i.e. videogames played on consoles, handheld devices, and/or personal computers) typically using adolescent samples in school settings (e.g., Brown & Robertson, 1993; Fisher, 1994; Griffiths, 1997; Griffiths & Dancaster, 1995; Griffiths & Hunt, 1995, 1998; Phillips, Rolls, Rouse, & Griffiths, 1995). Despite the increase of research into problematic video gaming in the 1990s in contrast with research conducted in the previous decade, one of the key limitations of these studies was that authors often used self-report surveys with relatively small sample sizes.

As pointed out by Griffiths et al. (2012), the main issue with these studies in the 1990s was that they assessed 'gaming addiction' using adapted versions of the DSM-III-R or DSM-IV criteria for pathological gambling. A similar critique was also made by Shaffer et al. (2000) where the authors suggested that 'it seems theoretically and clinically premature to assume that the psychodynamics of gambling and computer-related disorders are identical' (p. 167). Most important, although similar, pathological gambling and excessive gaming do not present with the same clinical features, and some have argued that using the diagnostic criteria for pathological gambling in order to diagnose gaming addiction only taps into obsessive use and pre-occupation rather than actual psychopathology (Charlton, 2002).

Given the fact that most studies published before 2000 specifically investigated arcade and/or console videogames rather than online videogames (Kuss & Griffiths, 2012c), there was a substantial growth in the number of studies on problematic gaming, almost solely due to the introduction of online videogames where games could be played as part of a gaming community (i.e. massively multi-player online role playing games [MMORPGs] such as *World of Warcraft* and *Everquest*) (Griffiths, Király, Pontes, & Demetrovics, 2015).

MMORPGs feature large, persistent on-line worlds that support social co-operative play and complex reward systems wherein players aspire to achieve various goals (King & Delfabbro, 2016). As players progress in the game, they reach 'end-game' activities (i.e., the parts of the game where basic level advancement reaches a predetermined fixed-interval cap and it is no longer possible to achieve new levels) (King & Delfabbro, 2016). In turn, end-game activities typically involve 'grinding' (i.e. constantly repeated actions) to achieve a kind of horizontal progression (e.g., such as refinement or customisation of game items already acquired by the player) (King & Delfabbro, 2016). The end-game content in MMORPGs employs time-consuming variable-ratio reinforcement schedules, featuring very low likelihoods of obtaining desired rewards (King & Delfabbro, 2016). Items with low 'drop-rates' become highly prized by players, who employ optimising in-game strategies and join groups (often termed as clans or guilds) to maximise their chances of obtaining them (King & Delfabbro, 2016). Players may spend more time playing to adhere to an increasingly demanding, rigid or complex and/or socially dependent schedule of play in pursuit of a specific reward payout (King & Delfabbro, 2016). Given these features and the subsequent empirical evidence (Pápay et al., 2014), MMORPGs appear to have an increased addictive potential in that players feel highly obligated to stay online, help their clans or guilds,

protect their virtual assets, and engage in hours of grinding just so that the whole clan or guild can benefit.

According to recent reviews on the topic (Griffiths et al., 2015; Griffiths et al., 2012; Kuss & Griffiths, 2012b), approximately 60 studies were published on gaming addiction between 2000–2010. Most of these studies focused on MMORPG addiction, and the samples used in most of these studies were not limited to adolescent males (although almost all were self-selected and non-representative). Furthermore, many of these studies collected their data online, and examined various other aspects of videogame addiction using non-self-report methodologies (e.g. polysomnographic measures and visual and verbal memory tests; medical evaluations; fMRI; EEG; and genotyping) (Griffiths et al., 2015; Griffiths et al., 2012). These reviews generally concluded that gaming addiction is a clinical entity and that can be categorised as a disorder that can potentially cause many problems in minority gamers' lives.

In order to study any disorder with a low prevalence rate such as gaming addiction, large sample pools are necessary for providing reliable estimates of prevalence rates amongst a population. However, very few studies have used nationally representative samples, although there are a few (e.g., Gentile, 2009; Pápay et al., 2013; Rehbein et al., 2010; Turner et al., 2012). Furthermore, even among those using nationally representative samples, different assessment instruments for estimating the prevalence rates of problematic gaming and gaming addiction have been used. Nonetheless, prevalence rates reported among those studies using representative samples ranged from 3% in one study (Rehbein et al., 2010) to 9.4% in another (Turner et al., 2012). Despite the relatively low prevalence rates reported, several methodological shortcomings are evident including the: (i) lack of consistent assessment criteria (i.e. no study used the same measure to assess gaming addiction); (ii) inclusion of children and adolescents samples only,

limiting the generalisability of the findings to other segments of the population (e.g. adult population); (iii) exclusive adoption of self-report measures; and (iv) lack of longitudinal studies designed in order to evaluate the causal pathways of gaming addiction.

Current Definitions and Frameworks

Over the last few years, research into Internet Gaming Disorder adopted different approaches for defining and conceptualising the phenomenon before the release of the DSM-5 (American Psychiatric Association, 2013). Broadly speaking, behavioural addictions, such as Internet Gaming Disorder, have typically been categorised either within the frameworks of impulse-control disorders or substance dependencies (Kuss & Griffiths, 2012c). However, criteria developed for the clinical diagnosis of Internet Gaming Disorder in empirical studies – prior to the release of the DSM-5 – were essentially based on either the criteria for pathological gambling (American Psychiatric Association, 1994) or on the criteria for substance dependence as in the DSM-IV (American Psychiatric Association, 1994).

This approach was mainly used because – since there was no standard definition for the phenomenon– it was believed that the way of determining whether behavioural addictions were addictive in a non-metaphorical sense was to compare them against clinical criteria for other established drug-ingested addictions (Griffiths, 1996a, 1998, 1999). Similarly, other researchers (Young, 1998b) believed that the phenomenon of Internet addiction could also be defined as an impulse-control disorder that did not involve the ingestion of a psychoactive substance (i.e. similar to disorders such as pathological gambling). Such conceptualisations also influenced the way in which research on Internet Gaming Disorder was conducted.

As previously discussed on Chapter 1 (p. 4), Internet Gaming Disorder was initially conceptualised as a specific sub-type of Internet addiction, based on an early study involving therapists (23 females and 12 males) with an average of 14 years of clinical practice that was conducted by Young et al. (1999). However, as noted before by key authors in the field (Griffiths, 1998, 2000b; Shaffer et al., 2000), the computer use itself may be the object of addiction, while in other cases the computer may be the mechanism for administering – or gaining access to – the object of addiction. The same may apply to the distinction between generalised Internet use and videogame playing as these are distinct behaviours as argued by several authors (e.g., Griffiths & Pontes, 2014; Király, Griffiths, et al., 2014; Montag et al., 2014; Rehbein & Mößle, 2013). Without this distinction, it may be the case that some clinicians may overlook other specific Internet-based addictive behaviours that involve other technologies, such as video and computer-based games.

Furthermore, the typology put forth by Young et al. (1999) had its own limitations. One of the issues raised by this conceptualisation was that many of the addicted users are not Internet addicts *per se*, but just used the Internet as a medium to fuel other addictions (Griffiths, 1999, 2000b). In other words, using an example of a gambling addict or a computer game addict who engages in their chosen behaviour online, it can be intuitively concluded that these users are not addicted to the Internet, since the internet is just the place where they engage in their chosen behaviour (Griffiths, 1999, 2000b). In fact, the distinction made between addictions *to* the Internet and addictions *on* the Internet originated from this idea (Griffiths, 2000b; Widyanto & Griffiths, 2007).

The corollary of this initial conceptualisation and Internet addiction typology suggested by Young et al. (1999) was that several authors (e.g., Kim, Namkoong, Ku, & Kim, 2008; King & Delfabbro, 2009; Ko, Yen, Chen, Chen, & Yen, 2005; Rehbein et al., 2010; Stetina, Kothgassner,

Lehenbauer, & Kryspin-Exner, 2011; Van Rooij, Schoenmakers, Van de Eijnden, & Van de Mheen, 2010) heavily relied on instruments designed to measure generalised Internet addiction to assess Internet Gaming Disorder, therefore creating methodological problems to the assessment and understanding of Internet Gaming Disorder. This aspect of research on Internet Gaming Disorder will be discussed in greater detail on Chapter 3.

Another influential framework for understanding the phenomenon was provided by Davis (2001) in his cognitive-behavioural model of pathological Internet use. One of the reasons for the increased popularity of this framework in the early 2000s was because it was the first to clearly distinguish between specific pathological Internet use and generalised pathological Internet use (see Chapter 1 [pp. 7-8] for an in-depth description of this framework).

More recently, Brand et al. (2014) further developed Davis' cognitive-behavioural model of pathological Internet use (Davis, 2001) by taking into account important neuropsychological mechanisms and control processes mediated by executive functions, and prefrontal cortical areas. Therefore, this model attempts to explain and understand the development and maintenance of both generalised Internet addiction and specific Internet addiction (e.g., Internet Gaming Disorder). According to Brand et al. (2014), it is important to distinguish between functional Internet use, generalised Internet addiction, and specific Internet addiction. While functional Internet use encompasses the use of the Internet as a tool for dealing with personal needs and goals in everyday life in a healthy way, both generalised Internet addiction and specific Internet addiction may serve different purposes in the context of addiction.

Furthermore, in the development and maintenance of generalised Internet addiction, the user has some needs and goals that can be satisfied using certain Internet applications. It is assumed that psychopathological symptoms (e.g., depression and anxiety) are pre-disposing factors for

developing generalised Internet addiction. Moreover, social cognitions (e.g., perceived social isolation and lack of offline support) are also assumed to be related to generalised Internet addiction (Brand et al., 2014).

Accordingly, particular emphasis is given to Internet use expectancies as it may involve anticipations of how the Internet can be helpful for distracting individuals from thinking about their problems and/or escaping from reality. Such activity can also be used to enhance positive mood states and/or minimise negative mood states. These expectancies may also interact with the user's general coping style and self-regulation capacities. Therefore, when going online, the user receives reinforcement in terms of dysfunctional coping strategies with negative feelings or problems in everyday life. While Internet use expectancies are positively reinforced, given the strong reinforcement character of certain Internet applications, the cognitive control concerning the Internet use becomes more effortful. This should particularly be the case if Internet-related cues interfere with executive processes.

In the development and maintenance of specific Internet addiction it is argued by Brand et al. (2014) that psychopathological symptoms are also particularly involved in this type of Internet addiction. Therefore, it is hypothesised that a specific person's predispositions increase the probability that an individual receives gratification from the use of certain applications and over-uses these applications again. In this framework, it is postulated that the expectancy that such Internet applications can satisfy certain desires increases the likelihood that these applications will be used frequently, and that the individual begins to lose control over the use of such applications. Consequently, gratification is experienced and, therefore, the use of such applications and also the specific Internet use expectancies and the coping style are reinforced positively. Another assumption of this perspective for understanding specific Internet addiction is that the more general

psychopathological tendencies (e.g., depression and social anxiety) are negatively reinforced due to the fact that additional specific Internet applications can be used to distract from problems in real life or to avoid negative feelings, such as loneliness or social isolation.

Contrary to the theory proposed by Davis (2001), where the model of pathological Internet use has been put to the test by developing a theory-driven instrument to assess Internet addiction (see Caplan, 2002, 2010; Davis, Flett, & Besser, 2002), the theoretical framework put forth by Brand et al. (2014), despite being promising, still remains to be tested empirically. On the other hand, the components model of addiction (Griffiths, 2005) is another well-established theoretical framework for conceptualising behavioural addictions as a whole. This model was put forth by some of Griffiths' early works (Griffiths, 1995, 1996b, 2000b, 2005), and drew upon (and then slightly modified) the six core components outlined by Brown (1993) (i.e. salience, mood modification, tolerance, withdrawal, relapse, and conflict). Simply put, this model postulates that substance-related and behavioural addictions (e.g., Internet Gaming Disorder) develop via similar biopsychosocial processes and share a number of similar characteristics, most notably the addiction criteria of salience, mood modification, tolerance, withdrawal, relapse, and conflict. More recently, it has been argued by Griffiths, King, and Demetrovics (2014) that the nine criteria of Internet Gaming Disorder as outlined in the DSM-5 (American Psychiatric Association, 2013) are very similar to the six components present in the components model of addiction (see Table 2.1).

Table 2.1. Model comparison: 'Components Model' (Griffiths, 2005) against Internet Gaming Disorder (IGD) DSM-5 criteria (American Psychiatric Association, 2013)

Components Model	Comparison	IGD DSM-5 Criteria	
Salience	Overlaps with the criterion	**1**	1. Preoccupation with games (The individual thinks about previous gaming activity or anticipates playing the next game; Gaming becomes the dominant activity in daily life.
Mood Modification	Overlaps with the criterion	**8**	8. Use of games to escape or relieve a negative mood (e.g., feelings of helplessness, guilt, anxiety).
Tolerance	Overlaps with the criterion	**3**	3. Tolerance – the need to spend increasing amounts of time engaged in games.
Withdrawal	Overlaps with the criterion	**2**	2. Withdrawal symptoms when gaming is taken away. (These symptoms are typically described as irritability, anxiety, or sadness, but are no physical signs of pharmacological withdrawal.
Conflict	Overlaps with the criterion	**5**, **6**, **7** & **9**	5. Loss of interests in previous hobbies and entertainment as a result of, and with the exception of, games. 6. Continued excessive use of games despite knowledge of psychosocial problems. 7. Has deceived family members, therapists, or others regarding the amount of gaming. 9. Has jeopardised or lost a significant relationship, job, or educational career opportunity because of participation in games.
Relapse	Overlaps with the criterion	**4**	4. Unsuccessful attempts to control the participation in Internet games[1].

Note: [1] Possible overlap with 'conflict' (as proposed in the components model of addiction by Griffiths (2005).

In the components model of addiction framework, other concepts are equally involved. For instance, technological addictions, which are defined by non-chemical (behavioural) addictions involving human-machine interactions, can be regarded as a sub-set of behavioural addictions (Griffiths, 1995, 1996b, 2000b; Marks, 1990). In turn, technological addictions can either be passive (e.g., television) or active (e.g., computer games), and usually contain inducing and

reinforcing features which may contribute to the promotion of addictive tendencies (Griffiths, 1995, 2000b). Addictive behaviours, in turn, are operationally defined as any behaviour featuring all six core components of addiction (Griffiths, 2000b). In short, any behaviour (including videogame playing) that features all six addiction criteria would be operationally defined as addictions.

As it has been argued on Chapter 1 (p. 6), the robustness and strength of this model can be witnessed by the fact that psychometric tools to assess several behavioural addictions have been derived from this model. Additionally, this framework helps to clarify the issues of construct validity surrounding behavioural addictions (and also Internet Gaming Disorder), since this process necessitates the development of an underlying model or scientific theory (Shaffer et al., 2000).

Developments in Neurobiological Research

More recently, several reviews have focused on the latest neurobiological findings concerning Internet Gaming Disorder and have summarised important findings (e.g., Brand et al., 2014; E Duven, Müller, & Wölfling, 2011; Kuss & Griffiths, 2012a; Lemos, Diniz, Peres, & Sougey, 2014; Meng, Deng, Wang, Guo, & Li, 2015). Understanding the emerging biological basis of Internet Gaming Disorder – while important – is beyond the scope of this chapter (but readers can consult other key reviews of this research including Brand et al. [2014], and Kuss and Griffiths [2012a]). Nevertheless, some of the overall key findings are reported below.

In these types of studies, the most common methods and techniques adopted to study the neural correlates of Internet Gaming Disorder often encompass the use of electroencephalogram (EEG), positron emission tomography (PET), single photon emission computed tomography

(SPECT), functional magnetic resonance imaging (fMRI), structural magnetic resonance imaging (sMRI), and diffusion-tensor imaging (DTI) (Kuss & Griffiths, 2012a). Several cortical areas have been identified and associated with Internet Gaming Disorder. In the case of generalised Internet addiction, a recent review on the topic (Brand et al., 2014) reported that certain prefrontal functions (in particular executive control functions) are related to symptoms of Internet addiction, which is in line with recent theoretical models on the development and maintenance of the addictive use of the Internet. Additionally, control processes appear to be particularly reduced when individuals with Internet addiction are confronted with Internet-related cues representing their first choice use. Although these findings relate to generalised Internet addiction, there is good reason to suspect that they may also be of importance in Internet Gaming Disorder.

In a recent study, Weng et al. (2013) used voxel-based morphometry analysis and tract-based spatial statistics to investigate the microstructural changes in disordered gamers and assessed the relationship between these morphology changes and the Internet Addiction Test (IAT) (Young, 1998a) scores in disordered gamers. The total sample consisted of 34 participants. Of these, 17 (13 females and four males) were diagnosed with Internet Gaming Disorder based on the answers given to the Young's Diagnostic Questionnaire (YDQ) (Young, 1998b), where respondents that answered 'yes' to questions 1-5 and positively to at least any one of the remaining three questions were classified as disordered gamers. The control group comprised 17 healthy participants (15 females and two males). According to Weng et al. (2013), the results showed that disordered gamers had significantly reduced fractional anisotropy in the right genu of the corpus callosum, bilateral frontal lobe white matter, and right external capsule. Moreover, grey matter volumes of the right orbitofrontal cortex, bilateral insula, and fractional anisotropy values of the right external capsule were significantly positively correlated with IAT scores among the disordered players. In

addition, the findings suggested that microstructure abnormalities of grey and white matter are present in Internet Gaming Disorder.

In a recently published neuroimaging meta-analysis (Meng et al., 2015) that combined voxel-wise whole-brain studies to investigate the functional responses to cognitive tasks in relation to Internet Gaming Disorder, 10 functional neuro-imaging studies were analysed and summarised using a quantitative ES-SDM meta-analytic method. Results showed that, compared to healthy controls, individuals with Internet Gaming Disorder showed a significant activation in the bilateral medial frontal gyrus and the left cingulate gyrus, as well as the left medial temporal gyrus and fusiform gyrus. Furthermore, time spent online by individuals with Internet Gaming Disorder was positively correlated with activations in the left medial frontal gyrus and the right cingulated gyrus.

It should also be noted that there is mounting empirical evidence from several studies (Brand et al., 2014; Ding et al., 2013; Feng et al., 2013; Han et al., 2011; Han, Hwang, & Renshaw, 2010; Ko, Liu, Yen, Chen, et al., 2013; Ko, Liu, Yen, Yen, et al., 2013) supporting the hypothesis that Internet Gaming Disorder is a behavioural addiction that may share similar neurobiological abnormalities with other addictive disorders. In a recent fMRI study conducted by Ko, Liu, Yen, Yen, et al. (2013), the brain correlates of cue-induced gaming urges or smoking craving among males with both Internet Gaming Disorder and nicotine dependence was investigated in order to make a simultaneous comparison of cue-induced brain reactivity for gaming and smoking. In this study, 16 male participants with both Internet Gaming Disorder and nicotine dependence (i.e., comorbid group) were recruited by an advertisement that asked for volunteers who smoked 10 or more cigarettes a day and played online games for four or more hours on weekdays and eight or more hours at weekends over the past year. A control group of 16 participants with no history of either Internet Gaming Disorder or nicotine dependence was also recruited. All participants were

interviewed by a psychiatrist to confirm the diagnoses of both Internet Gaming Disorder and nicotine dependence, in accordance with the Diagnostic Criteria for Internet Addiction (DCIA) developed by Ko et al. (2009) and the DSMIV-TR (American Psychiatric Association, 2000), respectively.

All participants underwent 3-T fMRIs scans while viewing images associated with online games, smoking, and neutral images, and results showed that anterior cingulate, and parahippocampus activated higher for both cue-induced gaming urges and smoking craving in the co-morbid group in comparison to the control group. Additionally, the conjunction analysis demonstrated that bilateral parahippocampal gyrus activated to a greater degree for both gaming urge and smoking craving among the co-morbid group in comparison to the control group. In sum, despite having included only male individuals, this was one of the first studies to demonstrate that both Internet Gaming Disorder and nicotine dependence share similar mechanisms of cue-induced reactivity over the fronto-limbic network, particularly for the parahippocampus. The authors also asserted that the parahippocampus is a key mechanism for not only cue-induced smoking craving, but also for cue-induced gaming urges.

In summary, some of the latest neurobiological findings related to Internet Gaming Disorder demonstrate that there is a significant progress in mapping the brain areas related to the phenomenon of Internet Gaming Disorder. The results appear to show that addictive use of the Internet and online gaming is linked to functional brain changes involving parts of the prefrontal cortex, accompanied by changes in other cortical and sub-cortical regions (Brand et al., 2014). Furthermore, there is some evidence that online addictive activity can lead to structural brain changes involving parts of the prefrontal cortex. The functional changes in prefrontal and striatal

areas are primarily observable when individuals with Internet addiction perform certain tasks, in particular those measuring executive functions and cue-reactivity (Brand et al., 2014).

Despite these promising results, full comprehension and understanding of the neurobiological mechanisms of Internet Gaming Disorder remains relatively unknown (Tian et al., 2014). Additionally, some of the key limitations of these studies is that a vast majority tend to (i) use generalised Internet addiction instruments to measure Internet Gaming Disorder; (ii) have low sample sizes; (iii) sometimes include only male participants; and (iv) not address systematically the age of the participants. This makes it difficult to compare the neural correlates of Internet Gaming Disorder across different age groups.

Psychometric Assessment

The heterogeneity of conceptual frameworks adopted by researchers to understand gaming addiction has led to the development of multiple psychometric instruments, each measuring different aspects associated with gaming problems and addiction. Consequently, this has resulted in diagnostic and conceptual confusion, leading some researchers to call for more commonly agreed criteria in which both reliability and validity can be better ascertained across studies (Kuss, 2013c). Based on recent reviews on gaming addiction assessment (King, Haagsma, Delfabbro, Gradisar, & Griffiths, 2013; Király, Nagygyörgy, Koronczai, Griffiths, & Demetrovics, 2014), Table 2.2 summarises some of the most widely used instruments for assessing gaming addiction.

In a recent systematic review, King et al. (2013) examined a total of 63 quantitative studies including 18 different instruments that had been used to assess problematic gaming and gaming addiction. According to the authors, the instruments reviewed could broadly be characterised as inconsistent since no two measures were alike in their conceptualisation and ability to ‘map out’

diagnostic features. Some of the key limitations included: (i) inconsistent coverage of core addiction indicators, (ii) varying cut-off scores to indicate clinical status, (iii) a lack of a temporal dimension, (iv) untested or inconsistent dimensionality, and (v) inadequate data on predictive validity and inter-rater reliability. Despite these criticisms, positive aspects of the 18 available measures included: (i) short length and ease of scoring, (ii) excellent internal consistency and convergent validity, and (iii) potentially adequate data for development of standardised norms for adolescent populations.

Table 2.2. Summary of Instruments Traditionally Used for Assessing Gaming Addiction [a, b]

Instrument	Author	Components	Number of Items	Time Frame	Addiction Criteria[c]	Clinical Validation	Sample Size & Characteristics
Adapted DSM-IV-TR for pathological gambling†	American Psychiatric Association (2000)	Preoccupation; tolerance; loss of control; withdrawal; escape; chasing; lies; illegal acts; negative consequences; bail out	10/11	12 months	≥ 4/5 criteria	No	-
Adapted DSM-IV-TR for substance dependence†	American Psychiatric Association (2000)	Loss of control; negative consequences of use	7	12 months	> 3 criteria	No	-
Addiction-Engagement Questionnaire (revised) †††	Charlton and Danforth (2007)	Addiction; engagement	24	NR	≥ 4 out of 7 'core' addiction criteria; highly engaged	No	N = 442; Mostly males adolescents and adults from the USA and Canada
Compulsive Internet Use Scale (CIUS) †	Meerkerk, Van den Eijnden, and Garretsen (2006)	Loss of control; preoccupation; withdrawal; conflict; coping	14	NR	None	No	N = 447; Male and female adult Dutch heavy Internet users
Exercise Addiction Inventory (adapted) †	Hussain and Griffiths (2009)	NR	6	NR	'At-risk of addiction' ≥ 24 out of 30 criteria	No	N = 119; Male and female adolescents and adults from the USA, Canada and UK

Game Addiction Scale (GAS) †††	Lemmens et al. (2009)	Salience; tolerance; mood modification; withdrawal; relapse; conflict; problem	21/7	6 months	At least "3 sometimes" on all 7 items	No	N = 721; Male and female Dutch young adolescents
Korean Internet Addiction Test (KIAT) †	M-S Lee et al. (2007)	Disturbance of adaptive functions; disturbance of reality testing; addictive automatic thoughts; withdrawal; virtual interpersonal relationships; deviant behaviour, tolerance	40	NR	NR	No	N = 627; Male and female South Korean young adolescents
Online Game Addiction Scale for Adolescents in Taiwan (OAST) †††	Wan and Chiou (2006)	Compulsive use; withdrawal; tolerance; conflict	29	NR	> 3	No	N = 127; Male and female Taiwanese young adolescents
Online Game Addiction Index (OGAI) †	Zhou and Li (2009)	Control; conflict; injury	12	6 months	NR	No	N = 195; Male and female Chinese adolescents and young adults
Problem Videogame Playing (PVP) Scale†††	Tejeiro Salguero and Morán (2002)	Preoccupation; tolerance; loss of control; withdrawal; escape; lies and deception disregard for physical or psychological consequences	9	12 months	≥ 4 criteria	No	N = 223; Male and female Spanish young adolescents

Problematic Internet Use Scale (ISS-20) (adapted) †	Stetina et al. (2011)	Loss of control, problems in social offline relationships; withdrawal symptoms; tolerance; impairments in daily life	20	NR	'Problematic': average ranking larger than 3 according to each item (88 percentile)	No	N = 468; Mostly male German-speaking adolescents and adults
Problematic Online Game Use Scale (POGU) †††	MG Kim and Kim (2010)	Euphoria; health problems; conflict; failure of self-control; preference for virtual relationship	20	NR	NR	No	N = 2,014; Male and female children and young adolescents from South Korea
Problematic Online Gaming Questionnaire†††	Demetrovics et al. (2012)	Preoccupation; overuse; immersion; social isolation; interpersonal conflicts; withdrawal	28	NR	'Problematic': ≥ 65	No	N = 3,415; Male and female Hungarian-speaking adolescent and young adult gamers
Problematic Online Gaming Questionnaire Short Form (POGQ-SF) ††	Pápay et al. (2013)	Preoccupation; overuse; immersion; social isolation; interpersonal conflicts; withdrawal	12	NR	'Problematic': ≥ 32	No	N = 2,774; Male and female Hungarian adolescent gamers
Video Game Addiction Test (VAT) †††	Van Rooij, Schoenmakers, Van den Eijnden, Vermulst, and Van de Mheen (2012)	Loss of control; intra- and inter- personal conflicts; preoccupation; mood modification; withdrawal	14	NR	NR	No	N = 2,894; Male and female Dutch adolescent gamers

Video Game Dependency Scale (KFN-CSAS-II) †††	Rehbein et al. (2010)	Preoccupation/salience; conflict; loss of control; withdrawal; tolerance	14	NR	'Dependent': ≥ 42	No	N = 15,168; Male and female German adolescents
Young's Diagnostic Questionnaire (YDQ) †††	Young (1998b)	Preoccupation; tolerance; loss of control/relapse; withdrawal; conflict; mood modification	8	NR	'Dependent': ≥ 5 symptoms	No	N = 496; Male and female adults from the USA
Internet Addiction Test (IAT) †††	Young (1998a)	Salience; excessive use; neglect-work; anticipation; lack of control; neglect-social[e]	20	NR	'Addiction': 70-100 points	Yes: Limited clinical utility[4]	N = 86; Male and female English-speaking internet users[d]
Pathological-Gaming Scale (PGS) ††	Gentile (2009)	DSM-IV criteria for pathological gambling; salience; euphoria or relief; tolerance; withdrawal symptoms; conflict; relapse and reinstatement	11	NR	≥ 6 symptoms	No	N = 1,178; Male and female children and young adolescents from the USA

Note: [a]: The term gaming addiction is used because none of the instruments were specifically developed according to the nine IGD criteria as proposed by the DSM-5 (American Psychiatric Association, 2013). [b]: This table was partially based on King et al. (2013) and Király, Nagygyörgy, et al. (2014) review studies. [c]: Cut-off score for addiction diagnose. [d]: As concluded by a study (Kim, S. J., Park, D.-H., Ryu, S.-H., Yu, J., & Ha, J. H. (2013). Usefulness of Young's Internet Addiction Test for clinical populations. Nordic Journal of Psychiatry, 67(6), 393-399.). [e]: Since the assessment of the psychometric properties of the IAT was not conducted by the original author of this test, the information provided refer to the first psychometric study conducted for the IAT (Widyanto & McMurran, 2004). †: Instruments originally included in King et al. (2013); †† Instruments originally included Király, Nagygyörgy, et al. (2014) review. †††: Instruments included in both reviews.

In a different analysis, Király, Nagygyörgy, et al. (2014) reviewed 12 psychometric measures on gaming addiction according to strict criteria. To be included, the assessment instrument had to have (i) been used in two or more empirical studies, (ii) used considerable sample sizes in their development, and (iii) shown good psychometric properties. Based on the authors' review, Király, Nagygyörgy, et al. (2014) pointed out the fact that a relatively large amount of studies on gaming addiction (i.e., Han et al., 2010; M-S Lee et al., 2007; Meerkerk, Van den Eijnden, Franken, & Garretsen, 2010; Meerkerk et al., 2006; Van Rooij et al., 2010; Van Rooij et al., 2011) measured the construct with psychometric tools for generalised Internet addiction and/or the criterion of time spent on online gaming.

Assessing gaming addiction with generalised Internet addiction measures or other non-standardised tools has become common practice. However, this method may under-estimate the number of addicted gamers because, for some of them, gaming may not be perceived as an Internet activity, but rather as a specific yet separate activity (Király, Nagygyörgy, et al., 2014). For these gamers, the content may be more relevant and important than the medium itself (i.e., Internet). Additionally, most instruments developed to assess Internet addiction report several different dimensions and factorial structures for the same construct. The heterogeneity of factorial structures reported for similar instruments may be partly explained by (i) different statistical methods used to define these dimensions (e.g., EFA vs CFA); (ii) use of heuristic approaches (e.g., Kaiser criterion for the interpretation of the eigenvalues, subjective scree plot interpretation); (iii) subjective labelling of the factors underlying the latent construct; and/or (iv) different cross-cultural aspects which are not being systematically addressed.

In relation to some of the problems raised concerning the cut-off points of most psychometric tools developed, one of the main problems regarding gaming addiction assessment

(and psychometric research more generally) concerns the fact that the vast majority of the available measures were not validated using clinical samples. This is especially important due to the fact that this is the only way to ascertain how robust the measures perform in truly discriminating gaming addicts from game enthusiasts. Nevertheless, some authors have recently proposed an empirically data-driven approach in order to distinguish between disordered and non-disordered players based on advanced statistical analyses such as latent class analysis (Van Rooij et al., 2011). The latent class analysis is a mixture modelling technique based on structural equation modelling used to identify the patterns of responses given by participants in the measure used, allowing the researcher to take into account the groups of participants (i.e., the classes) that scored higher in the measure adopted, and then use it as a '*gold standard*' to later study the sensitivity and specificity of the measure regarding its diagnostic power. The sensitivity and specificity analyses provide an empirical overview of how accurate several cut-off points can perform in discriminating disordered and non-disordered players.

In general, most studies developing measures for assessing Internet Gaming Disorder have not established empirical or clinical cut-off points. Nevertheless, the use of such advanced statistical approaches to develop empirical cut-off points may not accurately distinguish between true disordered and non-disordered players since they still lack clinical validity. Furthermore, this is a procedure entirely based on empirical – rather than clinical – assumptions. In line with the notion of addictions *on* the internet and addiction to *the* internet (Griffiths, 1999), Rehbein and Mößle (2013) asserted that gaming addiction and generalised Internet addiction should be assessed separately, since these, despite being somewhat related, are different phenomena.

Emerging Trends in Assessment

Given the heterogeneity of instruments designed for assessing gaming addiction and some of the criticisms previously made to them (i.e., inconsistency in the conceptualisation of gaming addiction; use of non-standardised criteria; use of *ad hoc* cut-off points, etc.), experts in the field have now called for unification in the assessment of gaming addiction (Griffiths et al., 2014; King et al., 2013; Petry & O'Brien, 2013; Petry et al., 2014). The call for a commonly agreed upon assessment criteria or a standardised instrument results from the need to increase reliability and validity across gaming addiction studies. This, in turn, will help to advocate adequate and efficacious treatments for the condition (Kuss, 2013c). The unification is equally important if the phenomenon of gaming addiction (i.e., Internet Gaming Disorder) is to be fully recognised by official medical bodies as a separate clinical disorder.

In line with the latest advancements in the field, two psychometric tools[4] developed by the present author aimed to cater for the need of a unified approach in the assessment of gaming addiction (i.e., Pontes & Griffiths, 2015a; Pontes, Király, et al., 2014) using the official nine criteria for Internet Gaming Disorder as in the DSM-5 (American Psychiatric Association, 2013). The first of these two measures, the Internet Gaming Disorder Test (IGD-20 Test) (Pontes, Király, et al., 2014) was developed using a sample of 1,003 English-speaking gamers from 58 different countries. The IGD-20 Test is an instrument for measuring the severity of gaming disorder throughout 20 items rated on a 5-point Likert scale (1 = '*Strongly disagree*' to 5 = '*Strongly agree*') reflecting the original nine Internet Gaming Disorder criteria incorporated in the theoretical framework of the components model of addiction (Griffiths, 2005). In order to conform with the

[4] These two psychometric tools alongside their development, will be discussed in greater detail on Chapters 4 and 5.

conceptualisation of Internet Gaming Disorder as outlined in the DSM-5, the test examines both online and offline gaming activities occurring over a 12-month period.

Furthermore, the IGD-20 Test is a reliable and valid psychometric tool comprising six dimensions (i.e., salience, mood modification, tolerance, withdrawal symptoms, conflict, and relapse). In addition to investigating the test's factorial validity, other sources of validity have also been obtained during the development of the IGD-20 Test, including criterion-related validity and concurrent validity. One of the advantages of this instrument over others is that, during the validation process, sophisticated statistical techniques were employed in order to provide an empirical cut-off. Therefore, based on the results of a latent profile analysis, sensitivity, and specificity analyses, an optimal cut-off of 71 points (out of 100) for distinguishing between disordered and non-disordered gamers was suggested.

Following the development of the IGD-20 Test and using the same rationale underpinning its development, Pontes and Griffiths (2015a) conducted a study utilising a sample of 1,397 English-speaking gamers from 58 different countries where the Internet Gaming Disorder Scale–Short-Form (IGDS9-SF) was developed. The IGDS9-SF is a short psychometric tool adapted from the nine core criteria that define Internet Gaming Disorder according to the DSM-5 (American Psychiatric Association, 2013). Similar to the 20-item version, the aim of this instrument is to assess the severity of Internet Gaming Disorder and its detrimental effects by examining both online and/or offline gaming activities occurring over a 12-month period. The nine questions are answered using a 5-point Likert scale (1 = '*Never*' to 5 = '*Very often*').

As noted by Pontes and Griffiths (2015a), the main purpose of the IGDS9-SF is not to diagnose Internet Gaming Disorder, but to assess its severity and accompanying detrimental effects to the gamers' life. However, for research purposes, it may be possible to classify disordered

gamers and non-disordered gamers by considering responses from participants where five out of the nine items are endorsed (i.e., answering '*very often*' to at least any of the five items), this approach was adopted as it mirrors the American Psychiatric Association's recommendation as in the DSM-5 for diagnosing Internet Gaming Disorder, and is also based on the findings of clinical studies that have found support for the validity of this diagnostic approach (Ko et al., 2014).

As with the IGD-20 Test, the IGDS9-SF also underwent rigorous psychometric analyses encompassing exploratory factor analysis, confirmatory factor analysis, analyses of the criterion-related and concurrent validity, reliability, standard error of measurement, population cross-validity, and, lastly, the authors also checked for floor and ceiling effects. As a result of these analyses, the nine items of the IGDS9-SF revealed a single-factor structure that was tested in two independent samples. Furthermore, the test demonstrated satisfactory validity, reliability, and proved to be highly suitable for measuring Internet Gaming Disorder (Pontes & Griffiths, 2015a). By developing these two psychometric measures, it was also envisaged by the present author that both tools will help facilitate unified research in the field and also help to overcome some of the incongruences in the assessment of the phenomenon of gaming addiction.

In order to facilitate the process of recognition of Internet Gaming Disorder as a clinical disorder in the future and also increase common knowledge about this tentative disorder, some authors have suggested that "*establishing the psychometric properties of instruments assessing these nine [Internet Gaming Disorder] criteria should begin using a cross-cultural perspective*." (Petry et al., 2014; p.6). For this reason, a few cross-cultural studies have sought to adapt and validate both the IGD-20 Test and the IGDS9-SF to other cultural contexts, including translation into Slovenian (Pontes, Macur, & Griffiths, 2016a, 2016b), Spanish (Fuster et al., 2016), Portuguese (Pontes & Griffiths, 2016), and Italian (Monacis, De Palo, Griffiths, & Sinatra, 2016).

Nevertheless, it is equally important that future studies test these two new instruments in other different contexts using heterogeneous samples and/or representative samples. As mentioned earlier, studies in the field using clinical samples are sparse; therefore, studies using these two measures in the clinical setting may help to corroborate the findings in regards to the adequacy of the assessment of Internet Gaming Disorder using these two instruments.

Conclusions

After more than two decades of research, official medical bodies (i.e., American Psychiatric Association) have now officially recognised for the first time that Internet Gaming Disorder is a condition that requires consideration by clinicians and researchers (Kuss, 2013c) standing alongside the only other behavioural addiction (i.e., Gambling Disorder), situating it clearly within the diagnostic category of Substance-Related and Addictive Disorders. Throughout this chapter, the latest research findings and official reports suggest the number of gamers and those with Internet Gaming Disorder have increased over the last few years. It is clear that the gaming industry will continue to innovate and that more complex and demanding games will be developed to cater for the ever-growing need of players for new and more complex games.

The issues encountered by contemporary researchers and clinicians regarding the assessment of Internet Gaming Disorder appear complex and include several factors. Firstly, it has been noted how historically the use of inconsistent heterogeneous and non-consensual nomenclatures to describe what appears to be the same phenomenon (i.e., Internet Gaming Disorder) has influenced the development of a varied number of definitions and frameworks for understanding and assessing Internet Gaming Disorder. Secondly, despite being important at some point, these definitions and frameworks largely contributed to the ‘boom’ in the development of

several psychometric tools for assessing Internet Gaming Disorder, irrespective of their viability. Thirdly, as outlined by recent literature reviews on the assessment of most used psychometric tools (King et al., 2013; Király, Nagygyörgy, et al., 2014), these tools have a wide range of problems. Some of these conceptual problems found in the literature regarding the assessment of Internet Gaming Disorder are important because – as noted by Shaffer et al. (2000) – without conceptual clarity and empirical support for treatment efficacy, it is also premature to offer clinical guidelines for the treatment of generalised Internet addiction or Internet Gaming Disorder.

Furthermore, because some of the early conceptualisations where Internet Gaming Disorder was seen as a sub-type of Internet addiction (e.g., Young et al., 1999), a trend for assessing Internet Gaming Disorder using generalised Internet addiction tools have been established and translated by a substantial number of studies using this method (e.g., Kim et al., 2008; King & Delfabbro, 2009; Ko et al., 2005; Rehbein et al., 2010; Stetina et al., 2011; Van Rooij et al., 2010). This, in turn, has contributed to some of the methodological problems in the literature regarding the assessment and understanding of Internet Gaming Disorder.

When dealing with the issue of Internet Gaming Disorder in the clinical setting, clinicians faced with patients that are struggling with online addictions must perform thorough diagnostic evaluations and determine the extent of co-morbid conditions (Shaffer et al., 2000). In this sense, it has also been highlighted how the patient's perceived self-diagnosis of Internet addiction may be representative of a real internet addiction (Widyanto et al., 2011). Therefore, clinicians are advised to take into account patients' subjective assessment regarding their difficult struggles with Internet Gaming Disorder.

Around 19 instruments have been analysed in the present review in light of previous works (King et al., 2013; Király, Nagygyörgy, et al., 2014). Surprisingly, all instruments were

inconsistent and none were alike in terms of the conceptualisation of the Internet Gaming Disorder phenomenon. Most notably, clinical validation is severely lacking in all instruments and, therefore, this should be considered in future research.

In order to overcome some of the problems found in most instruments used to assess Internet Gaming Disorder, Koronczai et al. (2011) suggested that a good measurement instrument should meet six criteria: (i) comprehensiveness (i.e., examining many and possibly all aspects of Internet Gaming Disorder); (ii) brevity, so that the instrument can be used for impulsive individuals and fit time-limited surveys; (iii) reliability and validity for different data collection methods; (iv) reliability and validity across different age groups; (v) cross-cultural reliability and validity; and (vi) validation on clinical samples for determining more precise cut-off points based not only on empirical data.

Given the recent call for unification in the assessment of Internet Gaming Disorder from experts in the field (Griffiths et al., 2014; King et al., 2013; Petry & O'Brien, 2013; Petry et al., 2014), two new psychometric tools (Pontes & Griffiths, 2015a; Pontes, Király, et al., 2014) have been developed by the present author in order to help overcome some of the challenges regarding the assessment of Internet Gaming Disorder. Despite the promise that these two new measurement tools hold, their validity regarding other more heterogeneous samples and even clinical samples remain to be tested. Therefore, researchers using these tools are encouraged to put them to test in clinical samples and other contexts. In comparison to other more established fields (e.g., Gambling Disorder), the Internet Gaming Disorder field is still in its early infancy. However, the benefits of an Internet Gaming Disorder diagnosis may include: (i) greater reliability across research, (ii) de-stigmatisation of individuals struggling with this condition, (iii) development of efficacious

treatments, and the (iv) creation of an incentive for public healthcare and insurance providers (Kuss, 2013c).

Additionally, the adoption of new assessment tools that properly and appropriately reflect the official conceptualisation proposed by the DSM-5 (American Psychiatric Association, 2013) and the use of a more standardised and consensual nomenclature (i.e., Internet Gaming Disorder) should be taken into account by researchers and clinicians wishing to research in this area as the use of old nomenclatures may be stigmatising to patients struggling with Internet Gaming Disorder (Kuss, 2013c). The current review indicates that research on Internet Gaming Disorder is on its way to overcoming some of its previously outlined limitations. However, more research aimed to understanding the context of Internet Gaming Disorder in large representative samples – not only using cross-sectional designs as most of the previous research – and also in the clinical setting by using clinical samples is needed.

CHAPTER 3: Psychometric Assessment of Internet Gaming Disorder in Neuroimaging Studies: A Systematic Review[5]

Introduction

Since the introduction of the concept of Internet Gaming Disorder as a tentative disorder in the latest (fifth) edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) (American Psychiatric Association, 2013), research into Internet Gaming Disorder using neuroimaging techniques has steadily increased. Neuroimaging studies appear to offer several advantages over traditional self-report and clinical research by highlighting specific areas of the brain involved in the development and maintenance processes of addiction (Kuss & Griffiths, 2012a). More recently, the American Psychiatric Association (2013) defined Internet Gaming Disorder as a behaviour that refers to "persistent and recurrent engagement in videogames, often with other players, leading to clinically significant impairments or distress as indicated by five (or more) of the following nine criteria in a 12-month period: (1) preoccupation with games; (2) withdrawal symptoms when gaming is taken away; (3) tolerance, resulting in the need to spend increasing amounts of time engaged in games; (4) unsuccessful attempts to control participation in games; (5) loss of interest in previous hobbies and entertainment as a result of, and with the exception of, games; (6) continued excessive use of games despite knowledge of psychosocial problems; (7) deceiving family members, therapists, or others regarding the amount of gaming; (8) use of games to escape or relieve negative moods; and (9) jeopardising or losing a significant relationship, job, or education or career opportunity because of participation in games (p.795)". .

[5] Most of the material featured in Chapter 3 resulted in the following refereed publication: Pontes, H. M., Kuss, D. J., & Griffiths, M. D. (in press). Psychometric assessment of Internet Gaming Disorder in neuroimaging studies: A systematic review. In C. Montag, & M. Reuter (Eds.), *Internet and smartphone addiction: Neuroscientific approaches*:Springer.

Numerous studies have systematically reported potentially harmful effects games can have on human health because of their potentially addictive features (Eichenbaum, Kattner, Bradford, Gentile, & Green, 2015; Lehenbauer-Baum et al., 2015; Schmitt & Livingston, 2015) and overall detrimental effects (Brunborg, Mentzoni, & Frøyland, 2014; Haghbin, Shaterian, Hosseinzadeh, & Griffiths, 2013; Hull, Williams, & Griffiths, 2013; Kuss & Griffiths, 2012c) both from a psychosocial and neuroscientific standpoint. From a psychosocial viewpoint, such harmful effects related to addiction to gaming can include decreased levels of exercise and sports (Henchoz et al., 2016), sacrificing work, education, hobbies, socialising, time with partner/family, and sleep (Griffiths, Davies, & Chappell, 2004), impaired decision-making (Yao et al., 2015), poorer psychosomatic health (Wittek et al., 2015), decreased emotional and behavioural functioning (Baer, Saran, & Green, 2012), increased stress (Snodgrass et al., 2014), greater incidence of psychiatric symptoms (Király, Urbán, et al., 2015; Vukosavljevic-Gvozden, Filipovic, & Opacic, 2015), lower expected college engagement and grades in adolescent students (Schmitt & Livingston, 2015), decreased academic performance (Brunborg et al., 2014), lower levels of sociability, self-efficacy and satisfaction with life (Festl, Scharkow, & Quandt, 2013), in addition to other psychiatric disorders and abnormal behaviours (see Griffiths et al., 2012, 2015; Kuss & Griffiths, 2012c).

On the other hand, from a neuroscientific perspective, a systematic review of neuroimaging studies of Internet and gaming addiction (Kuss & Griffiths, 2012a) found that excessive Internet use and gaming is associated with changes on the behavioural, as well as molecular and neural circuitry levels, providing objective evidence of the biological similarity between Internet and gaming addiction and more traditional substance-related addictions. Previous studies (e.g., Dong et al., 2012; Dong & Potenza, 2014; Dong, Shen, Huang, & Du, 2013; J Liu et al., 2016) have

found that Internet Gaming Disorder is associated with abnormal activations in frontal, insular, temporal, and parietal cortices when affected individuals perform tasks related to impulse control. Additionally, previous structural studies have found that Internet Gaming Disorder was associated with structural abnormalities in grey matter, such as decreased lower grey matter density in the bilateral inferior frontal gyrus, left cingulate gyrus, insula, right precuneus, and right hippocampus (X Lin, Dong, Wang, & Du, 2015). In addition, Internet Gaming Disorder has also found to be associated with lower white matter density in the inferior frontal gyrus, insula, amygdala, and anterior cingulate, brain regions that are involved in decision-making, behavioural inhibition and emotional regulation (X Lin, Dong, et al., 2015).

Objectives

Since Internet Gaming Disorder may be related to a wide range of health and psychiatric disorders as reported by previous studies, it has become vital to understand and evaluate the potential methodological shortcomings of research on Internet Gaming Disorder using neuroimaging techniques in order to refine future research. For this reason, and given the ongoing debates surrounding the issue of assessment of Internet Gaming Disorder and the need for unification in the way assessment of this disorder is carried out (Griffiths et al., 2014; Griffiths et al., 2016; Petry & O'Brien, 2013; Petry, Rehbein, Gentile, et al., 2015; Petry et al., 2014; Pontes & Griffiths, 2015b), the present chapter systematically reviews the extant neurobiological evidence of studies that have adopted commonly used types of neuroimaging techniques to investigate the psychobiology of Internet Gaming Disorder. More specifically, the main aim of this chapter is to investigate what are (if any) the caveats and potential biases and limitations stemming from an assessment of Internet Gaming Disorder during participant recruitment in such studies. The secondary objective of this chapter is to ascertain the publication rates of Internet Gaming Disorder

studies using neuroimaging techniques as of May 2013 and also briefly summarise the main findings of these studies. To the best of this author's knowledge, no previous review has attempted to summarise and critique the existing evidence regarding the assessment of Internet Gaming Disorder in neuroimaging studies (as opposed to describing neuroimaging evidence for Internet and gaming addiction; Kuss & Griffiths, 2012c). This chapter contributes a critical discussion of current practices in the assessment of Internet Gaming Disorder and may pave the way for new methodologically robust research.

Method

Eligibility Criteria

To be eligible for inclusion in this systematic review, only original studies investigating Internet Gaming Disorder and its associated neurological correlates were included. Additionally, eligible studies had to: (i) assess Internet Gaming Disorder or direct effects of gaming on neurological functioning, (ii) be an empirical study, (iii) use neuroimaging techniques, (iii) be published in a scholarly peer-reviewed journal, and (iv) be written in English, Spanish, German, Polish or Portuguese language as these were the language spoken by the researchers conducting this study. Searches were limited to articles published from May 2013 to January 2016, because Internet Gaming Disorder was officially defined and conceptualised by the American Psychiatric Association in May 2013, which followed the publication of psychometric tools using this framework to assess Internet Gaming Disorder. Studies were excluded from review if they were (i) unpublished dissertation and thesis studies, (ii) single-case reports (N = 1), and (iii) review studies.

Information Sources and Search

The identification of studies was carried out by performing electronic searches on ProQuest, which included the following databases: *Applied Social Sciences Index and Abstracts (ASSIA), ERIC, ProQuest Psychology Journals, PsycARTICLES, and PsycINFO*. An additional independent search was carried out on *MEDLINE* to enhance the accuracy of the results regarding the systematic search of relevant studies. The search strategy adopted to identify relevant papers in the aforementioned databases sought to include and be able to retrieve the most common types of neuroimaging techniques employed in research on Internet Gaming Disorder (i.e., electroencephalogram [EEG], positron emission tomography [PET], single photon emission computed tomography [SPECT], functional magnetic resonance imaging [fMRI], structural magnetic resonance imaging [sMRI], diffusion-tensor imaging [DTI]) as reported in a previous systematic review (i.e., Kuss & Griffiths, 2012a). As a result, the following search strategy was used:

(patholog* OR problem* OR addict* OR compulsive OR dependen* OR disorder*) AND (video OR computer OR internet) gam* AND (neuroimaging OR eeg OR pet OR spect or fmri OR smri OR dti)

Study Selection and Data Collection Processes

All procedures reported in this subsection were conducted by the research team in order increase the rigour and robustness of this study. Following the initial literature searches, each study's title and abstract were screened for eligibility. Full texts of all potentially relevant studies were then retrieved and further examined for eligibility. The flow diagram in Figure 3.1 details the

selection process. Information from the included studies was recorded in an electronic spreadsheet after in-depth analysis. The overall data extracted from the studies reviewed subdivided into two larger overarching groups: (i) methodological characteristics and (ii) instrument characteristics. The information extracted concerning the studies' methodological characteristics included: provenience of the sample recruited (i.e., country), sample size, gender distribution, age range (and mean age), sample characteristics, neuroimaging technique used, study aims, and main findings. The information extracted regarding the features of the instruments used to diagnose Internet Gaming Disorder included: instrument utilised, item sensitivity, criteria included, time scale, theoretical framework, suitability to assess Internet Gaming Disorder, alignment with the nine Internet Gaming Disorder criteria, and missing Internet Gaming Disorder criteria.

Results

Study Selection

After performing the aforementioned electronic searches, a total of 853 studies (*ProQuest* n = 745; *MEDLINE* n = 108) were initially identified, with the search performed on the *ProQuest* website yielding the following results: *ProQuest Psychology Journals* n = 524; *PsycARTICLES* n = 115; *PsycINFO* n = 106; *Applied Social Sciences Index and Abstracts* n = 0; and *ERIC* n = 0. All 853 papers had their titles and abstracts screened, resulting in the exclusion of 833 papers that were of no relevance for the present review. Consequently, a total of 20 studies were eligible for further review. Of these, six papers had to be further excluded because they were either duplicated (n = 2), did not assess Internet Gaming Disorder (n = 1), or were review papers (n = 3). Following this study selection process, 14 studies were eligible for further analysis as they fully endorsed all inclusion criteria (see Figure 3.1).

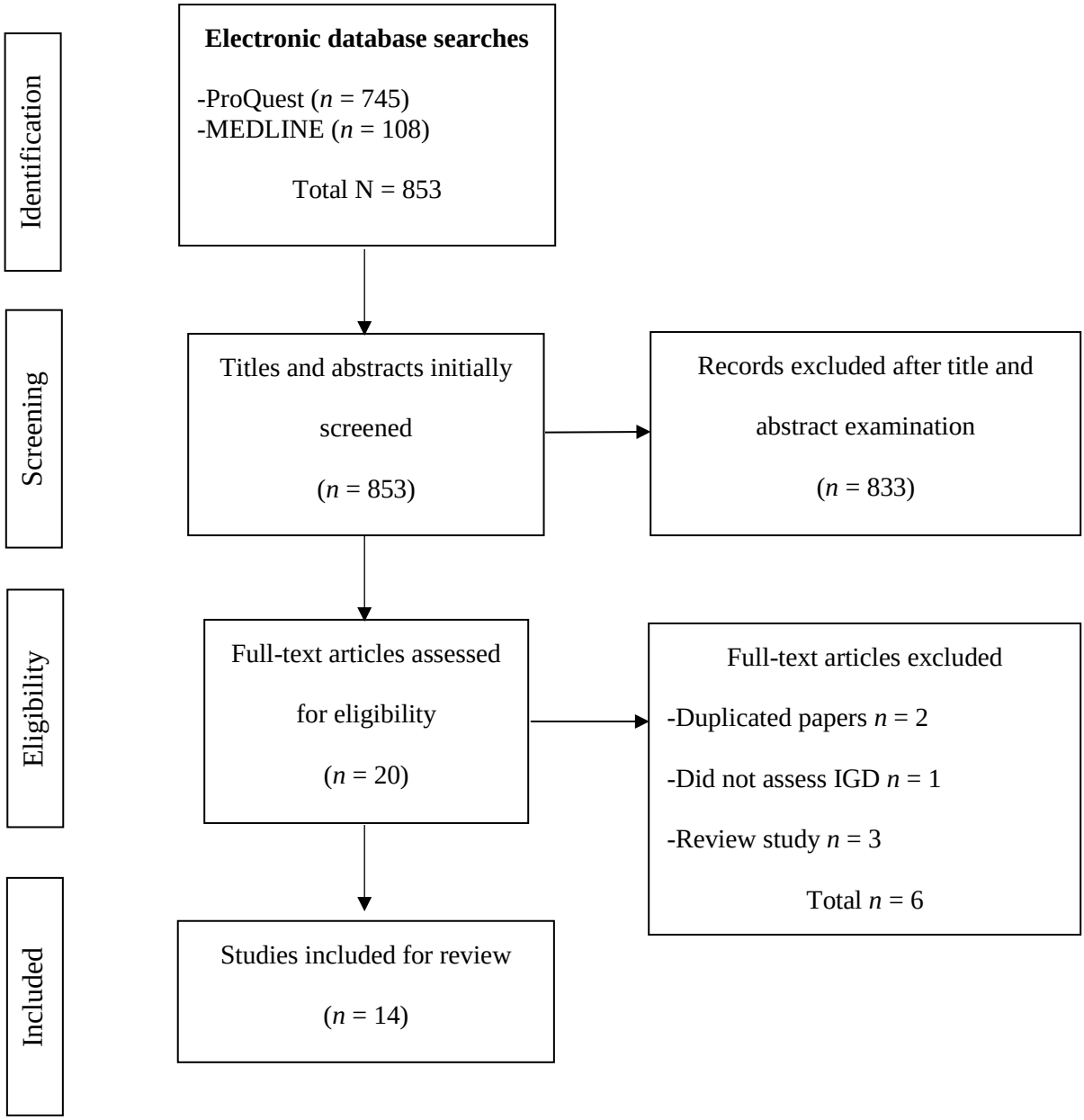

Figure 3.1. Flow Diagram of the Study Selection Process

Publication Rate of Peer-reviewed Neuroimaging Studies on Internet Gaming Disorder

One of the conditions set by the American Psychiatric Association in the DSM-5 was that if Internet Gaming Disorder is to be recognised as an independent disorder in the future, more studies should be carried out to help ascertain the prevalence rates of Internet Gaming Disorder across the globe, its clinical course and possible genetic influences, and potential biological factors, based on, for instance, brain imaging data (American Psychiatric Association, 2013). For this reason, research on Internet Gaming Disorder employing neuroimaging techniques is of utmost importance not only because of its methodological capabilities, but also because the apparent weight it may carry towards the formal recognition of Internet Gaming Disorder as an independent disorder in the future (as neurobiological empirical evidence appears to be given more weight than psychological empirical evidence when considering the inclusion of behavioural addictions – such as Internet Gaming Disorder and sex addiction – in the DSM; Griffiths, 2016). In light of this, Figure 3.2 shows a clear trend towards an increase of published peer-reviewed studies on Internet Gaming Disorder using neuroimaging techniques. This increase trend is most obvious from the period of 2014 to 2015 because the official diagnosis of Internet Gaming Disorder only appeared in the scientific literature in May 2013 with the publication of the DSM-5, and also because the systematic searches performed for this review were conducted in January 2016.

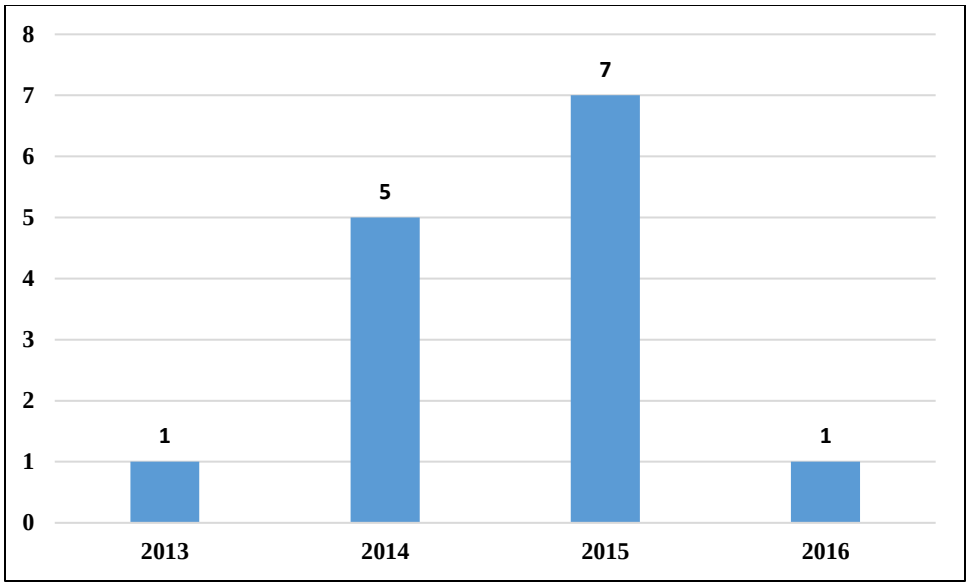

Figure 3.2. Publication rate of Peer-reviewed Neuroimaging Studies on Internet Gaming Disorder (IGD) from May 2013 to January 2016

Note: This figure only includes studies that met all inclusion criteria of the present systematic review.

Neuroimaging of Internet Gaming Disorder

In order to present some of the latest neuroimaging research on Internet Gaming Disorder, this section briefly summarises the main findings of the studies that fully met the inclusion criteria of this review as previously outlined. Ding et al. (2014) found that the prefrontal cortex may be involved in the circuit modulating impulsivity, while its impaired function may be related to high impulsivity in adolescents with Internet Gaming Disorder, which in turn, may contribute to the Internet Gaming Disorder process. Sun et al. (2014) concluded that diffusional kurtosis imaging (DKI) can detect subtle differences in grey matter microstructure between Internet Gaming Disorder and healthy individuals, and that DKI can provide sensitive imaging biomarkers for assessing the severity of Internet Gaming Disorder. In the study conducted by Dieter et al. (2015),

the authors found that disordered gamers tend to identify significantly more with their avatar in comparison to non-disordered gamers. The authors also noted that "the concrete avatar might increasingly replace the rather abstract ideal in the transition from non-disordered gaming to disordered gaming" (p. 8).

Wang et al. (2015) found that individuals with Internet Gaming Disorder presented with significant grey matter volume reduction in the bilateral anterior cingulated cortex and other brain regions when compared to healthy individuals. Additionally, Internet Gaming Disorder was also found to compromise both behavioural and neural structure in adolescents with Internet Gaming Disorder. Xing et al. (2014) found that the abnormal structural connectivity in the right salience network was associated with impaired executive function in adolescents with Internet Gaming Disorder, with structural connectivity differences found between adolescents with Internet Gaming Disorder and healthy controls. Yuan et al. (2016) found that differences between individuals with Internet Gaming Disorder and healthy controls in the striatum volume and frontostriatal circuits resting-state functional connectivity (RSFC) emerged. Additionally, cognitive control deficits detected in Internet Gaming Disorder were associated with reduced frontostriatal RSFC strength.

In addition to these findings, Hahn et al. (2014) concluded that converging evidence for a general reward system deficiency in frequent online gamers exists as frequent players displayed significantly decreased neural activation when anticipating both small and large monetary rewards in the ventral striatum. Luijten, Meerkerk, Franken, Van de Wetering, and Schoenmakers (2015) found reduced inhibitory control amongst individuals with Internet Gaming Disorder but no evidence was found for reduced error processing. Furthermore, attentional control and error processing were mostly intact in individuals with Internet Gaming Disorder. At the molecular level, Tian et al. (2014) found that the D_2 receptor level is significantly associated with glucose

metabolism in disordered gamers, indicating that D_2/5-HT_{2A} receptor-mediated dysregulation of the orbitofrontal cortex could underlie a mechanism for loss of control and compulsive behaviour in individuals with Internet Gaming Disorder. Duven, Müller, Beutel, and Wölfling (2015) reported that tolerance effects are present in patients with Internet Gaming Disorder and noted that the initial orienting toward the gaming reward is suggested to consume more capacity for patients with Internet Gaming Disorder when compared to healthy controls.

Lin, Jia, Zang, and Dong (2015) found that individuals with Internet Gaming Disorder demonstrated lower low-frequency fluctuation (fALFF) values in superior temporal gyrus and higher fALFF values in the cerebellum. Wang et al. (2015) found that adolescents with Internet Gaming Disorder exhibited decreased voxel-mirrored homotopic connectivity (VMHC) between the left and right superior frontal gyrus (orbital part), inferior frontal gyrus (orbital part), middle frontal gyrus and superior frontal gyrus. Son et al. (2015) found that lower absolute beta power can be used as a potential trait marker of Internet Gaming Disorder. Finally, Yuan et al. (2013) found that adolescents with Internet Gaming Disorder presented with abnormal amplitude of low frequency fluctuations in comparison to controls.

In summary, with regards to the functional and structural changes found in individuals with Internet Gaming Disorder when compared to healthy controls, these are often observed within specific brain areas in the frontal lobe (i.e., dorsolateral prefrontal cortex, orbitofrontal cortex, prefrontal gyrus, and the middle frontal gyrus), parietal and temporal lobes (i.e., parahippocampal gyrus), basal ganglia, thalamus, insula and the cerebellum. A finding that mirrors those recently report in similar review studies (Lemos et al., 2014). Furthermore, regardless of the neuroimaging technique utilised, these studies provide preliminary evidence that illustrate converging points and similarities between substance use disorders and Internet Gaming Disorder, especially during

craving processes, a finding that has been previously reported (Smith, Hummer, & Hulvershorn, 2015) and that warrants further investigation as at this point, it may be premature to draw definite conclusions regarding the similarities between Internet Gaming Disorder and substance use disorders as the definition of Internet Gaming Disorder currently includes many features present in the definition and diagnostic framework of substance use disorders. Taken together, the main findings reported across all reviewed studies do not provide a complete picture of neuroimaging studies on Internet Gaming Disorder as other potentially useful findings from similar studies may be missing due to strict inclusion criteria employed in this review.

Methodological Characteristics of Studies

In order to assess some of the methodological features of existing neuroimaging studies examining Internet Gaming Disorder, key variables were analysed amongst the reviewed studies, such as: geographical location of the sample recruited (i.e., country), sample size, gender distribution, age range and mean, sample characteristics, neuroimaging technique used, study aims, and main findings (see Table 3.1).

Regarding the cultural context of the samples recruited, nine studies out of fourteen recruited Chinese samples (Ding et al., 2014; Lin, Jia, et al., 2015; Sun et al., 2014; Tian et al., 2014; Wang et al., 2015; Wang et al., 2015; Xing et al., 2014; Yuan et al., 2013; Yuan et al., 2016), three studies used German samples (Dieter et al., 2015; Duven et al., 2015; Hahn et al., 2014), one study used a Dutch sample (Luijten et al., 2015), and one study used a South Korean sample (Son et al., 2015). As for the sample sizes, studies recruited from a minimum of 26 disordered gamers in one study (Tian et al., 2014) to a maximum 87 disordered gamers in another study (Yuan et al., 2016). The mean number of disordered gamers recruited across all 14 studies was 43 (S.D. = 18.3).

Table 3.1. Main Methodological Characteristics of the Studies that met the Inclusion Criteria

Author	Country	Sample Size	Gender Distribution (%)	Age range (years) & Mean Age (S.D.)	Sample Characteristics	Neuroimaging Technique	Study Aims	Main Findings
Ding et al. (2014)	China	34	50% male	NR;16.41 (3.20)[1]	Adolescents recruited from a mental health centre[1]	fMRI	To investigate if different facets of trait impulsivity may be specifically linked to the brain regions characteristic of impaired impulse inhibition in IGD subjects	The prefrontal cortex may be involved in the circuit modulating impulsivity, while its impaired function may relate to high impulsivity in adolescents with IGD, which may contribute directly to the IGD process
Sun et al. (2014)	China	39	83% male[1]	NR; 20.50 (3.55)[1]	Adolescents recruited from a mental health centre (i.e., IGD group) and advertisements (i.e., healthy controls)	fMRI	To investigate the utility of diffusional kurtosis imaging (DKI) in the detection of grey matter alterations in people suffering from IGD	DKI can detect subtle differences in grey matter microstructure between IGD and healthy individuals. Additionally, DKI model can provide sensitive imaging biomarkers for assessing the severity of IGD

Dieter et al. (2015)	Germany	32	91% male	NR; 26.72 (6.30)	Adults with IGD recruited through a mental health centre and healthy controls recruited from advertisements	fMRI	To investigate the psychological and neurobiological correlates reflecting the relation of the avatar to disordered gamers' concepts of their self and ideal self	Disordered gamers identify significantly more with their avatar than non-disordered gamers. The avatar might increasingly replace gamers' ideal self as the addiction progresses
H Wang et al. (2015)	China	56	67% male	NR; 18.80 (1.33)[1]	Late adolescent college students	VBM	To investigate the relationship between alteration of grey matter volume and cognitive control feature in adolescents with IGD	Grey matter volume reduction was found in the bilateral anterior cingulate cortex and other brain regions. IGD compromised both behavioural activity and neural structure in adolescents with IGD
Xing et al. (2014)	China	34	61% male	NR; 19.10 (0.70)[1]	Adolescents	rsfMRI	To investigate the relationship between the connections within salience network and cognitive control in IGD adolescents	The abnormal structural connectivity in the right salience network was associated with impaired executive function in IGD adolescents. Structural connectivity differences were found between IGD adolescents and healthy controls

Yuan et al. (2016)	China	87	75% male	15-23; 19 (1.40)[1]	Adolescent and young adult university students	rsfMRI	To investigate the differences of striatum volume and resting-state functional connectivity (RSFC) networks in IGD and healthy individuals	Differences between IGD and healthy controls in the striatum volume and frontostriatal circuits RSFC emerged. Cognitive control deficits detected in IGD were correlated with reduced frontostriatal RSFC strength
Hahn et al. (2014)	Germany	33	100% male	18-34; 25.50 (4.18)[1]	Adolescent and adult gamers and non-gamers	rsfMRI	To investigate if players of the Massively Multiplayer Online Role-Playing Game World of Warcraft show a generally deficient reward system as in substance use disorders	Converging evidence for a general reward system deficiency in frequent online gamers was found. Frequent players displayed significantly decreased neural activation during the anticipation of both small and large monetary rewards in the ventral striatum

Luijten et al. (2015)	Netherlands	34	100% male	NR; 20.83 (3.05)[1]	Adolescent and adult gamers and non-gamers	fMRI	To investigate if IGD players are characterised by deficits in various aspects of cognitive control (i.e., inhibitory control, error processing, attentional control)	Reduced inhibitory control amongst IGD players was found while no evidence was found for reduced error processing in IGD players. Attentional control and error processing were mostly intact
Tian et al. (2014)	China	26	100% male	NR; 23.50 (2.60)[1]	Adolescent and adult gamers and non-gamers	PET	To examine the post synaptic D_2 receptors and regional brain glucose metabolism in IGD	The D_2 receptor level is significantly associated with glucose metabolism in disordered gamers, indicating that D_2/5-HT_{2A} receptor-mediated dysregulation of the orbitofrontal cortex could underlie a mechanism for loss of control and compulsive behaviour in IGD individuals
Duven et al. (2015)	Germany	27	100% male	NR; 24.29 (5.84)[1]	Adults with IGD recruited through a mental health centre and healthy controls recruited from advertisements	EEG	To investigate whether enhanced motivational attention or tolerance effects are present in patients with IGD	Tolerance effects are present in patients with IGD. Furthermore, the initial orienting toward the gaming reward is suggested to consume more capacity for patients with IGD

X Lin, Jia, et al. (2015)	China	52	100% male	NR; 22.20 (3.13)[1]	Late adolescent and adult college students	rsfMRI	To investigate the abnormal spontaneous brain activity in IGD with the low-frequency fluctuation (fALFF) at different frequency bands	IGD individuals demonstrated lower fALFF values in superior temporal gyrus and higher fALFF values in cerebellum
Wang et al. (2015)	China	41	76% male	14-17; 16.94 (2.73)[1]	Adolescents with IGD recruited from a mental health centre and healthy controls	rsfMRI	To investigate the interhemispheric resting state functional connectivity of the whole brain of adolescents with IGD using a new voxel-mirrored homotopic connectivity (VMHC) method	Adolescents with IGD exhibited decreased VMHC between the left and right superior frontal gyrus (orbital part), inferior frontal gyrus (orbital part), middle frontal gyrus and superior frontal gyrus
Son et al. (2015)	South Korea	76	100% male	NR; 22.71 (5.47)	Young males diagnosed with IGD (N = 34), alcohol use disorder (N = 17) and 25 healthy controls	rsEEG	To identify the unique neurophysiological characteristics that can be used as biomarkers of IGD	Lower absolute beta power can be used as a potential trait marker of IGD

Yuan et al. (2013)	China	36	66% male	NR; 19.40 (3.10)[1]	Adolescent college students	rsfMRI	To investigate the local features of spontaneous brain activity in adolescents with IGD and healthy controls during resting-state	IGD adolescents presented with abnormal amplitude of low frequency fluctuations in comparison to controls

Superscripts: [1] Information concerning the experimental (i.e., disordered gamers) group.
Abbreviations: **NR**: not reported; **fMRI**: functional magnetic resonance imaging; **VBM**: voxel-based morphometry; **rsFMRI**: resting-state functional magnetic resonance imaging; **PET**: positron emission tomography; **EEG**: electroencephalography. **rsEEG**: resting-state electroencephalography.

In terms of gender distribution across all studies, only one study had an even split between genders (Ding et al., 2014) while six studies recruited male-only samples (Duven et al., 2015; Hahn et al., 2014; Lin, Jia, et al., 2015; Luijten et al., 2015; Son et al., 2015; Tian et al., 2014). Although Table 3.1 summarises the age of gamers recruited, little information was available in the reviewed studies regarding the overall age range of all gamers as the studies usually reported this information only for each group of participants (e.g., experimental and control groups). Despite this limitation, the data gathered suggests that most disordered gamers recruited were in their mid- to late adolescence given the characteristics of the samples recruited across all studies. Almost half of all reviewed studies included gamers that were either addicted to *World of Warcraft* (*WoW*) (i.e., Hahn et al., 2014; Tian et al., 2014; Yuan et al., 2013) or *League of Legends* (*LoL*) (i.e., Xing et al., 2014; Yuan et al., 2016) or included both types of gamers (i.e., participants addicted to *WoW* and participants addicted to *LoL*) (i.e., Dieter et al., 2015) only. The procedure of recruiting participants having problems with only a particular game or specific game genre is questionable because it clearly limits the external validity of the findings reported in such studies as it is unclear to what extent these findings can be replicated across all disordered gamers. Interestingly, all studies provided some form of control group, as well as inclusion, and exclusion criteria in the recruitment of participants, which certainly helped mitigate some of the potential threats to the internal validity of the studies in question.

Finally, as to the neuroimaging techniques used, six studies employed resting-state functional magnetic resonance imaging (rsfMRI) (Hahn et al., 2014; Lin, Jia, et al., 2015; Y Wang et al., 2015; Xing et al., 2014; Yuan et al., 2013; Yuan et al., 2016), four studies used functional magnetic resonance imaging (fMRI) (Dieter et al., 2015; Ding et al., 2014; Luijten et al., 2015; Sun et al., 2014), one study used positron emission tomography (PET) (Tian et al., 2014), one

study used electroencephalography (EEG) (Duven et al., 2015), one study used resting-state electroencephalography (rsEEG) (Son et al., 2015), and one study used voxel-based morphometry (VBM) (Wang et al., 2015).

Methodological Characteristics of the Instruments Used to Assess Internet Gaming Disorder

Table 3.2 provides an overview regarding the preferred methods for diagnosing Internet Gaming Disorder among the reviewed studies and the features of these instruments and/or diagnostic approaches. Even though the main construct under investigation of the studies reviewed was Internet Gaming Disorder, the diagnosis of this disorder was carried out most of the time using measures that were either (i) designed to assess generalised Internet addiction or (ii) measures that had their theoretical framework based on the concept of Internet addiction or non-validated diagnostic criteria. More specifically, in terms of diagnosis of Internet Gaming Disorder, five studies (i.e., Ding et al., 2014; Sun et al., 2014; Wang et al., 2015; Y Wang et al., 2015; Yuan et al., 2013) used Young's Diagnostic Questionnaire (YDQ) (Young, 1998b) with Beard and Wolf's suggested criteria for Internet addiction (Beard & Wolf, 2001), two studies (i.e., Lin, Jia, et al., 2015; Xing et al., 2014) used the Internet Addiction Test (IAT) (Young, 1998a), one study (i.e., Luijten et al., 2015) used the Videogame Addiction Test (VAT)[6] (Van Rooij et al., 2012), one study (i.e., Tian et al., 2014) used Tao and colleagues' diagnostic criteria for Internet addiction Tao and colleagues' (Tao et al., 2010), one study (i.e., Dieter et al., 2015) used the checklist for the Assessment of Internet and Computer Game Addiction (AICA-C) (Wölfling, Beutel, & Müller, 2012), another study (i.e., Duven et al., 2015) used the Scale for the Assessment of Internet and Computer Game Addiction (AICA-S, CSV-S) (Wölfling, Müller, & Beutel, 2011), and one study

[6] Although this test presents with some degree of validity to assess gaming addiction, its theoretical framework is based on Compulsive Internet Use theory derived from the DSM-IV criteria for dependence and obsessive-compulsive disorder and the components model of addiction.

(i.e., Hahn et al., 2014) adopted a frequency criterion based on time spent gaming (i.e., playing at least four times per week for one hour or more for at least one year). Finally, only two studies (i.e., Son et al., 2015; Yuan et al., 2016) used the DSM-5 criteria (American Psychiatric Association, 2013) to diagnose Internet Gaming Disorder.

Although most studies relied on only one instrument or criterion to diagnose and assess the severity of Internet Gaming Disorder, five studies, including the two studies that used the official nine criteria to diagnose Internet Gaming Disorder, adopted two different instruments to diagnose and assess the severity of Internet Gaming Disorder (Ding et al., 2014; Son et al., 2015; Sun et al., 2014; Y Wang et al., 2015; Yuan et al., 2016), with these instruments either being the Chen Internet Addiction Scale (CIAS) (i.e., Ding et al., 2014; Sun et al., 2014; Wang et al., 2015) or the IAT (i.e., Son et al., 2015; Yuan et al., 2016).

Table 3.2. Main Features of the Instruments Used to Assess Internet Gaming Disorder (IGD) in Neuroimaging Studies

Author	Instrument	Item sensitivity	Criteria covered	Time Frame	Theoretical framework	Suitability to assess IGD[1]	Alignment with IGD criteria	Missing IGD criteria
Ding et al. (2014)	Young's Diagnostic Questionnaire (YDQ) modified to reflect Beard and Wolf's (2001) criteria for Internet addiction[2]	Yes/No	Preoccupation; tolerance; inability to control use; withdrawal; salience; jeopardy of opportunities; deception; mood modification	NR	Pathological gambling (DSM-IV)	No	Partial	3, 5, & 6
Sun et al. (2014)	Young's Diagnostic Questionnaire (YDQ) modified to reflect Beard and Wolf's (2001) criteria for Internet addiction[2]	Yes/No	Preoccupation; tolerance; inability to control use; withdrawal; salience; jeopardy of opportunities; deception; mood modification	NR	Pathological gambling (DSM-IV)	No	Partial	3, 5, & 6

Dieter et al. (2015)	Checklist for the Assessment of Internet and Computer game Addiction (AICA-C)	6-point	Craving; tolerance; withdrawal; loss of control; preoccupation; negative consequences	1 month	Internet addiction as a generalised problem including specific usages (e.g., video gaming)	Yes	Partial	5, 6, 7, & 8
Wang et al. (2015)	Young's Diagnostic Questionnaire (YDQ) modified to reflect Beard and Wolf's (2001) criteria for Internet addiction	Yes/No	Preoccupation; tolerance; inability to control use; withdrawal; salience; jeopardy of opportunities; deception; mood modification	NR	Pathological gambling (DSM-IV)	No	Partial	3, 5, & 6
Xing et al. (2014)	Internet Addiction Test (IAT)	6-point	Salience; excessive use; neglect work; anticipation; lack of control; neglect social life	1 month	Pathological gambling (DSM-IV)	No	Partial	2, 5, 6, & 8

Yuan et al. (2016)	IGD criteria (DSM-5)[3]	Yes/No	Preoccupation; withdrawal; tolerance; inability to control use; loss of interest in activities; continued excessive use despite knowledge of problems; deception; escape/mood modification; jeopardy or loss of relationships and opportunities	1 month	Internet Gaming Disorder (DSM-5)	Yes	Total	None
Hahn et al. (2014)	Frequency criteria (i.e., playing at least four times per week for 1 hour or more for at least 1 year)	-	Salience	12 months	Excessive playing time is likely to reflect IGD	No	Partial	2, 3, 4, 5, 6, 7, 8, & 9

Luijten et al. (2015)	Videogame Addiction Test (VAT)	5-point	Loss of control, conflict, preoccupation/ salience, coping/mood modification, withdrawal	NR	Compulsive Internet Use theory derived from the DSM-IV criteria for dependence and obsessive-compulsive disorder and the components model of addiction	Yes	Partial	3, 5, 6, 7, & 9
Tian et al. (2014)	Diagnostic criteria for Internet addiction by Tao et al. (2010)	NR	Preoccupation; withdrawal; tolerance; lack of control; excessive use despite problems; loss of interests; mood modification	3 months	Impulsive control disorder; pathological gambling (DSM-IV); components model of addiction and substance use disorder	No	Partial	7 & 9

Duven et al. (2015)	Scale for the Assessment of Internet and Computer Game Addiction (AICA-S, CSV-S)	5-point	Excessive use; preoccupation; compulsive use; tolerance; withdrawal; craving; escape; inability to control use; negative consequences	NR	Substance dependence (DSM-IV-TR and ICD-10)	Yes	Partial	2, 5, 6, 7, & 9
X Lin, Jia, et al. (2015)	Internet Addiction Test (IAT)	6-point	Salience; excessive use; neglect work; anticipation; lack of control; neglect social life	1 month	Pathological gambling (DSM-IV)	No	Partial	2, 5, 6, & 8
Wang et al. (2015)	Young's Diagnostic Questionnaire (YDQ) modified to reflect Beard and Wolf's (2001) criteria for Internet addiction[2]	Yes/No	Preoccupation; tolerance; inability to control use; withdrawal; salience; jeopardy of opportunities; deception; mood modification	NR	Pathological gambling (DSM-IV)	No	Partial	3, 5, & 6

Son et al. (2015)	IGD criteria (DSM-5)[3]	Yes/No	Preoccupation; withdrawal; tolerance; inability to control use; loss of interest in activities; continued excessive use despite knowledge of problems; deception; escape/mood modification; jeopardy or loss of relationships and opportunities	1 month	Internet Gaming Disorder (DSM-5)	Yes	Total	None
Yuan et al. (2013)	Young's Diagnostic Questionnaire (YDQ) modified to reflect Beard and Wolf's (2001) criteria for Internet addiction	Yes/No	Preoccupation; tolerance; inability to control use; withdrawal; salience; jeopardy of opportunities; deception; mood modification	NR	Pathological gambling (DSM-IV)	No	Partial	3, 5, & 6

Superscript: [1] Suitability was evaluated by verification of published peer-reviewed psychometric validation studies investigating the validity and reliability of the instrument to assess IGD; [2] The severity of IGD was assessed with the Chen Internet Addiction Scale (CIAS); [3] The severity of IGD was assessed with the IAT.
Abbreviation: NR: Not Reported.

Discussion

The present chapter sought to systematically review and evaluate some of the methodological and instrument characteristics of the most recent Internet Gaming Disorder studies that have employed commonly used neuroimaging techniques. In regards to the methodological features assessed in the reviewed studies, data were collected and analysed concerning the studies' methodological characteristics such as: geographical location of the sample recruited (i.e., country), sample size, gender distribution, age range and mean, sample characteristics, neuroimaging technique used, study aims, and main findings. Additionally, the quality of assessment of Internet Gaming Disorder amongst neuroimaging studies published after the formulation of the nine Internet Gaming Disorder criteria in the DSM-5 (American Psychiatric Association, 2013) was also assessed by examining the following indicators across all reviewed studies: instrument utilised, item sensitivity, criteria covered, time scale, theoretical framework, suitability to assess Internet Gaming Disorder, alignment with the nine Internet Gaming Disorder criteria, and missing Internet Gaming Disorder criteria.

Overall, this chapter provides objective data concerning a trend suggesting an increase in the publication rates of Internet Gaming Disorder studies using neuroimaging techniques since the publication of the DSM-5 (American Psychiatric Association, 2013). As shown in Figure 3.2, the number of such studies is increasing and this may be beneficial to the process of formal recognition of Internet Gaming Disorder in future editions of the DSM (and other diagnostic manuals). This is because the American Psychiatric Association suggested neurobiological evidence for Internet Gaming Disorder is of the utmost importance. However, quantity does not necessarily equate to quality because there are a series of methodological issues that appear to hinder the progress of this type of research. Based on the overall results found in this review, the following

recommendations are made to help improve the overall quality of future studies on Internet Gaming Disorder using neuroimaging techniques. Some of these recommendations apply to other types of Internet Gaming Disorder research (e.g., self-report surveys, focus group interviews, experiments, etc.), so the application of such recommendations is advised whenever possible as it may help strengthen the overall quality of future research into Internet Gaming Disorder.

Methodological Recommendations

1. Recruitment of gamers (cultural background): since most of the reviewed studies were carried out in Asian countries, mostly in China, and only few studies were conducted in Western countries, it is recommended that future studies recruit participants from both Western and Eastern regions of the world where online games are played. This procedure is crucial to improving the quality of research on Internet Gaming Disorder as replicability of findings across all cultures where online gaming is prevalent is important if research is to progress.
2. Recruitment of gamers (gender and age groups): based on the findings collated in this review, it is also recommended that researchers recruit samples that are balanced in terms of gender and age. It is important to recruit gamers from diversified cultural backgrounds otherwise, findings may (potentially) be gender/culture biased or gender/culture-specific, and therefore, less likely to be replicated.
3. Recruitment of gamers (clinical vs. experimental groups): although it is common practice to recruit participants seemingly addicted to specific types of games (e.g., *WoW, LoL*, etc.) or game genres (e.g., Massively Multiplayer Online Role Playing Games), as suggested by the findings of this review, this procedure should be avoided as it has been largely adopted

in past gaming addiction research from the early 2000s as discussed on Chapter 2 (see Pontes & Griffiths, 2014) and is known for being problematic because Internet Gaming Disorder can occur in any type of gaming and therefore is not limited to a specific type of game and/or genre. Ultimately, limiting the recruitment of individuals affected with Internet Gaming Disorder to specific games may lead to biased results as other disordered gamers who play other games and genres may be overlooked.

4. Neuroimaging data (use of eclectic techniques): one noticeable finding in this review was that a large number of studies employed rsFMRI in order to collect imaging data from gamers. Although this may not be problematic in and of itself, authors are advised to adopt an eclectic approach to imaging data collection by using more heterogeneous and other cutting-edge techniques so more information regarding the neurobiological aetiology and course of Internet Gaming Disorder may be acquired. For instance, the combination of fMRI techniques with insights from PET research provides more direct insights to the biochemical mechanism of human behaviours, including Internet Gaming Disorder (Ko, Liu, & Yen, 2015). The adoption of such approaches is likely to lead to quicker recognition of Internet Gaming Disorder by the psychiatric community as an independent disorder because greater and more diversified data will be available.
5. The inherent potential of using fMRI (refining the diagnostic features of Internet Gaming Disorder): due to the need for differentiating chemical and non-chemical addictions coupled with the need to refine the diagnostic features of Internet Gaming Disorder, studies using fMRI techniques are welcome due to their inherent potential for investigating the specific mechanisms of addiction, including response to a substance, vulnerability for addiction, characteristics or symptoms of addictive behaviour, and consequences of

addiction (Fowler, Volkow, Kassed, & Chang, 2007; Ko et al., 2015). For this reason, neurobiological research into Internet Gaming Disorder should formulate clear hypotheses derived from previous evidence from brain imaging studies as they might help clarify the utility and appropriateness of having specific diagnostic criteria within the diagnostic framework of Internet Gaming Disorder. Consequently, this type of research may provide robust evidence to either confirm or disconfirm claims that Internet Gaming Disorder may arise without associated withdrawal symptoms (Kaptsis, King, Delfabbro, & Gradisar, 2016) or that the tolerance criterion of Internet Gaming Disorder might be a prominent characteristic of passionate gaming rather than a criterion indicative of bona fide gaming addiction (Kardefelt-Winther, 2015a).

6. Impacts of Internet Gaming Disorder on cognition (avoiding premature conclusions): according to Ko et al. (2015), any conclusions regarding cognitive function in Internet Gaming Disorder would still be premature as the overall effect of Internet Gaming Disorder on cognitive functioning remains controversial. Contrary to most controlled substances that are known to have damaging effects on the brain, a reasonable assumption is that they impair cognitive function. However, it is known that gaming can exercise and enhance many specific cognitive functions (e.g., Stroud & Whitbourne, 2015; Toril, Reales, & Ballesteros, 2014). For this reason, the hypothesis that gaming in and of itself produces a deficit in cognitive function is questionable because perfect performance in gaming requires good cognitive function (Ko et al., 2015). Thus, studies reporting potentially negative impacts of Internet Gaming Disorder on cognition should take into account the fact that gaming may also produce positive cognitive effects on gamers.

Recommendations for the Assessment of Internet Gaming Disorder

7. Assessment of Internet Gaming Disorder (key assessment issues): as shown in Table 3.2, although all studies reviewed concerned the phenomenon of Internet Gaming Disorder, the diagnosis of this potential disorder was largely conducted by employing assessment instruments that were either (i) designed to assess generalised Internet addiction or (ii) had their theoretical framework based on the concept of Internet addiction or non-validated diagnostic criteria. This is a critical finding of this review because the use of different, non-specific, and/or psychometrically weak tools to assess Internet Gaming Disorder not only represents a threat to the call for unification in the assessment of Internet Gaming Disorder (Griffiths et al., 2016), but also hinders the progress of research in this field as cross-cultural comparisons between studies are virtually impossible to be achieved under such circumstances (Kuss, Griffiths, et al., 2014). Moreover, researchers in the field are discouraged to adopt such procedures because they severely compromise the overall validity of neuroimaging studies on Internet Gaming Disorder since the main construct under investigation is not being properly assessed but instead, other related (and yet different) constructs are being assessed (i.e., generalised Internet addiction rather than Internet Gaming Disorder).
8. Assessment of Internet Gaming Disorder (frequency of gameplay and Internet Gaming Disorder): although it is not common practice to assess Internet Gaming Disorder based on frequency of gameplay (i.e., time spent gaming), there are still studies using the frequency criterion as a way to diagnosing Internet Gaming Disorder cases. It has now been long establish in the field that excessive gaming does not necessarily equate to addiction (Griffiths, 2010a; Kuss, Louws, & Wiers, 2012) and that there is a difference between

engaged and addicted gamers (see Charlton & Danforth, 2007; Fuster et al., 2016; Pontes, Király, et al., 2014). Therefore, authors are encouraged to assess and diagnose Internet Gaming Disorder based on newly developed standardised instruments available that were devised using the updated framework to assess Internet Gaming Disorder (i.e., the American Psychiatric Association's nine criteria) and that have been shown to possess acceptable levels of validity and reliability (such as: Király, Sleczka, et al., 2017; Lemmens, Valkenburg, & Gentile, 2015; Pontes & Griffiths, 2015a; Pontes, Király, et al., 2014). By adopting such a recommendation, the goal of unification in the assessment of Internet Gaming Disorder will be more tangible and less difficult to achieve.

9. Assessment of Internet Gaming Disorder (heterogeneity issues): the findings of the present chapter mirrored those found by King and colleagues (2013). More specifically, the present review found that the included studies used eight different methods for diagnosing Internet Gaming Disorder, which suggests great disparity and heterogeneity between the preferred methods for assessing Internet Gaming Disorder in this new era of research. As noted above, there are valid and reliable psychometric tools designed to assess Internet Gaming Disorder based on the American Psychiatric Association's suggested framework and these should be used. Because of the inherent difficulties in obtaining a gold standard for Internet Gaming Disorder across studies, authors can mitigate the possible biases stemming from the assessment of this disorder by adopting commonly used tools that assess Internet Gaming Disorder using the American Psychiatric Association criteria and possess some degree of validity and reliability. This is an important aspect of research into Internet Gaming Disorder more generally because (as shown in Table 3.2) most instruments used to assess Internet Gaming Disorder are based on theoretical frameworks of Internet

addiction that lack content validity to assess Internet Gaming Disorder because many important aspects of the Internet Gaming Disorder construct are not fully covered.

10. Assessment of Internet Gaming Disorder (diagnosis vs. severity): according to the findings reported, most of the studies reviewed relied on one instrument or criterion to diagnose Internet Gaming Disorder and another one to assess the severity of Internet Gaming Disorder. More specifically, five studies, including the two studies that have used the nine official criteria to diagnose Internet Gaming Disorder, adopted two different instruments to diagnose and assess the severity of Internet Gaming Disorder (Ding et al., 2014; Son et al., 2015; Sun et al., 2014; Wang et al., 2015; Yuan et al., 2016), with these instruments either being the CIAS (i.e., Ding et al., 2014; Sun et al., 2014; Wang et al., 2015) or the IAT (i.e., Son et al., 2015; Yuan et al., 2016). Although it is not entirely clear as to why two different instruments were used to diagnose and assess the severity of Internet Gaming Disorder, this certainly does not facilitate a sound assessment of Internet Gaming Disorder as more noise is introduced into such studies with the use of different assessment tools. Additionally, assessing the severity of Internet Gaming Disorder with generalised Internet addiction is not the way forward as issues of construct validity may emerge. Hence, it is recommended to use one of the newly standardised psychometric tools to assess the severity of Internet Gaming Disorder as well as an initial structured interview to diagnose Internet Gaming Disorder based on the nine Internet Gaming Disorder criteria if necessary as they appear to have clinical validity (Ko et al., 2014).

Based on the findings raised and highlighted in this chapter (and the recommendations generated upon them), it is hoped that future Internet Gaming Disorder studies, especially those

using neuroimaging techniques, may improve their methodological and instrumentation features as there are several different ways to overcome such shortcomings that most of the extant studies on Internet Gaming Disorder using neuroimaging techniques present with.

PART II: EMPIRICAL STUDIES

CHAPTER 4: The Conceptualisation and Measurement of DSM-5 Internet Gaming Disorder: The Development of the IGD-20 Test[7]

Introduction

Over the last decade, there has been growing worldwide concern from researchers about 'gaming addiction'. Official medical bodies such as the American Psychiatric Association (American Psychiatric Association, 2013) and numerous scholars (Griffiths et al., 2014; King et al., 2013; Petry & O'Brien, 2013; Petry et al., 2014; Pontes & Griffiths, 2014) have suggested the need for unification and consensus for the assessment of gaming addiction if this phenomenon is to be considered as an independent clinical entity in the future. Despite the proliferation of research on gaming behaviour over the last few years (Griffiths et al., 2012; Kuss & Griffiths, 2012b), the field has been hindered by the use of inconsistent and non-standardised criteria to assess and identify problematic and/or addictive videogame use (Griffiths et al., 2012). Moreover, this problem may be also reflected by the heterogeneity of nomenclatures used by researchers to address the same phenomenon including such terms as videogame addiction (Griffiths, 1993), computer game playing dependence (Griffiths & Hunt, 1998), Internet addiction disorder (Young, 1998b), videogame dependency (Rehbein et al., 2010), problematic online gaming (Demetrovics et al., 2012), and pathological video-game use (Gentile, 2009). In addition to these issues, most psychometric tools developed for assessing behavioural addictions (including gaming addiction)

[7] Most of the material featured in Chapter 4 resulted in the following refereed publication: Pontes, H. M., Király, O., Demetrovics, Z., & Griffiths, M. D. (2014). The conceptualisation and measurement of DSM-5 Internet Gaming Disorder: The development of the IGD-20 Test. *PLoS ONE*, *9*(10), e110137. doi:10.1371/journal.pone.0110137

have either used an *ad hoc* cut-off point or lacked a strong empirical base for establishing such cut-off points.

These problems may be partially explained by the lack of agreement amongst researchers on how to approach the assessment of the phenomenon. For instance, some studies (Gentile, 2009; Lemmens et al., 2009) adapted the definition of pathological gambling from the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; DSM-IV; American Psychiatric Association, 1994) to assess this phenomenon. Others have been based on the DSM-IV criteria of substance use dependence (American Psychiatric Association, 2000), or have combined these two approaches and used criteria from both pathological gambling and substance use dependence (Tejeiro Salguero & Morán, 2002). Additionally, some researchers have used criteria from various different behavioural addictions such as Internet addiction (Thomas & Martin, 2010) or exercise addiction (Hussain & Griffiths, 2009).

In acknowledgement of the many studies now published in the area of problematic gaming, Section III of the fifth revision of the DSM (DSM-5) (American Psychiatric Association, 2013) included Internet Gaming Disorder for the first time. Here, Internet Gaming Disorder was viewed as a behavioural addiction that needs further study before being recognised as an independent clinical disorder. This represents a milestone achievement by attempting to (i) provide a consensual view of the phenomenon from a scientific point of view, and (ii) unify different approaches into a single one (Griffiths et al., 2014).

According to the American Psychiatric Association (2013), the clinical diagnosis of Internet Gaming Disorder comprises a behavioural pattern encompassing persistent and recurrent use of games, leading to significant impairment or distress in a period of 12 months as indicated by five (or more) out of the nine criteria that must be present. More specifically, the nine proposed

criteria for Internet Gaming Disorder include: (1) preoccupation with games; (2) withdrawal symptoms when gaming is taken away; (3) tolerance, resulting in the need to spend increasing amounts of time engaged in games; (4) unsuccessful attempts to control participation in games; (5) loss of interests in previous hobbies and entertainment as a result of, and with the exception of, games; (6) continued excessive use of games despite knowledge of psychosocial problems; (7) deceiving family members, therapists, or others regarding the amount of gaming; (8) use of games to escape or relieve negative moods; and (9) jeopardising or losing a significant relationship, job, or education or career opportunity because of participation in games. Furthermore, it has been asserted that Internet Gaming Disorder may lead to school/college failure, job loss, or marriage failure as the compulsive gaming behaviour tends to displace usual and expected social, work and/or educational, relationship, and family activities (American Psychiatric Association, 2013). It has also been noted (Griffiths et al., 2014; Pontes & Griffiths, 2014), that the nine Internet Gaming Disorder criteria directly map onto the six criteria of Griffiths' components model of addiction (i.e., salience, mood modification, tolerance, withdrawal symptoms, conflict and relapse) (Griffiths, 2005).

The aim of the present study was twofold. The main goal was to examine whether the nine Internet Gaming Disorder criteria from the DSM-5 (American Psychiatric Association, 2013) can empirically correspond with the six dimensions of the components model of addiction by developing a new standardised psychometric tool. The second goal was to provide evidence of its reliability and validity alongside an empirical cut-off point for future studies wishing to assess Internet Gaming Disorder in line with the DSM-5. If the results of the study support these two aims, then the newly developed tool represents a valuable instrument for future researchers to empirically investigate Internet Gaming Disorder.

Method

This study was approved by the College Research Ethics Committee of Nottingham Trent University (UK). In order to participate in the study informed consent was sought amongst participants and the minimum age of participation in the study was 16 years old.

Sample, Procedure, and Participants

Participants were invited to take part in the study by clicking a survey link that was provided in 52 online gaming forums selected via Google searches. The forums were not related to a specific game genre or type (i.e., online or offline) in order to represent as much as possible the most popular genres and the gaming community. In order to advertise the survey, permission from forum moderators were sought and a thread was created and daily checked for a month on each of the 52 online forums specifying the nature of the study. The survey was created and hosted online. The online data collection methodology was chosen because of its inherent benefits, such as ease of access to larger sample pools, cost-efficiency, and its usefulness and practical advantages for researching behavioural addictions in general (Griffiths, 2012; R Wood & Griffiths, 2007), especially in the case of online gamers. This methodology might also increase participant's self-disclosure (Joinson, 2001) and disinhibition (Suler, 2004), which helps to decrease social desirability. A total of 1.397 questionnaires were collected. However, 394 of these (28.2%) were not fully completed and were therefore excluded from the subsequent analyses.

Measures

Socio-demographics. Information regarding gender, age, country of residence, age when participants first began gaming, relationship status, ownership of mobile device with Internet access and/or gaming console and other gaming devices were collected.

Weekly Gameplay. This variable examined players' average weekly time spent gaming on computers, consoles, and/or other gaming platforms (e.g., handheld devices). This variable was operationalised into distinct playing categories (i.e., less than 7 hours a week; between 8 and 14 hours a week; between 15 and 20 hours a week; between 21 and 30 hours a week; between 31 and 40 hours a week, and more than 40 hours per week), and was later recoded to distinguish between players that played more or less than 30 hours a week in order to fully reflect American Psychiatric Association's definition of Internet Gaming Disorder concerning the time spent playing.

Internet Gaming Disorder Test (IGD-20 Test). The IGD-20 Test includes 20 items reflecting the nine criteria of Internet Gaming Disorder as in the DSM-5 (American Psychiatric Association, 2013) and incorporates the theoretical framework of the components model of addiction (i.e., salience, mood modification, tolerance, withdrawal symptoms, conflict and relapse) (Griffiths, 2005). Consequently, three items were devised for each of the following Internet Gaming Disorder criteria 1, 2, 3, 4 and 8 and another five items for criteria 5, 6, 7 and 9 altogether because these latter four criteria appear to reflect the conflict dimension (see Table 2.1, Chapter 2, pg. 47). All pilot items were checked for face and content validity by the research team and a convenience sample of five gamers prior to the data collection. The IGD-20 Test examines both online and/or offline gaming activities occurring over a 12-month period, since the DSM-5 criteria for Internet Gaming Disorder are based on persistent and recurrent gaming. This most often involves specific Internet games, but can also include non-Internet computerised games (American Psychiatric Association, 2013). Participants rated all items of this test on a 5-point Likert scale: 1 (‘Strongly disagree’), 2 (‘Disagree’), 3 (‘Neither agree or disagree’), 4 (‘Agree’), and 5 (‘Strongly agree’). The IGD-20 Test is presented on Appendix II.

Diagnostic Criteria for Internet Gaming Disorder in DSM-5 (DCIGD). The diagnostic features of the Internet Gaming Disorder in the DSM-5 comprise nine criteria reflecting its key aspects. According to the American Psychiatric Association (2013), to be diagnosed with Internet Gaming Disorder a person has to endorse at least five (or more) of the nine criteria over a 12-month period. Since these nine criteria were developed to be used by clinicians as a form of checklist in a binary system (i.e., yes or no), we slightly modified the response option so that it could be presented to participants along a continuum using a 5-point scale (i.e., 1 'Never', 2 'Rarely', 3 'Sometimes', 4 'Often', 5 'Very often'). This was incorporated due to the restrictiveness present in the two-option (yes/no) choice and its potential problems from a statistical standpoint (Comrey, 1988). Additionally, previous research suggested that multiple-choice items traditionally yield more reliable test scores than scores derived from dichotomous items (Haladyna, 1992). In the present study, the DCIGD's internal consistency as measured by the Cronbach's alpha was .87. The DCIGD is presented on Appendix III.

Statistical Analyses

In order to test the proposed model for Internet Gaming Disorder, confirmatory factor analysis (CFA) was performed with maximum likelihood estimation with robust standard errors (MLR) in MPLUS 6.1 (Muthén & Muthén, 2011). The goodness of fit was evaluated using a *p* value of Chi-square smaller than .05 for the test of close fit. Additional fit indices included the Comparative Fit Index (CFI), Tucker-Lewis Fit index (TLI), Root Mean Square Error of Approximation (RMSEA) and its 90% confidence interval (90% CI), and Standardised Root Mean Square Residual (SRMR). A model presents an acceptable fit by a CFI greater than .90 and a

RMSEA value smaller than .08. In turn, a good fit is expressed by a CFI value higher than .95 and a RMSEA value close to .06 (Byrne, 2013; Hu & Bentler, 1999).

In order to identify the groups of gamers with higher risk of Internet Gaming Disorder, Latent Profile Analysis (LPA) was performed in MPLUS 6.1 (Muthén & Muthén, 2011). The LPA is a mixture modelling technique used to identify latent groups of people that are similar in their responses to certain variables – in this case average sum scores given for the six IGD-20 Test dimensions (continuous manifest variables) (Collins & Lanza, 2010). In the process of determining the number of latent classes, the Bayesian Information Criteria Parsimony Index was used, alongside the minimisation of cross-classification probabilities, entropy and the interpretability of clusters. In the final determination of the number of classes, the likelihood-ratio difference test (Lo-Mendell-Rubin Adjusted LRT Test) was also used. This compares the estimated model with a model having one less class than the estimated model (Muthén & Muthén, 2011). A low *p* value (<.05) suggests that the model with one less class is rejected in favour of the estimated model.

To determine the cut-off points of the IGD-20 Test, a sensitivity analysis based on membership in the '*disordered gamers*' group from the LPA as the '*gold standard*' was carried out. Thus, the accuracy of the IGD-20 Test by calculating the proportion of participants classified as '*disordered gamers*' versus other gamers could be assessed. The sensitivity (i.e., the proportion of true positives belonging to the disordered group based on LPA) and specificity (i.e., the proportion of true negatives among the non-disordered gamers) were defined by procedures and definitions put forth by Altman and Bland (1994b) and Glaros and Kline (1988). In order to explore the probability that the IGD-20 Test would give the correct '*diagnosis*', the Positive Predictive Values (PPVs), the Negative Predictive Values (NPVs), and the accuracy values for each possible IGD-20 Test cut-off points were calculated. PPV was defined as the proportion of participants with

positive test results who are correctly diagnosed (Altman & Bland, 1994a; Glaros & Kline, 1988) and the NPV was defined as the proportion of participants with negative test results who are correctly diagnosed (Altman & Bland, 1994a; Glaros & Kline, 1988).

Additionally, to further assess the validity of the IGD-20 Test, the LPA classes were compared alongside other variables (i.e., gender, age, weekly gameplay, DCIGD scores, and IGD-20 Test scores) relevant to the phenomenon of Internet Gaming Disorder. In order to do these comparisons, Wald's Chi-square test of mean equality for latent class predictors in mixture modelling was also performed because it takes into account the probabilistic nature of the LPA groups (for description of analysis, see www.statmodel.com/download/meantest2.pdf).

Results

Descriptive Statistics

The total sample comprised 1,003 participants, with the majority (85.2%) being male (n = 855). Ages varied between 16 and 58 years, and the mean age was 26 years (S.D. = 8.2 years). All sample characteristics are presented in Table 4.1.

Table 4.1. Socio-demographic Characteristics of the Sample

N	1.003
Gender (male, n, %)	85.2
Age, years; Mean (S.D.)	26.5 (0.26)
Country (n, %)	
United Kingdom	281 (28)
United States	212 (21.1)
Sweden	66 (6.6)
Netherlands	48 (4.8)
Germany	38 (3.8)
Canada	34 (3.4)
Finland	31 (3.1)
Other countries	293 (29.2)
Weekly Gameplay (n, %)	
More than 30 hours	260 (25.9)
Relationship Status (n, %)	
In a relationship	450 (44.9)
Use of Substance > 3 times a week (n, %)	
Cigarettes	155 (15.5)
Alcohol	113 (11.3)
Owning a mobile phone with Internet access (n, %)	862 (85.9)
Owning a game console or other dedicated gaming device (n, %)	708 (70.6)

Confirmatory Factor Analysis

The analysis of the first-order model with the six factors (i.e., salience, mood modification, tolerance, withdrawal symptoms, conflict, and relapse) provided an acceptable model fit for the IGD-20 Test, χ^2 (151, n = 1003) = 504.6, $p < .0001$; CFI = .935; TLI = .918 RMSEA = 0.048 (90%CI: 0.044-0.053), *p*close = .716; SRMR = 0.041. With the exception of item 19, all factor loadings were higher than .50 with their respective latent factors. The correlations among the factors ranged from .47 to .94, with the highest correlation observed being between salience and tolerance and the lowest between mood modification and conflict (see Table 4.2).

Table 4.2. Confirmatory Factor Analysis of the 20 items of the Internet Gaming Disorder Test (IGD-20 Test)

	Salience	Mood Modification	Tolerance	Withdrawal Symptoms	Conflict	Relapse
1. I often lose sleep because of long gaming sessions.	.61					
7. I usually think about my next gaming session when I am not playing.	.57					
13. I think gaming has become the most time consuming activity in my life.	.67					
8. I play games to help me cope with any bad feelings I might have.		.87				
2. I never play games in order to feel better. [R]		.60				
14. I play games to forget about whatever's bothering me.		.76				
3. I have significantly increased the amount of time I play games over last year.			.56			
9. I need to spend increasing amounts of time engaged in playing games.			.64			
15. I often think that a whole day is not enough to do everything I need to do in-game.			.59			
4. When I am not gaming I feel more irritable.				.75		
10. I feel sad if I am not able to play games.				.71		
16. I tend to get anxious if I can't play games for any reason.				.82		
5. I have lost interest in other hobbies because of my gaming.					.59	
11. I have lied to my family members because the amount of gaming I do.					.65	

19. I know my main daily activity (i.e., occupation, education, homemaker, etc.) has not been negatively affected by my gaming. [R]					.47	
17. I think my gaming has jeopardised the relationship with my partner.					.52	
20. I believe my gaming is negatively impacting on important areas of my life.					.70	
6. I would like to cut down my gaming time but it's difficult to do.						.61
12. I do not think I could stop gaming.						.50
18. I often try to play games less but find I cannot.						.66
Correlations Between Factors						
Salience	1	.47	.94	.70	.74	.69
Mood Modification		1	.49	.45	.42	.48
Tolerance			1	.77	.66	.72
Withdrawal Symptoms				1	.63	.63
Conflict					1	.86
Factor determinacies	.90	.91	.90	.92	.89	.88
Cronbach's α	.64	.78	.63	.80	.74	.63
Mean	2.81	3.06	2.29	2.08	2.18	2.35
S.D.	.93	.98	.87	.88	.81	.83

Empty cells represent the factor loadings that are fixed to 0; all other factor loadings are significant at least at $p < .001$. Cronbach's alpha of the total 20 items of the IGD-20 Test is .88.; [R]: Reversely scored items.

Criterion-related Validity, Concurrent Validity, and Reliability

Criterion-related validity was assessed by the association between weekly gameplay and the IGD-20 Test scores (r_s [1003]=.77, $p < .001$). Although time spent on games itself should not be the sole indicator of Internet Gaming Disorder, disordered players typically devote between 8 to 10 hours or more per day to gaming activity and at least 30 hours per week according to the American Psychiatric Association (2013). Therefore, a strong correlation between these two variables was considered an evidence of criterion-related validity. Concurrent validity was assessed by the association of the IGD-20 Test with the nine Internet Gaming Disorder criteria from the DSM-5 as assessed by the DCIGD (r_s [1003]= .82, $p < .001$). Additionally, the six IGD-20 Test dimensions were strongly correlated with their corresponding Internet Gaming Disorder criteria (see Table 4.3). The IGD-20 Test's internal consistency as measured by the Cronbach's alpha was .88.

Table 4.3. Correlation Matrix Between the Six Factors of the Internet Gaming Disorder Test (IGD-20 Test) and Their Corresponding Official Criteria

IGD Criteria	IGD-20 Test Factors					
	Salience	**Mood Modification**	**Tolerance**	**Withdrawal Symptoms**	**Conflict**	**Relapse**
1	**.58****	.25**	.43**	.43**	.44**	.40**
2	.45**	.36**	.42**	**.63****	.48**	.44**
3	.44**	.28**	**.49****	.47**	.48**	.44**
4	.40**	.30**	.42**	.45**	.54**	**.56****
5	.37**	.23**	.32**	.39**	**.61****	.39**
6	.43**	.28**	.34**	.40**	**.59****	.41**
7	.38**	.23**	.32**	.34**	**.60****	.38**
8	.32**	**.71****	.31**	.37**	.32**	.34**
9	.35**	.24**	.32**	.35**	**.57****	.37**

** Correlation is significant at the .01 level (2-tailed).

*** For a more comprehensive review on how the nine Internet Gaming Disorder criteria overlap with each one of the six factors outlined see Griffiths, M. D., King, D., Demetrovics, Z. (2014). DSM-5 Internet Gaming Disorder needs a unified approach to assessment. *Neuropsychiatry, 4*(1), 1-4.doi: 10.2217/npy.13.82

Latent Profile Analysis

After performing the LPA on the six dimensions of the IGD-20 Test, a five-class solution was found according to the adopted decision criteria aforementioned. As shown in Table 4.4, the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC), and the sample-size adjusted BIC (SSABIC) continued to decrease as more latent classes were added. However, a levelling-off after the five-latent-class solution was observed. In inspection of entropy, the five-class solution provided an adequate level. Based on the Lo-Mendell-Rubin Test (L-M-R Test), the five-class solution was accepted.

Table 4.4. Results Obtained from the Latent Profile Analysis

Number of latent classes	AIC	BIC	SSABIC	Entropy	L-M-R Test	*p*
2 classes	14315	14409	14349	0.775	1259	<0.001
3 classes	13912	14039	13957	0.777	410	0.034
4 classes	13775	13938	13833	0.752	147	0.003
5 classes	**13688**	**13884**	**13757**	**0.753**	**100**	**0.048**
6 classes	13660	13890	13741	0.762	41	0.407

Abbreviations: **AIC**: Akaike Information Criterion; **BIC**: Bayesian Information Criterion; **SSABIC**: Sample-size Adjusted Bayesian Information Criterion; **L-M-R Test**: Lo-Mendell-Rubin Test.

The features of the five classes are presented in Figure 4.1 and Table 4.5. The first and the second classes represent '*casual gamers*' (19.1%) and '*regular gamers*' (48.6%), that is, gamers that generally scored below the mean average. The third class represents '*low risk engagement gamers*' (10.4%), while the fourth class represents '*at risk high engagement gamers*' (16.7%). The main difference between these two classes is that the '*at risk high engagement gamers*' scored much higher on conflict and relapse, while the '*low risk high engagement gamers*' scored slightly higher in salience, mood modification, tolerance, and withdrawal symptoms. The final (fifth) class represents the '*disordered gamers*' (5.3%) that scored much higher on all six dimensions than the other four groups of gamers. Players with membership to this latter class were more likely to (i) be male, (ii) play for more than 30 hours per week, and (iii) have an overall higher score on the nine Internet Gaming Disorder criteria and IGD-20 Test (see Table 4.6).

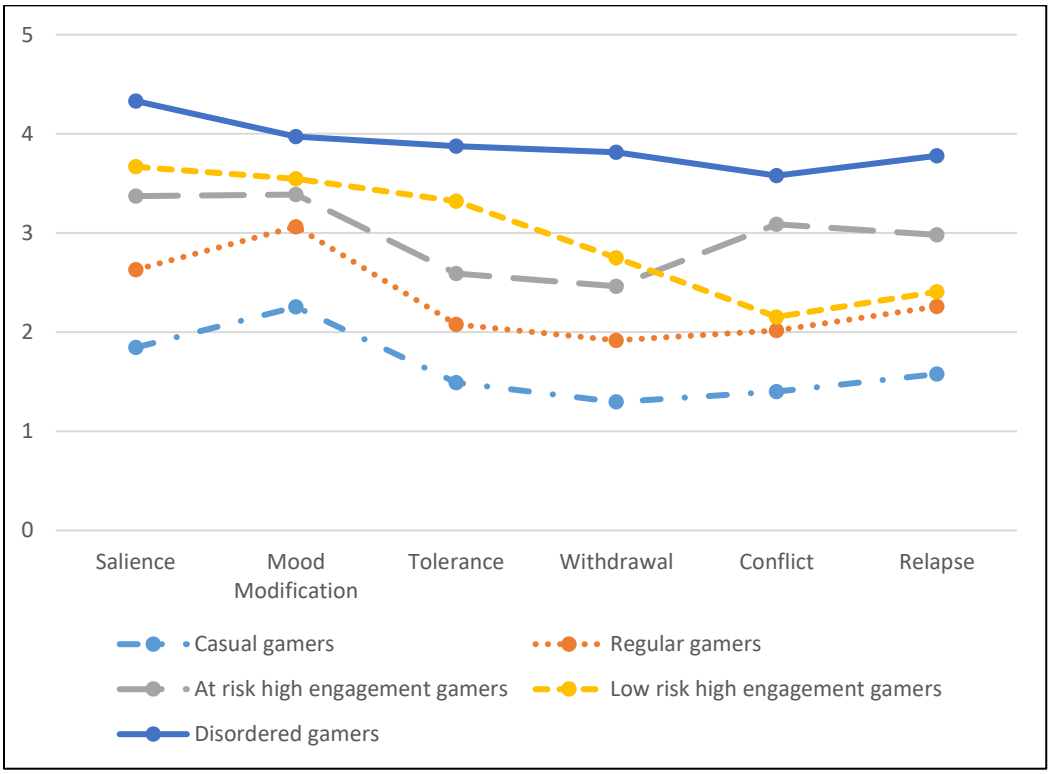

Figure 4.1. The Five Classes Obtained from the Latent Profile Analysis

Table 4.5. Comparison of the Five Latent Classes: Testing Equality for Latent Class Predictors

	Casual gamers (N=192)	**Regular gamers (N=487)**	**Low risk high-engagement gamers (N=104)**	**At risk high engagement gamers (N=167)**	**Disordered gamers (N=53)**	**Overall test**	
						Wald χ^2	***p value***
Salience, (min. 1, max. 5, mean 2.81 (S.D.=0.93)), Mean (S.E.)	1.84 (0.05)$_a$	2.64 (0.04)$_b$	3.67 (0.08)$_c$	3.38 (0.06)$_d$	4.36 (0.10)$_e$	286.5	<0.001
Mood Modification**, (min. 1, max. 5, mean 3.06 (S.D.=0.98)), Mean (S.E.)	2.28 (0.07)$_a$	3.06 (0.05)$_b$	3.55 (0.11)$_c$	3.38 (0.08)$_c$	3.95 (0.12)$_d$	91.5	<0.001
Tolerance, (min. 1, max. 5, mean 1.97 (S.D.=0.74)), Mean (S.E.)	1.50 (0.05)$_a$	2.09 (0.03)$_b$	3.34 (008)$_c$	2.60 (0.06)$_d$	3.89 (0.12)$_e$	184.6	<0.001
Withdrawal Symptoms (min. 1, max. 5, mean 2.29 (S.D.=0.87)), Mean (S.E.)	1.27 (0.04)$_a$	1.90 (004)$_b$	2.75 (0.09)$_c$	2.46 (0.07)$_d$	3.83 (0.11)$_e$	243.9	<0.001
Conflict, (min. 1, max. 5, mean 2.18 (S.D.=0.81)), Mean (S.E.)	1.40 (0.04)$_a$	2.01 (0.03)$_b$	2.14 (0.07)$_b$	3.10 (0.06)$_c$	3.60 (0.09)$_d$	770.1	<0.001
Relapse, (min. 1, max. 5, mean 2.35 (S.D.=0.83)), Mean (S.E.)	1.57 (0.05)$_a$	2.25 (0.04)$_b$	2.40 (0.08)$_b$	3.00 (0.06)$_c$	3.78 (0.13)$_d$	364.9	<0.001

*Means having different subscript letters are different on at least $p < .05$ level according to the pairwise Wald χ^2 test of mean equality for latent class predictors in mixture modelling (http://bit.ly/NNCxju).

Abbreviations: **Min.**: Minimum; **Max.**: Maximum; **S.D.**: Standard Deviation; **S.E.**: Standard Error.

Table 4.6. Comparison of the Five Latent Classes: Testing Equality for Latent Class Predictors

	Casual gamers (N=192)	**Regular gamers (N=487)**	**Low risk high-engagement gamers (N=104)**	**At risk high engagement gamers (N=167)**	**Disordered gamers (N=53)**	**Overall test**	
						Wald χ^2	***p value***
Gender (Male %)	84.4_{a}	85.5_{a}	82.6_{a}	87.2_{a}	85.7_{a}	1.2	0.875
Age (years), Mean (S.E.)	$29.7\ (0.77)_{a}$	$27.0\ (0.44)_{b}$	$24.0\ (0.83)_{cd}$	$25.6\ (0.70)_{bd}$	$22.9\ (0.97)_{ec}$	12.2	0.016
Weekly Gameplay (≥ 30 hours) %	$10.7\ (0.02)_{a}$	$20.7\ (0.07)_{b}$	$42.6\ (0.16)_{c}$	$34.0\ (0.13)_{c}$	$66.4\ (0.17)_{d}$	31.4	<0.001
DCIGD (min. 1, max. 5, mean 1.97 (S.D.=0.74)), Mean (S.E.)	$1.23\ (0.04)_{a}$	$1.76\ (0.03)_{b}$	$2.14\ (0.07)_{c}$	$2.58\ (0.06)_{d}$	$3.58\ (0.12)_{e}$	397.9	<0.001
IGD-20 Test (min 1, max 5, mean 2.43 (S.D.=0.64)), Mean (S.E.)	$1.72\ (0.03)_{a}$	$2.27\ (0.02)_{b}$	$2.93\ (0.04)_{c}$	$3.01\ (0.02)_{c}$	$3.95\ (0.06)_{d}$	1131.5	<0.001

*Means having different subscript letters are different on at least $p < .05$ level according to the pairwise Wald χ^2 test of mean equality for latent class predictors in mixture modelling (http://bit.ly/NNCxju).

Abbreviations: **S.D.**: Standard Deviation; **S.E.**: Standard Error; **Min.**: Minimum; **Max.**: Maximum; **DCIGD**: The official nine Internet Gaming Disorder criteria; **IGD-20 Test**: The Internet Gaming Disorder Test.

Determining the Cut-off for the IGD-20 Test: Sensitivity and Specificity Analyses

The sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and accuracy of the IGD-20 Test at different possible cut-off points were calculated considering participants' membership to the fifth class (i.e., '*disordered gamers*') as the '*gold standard*'. Based on this analysis, a cut-off score of 71 was found to be the ideal empirical cut-off to distinguish disordered gamers from non-disordered gamers (see Table 4.7).

In this case, the specificity is 100%, while the sensitivity is 96%. That is, practically none of the non-disordered cases are considered as disordered, while only 4% of the truly disordered gamers are not identified by the measure. Additionally, PPV is 94% and NPV is 100%. In other words, only 6% of the individuals with a positive test result are mistakenly identified, while all individuals with negative test results are identified correctly. The accuracy was 100%. Increasing the cut-off points would result in more false negative cases, while decreasing would increase the number of gamers mistakenly diagnosed (see Table 4.7).

Table 4.7. Cut-off Points for the Internet Gaming Disorder Test (IGD-20 Test) Based on the Fifth Class (i.e., High Addiction Risk Group) Derived from the Latent Profile Analysis

Cut-off	True Positive	True Negative	False Positive	False Negative	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
66	53	912	38	0	100	96	58	100	96
67	53	920	30	0	100	97	64	100	97
68	51	930	20	2	96	98	72	100	98
69	51	942	8	2	96	99	86	100	99
70	51	945	8	2	96	99	86	100	99
71	**51**	**947**	**3**	**2**	**96**	**100**	**94**	**100**	**100**
72	48	950	0	5	91	100	100	99	100
73	43	950	0	10	81	100	100	99	99
74	41	950	0	12	77	100	100	99	99
75	34	950	0	19	64	100	100	98	98
6	28	950	0	25	53	100	100	97	98
77	24	950	0	29	45	100	100	97	97
78	21	950	0	32	40	100	100	97	97
79	19	950	0	34	36	100	100	97	97

Abbreviations: **PPV**: Positive Predictive Value; **NPV**: Negative Predictive Value.

Discussion

Based on the need for a unified psychometrically sound measurement tool for the assessment of Internet Gaming Disorder, the present study aimed to develop and construct the IGD-20 Test based on a solid theoretical framework (i.e., components model of addiction) integrating in its model the official nine Internet Gaming Disorder criteria presented in the DSM-5 as proposed by the American Psychiatric Association (2013). When administered to a large sample of heterogeneous gamers, the IGD-20 Test appeared to be an appropriate instrument for assessing the construct of Internet Gaming Disorder.

Overall, the psychometric analyses of the IGD-20 Test yielded good results in terms of validity and reliability. Additionally, the present model appears to have an acceptable model fit according to the results obtained from the CFA. More specifically, criterion-related and concurrent validity were warranted by the observed significant correlations between the (i) IGD-20 Test and weekly gameplay, and (ii) IGD-20 Test and the DCIGD. Additionally, significant correlations between the IGD-20 Test's six factors and its corresponding Internet Gaming Disorder criteria (as assessed by the DCIGD) also supported the test's concurrent validity. According to the latent profile analysis, 5.3% of the players belonged to the '*disordered gamers*' group, indicating a relatively conservative prevalence of disordered gamers among the sample, and is in line with other previously published and nationally representative studies (e.g., Gentile, 2009; Pontes, Macur, et al., 2016b; Rehbein et al., 2010).

Previous research has attempted to distinguish between '*addicted*' and '*highly engaged*' players. Highly engaged players are non-disordered gamers displaying high levels of cognitive salience, tolerance and euphoria, while addicted players are those that display high levels of conflict, withdrawal, relapse, and behavioural salience in the first place (Charlton, 2002; Charlton

& Danforth, 2007). Interestingly, the '*low risk high engagement gamers*' group as shown in the LPA analysis, matched the profile described by Charlton and Danforth as highly engaged players. Hence, this group scored high on salience, mood modification, and tolerance, while scoring lower on the core components of addiction (i.e., conflict, withdrawal, and relapse). On the other hand, the '*at risk high engagement*' group scored high on two core addiction components (i.e., conflict and relapse) in addition to scoring high on both salience and mood modification. Although this group does not perfectly match the '*addiction*' group defined by Charlton and Danforth (2007), when compared to the '*low risk high engagement*' group, they might be at greater risk due to a higher displacement of conflict and relapse components. Therefore, in addition to using the suggested cut-off score (i.e., 71) to identify '*disordered gamers*', we propose the use of a 'pattern analysis' for the remaining gamers to distinguish between '*low risk*' and at '*risk high engagement*' players. Players scoring high on the conflict, withdrawal, and relapse dimensions might be at greater risk than those scoring lower on these dimensions based on Charlton and Danforth's findings. The '*disordered gamers*' group was more likely to be male, and play for more than 30 hours per week. Although this finding cannot be generalised to all gamers given the sampling technique used and the uneven gender distribution, it lends support to several studies that found higher rates of gaming addiction among males (Cole & Griffiths, 2007; Griffiths et al., 2004; Pápay et al., 2013; Rehbein et al., 2010), and those that found addicted gamers spend significantly more time playing than non-addicted players (Gentile, 2009; Grüsser, Thalemann, & Griffiths, 2007; Pápay et al., 2013).

Finally, the sensitivity and specificity analysis revealed an empirically optimal cut-off of 71 points for diagnosing Internet Gaming Disorder with the IGD-20 Test. Nevertheless, future studies should further assess this in a clinical sample in order to corroborate the present findings.

Recent research has already addressed this issue using the original nine criteria for Internet Gaming Disorder in semi-structured interviews (Ko et al., 2014). However, this should also be done using a standardised and unified measurement tool in order to warrant progress and unification of the field.

The present study is not without limitations as it relied on a convenience sample of gamers that was self-selecting (and therefore was not necessarily representative of all gamers). Consequently, the present findings need to be cautiously interpreted in terms of their generalisability to the broader population. Another aspect that may warrants further refinement relates to the content of item 17 ("*I think my gaming has jeopardised the relationship with my partner*.") as some gamers may not be in a relationship, this may be particularly relevant in younger samples. To overcome this potential issue, replacing the term "*partner*" with "*significant others*", "*friends*" or "*family*" may be fruitful. Notwithstanding this, future studies should aim to confirm or disconfirm these results in representative samples (at either a national level and/or among the gaming community). Another important and difficult issue to overcome is the use of self-report questionnaires and their associated possible biases (e.g., social desirability biases, short-term recall biases, etc.). Future research should also attempt to confirm these findings using behavioural data and assess Internet Gaming Disorder in clinical samples in order to achieve recognition of this disorder as an independent clinical entity that merits inclusion in future editions of the DSM. Future studies could also include such measures as the Marlowe-Crowne Social Desirability Scale (Crowne & Marlowe, 1960) to help overcome such biases (although this would lengthen such surveys and may lead to less participants completing them). This may also be related to the issue of non-completion of the survey. In the present study, just over 28% of the participants started but did not finish the survey. There is no way of knowing why the non-completion rate was so high,

but this may be related to the survey being too long and/or gamers wanting to know what the survey was about with no intention of completing it (i.e., doing it out of curiosity). Whether the non-completers were any different from those gamers that completed the survey is not known, but this should be taken into account when considering the study's findings. Finally, participants in the present study were recruited from English-speaking online forums and communities, therefore, they were not filtered based on their first language. This may represent a possible limitation in that such people may not have fully understood the questions being asked. Therefore, future studies should take into account the first language of the participants.

Taken as a whole, the findings of the present study support the concept of Internet Gaming Disorder. It also supports the viability of its further study as reflected by the nine Internet Gaming Disorder criteria and the components model of addiction. Furthermore, the current findings also suggest that the IGD-20 Test satisfies the need for a standardised and psychometrically sound measurement tool for assessing this behavioural addiction in accordance to the IGD criteria outlined in the DSM-5 (American Psychiatric Association, 2013). Additionally, the IGD-20 Test was designed to be applicable and cover all gamers irrespective of the genre played, demarcating from previous trend of researching and assessing specific games and gamers such as those that play Massively Multiplayer Online Role Playing Games (Charlton, 2002; Griffiths et al., 2012). Consequently, it is hoped that the IGD-20 Test will facilitate consensus in the field in terms of assessment and conceptual definition of this increasingly studied phenomenon.

CHAPTER 5: Measuring DSM-5 Internet Gaming Disorder: Development and Validation of a Short Psychometric Scale[8]

Introduction

In Section III of the latest (fifth) edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5), Internet Gaming Disorder was included as a condition worthy of future study (American Psychiatric Association, 2013). The inclusion of Internet Gaming Disorder followed the increasing amount of research published over the last decade and the debates surrounding the legitimacy of the construct as an independent clinical disorder. As suggested by the American Psychiatric Association (2013), the clinical diagnosis of Internet Gaming Disorder comprises a behavioural pattern encompassing persistent and recurrent use of the Internet to engage in online games, leading to significant impairment or distress over a period of 12 months as indicated by endorsing five (or more) of nine criteria. As mentioned earlier in the thesis, the nine proposed criteria for Internet Gaming Disorder include: (1) preoccupation with games; (2) withdrawal symptoms when gaming is taken away; (3) tolerance, resulting in the need to spend increasing amounts of time engaged in games; (4) unsuccessful attempts to control participation in games; (5) loss of interest in previous hobbies and entertainment as a result of, and with the exception of, games; (6) continued excessive use of games despite knowledge of psychosocial problems; (7) deceiving family members, therapists, or others regarding the amount of gaming; (8) use of games to escape or relieve negative moods; and (9) jeopardising or losing a significant relationship, job, or education or career opportunity because of participation in games. Moreover, Internet Gaming Disorder may lead to school/college failure, job loss, or marriage failure as the problematic gaming

[8] Most of the material featured in Chapter 5 resulted in the following refereed publication: Pontes, H. M., & Griffiths, M. D. (2015). Measuring DSM-5 Internet Gaming Disorder: Development and validation of a short psychometric scale. *Computers in Human Behavior, 45*, 137-143. doi:10.1016/j.chb.2014.12.006

behaviour tends to displace usual and expected social, work and/or educational, relationship, and family activities (American Psychiatric Association, 2013).

Research into the psychosocial effects of videogames has increased with many studies being published (Kowert, Domahidi, Festl, & Quandt, 2014; Kuss, Griffiths, et al., 2013; Kuss, Van Rooij, Shorter, Griffiths, & Van de Mheen, 2013; Lopez-Fernandez, Honrubia-Serrano, Gibson, & Griffiths, 2014; Odrowska & Massar, 2014). More recently, several scholars (Griffiths et al., 2014; King et al., 2013; Petry & O'Brien, 2013; Petry et al., 2014) have noted the need for developing a new psychometric tool for Internet Gaming Disorder capable of integrating the new aspects of the concept. Although research on gaming behaviour has increased greatly over the last few years (Griffiths et al., 2012; Kuss & Griffiths, 2012b), the field has been arguably hindered by the use inconsistent non-standardised criteria to assess gaming addiction (Griffiths et al., 2012). Traditionally, researchers have adopted a broad range of nomenclatures (e.g., problematic gaming, videogame addiction, online gaming addiction, compulsive Internet use) to address the same phenomenon (Demetrovics et al., 2012; Gentile, 2009; Griffiths, 1993; Griffiths & Hunt, 1998; Rehbein et al., 2010; Young, 1998b). This has resulted in a lack of a widely accepted definition and difficulty in unifying the field. Therefore, the use of a nomenclature that researchers can agree upon (e.g., Internet Gaming Disorder) and standardised psychometric tool rooted in the Internet Gaming Disorder concept, may represent an important step in providing a consensual view of the phenomenon from a scientific standpoint, and may help unify different approaches into a singular one amongst researchers (Griffiths et al., 2014).

In light of this, the aim of the present study is twofold. Firstly, the main goal is to examine whether the nine adapted Internet Gaming Disorder criteria from the DSM-5 (American Psychiatric Association, 2013) can serve as a basis for developing a new standardised

psychometric tool for measuring Internet Gaming Disorder (namely the nine-item Internet Gaming Disorder Scale-Short-Form [IGDS9-SF]. Secondly, to explore its psychometric properties in-depth in order to ascertain if it can be a valid and reliable tool for assessing Internet Gaming Disorder in accordance with the nine criteria from the DSM-5 (American Psychiatric Association, 2013). In addition to this, developing a brief psychometric test to assess Internet Gaming Disorder may facilitate access to larger pools of participants and reduce attrition rates in future longitudinal studies.

Method

This study was approved by the College Research Ethics Committee of Nottingham Trent University (UK). In order to participate in the study informed consent was sought amongst participants and the minimum age of participation in the study was 16 years old.

Participants and Procedures

A total sample comprising 1,397 English-speaking gamers from 58 different countries were recruited to take part in the study by clicking the survey link provided in 52 English-speaking online gaming forums. To advertise the survey link, authorisation from the gaming forum's moderators was sought prior the creation of a thread containing the survey link and specifying its nature on each forum. Every thread was individually checked for a period of one month on a daily basis. Any important queries addressed by the participants to the research team were given personalised feedback.

The online data collection methodology was chosen because of its benefits regarding ease of access to larger sample pools, opportunity to reach a heterogeneous group of gamers and not only those playing Massively Multiplayer Online Role-Playing Games (MMORPGs), cost-

efficiency, and its usefulness and practical advantages for researching behavioural addictions in general (Griffiths, 2012; Wood & Griffiths, 2007), especially in the case of online gamers.

Furthermore, a total of 337 out of 1.397 (24%) questionnaires were excluded from the final analyses due to severe incompleteness or other potential response biases (e.g., acquiescence bias) and mischievous responding (e.g., specifying an unlikely value for age), resulting in an overall heterogeneous self-selected sample comprising 1.060 English-speaking gamers. Potential acquiescence bias was determined by assessment of similar and repetitive patterns of responses to the study's key measures. The sample was predominantly male (85.1%; n = 902) with ages ranging from 16 to 70 years (M_{age} = 27 years, S.D. = 9.02). All participants were assured of anonymity and confidentiality.

Measures

Socio-demographics. The survey included questions relating to gender, age, country of residence, first time of gameplay (online and/or offline), relationship status, use of psychoactive substances for more than three times a week (i.e., cigarettes and alcohol) in order to map onto excessive substance use behaviours, ownership of mobile device with Internet access, and ownership of gaming console and/or other gaming devices were collected.

Internet Gaming Disorder Scale-Short-Form (IGDS9-SF). The IGDS9-SF is a short psychometric tool adapted from the nine core criteria that define Internet Gaming Disorder according to the DSM-5 (American Psychiatric Association, 2013). The aim of this instrument is to assess the severity of IGDS9-SF and its detrimental effects by examining both online and/or offline gaming activities occurring over a 12-month period. The nine questions comprising the IGDS9-SF are answered using a 5-point Likert scale: 1 ('Never'), 2 ('Rarely'), 3 ('Sometimes'), 4 ('Often'), and 5 ('Very often'). The scores are obtained by summing the gamer's answers and

total scores can range from 9 to 45, with higher scores being indicative of higher degrees of gaming disorder. In order to classify disordered gamers, a strict diagnostic approach of endorsement of five or more of the nine Internet Gaming Disorder criteria as assessed by the IGDS9-SF on the basis of answering 'Very often' only should be considered. It is worth noting that the main purpose of this instrument is not to diagnose Internet Gaming Disorder but to assess its severity and accompanying detrimental effects to the gamer's life. As an alternative, for clinical diagnosis purposes, the American Psychiatric Association symptom checklist containing the nine Internet Gaming Disorder criteria in their 'yes/no' format should be given preference over the IGDS9-SF for diagnosing Internet Gaming Disorder since this strategy appears to have diagnostic validity (Ko et al., 2014). The IGDS9-SF is presented on Appendix IV.

Weekly Gameplay. This variable examined the gamer's weekly time spent playing on computers, consoles, and/or other gaming platforms (e.g., handheld devices) and distinguished between those that played less than 7 hours, between 8 and 14 hours, between 15 and 20 hours, between 21 and 30 hours, between 31 and 40 hours, and more than 40 hours per week respectively. This variable helps to inform American Psychiatric Association's definition of Internet Gaming Disorder since disordered gamers typically devote at least 30 hours per week gaming (American Psychiatric Association, 2013). Consequently, a significant positive correlation between this variable and the IGDS9-SF test scores would be suggestive of the scale's criterion-related validity, and is a common procedure of studies of this nature (see Lemmens et al., 2009).

Internet Gaming Disorder Test (IGD-20 Test). The IGD-20 Test (Pontes, Király, et al., 2014) was the first psychometric tool developed to assess the phenomenon of Internet Gaming Disorder published in a refereed journal, and is one of the few psychometric tools of its kind that has been used and validated internationally (Fuster et al., 2016). The IGD-20 Test comprises 20

items rated on a 5-point Likert scale: 1 (‘Strongly disagree’), 2 (‘Disagree’), 3 (‘Neither agree or disagree’), 4 (‘Agree’), and 5 (‘Strongly agree’) that reflects the nine criteria of Internet Gaming Disorder as in the DSM-5 (American Psychiatric Association, 2013) and is also embedded in the theoretical framework of the components model of addiction (i.e., salience, mood modification, tolerance, withdrawal symptoms, conflict and relapse) proposed by Griffiths (2005). Moreover, the aim of the IGD-20 Test is to assess the severity of Internet Gaming Disorder by examining both online and/or offline gaming activities occurring over a 12-month period. In the present study, the Cronbach’s alpha for the IGD-20 Test was .88. Similar to the weekly gameplay variable, this measure was used to examine the IGDS-SF9 concurrent validity should a significant positive correlation be observed between the two measures.

Statistical Analyses

Statistical analysis comprised of (i) descriptive statistics of the main sample’s characteristics and (ii) a psychometric evaluation of the IGDS9-SF. These latter analyses encompassed an exploratory factor analysis (EFA), confirmatory factor analysis (CFA), assessment of the criterion-related validity, concurrent validity, population cross-validity, reliability, standard measurement error (SEM), and floor and ceiling effects. To carry out the analyses, MPLUS 7 (Muthén & Muthén, 2012) was used for the CFA and IBM SPSS Statistics Version 20 (IBM Corp, 2011) for the remaining analyses. All statistical tests adopted a significance level of .05.

Results

Descriptive Analysis

Table 5.1 summarises all relevant socio-demographic information collected in the current sample. Results of the analysis showed that half of the sample were in a relationship (45.7%, n = 484). Additionally, most gamers reported they first played videogames at a very early age, that is, before the age of 6 years (45.8%, n = 485) and between the age of 7 and 12 years (44.3%, n = 470). Almost one-third of the total sample (26.7%, n = 283) reported playing games for more than 30 h per week. In addition, only a small percentage of the sample reported smoking cigarettes (17.7%, n = 188) and drinking alcohol (12.4%, n = 131) for more than three times a week. Furthermore, most gamers reported owning a mobile device with Internet access (86.4%, n = 916) and a game console or other dedicated gaming device (70.1%, n = 743).

Table 5.1. Socio-demographic Characteristics of the Sample

N	1.060
Gender (male, n, %)	902 (85.1)
Age, years; Mean (S.D.)	27.3 (9.02)
Top 5 Countries (n, %)	
United Kingdom	281 (26.5)
United States	240 (22.6)
Sweden	73 (6.9)
Netherlands	52 (4.9)
Germany	36 (3.4)
Other countries	378 (35.7)
First time of Gameplay (n, %)	
Before the age of 6	485 (45.8)
Between 7 and 12 years old	470 (44.3)
Between 13 and 17 years old	67 (6.3)
After 18 years old	30 (2.8)
Don't really remember	8 (0.8)
Weekly Gameplay (n, %)	
Less than 7 hours	101 (9.5)
Between 8 and 14 hours	230 (21.7)
Between 15 and 20 hours	223 (21)
Between 21 and 30 hours	223 (21)
Between 31 and 40 hours	133 (12.5)
More than 40 hours	150 (14.2)
Relationship Status (n, %)	
In a relationship	484 (45.7)
Use of Substance > 3 times a week (yes, n, %)	
Cigarettes	188 (17.7)
Alcohol	131 (12.4)
Owning a mobile device with Internet access (n, %)	916 (86.4)
Owning a game console or other dedicated gaming device (n, %)	743 (70.1)

Exploratory Factor Analysis (EFA)

Before investigating the IGDS9-SF's factor structure (i.e., EFA and CFA), the whole sample was randomly split into two samples. Therefore, an EFA using the Principal Axis Factoring extraction method with Promax (oblique) rotation on the nine items of the IGDS9-SF was performed in sample 1 (n = 532) to examine its factorial structure and construct validity. The number of components to be extracted was determined through an examination of the scree plot (Cattell, 1966) in combination with the conventional Kaiser criterion (i.e., all factors with eigenvalues greater than one) (Kaiser, 1960). Furthermore, the acceptable threshold of items with factor loadings above .50 and/or parallel loadings below .20 were used as the criteria to retain items (Ferguson & Cox, 1993).

The appropriateness for conducting the EFA was confirmed by the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO = .915) and Bartlett's Test of Sphericity (χ^2 [36, 532] = 1929, $p < .0001$) results (Hair, Black, Babin, & Anderson, 2010; Malhotra, 1999). The analysis revealed a single factor explaining 45.4% of the total variance of the construct and was extracted after four iterations (see Table 5.2).

Because the Kaiser criterion technique for determining the number of factors to be retained can be problematic (Costello & Osborne, 2005; Velicer & Jackson, 1990; Zwick & Velicer, 1982, 1986), Horn's Parallel Analysis (Horn, 1965) was performed as this procedure compares the observed eigenvalues extracted from the correlation matrix to be analysed with those obtained from uncorrelated normal variables. This statistical method is based on the Monte Carlo simulation process, since 'expected' eigenvalues are obtained by simulating normal random samples that parallel the observed data in terms of sample size and number of variables (Ledesma & Valero-Mora, 2007). By adopting the rule that a factor was considered significant if the associated

eigenvalue was larger than the mean of those obtained from the random uncorrelated data, the single factor solution was further corroborated by this analysis.

Table 5.2. Summary of the Results from the Exploratory Factor Analysis (EFA) on the IGDS9-SF nine items obtained from Sample 1 (n = 532)

Item[a]	*Factor Loadings*	*Communalities*	
	Factor 1[b, c, d]	**Initial**	**Extraction**
1	.544	.303	.296
2	.773	.560	.597
3	.687	.437	.472
4	.747	.516	.558
5	.640	.399	.409
6	.736	.496	.542
7	.669	.437	.448
8	.536	.276	.287
9	.688	.467	.473

[a]: Item description were omitted from the table for the sake of clarity. For a full description of the items please see Table 5.3.
[b]: Eigenvalue = 4.608.
[c]: Percentage of the Total Variance Explained = 45.4%.
[d]: Only one factor was possible to be extracted from the EFA after 4 iterations.

Confirmatory Factor Analysis (CFA)

In order to confirm the single factor solution found of the IGDS9-SF obtained in the EFA, a CFA with maximum likelihood with robust standard errors estimation method (MLR) was performed on Sample 2 (n = 528) using the nine IGDS9-SF items in order to confirm a high-order single factor solution and further corroborate the factor structure found previously. This estimation method was preferred over the more traditional maximum-likelihood method because it deals better with non-normality issues. The latent construct was Internet Gaming Disorder – which was not directly observed – as it was considered the endogenous variable, whereas the nine items from the IGDS9-SF were considered the exogenous variables (i.e., indicators) used to measure gamers' Internet Gaming Disorder level.

For the CFA goodness of fit, a *p* value of chi-square smaller than .05 for test of close fit was considered. Additionally, other fit indices included Comparative Fit Index (CFI), Tucker-Lewis Fit Index (TLI), Root Mean Square Residual (SRMR). For both CFI and TLI, values greater than .90 were considered acceptable whereas values above .95 were considered optimal. Moreover, a RMSEA value smaller than .08 expresses an acceptable fit, whereas an optimal fit is expressed by a value close to .06 (Byrne, 2013; Hu & Bentler, 1999). In light of the aforementioned assumptions, the analysis of the first-order model provided an optimal model fit for the IGDS9-SF. More specifically, χ^2 [27, 528] = 68.02, $p < .00001$; CFI = .964; TLI = .952; RMSEA = .054 (90% CI: [.038-.070]), *pclose* = .331; SRMR = .034. As shown in Figure 1 and Table 5.3, all factor loadings were statistically significant and within the conventional acceptable threshold of >.50.

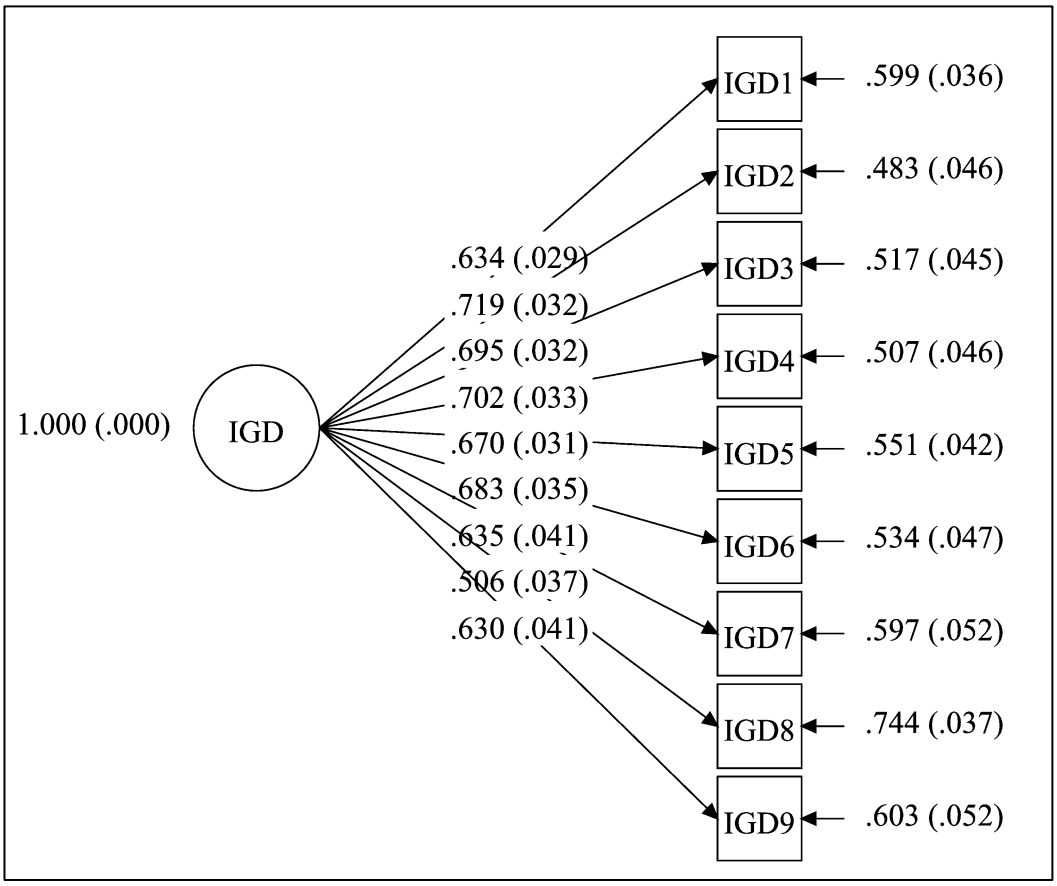

Figure 5.1. Graphical summary of Confirmatory Factor Analysis results obtained from the nine items of the IGD9-SF on Sample 2 (n = 528)

Table 5.3. Summary of Confirmatory Factor Analysis results obtained from the nine items of the Internet Gaming Disorder Scale-Short-Form (IGDS9-SF) a on Sample 2 (n = 528)

	Factor Loadings[b]	*R-Square*
1. Do you feel preoccupied with your gaming behaviour? (Some examples: Do you think about previous gaming activity or anticipate the next gaming session? Do you think gaming has become the dominant activity in your daily life?)	.634	.401
2. Do you feel more irritability, anxiety or even sadness when you try to either reduce or stop your gaming activity?	.719	.517
3. Do you feel the need to spend increasing amount of time engaged gaming in order to achieve satisfaction or pleasure?	.695	.483
4. Do you systematically fail when trying to control or cease your gaming activity?	.702	.493
5. Have you lost interests in previous hobbies and other entertainment activities as a result of your engagement with the game?	.670	.449
6. Have you continued your gaming activity despite knowing it was causing problems between you and other people?	.683	.466
7. Have you deceived any of your family members, therapists or others because the amount of your gaming activity?	.635	.403
8. Do you play in order to temporarily escape or relieve a negative mood (e.g., helplessness, guilt, anxiety)?	.506	.256
9. Have you jeopardised or lost an important relationship, job or an educational or career opportunity because of your gaming activity?	.630	.397
Factor determinacies		.94
Cronbach's alpha[c]		.87
Mean		18
Standard deviation		6.63

[a]: *Instructions*: *These questions will ask you about your gaming activity during the past year (i.e., last 12 months). By gaming activity we understand any gaming-related activity that has been played either from a computer/laptop or from a gaming console or any other kind of device (e.g., mobile phone, tablet, etc.) both online and/or offline.*

[b]: All factor loadings were statistically significant (i.e., $p < .0001$).

[c]: Cronbach's alpha of the nine items of the IGD9-SF for Sample 2. For the purpose of clarity: sample 1 (n = 532) (α = .88), sample 2 (n = 528) (α = .87), and overall sample (N = 1.060) (α = .87).

Validity, Reliability and Standard Error of Measurement (SEM)

As noted above, another goal of this study was to further investigate the validity of the IGDS9-SF. To examine the criterion-related validity of the IGDS9-SF, the respondents' test score on the IGDS9-SF were correlated with weekly gameplay and the total score obtained in the IGD-20 Test. As Table 5.4 shows, the IGDS9-SF showed moderate to strong correlations with weekly gameplay and the IGD-20 Test in the expected directions. Moreover, the highest correlations observed between the IGDS9-SF and the IGD-20 Test (r (473) = .842, p < .0001) and weekly gameplay (r (532) = .325, p < .0001) were both in sample 1. Furthermore, the correlations were highly comparable and consistent across the samples.

Table 5.4. Correlations Between the Internet Gaming Disorder Scale-Short-Form (IGDS9-SF) and the Concepts used for Establishing Their Criterion-related Validity and Concurrent Validity

	Overall Sample	**Sample 1**	**Sample 2**
	N = 1.060	n = 532	n = 528
Weekly Gameplay	.319*	.325*	.312*
IGD-20 Test	.816*	.842*	.783*

* p < .0001.

Population cross-validity can be assessed by investigating if the results obtained in one sample of a population can also be replicated in another sample drawn from the same population (e.g., Raju, Bilgic, Edwards, & Fleer, 1997, 1999). In the present study, population cross-validation was examined by splitting the total sample into two random independent samples and assessing

whether the single factor solution found for the IGDS9-SF in sample 1 would be replicated in sample 2. As shown in Table 5.3, the IGDS9-SF internal consistency as measured by the Cronbach's alpha was very high across the samples. More specifically, for sample 1 (n = 532) the Cronbach's alpha was .88, whereas for sample 2 (n = 528) was .87, and .87 for the overall sample (N = 1.060). Additionally, the IGDS9-SF would not have its reliability increased by removing any of the nine items in any of the three samples.

In addition, the SEM was calculated because it reflects the degree to which the observed scores obtained on the IGDS9-SF fluctuate as a result of the errors of measurement (Morrow, Jackson, Disch, & Mood, 2011). The SEM was computed by the standard deviation of the measure multiplied by the square root of one minus its reliability coefficient (Morrow et al., 2011). SEM ≤ S.D./2 was taken as the criterion of acceptable precision (Wuang, Su, & Huang, 2012; Wyrwich, Nienaber, Tierney, & Wolinsky, 1999). The lower the reliability, the greater the SEM, and the less precise the measure. As expected, the SEM values for the IGDS9-SF scores across the overall sample, sample 1, and sample 2 all attained the criterion (SEM ≤ S.D./2), suggesting an acceptable measurement precision of the measure (see Table 5.5).

Table 5.5. Analysis of the Standard Error of Measurement (SEM) of the Internet Gaming Disorder Scale-Short-Form (IGDS9-SF) across the Overall Sample, Sample 1 and Sample 2

	Overall Sample	**Sample 1**	**Sample 2**
	N = 1.060	n = 532	n = 528
SEM	2.45	2.40	2.43
S.D./2	3.40*	3.39*	3.31*

Note: Overall Sample S.D. = 6.800; sample 1 S.D. = 6.795; sample 2 S.D. = 6.626;
* SEM ≤ S.D./2.

Analysis of the Distribution: Floor and Ceiling Effects

The score distributions of the IGDS9-SF items were examined across the samples for floor and ceiling effects. The ceiling effect represents a limitation of an instrument whereby the scale cannot determine increased performance beyond a certain level. Similarly, the floor effect represents the opposite extreme (Wuang et al., 2012). In order to examine the presence of these effects, the percentage of gamers reporting the lowest scores (i.e., 9) and the highest possible scores (i.e., 45) for the IGDS9-SF were calculated. The recommendations of Terwee et al. (2007) were used to ascertain whether a floor or ceiling effect was present. Essentially, in any sample of 50 or more gamers, having 15% or more of the gamers scoring at the highest or lowest score indicates a floor or ceiling effect.

As shown in Table 5.6, the IGDS9-SF was found to have negligible floor or ceiling effects across the overall sample, sample 1, and sample 2. In regard to the overall sample, only 50 (4.7%) gamers responded '*never*' to all nine questions on the IGDS9-SF while another five gamers (.5%) responded '*very often*' to all nine questions of the test. Similarly, for gamers in sample 1, only 30

(5.6%) endorsed the lowest category for the IGDS9-SF whereas four gamers (0.8%) endorsed the highest category of the scale. Finally, regarding gamers in sample 2, only 20 (3.8%) reported '*never*' to all questions while only one gamer (0.2%) reported '*very often*'. More gamers reported the lowest score than the highest score. In sum, none of the samples analysed reached the threshold for significant floor or ceiling effect.

Table 5.6. Summary of the Distribution Analysis: Floor and Ceiling Effects of the Internet Gaming Disorder Scale-Short-Form (IGDS9-SF) across the Overall Sample (N = 1.060), Sample 1 (n = 532) and Sample 2 (n = 528)

Floor Effect (n, %)			**Ceiling Effect (n, %)**		
Overall Sample	*Sample 1*	*Sample 2*	*Overall Sample*	*Sample 1*	*Sample 2*
50 (4.7%)	30 (5.6%)	20 (3.8%)	5 (0.5%)	4 (0.8%)	1 (0.2%)

Discussion and Conclusion

The purpose of this study was to develop a brief screening tool to assess gaming addiction based on the latest diagnostic DSM-5 criteria for Internet Gaming Disorder (American Psychiatric Association, 2013). To achieve this goal, two steps were taken. Firstly, a short psychometric tool comprising nine items based on the DSM-5 diagnostic criteria of Internet Gaming Disorder was developed. Secondly, the newly developed tool was subject to in-depth psychometric examination in order to ascertain whether it reflected the concept of Internet Gaming Disorder. The results demonstrated a single-factor solution for Internet Gaming Disorder using the nine items of the IGDS9-SF. This structure emerged in the EFA and was later confirmed by the CFA results that

provided fit indices that confirmed the viability of the proposed single-factor solution as the model optimally fitted the data.

The literature on Internet Gaming Disorder is scarce. This is because it is only recently that Internet Gaming Disorder has been proposed by official medical bodies (e.g., American Psychiatric Association) as a condition worthy of future studies before being included in future mental health diagnostic manuals (e.g., DSM). Notwithstanding this, a few studies have investigated Internet Gaming Disorder under this new conceptualisation (see Cho et al., 2014; Ko et al., 2014; Pontes, Király, et al., 2014). In one study (Pontes, Király, et al., 2014), Internet Gaming Disorder was conceptualised in terms of gaming addiction, resulting in the development of a new psychometric tool for assessing Internet Gaming Disorder with 20 items, while the other two studies either examined Internet Gaming Disorder's diagnostic validity in the clinical setting (Ko et al., 2014) or attempted to test the viability of the concept for assessing generalised Internet addiction (Cho et al., 2014). Consequently, the present study represents a new contribution to the behavioural addiction literature by providing a new and brief valid psychometric tool for assessing Internet Gaming Disorder. Therefore, future research in the field should investigate if the single-factor solution holds for other samples in different contexts and populations. If the present conceptualisation of Internet Gaming Disorder can be replicated in future studies, it will potentially help reduce the several inconsistencies found in the literature related to gaming addiction prior to the conceptualisation of Internet Gaming Disorder.

In addition, future studies should further examine if the suggested cut-off points proposed for distinguishing disordered and non-disordered gamers using the IGDS9-SF has clinical and empirical validity. To investigate whether the cut-off has clinical validity, a comparison with a clinically diagnosed sample could be made to actual IGDS9-SF test scores. On the other hand,

empirical validity could also be conducted by more sophisticated statistical analyses such as latent profile analysis using the empirical cut-off of endorsement of five out of nine criteria as a '*gold standard*' for determining the profile of gamers and also conducting a subsequent sensitivity and specificity analyses.

In terms of the test's validity and reliability, the IGDS9-SF appeared to be a valid and reliable measure for assessing Internet Gaming Disorder as suggested by the DSM-5 (American Psychiatric Association, 2013). The statistically significant positive associations found between the IGDS9-SF, weekly gameplay, and the IGD-20 Test, lend empirical evidence for the test's validity. Furthermore, the results stemming from the EFA and CFA also support the population cross-validity of the IGDS9-SF as it was demonstrated that the single-factor solution found in the EFA (i.e., Sample 1) was also replicated and confirmed in the CFA (i.e., Sample 2). Moreover, the instrument was highly reliable across the samples since the Cronbach's alphas were very high and not possible to be increased by deleting any of the nine items of the scale. Additionally, the present study provided further psychometric data regarding the variability of the errors of measurement based on the SEM. The SEMs obtained for the overall sample, sample 1 and sample 2 were 2.45, 2.40, and 2.43 respectively. In sum, this suggests that the IGDS9-SF is reliable and accurate measure for detecting changes in Internet Gaming Disorder levels.

It should also be noted that very few gamers had scores at the floor or ceiling levels of the IGDS9-SF. Typically floor and ceiling effects are considered problematic when more than 15% of the sample has either the lowest or highest score possible (Terwee et al., 2007). The IGDS9-SF did not show either floor and/or ceiling of this magnitude in the present study. Overall, the IGDS9-SF had more gamers at the floor level scores (i.e., 3.8-5.6%) than at the ceiling level (i.e., 0.2-0.8%).

The present study is not without limitations. Firstly, the use of convenience samples despite being common practice across various domains of the psychological literature, is not without its problems. In the present study, most participants were male and a convenience sample of gamers was used, and therefore was not necessarily representative of all gamers. Hence, these findings should be cautiously interpreted in terms of its generalisability. Future studies should aim to replicate the present findings using representative samples. Secondly, despite being a difficult issue to overcome, the use of self-report questionnaires is accompanied by possible associated biases (e.g., social desirability biases, short-term recall biases, etc.).

Overall, the findings of the present study lend empirical support for the concept of Internet Gaming Disorder as suggested by the DSM-5 (American Psychiatric Association, 2013) while also supporting the viability of further study of this phenomenon. Moreover, the current findings suggested that the IGDS9-SF can cater for the generalised need for a brief standardised and psychometrically sound tool for assessing gaming addiction according to the new framework of gaming addiction presented in the DSM-5 (American Psychiatric Association, 2013). Consequently, it is envisaged that this new tool will help facilitate research in the field by providing a concise, valid and reliable instrument for measuring Internet Gaming Disorder.

CHAPTER 6: The Development and Psychometric Evaluation of the Internet Disorder Scale (IDS-15)[9]

Introduction

Over the past two decades, Internet addiction has received increasing attention from scholars of different fields due to its clinical and sociological importance (Kuss, Griffiths, et al., 2014). Internet addiction can be broadly characterised by excessive or poorly controlled preoccupations, urges, or behaviours regarding Internet use that lead to impairment or distress (Weinstein et al., 2014). A consistent and large body of emerging research suggests that Internet addiction is a serious condition that is often associated with several psychosocial and psychological factors such as social anxiety in young adults (Weinstein et al., 2015), lower levels of family functioning, life satisfaction as well as more problems in family interactions (Wartberg et al., 2015), attention deficit/hyperactivity disorder and depression (Sariyska et al., 2015), higher incidence of substance use, poor emotional wellbeing, and decreased academic performance in adolescents (Rücker et al., 2015), increased academic stress (Jun & Choi, 2015), impulsive behaviours (Reed et al., 2015), introversion (McIntyre, Wiener, & Saliba, 2015), and higher levels of loneliness, alexithymia, and suicide (Alpaslan, Avci, Soylu, & Guzel, 2015).

Although Internet addiction is not (as yet) recognised as an official disorder, many researchers from all over the world have backed its inclusion in the mental health diagnostic manuals given that the knowledge of this emerging disorder has grown markedly over the last two decades (Kuss, Griffiths, et al., 2014; Pontes, Kuss, & Griffiths, 2015). Even though the knowledge base on Internet addiction and its neurobiological correlates have progressed considerably over the

[9] Most of the material featured in Chapter 6 resulted in the following refereed publication: Pontes, H. M., & Griffiths, M. D. (2017). The development and psychometric evaluation of the internet disorder scale (IDS-15). *Addictive Behaviors, 64,*261-268. doi:10.1016/j.addbeh.2015.09.003

last 15 years (Pontes, Kuss & Griffiths, 2015), research in the area comes with a caveat in terms of definition and characterisation of this phenomenon, ultimately leading to inadequate psychometric assessment of this phenomenon on the basis of extant assessment tools.

More recently, Király, Nagygyörgy, et al. (2014) conducted a review on the nine most used instruments for assessing Internet addiction and found several inconsistencies among them. Most of the discrepancies identified were observed at the level of (i) theoretical basis of instruments, (ii) factor structures, (ii) and psychometric properties. More specifically, the majority of instruments to assess Internet addiction were based on the DSM-IV criteria for pathological gambling and/or substance dependence (American Psychiatric Association, 1994). Additionally, some instruments did not report their factor structure, although in general, instruments tend to present with either one or up to seven factors, and only a few psychometric properties were assessed.

As noted elsewhere in this thesis, Internet Gaming Disorder was included in the Section III of the latest (fifth) edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) (American Psychiatric Association, 2013) as a condition worthy of future study. The nine Internet Gaming Disorder criteria relate to the following aspects of excessive and problematic gaming: (i) preoccupation with Internet gaming; (ii) withdrawal symptoms when Internet is taken away; (iii) tolerance, expressed by the need to spend increasing amounts of time engaged with Internet gaming; (iv) unsuccessful attempts to control Internet gaming use; (v) continued excessive Internet use despite knowledge of negative psychosocial problems; (vi) loss of interests, previous hobbies, entertainment as result of, and with the exception of Internet gaming use, (vii) use of the Internet gaming to escape or relieve a dysphoric mood, (viii) deception of family members, therapists, or others regarding the amount of Internet gaming, and (ix) jeopardising or losing a significant relationship, job, or educational or career opportunity because of Internet gaming use.

Arguably, one of the arguments sustaining the initial inclusion of Internet Gaming Disorder in the DSM-5 relates to the latest developments in the neurobiological field that further support the status of this condition as a tentative behavioural addiction. Nevertheless, although Internet Gaming Disorder refers exclusively to gaming addiction, researchers have recently suggested the potential benefits and advantages of applying the nine Internet Gaming Disorder criteria to assess Internet addiction (e.g., Rumpf et al., 2015). In order to overcome some of the problems found in most instruments that are used to assess Internet addiction, Koronczai et al. (2011) suggested that a suitable measure should meet the following six criteria: (i) comprehensiveness (i.e., examining many and possibly all aspects of Internet addiction); (ii) brevity, so that it can be used for impulsive individuals and fit time-limited surveys; (iii) reliability and validity for different data collection methods; (iv) reliability and validity across different age groups; (v) cross-cultural reliability and validity; and (vi) validation on clinical samples for determining more precise cut-off points based not only on empirical data.

To date, and to the best of this author's knowledge, only one study (i.e., Cho et al., 2014) has adopted this approach to assess Internet addiction based on modification of the nine Internet Gaming Disorder criteria. However, the new instrument (i) was arguably lengthy as it contained 41 items, and might constitute a problem for time-limited research, (ii) was developed using a limited sample of adolescents (aged 13 and 14 years), thus limiting the extent as to which it could be assumed that the new instrument would work adequately in other segments of the population (i.e., adults and elderly), and (iii) lacked robust psychometric properties (e.g., very low reliability, $\alpha = .49$ and $\alpha = .65$ in two latent factors).

In light of the conceptual and methodological issues raised, the aim of the present study was twofold. The primary goal was to develop a new robust standardised psychometric tool to

assess Internet addiction by using a set of items based on modification of the nine Internet Gaming Disorder criteria outlined in the DSM-5 (American Psychiatric Association, 2013) while also providing evidence of its validity and reliability. The second goal was to further explore and characterise the different types of Internet users based on their potential risk for developing Internet addiction. By identifying factors that may explain the risk of Internet addiction, such insights may help provide useful clinical recommendations for emerging prevention and treatment interventions (Stavropoulos, Kuss, Griffiths, & Motti-Stefanidi, 2016).

Method

Participants and Procedures

To aid participant recruitment, a cross-sectional design and a web-based recruitment strategy involving opportunity and snowball sampling methods was utilised. More specifically, several online forums (e.g., *Something Awful, The Student Room*, etc.) and social networking websites (e.g., *Facebook* and *LinkedIn*) were used to attract potential Internet users to participate in the present study. By strategically using forum threads, social network posts, and personalised messages, invitations to participate in a study were sent out to contact Internet users over a period of six months spanning February to July 2014. Whenever possible, personalised feedback was provided to participants' questions and issues encountered during survey administration.

In order to take part in the study, participants had to (i) be at least 16 years of age and (ii) provide individualised online written informed consent. Furthermore, participants took part in this study voluntarily, without receiving any form of compensation (e.g., financial, material, etc.). The survey took approximately five to seven minutes to complete. The recruited sample included 1,105 Internet users that filled out the study's questionnaires. Data cleaning was performed before

conducting the final statistical analysis. Moreover, both univariate normality and univariate outliers were checked. As for the univariate normality, no item of the newly developed instrument had absolute values of Skewness > 3.0 and Kurtosis > 8.0, thus warranting univariate normality of the study's main measure (Kline, 2011). In order to screen for univariate outliers, a standardised composite sum score of the dependent variable (i.e., Internet addiction) as assessed by the new instrument was created, and participants were deemed univariate outliers if they scored ≥ 3 standard deviation points above or below the standardised mean. This procedure yielded 11 outliers that were then removed from the dataset and subsequent analyses. As a result, the final sample comprised 1.094 Internet users. Of those, 36.7% (n = 405) were from the United States of America, 30.4% (n = 336) from India, 24.6% (n = 272) from the United Kingdom, and a small minority (n = 92, 8.3%) from other countries. The sample was predominantly male (n = 671, 61.3%) with ages ranging from 16 to 70 years (M_{age} = 33 years, S.D. = 12.25). All participants were assured of anonymity and confidentiality, and the study was granted with approval of Nottingham Trent University's College Research Ethics Committee.

Measures

Socio-demographics, Substance, and Internet use. A questionnaire was developed in order to collect data on gender, age (year at the time of survey completion), relationship status (not in a relationship/in a relationship), weekly Internet usage (average weekly hours spent on the Internet for leisure purposes), cigarette usage (smoke cigarettes more than three times a week - yes/no) and alcohol usage (drink alcohol more than three times a week – yes/no) consumption, age of Internet use initiation (age participant remembers first using the Internet), and ownership of Internet-enabled electronic devices (yes/no).

The Internet Disorder Scale (IDS-15). The IDS-15 is a psychometric tool that was developed by the author of the present study by modifying the nine Internet Gaming Disorder criteria outlined in the DSM-5 (American Psychiatric Association, 2013) to adjust to the case of Internet addiction. Based on this rationale, the IDS-15 aims to assess the severity of Internet addiction and the impact of its detrimental effects by only focusing upon users' online leisure activity (i.e., excluding academic and/or occupational Internet use) from any device with Internet access in the past year. After developing the items of the IDS-15, it was found that the new 15 items could be grouped at the theoretical level, into four main and qualitatively distinct Internet addiction-related domains: (i) '*Escapism and Dysfunctional Emotional Coping*' (e.g., '*I go online to help me cope with any bad feelings I might have.*'), (ii) '*Withdrawal Symptoms*' (e.g., '*I tend to get anxious if I can't check what's happening online for any reason.*'), (iii) '*Impairments and Dysfunctional Self-Regulation*' (e.g., '*I think the amount of time I spend online is negatively impacting on important areas of my life.*'), and (iv) '*Dysfunctional Internet-related Self-Control*' (e.g., '*I am able to control and/or reduce the time I spend online.*'). Participants respond to items using a 5-point Likert scale: 1 ('Strongly disagree'), 2 ('Disagree'), 3 ('Neither agree nor disagree'), 4 ('Agree'), or 5 ('Strongly agree'). The total IDS-15 score is obtained by summing up participants' responses and can range from 15 to 75, with higher scores being an indication of higher degrees of Internet addiction. The IDS-15 is presented on Appendix V.

Statistical Analysis

Statistical analysis comprised (i) descriptive statistics of the main sample's characteristics (i.e., frequencies and percentages), (ii) a psychometric evaluation of the IDS-15 that included analysis of the construct validity (i.e., factorial validity via confirmatory factor analysis [CFA], convergent and discriminant validity analysis based on the average variance extracted [AVE]

coefficients of each latent variable), and criterion-related validity (i.e., bootstrapped correlation with Bias-corrected accelerated 95% confidence intervals between the IDS-15 overall scores and the chosen criterion), and reliability analysis using different coefficients and indicators of internal consistency (i.e., Cronbach's alpha, composite reliability, and factor determinacies). Finally, (iii) a latent profile analysis (LPA) was carried out in order to identify and describe the taxonomy and patterns of the Internet users alongside their potential risk of Internet addiction based on their responses to the four subscales of the IDS-15, with the resulting final classes being subject to Wald's chi-square test using several socio-demographic and Internet-related variables in order to ascertain the characteristics and specificities of each class. All statistical analyses were performed using MPLUS 7.2 (Muthén & Muthén, 2012) and IBM SPSS Statistics Version 20.0 (IBM Corp, 2011).

Results

Descriptive Statistics

Table 6.1 summarises participants' main socio-demographic characteristics, substance use, and Internet use patterns. The majority of participants reported being in a relationship (n = 741, 67.7%) and started using the Internet only after 18 years of age (n = 445, 40.7%), followed by those that reported starting to use it between 13 and 17 years (n = 312, 28.5%), between 7 and 12 years (n = 283, 25.9%), and before the age of 6 years (n = 22, 2%). Only 2.9% of the participants (n = 32) reported not remembering their age of Internet use initiation at the time they filled out the survey. Moreover, 90.3% (n = 988) of the sample reported owning Internet-enabled electronic devices (see Table 6.1).

Table 6.1. Sample's Main Socio-demographic Characteristics, and Substance, and Internet use Patterns

N	1.094
Gender (male, %)	671 (61.3)
Age (years) (mean, S.D.)	33 (12.3)
Country of origin (n, %)	
United States of America	405 (37)
India	327 (29.9)
United Kingdom	271 (24.8)
Other Countries	91 (8.3)
Relationship status (In a relationship, %)	741 (67.7)
Weekly Internet usage (n, %)	
Less than 7 hours	48 (4.4)
Between 8 and 14 hours	141 (12.9)
Between 15 and 20 hours	186 (17)
Between 21 and 30 hours	229 (20.9)
Between 31 and 40 hours	170 (15.5)
More than 40 hours	320 (29.3)
Cigarette consumption (> 3 times a week, %)	211 (19.3)
Alcohol consumption (> 3 times a week, %)	248 (22.7)
Age of Internet use initiation (n, %)	
Before 6 years old	22 (2)
Between 7 and 12 years old	283 (25.9)
Between 13 and 17 years old	312 (28.5)
After 18 years old	445 (40.7)
Do not remember	32 (2.9)
Ownership of Internet-enabled electronic devices (yes, %)	988 (90.3)

Construct Validity

As outlined in the in the previous section, in order to examine the construct validity of the IDS-15, factorial, convergent, and discriminant validity were investigated.

Factorial Validity: Confirmatory Factor Analysis (CFA)

As aforementioned, the indicators of the IDS-15 appeared to be associated, at least at the theoretical level, to four distinct domains of Internet addiction (i.e., Escapism and Dysfunctional Emotional Coping, Withdrawal Symptoms, Impairments and Dysfunctional Self-Regulation, and Dysfunctional Internet-related Self-Control.). Hence, a CFA on the fifteen items of the IDS-15 with maximum likelihood with robust standard errors estimation method (MLR) was performed on the whole sample (N = 1.094). Because there is no consensus on the fit indices for evaluating structural equation models (see Bollen & Long, 1993; Boomsma, 2000; Hoyle & Panter, 1995), the goodness of fit was based on several fit indices using the following thresholds: χ2/d.f. [1;4], Root Mean Square Error of Approximation (RMSEA) [0.05;0.08], RMSEA 90% confidence interval with its lower limit close to 0 and the upper limit below .08, *p-close* > .05, Standardised Root Mean Square Residual (SRMR) [0.05;0.08], Comparative Fit Index (CFI) and Tucker-Lewis Fit Index (TLI) [.90;.95]. All fifteen indicators were entered into a four first-order factorial solution. The results obtained for the four first-order model provided an acceptable model fit for the IDS-15 (χ^2 [84] = 343.6, χ^2/d.f. = 4; RMSEA = 0.053 [90% CI: 0.047-0.059], *p-close* = .18; SRMR = 0.039, CFI = .95; TLI = .94) with acceptable standardised item loadings (i.e., $\lambda_{ij} \geq .50$) (see Table 6.2). Thus, it can be concluded that the results of the CFA warrant the factorial validity of the IDS-15 given that the obtained fit indices were acceptable, and that all standardised factor loadings were relatively high (i.e., $\lambda_{ij} \geq .50$) (Marôco, 2014).

Table 6.2. Confirmatory Factor Analysis (CFA) of the 15 items of the Internet Disorder Scale (IDS-15) [a]

Items	F1	F2	F3	F4
Escapism and Dysfunctional Emotional Coping (Factor 1)				
1. I never go online to feel better. [R]	.67			
2. I think that being online can greatly change my mood for the better.	.66			
3. I go online to help me cope with any bad feelings I might have.	.84			
4. I go online to forget about whatever's bothering me.	.74			
Withdrawal Symptoms (Factor 2)				
5. When I am not online I feel irritable, restless, anxious and/or frustrated.		.74		
6. I feel sad if I am not able to go online.		.76		
7. I tend to get anxious if I can't check what's happening online for any reason.		.80		
8. I feel restless every time I am unable to go online.		.78		
Impairments and Dysfunctional Self-Regulation (Factor 3)				
9. I think the amount of time I spend online has jeopardised the relationship with my partner.			.67	
10. I think the amount of time I spend online is negatively impacting on important areas of my life.			.79	
11. I would like to cut down the amount of time I spend online but it's difficult for me to do.			.70	
12. I often try to spend less time online but find I cannot.			.72	
Dysfunctional Internet-related Self-Control (Factor 4)				
13. I could easily stop spending time online if I wanted to without any problem. [R]				.69
14. I can easily cut down the time I spend online any time that I want to. [R]				.85
15. I am able to control and/or reduce the time I spend online. [R]				.71
Factors' Descriptive Statistics				
Mean	3.06	2.50	2.41	2.51
Standard Deviation	0.91	1.00	0.90	0.81

Note: All factor loadings are significant at least at $p < .0001$. [a]: **Instructions**: These questions relate to your Internet usage during the past year (i.e., 12 months). By *Internet usage* we mean any activity performed online for leisure purpose only on either a computer or a laptop, or any other kind of portable device with Internet access. [R]: Reversely scored item.

Convergent Validity, Discriminant Validity, and Reliability

Convergent validity relates to the extent to which the items of an instrument appear to be indicators of a single underlying construct (ZWY Lee, Cheung, & Chan, 2015). In light of this, convergent validity was deemed adequately when the AVE of each latent variable is ≥ .50 and the composite reliability is ≥ .70 (Fornell & Larcker, 1981; Hair et al., 2010). As shown in Table 6.3, the values obtained for the AVE fell between .53 and .60, and the composite reliability ranged from .80 to .85. Additionally, discriminant validity refers to the degree to which the measures of distinct constructs differ (ZWY Lee et al., 2015), and can be demonstrated when the square root of the AVE for each construct is higher than the correlations between it and the rest of the constructs (Fornell & Larcker, 1981; Hair et al., 2010). The square root of the AVE for each construct is shown in Table 6.3 (located in bold on the diagonal of the table). Results demonstrated that the value for each construct was higher than the correlations between it and the other constructs.

Table 6.3. Reliability, Convergent, and Discriminant Validity of the Internet Disorder Scale (IDS-15)

Construct	Cronbach's alpha	Factor determinacies	Composite reliability	AVE	Correlation Matrix			
					F1	F2	F3	F4
Factor 1 (F1)	.79	.92	.82	.53	**.73**			
Factor 2 (F2)	.85	.94	.85	.60	.69	**.77**		
Factor 3 (F3)	.81	.92	.81	.52	.54	.67	**.72**	
Factor 4 (F4)	.79	.91	.80	.57	.30	.47	.46	**.75**

Abbreviations: AVE = Average Variance Extracted.
Note: **Factor 1**: "*Escapism and Dysfunctional Emotional Coping*"; **Factor 2**: "*Withdrawal Symptoms*"; **Factor 3**: "*Impairments and Dysfunctional Self-Regulation*"; **Factor 4**: "*Dysfunctional Internet-related Self-Control*". The Cronbach's alpha obtained for all 15 items was .88.

The internal consistency of the IDS-15 as assessed by the Cronbach's alpha, composite reliability, and factor determinacies, were relatively stable and deemed satisfactory (see Table 6.3). Cronbach's alpha for individual dimensions ranged from .79 to .85 whereas all factor determinacies were above the threshold of ≥.80 (Mónok et al., 2012; Muthén & Muthén, 2011; Schembre & Geller, 2011) and composite reliability coefficients also exceeded the desired threshold of ≥ .70 (Fornell & Larcker, 1981; Hair et al., 2010). Taken altogether, these results illustrate that the IDS-15 demonstrated sufficient convergent validity, discriminant validity, and also reliability.

Criterion-related Validity

Based on the findings of previous empirical studies (e.g., Pontes & Griffiths, 2015c; Pontes, Patrão, & Griffiths, 2014; Quiñones-García & Korak-Kakabadse, 2014; Wartberg et al., 2015), criterion-related validity was assessed by the association (i.e., bootstrapped correlation with Bias-corrected accelerated 95% confidence intervals) between the IDS-15 overall scores and participants' self-reported age of Internet use initiation, relationship status, hours spent on the Internet per week, and the composite score obtained in each one of the four IDS-15 subscales. As expected, participants' level of Internet addiction (as assessed by the IDS-15) was associated with the variables of interest, and these correlation coefficients ranged from -.12 to .86 (see Table 6.4). Therefore, it can be concluded that the IDS-15 exhibited satisfactory criterion-related validity when considering the variables analysed.

Table 6.4. Bootstrapped correlation matrix with Bias-corrected and accelerated 95% confidence interval (BCa 95% CI) between the overall score obtained in the Internet Disorder Scale (IDS-15) and its related variables

Measure	IDS-15	BCa 95% CI	R^2
Age of Internet use initiation	-.17**	-.23;-.11	0.03
Relationship status	-.12**	-.18;-.07	0.01
Weekly Internet usage	.23**	.17;.28	0.05
Factor 1	.75**	.72;.78	0.56
Factor 2	.86**	.84;.87	0.74
Factor 3	.78**	.75;.81	0.61
Factor 4	.74**	.71;.77	0.55

Note: Unless otherwise specified, bootstrap results are based on 10.000 bootstrap samples; ** = $p < .01$; **Factor 1**: "*Escapism and Dysfunctional Emotional Coping*"; **Factor 2**: "*Withdrawal Symptoms*"; **Factor 3**: "*Impairments and Dysfunctional Self-Regulation*"; **Factor 4**: "*Dysfunctional Internet-related Self-Control*". **Abbreviations: R^2**: Coefficient of Determination.

Latent Profile Analysis (LPA)

LPA was carried out to identify and characterise different types of Internet users while also estimating participants' potential Internet addiction risk based on their class membership. The LPA procedure is a mixture modelling statistical technique used to identify groups of individuals (categorical latent variables) that give similar responses to specific continuous variables (Collins & Lanza, 2010), which in the context of the present study were participants' responses to the four IDS-15 factors. The analysis was carried out with two to four classes and multiple fit indices were adopted to help determining the optimal number of latent classes, such as those from the (i) information theory (i.e., Akaike Information Criteria [AIC], Bayesian Information Criteria [BIC], and Sample-size Adjusted BIC [SSABIC]) with lower values indicating more parsimonious models, (ii) the Entropy criterion in order ascertain the accuracy of classifying participants into their respective profiles (i.e., higher values suggesting better fit), and (iii) the Lo-Mendell-Rubin Adjusted Likelihood Ration Test (L-M-R Test) to help determining the final number of classes,

where a significant *p* value (i.e., <.05) indicates that the tested model fits better than the previous one (Muthén & Muthén, 2012).

Table 6.5 summarises the results obtained from the LPA analysis with two to four classes that was performed on the four dimensions of the IDS-15. According to the aforementioned criteria, the three-class solution was chosen as the optimal solution for several reasons. The AIC, BIC, and SSABIC decreased consistently and continuously with the addition of more classes and the degree of the observed decrease in the model with four classes in comparison to the one with three classes was not substantial. In terms of the entropy, the two-class solution had the best value and the three-class solution the worst. However, a further examination of the L-M-R test values and their levels of significance clearly indicated that the four-class solution should be rejected in favour of the three-class solution.

Table 6.5. Summary of the Goodness of Fit Obtained from the Latent Profile Analysis (LPA)[a]

Number of Latent Classes	AIC	BIC	SSABIC	Entropy	L-M-R Test	*P*
2	10765	10829	10788	0.765	902	< .00001
3	**10571**	**10661**	**10604**	**0.735**	**198**	**< .00001**
4	10468	10583	10510	0.753	109	.1942

Abbreviations: **AIC**: Akaike Information Criteria; **BIC**: Bayesian Information Criteria; **SSABIC**: Sample-size Adjusted Bayesian Information Criteria; **L-M-R Test**: Lo-Mendell-Rubin Adjusted Likelihood Ratio Test Value; ***P***: *p* value associated with the L-M-R Test.

[a]: The best loglikelihood value has been successfully replicated across all analyses even after a twofold increasing of the random starts.

The final three latent classes and their characteristics are presented in Figure 6.1. The first identified class (i.e., '*low addiction risk*') features Internet users that have a low risk of Internet addiction (n = 183, 18.2%) as they tended to score low on all four dimensions of the IDS-15, and thus exhibited lower levels of symptoms and impairments caused by Internet addiction.

Furthermore, participants belonging to this class had an average score of 38.28 (S.D. = 11.01, 95% CI [36.67-39.89]) on the IDS-15. Moreover, the second identified class (i.e., '*medium addiction risk*') included Internet users exhibiting a relatively medium risk of Internet addiction (n = 456, 41.1%). Participants belonging to this class scored markedly high on the '*Escapism and Dysfunctional Emotional Coping*' dimension and had low scores on the remaining dimensions of the IDS-15. Additionally, the mean score for these participants on the IDS-15 was 38.58 (S.D. = 10.75, 95% CI [37.59-39.57]). Finally, the third class (i.e., '*high addiction risk*') featured those exhibiting the greatest risk for developing Internet addiction (n = 455, 40.7%) as their scores on all four dimensions of the IDS-15 was generally higher than the other classes. Participants in this class scored higher on the '*Escapism and Dysfunctional Emotional Coping*' and '*Withdrawal Symptoms*' dimensions due to their excessive Internet use. Unsurprisingly, participants belonging to this class had an observed mean score of 40.43 (S.D. = 10.05, 95% CI [39.50-41.36]) on the IDS-15, which was greater than the other two classes.

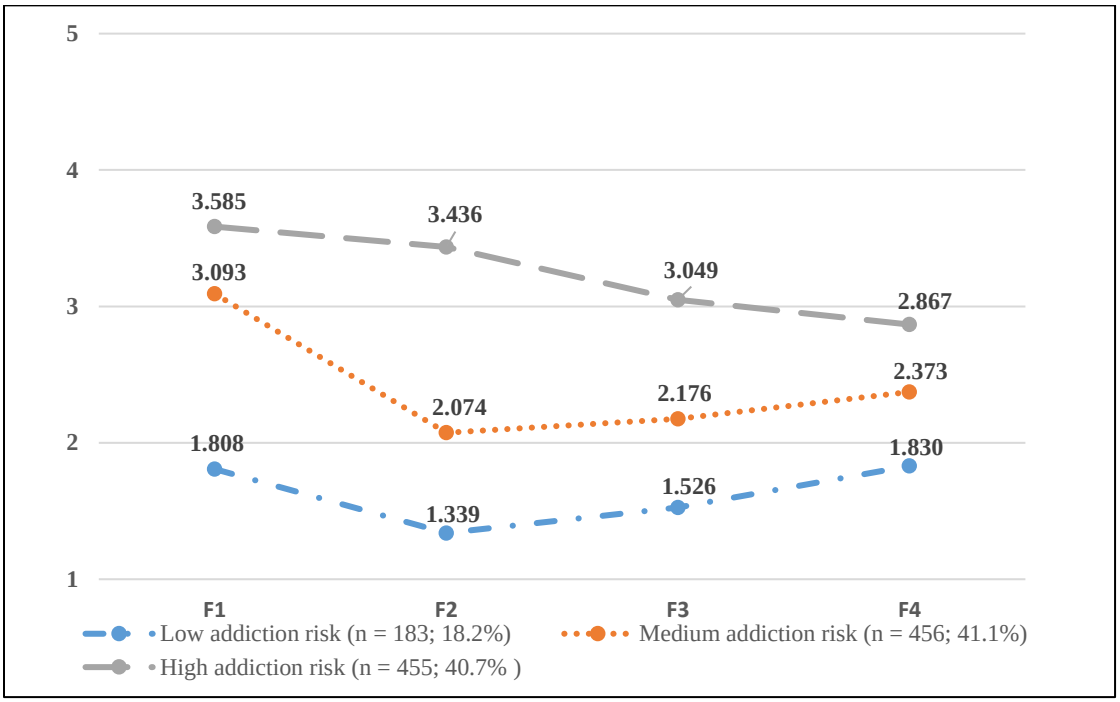

Figure 6.1. The three-class solution obtained from the Latent Profile Analysis (LPA) and the potential risk of Internet addiction associated with each class on the basis of participants' responses to the four subscales of the Internet Disorder Scale (IDS-15)

Abbreviations: **F1**: Factor 1: '*Escapism and Dysfunctional Emotional Coping*'; **F2**: Factor 2: '*Withdrawal Symptoms*'; **F3**: Factor 3: '*Impairments and Dysfunctional Self-Regulation*'; **F4**: Factor 4: '*Dysfunctional Internet-related Self-Control*'.

In addition to the LPA, Wald's chi-square tests were computed to help identify and characterise the final three classes obtained in the LPA. The Wald's chi-square test of mean equality is used for latent class predictors in mixture modelling as it takes into account the probabilistic nature of the LPA classes (see www.statmodel.com/download/meaantest2.pdf for further information). Therefore, the three classes were compared across relevant variables related to Internet addiction including gender, age, relationship status, cigarette and alcohol consumption, ownership of Internet-enabled electronic devices, weekly Internet usage, age of Internet use initiation, and participants' overall total score obtained on the IDS-15.

As shown in Table 6.6, there were no statistically significant differences between the three classes in terms of gender, drinking alcohol more than three times a week, and owning Internet-enabled electronic devices. However, age differed significantly across the three classes with participants in the '*high addiction risk*' class being significantly younger than participants in the '*low addiction risk*' ($\chi^2 = 108.9$, $p \leq .001$) and '*medium addiction risk*' ($\chi 2 = 28.8$, $p \leq .001$) classes. In terms of relationship status, the '*high addiction risk*' class had significantly less participants reporting being in a relationship in comparison those belonging to the '*low addiction risk*' class ($\chi^2 = 18.1$, $p \leq .001$) but not those in the '*medium addiction risk*' class ($\chi^2 = 0.1$, $p = .79$). Participants with membership in the '*high addiction risk*' class reported smoking significantly more often more than three cigarettes a week than those in the '*low addiction risk*' ($\chi^2 = 12.6$, $p \leq .001$) and '*medium addiction risk*' ($\chi^2 = 9.2$, $p = .002$) classes. As expected, the '*high addiction risk*' class had a significantly higher proportion of Internet users using the Internet for more than 30 hours a week than those in the '*low addiction risk*' class ($\chi^2 = 26.1$, $p \leq .001$) but not in comparison to participants classed as '*medium addiction risk*' ($\chi^2 = 0.9$, $p = .342$). In regards to participants' age of Internet use initiation, those in the '*high addiction risk*' class reported

significantly more often that they had started using the Internet before the age of six years than participants in the '*low addiction risk*' class (χ^2 = 7.5, p = .006) but not when compared to those classed as '*medium addiction risk*' (χ^2 = 3.5, p = .063). Finally, participants classed as '*low addiction risk*' had significantly lower scores on the IDS-15 than participants in the '*medium addiction risk*' ($\chi 2$ = 593.2, $p \leq .001$) and '*high addiction risk*' (χ^2 = 2226.1, $p \leq .001$) classes. Moreover, participants in the '*high addiction risk*' class scored significantly higher than those in the '*medium addiction risk*' class (χ^2 = 981.9, $p \leq .001$).

Table 6.6. Comparison of the Three Latent Classes: Testing Equality for Latent Class Predictors

	Low addiction risk (N=183)	Medium addiction risk (N=456)	High addiction risk (N=455)	Overall test	
				Wald's χ^2	*p value*
Gender (male %)	55.8 $(0.04)_a$	62.5 $(0.03)_a$	62.7 $(0.03)_a$	2.2	.339
Age (years), Mean (S.E.)	41.9 $(1.07)_a$	34.2 $(0.65)_b$	29.7 $(0.47)_c$	73.4	< .0001
Relationship status (in a relationship %)	81.0 $(0.03)_a$	65.3 $(0.02)_{bc}$	64.3 $(0.02)_c$	17.2	< .0001
Cigarette consumption (yes %)	13.3 $(0.03)_a$	16.1 $(0.02)_a$	25.3 $(0.02)_c$	11.9	.003
Alcohol consumption (yes %)	26.2 $(0.03)_a$	21.5 $(0.02)_a$	22.3 $(0.02)_a$	1.4	.494
Ownership of Internet-enabled electronic devices (yes %)	88.3 $(0.03)_a$	89.9 $(0.02)_a$	91.6 $(0.01)_a$	0.9	.646
Weekly Internet usage (≥ 30 hours %)	27.8 $(0.04)_a$	46.8 $(0.03)_{bc}$	50.4 $(0.03)_c$	20.3	< .0001
Age of Internet use initiation (< 6 years %)	0.5 $(0.01)_a$	1.4 $(0.01)_{ac}$	3.5 $(0.01)_c$	4.9	.083
IDS-15 total score, Mean (S.E.)	24.2 $(0.42)_a$	36.5 $(0.29)_b$	48.9 $(0.29)_c$	1300.7	< .0001

Note: Means having different subscript letters are different on at least $p < .05$ level according to the pairwise Wald's chi-square test of mean equality for latent class predictors in mixture modelling (http://bit.ly/NNCxju).

Discussion

The main aim of this study was to develop a new psychometrically validated instrument to assess Internet addiction, and further investigate its psychometric properties in several domains using an updated theoretical framework based on the modified criteria for Internet Gaming Disorder in the DSM-5 (American Psychiatric Association, 2013). In order to achieve this, construct validity was examined on the basis of factorial, convergent, and discriminant validity. Factorial validity was investigated via a CFA and it provided an acceptable model fit according to the results obtained, thus warranting factorial validity for the newly developed instrument. The analysis of both convergent and discriminant validity also yielded satisfactory results that further highlighted the new instrument's convergent and discriminant capabilities. As to the reliability of the IDS-15, the results supported its adequacy concerning its internal consistency as assessed by several indicators such as the Cronbach's alpha, composite reliability, and factor determinacies. The IDS-15 also demonstrated expected associations with key variables (i.e., age of Internet use initiation, relationship status, weekly Internet usage, and all four subdomains of the IDS-15) that are usually associated with Internet addiction, thus warranting criterion-related validity.

The second objective of the present study was also to provide a description of the taxonomy and patterns of participants' Internet use alongside their potential Internet addiction risk based on their responses given using the IDS-15. According to the results obtained in the LPA, three classes of Internet users based on their risk of addiction were identified. Participants in the '*low addiction risk*' class represented 18.2% of the sample and were characterised as showing very few problems related to Internet addiction and also low scores on the IDS-15. Furthermore, 41.1% of the sample was classed as having a '*medium addiction risk*' due their excessive online behaviour. Participants with '*medium addiction risk*' tended to rely more on the Internet as a means to escape and cope

with their emotions in a dysfunctional manner and scored significantly higher in all four IDS-15 subdomains than participants in the '*low addiction risk*' class. The third and final class represented those with '*high addiction risk*' as participants in this class scored significantly higher on all four dimensions of the IDS-15 and therefore exhibited more Internet-related problems than the other two classes. Although none of the three classes represent the condition of being addicted to the Internet, participants classed as having '*high addiction risk*' can be characterised as being more avoidant since they used the Internet more as a means to escape and cope with their negative emotions, experiencing more withdrawal symptoms due to excessive Internet use, having more conflicts and impairments alongside dysfunctional self-regulation towards Internet use, and also showing more difficulties in using the Internet in a healthy and balanced way.

The three classes obtained in the LPA were also further characterised in terms of participants' socio-demographic and Internet-related variables in order to ascertain the characteristics and specificities of each class. The results of this analysis demonstrated that key differences emerged among the three classes. Overall, the main differences observed were in (i) age, (ii) relationship status, (iii) weekly cigarette consumption, (iv) weekly Internet usage, (v) age of Internet use initiation, and in the (vi) IDS-15 total scores. More specifically, participants exhibiting '*high addiction risk*' were generally younger, single (i.e., not in a romantic relationship), smoked more cigarettes weekly, used the Internet for longer hours weekly, started using the Internet at an earlier age, and scored significantly higher in the IDS-15 in comparison to the other classes. This finding parallels the results of previous studies in which younger age (e.g., Vink, Van Beijsterveldt, Huppertz, Bartels, & Boomsma, 2016), not being in a romantic relationship (e.g., Pontes, Szabo, et al., 2015), increased cigarette consumption (e.g., Evren et al., 2014), high weekly Internet usage (e.g., Bouna-Pyrrou, Mühle, Kornhuber, & Lenz, 2015), and early Internet use

initiation (e.g., Pontes & Griffiths, 2015c) were found to be associated with greater risk for developing Internet addiction. Notwithstanding this, clinicians working with patients fulfilling the conditions for a clinical diagnosis of Internet addiction could employ the IDS-15 in order to further extend the present findings regarding the LPA analysis. This would represent an important contribution to the development of this particular study as it would further allow the confirmation or rejection of the results presented here, ultimately, helping the field further progress.

The findings obtained from the LPA and the Wald's chi-square tests concur with the idea put forth by Stavropoulos et al. (2016) about the conceptualisation of the development of Internet addiction. Therefore, the risk for developing Internet addiction should be framed as a result of the dynamic interplay between individual and ecological risks and resources over time (Stavropoulos et al., 2016). Consequently, Internet addiction can be conceptualised as being a continuum that ranges from minimum to maximum risk, and that its associated factors involving age-related changes, characteristics of the individual user, factors within Internet users' proximate context, and factors that refer to characteristics of the medium as well as their interactions, should all be taken into account (Stavropoulos et al., 2016). Future studies could expand on these results by further examining how well the IDS-15 instrument identifies and replicates the classes found here in other samples and contexts. Future research could also provide information on the IDS-15's invariance across both genders and other sociodemographic groups. Additionally, studies using clinical samples aimed to derive an empirically and clinically-based cut-off point for the IDS-15 might also be beneficial to researchers using this instrument.

Although the present study provided reliable findings, it is not without its limitations. The study used a convenience sample of Internet users that was not necessarily representative of all Internet users. The fact that the study used a self-selected sample of Internet users may have also

impacted on the relatively high percentage of individuals in the '*high addiction risk*' group. Therefore, the present findings should be cautiously interpreted and not generalised to a more broad population. Other potential biases commonly associated with the use of self-report questionnaires may also need to be taken into account. Finally, although several forms of validity were examined, other types of validity could also have been assessed (e.g., concurrent validity).

Taken as a whole, the findings of the present study support the concept of Internet addiction and its psychometric assessment when using modified Internet Gaming Disorder criteria as outlined in the DSM-5 (American Psychiatric Association, 2013). Furthermore, the IDS-15 may prove to be a psychometrically robust tool to assess Internet addiction provided that future studies can replicate and expand the present findings in different research contexts and cultures.

CHAPTER 7: The Development and Psychometric Properties of the Internet Disorder Scale – Short-Form (IDS9-SF)[10]

Introduction

Research into Internet addiction has grown considerably over the course of the last decade (Kuss, Griffiths, et al., 2014; Pontes, Kuss, et al., 2015), mostly because of its clinical and sociological relevance (Kuss, Griffiths, et al., 2014). Generally speaking, Internet addiction has been characterised by excessive or poorly controlled preoccupation, urges, and/or behaviours regarding Internet use that lead to impairment or distress in many different life domains (Weinstein et al., 2014). Several definitions and terminologies can be found in the psychological and psychiatric literature to describe what appears to be the same phenomenon. For instance, Internet addiction has been traditionally conceptualised as a problematic behaviour akin to pathological gambling that can be operationally defined as an impulse control disorder that does not involve the ingestion of psychoactive intoxicants (Young, 1998b). Nevertheless, Internet addiction has also been characterised as a form of technological addiction (Griffiths, 1995, 1996b, 1998), which is operationally defined as a non-chemical (behavioural) addiction involving excessive human-machine interaction (Griffiths, 1995). In this theoretical framework, technological addictions such as Internet addiction represent a subset of behavioural addictions featuring six core components: salience, mood modification, tolerance, withdrawal, conflict, and relapse (Griffiths, 2005; Marks, 1990).

Research on Internet addiction is also warranted due to a large body of emerging research showing that it is a serious condition, often linked with social anxiety in young adults (Weinstein

[10] Most of the material featured in Chapter 7 has been published at Pontes, H. M., & Griffiths, M. D. (2016). The development and psychometric properties of the Internet Disorder Scale-Short Form (IDS9-SF). *Addicta: The Turkish Journal on Addictions, 3*(2), 1-16. doi:10.15805/addicta.2016.3.0102

et al., 2015), lower levels of family functioning, life satisfaction as well as more problems in family interactions (Wartberg et al., 2015), attention deficit/hyperactivity disorder and depression (Sariyska et al., 2015), higher incidence of substance use, poor emotional wellbeing, and decreased academic performance in adolescents (Rücker et al., 2015), increased academic stress (Jun & Choi, 2015), impulsive behaviours (Reed et al., 2015), introversion (McIntyre et al., 2015), and higher levels of loneliness, alexithymia, and suicide (Alpaslan et al., 2015).

Despite the fact that Internet addiction is not (as yet) recognised as an official clinical disorder by official medical bodies, researchers from all over the world have shown support for its inclusion in the mental health diagnostic manuals given that the knowledge of this potential disorder has grown substantially over the last two decades (Kuss, Griffiths, et al., 2014; Pontes, Kuss & Griffiths, 2015). Even though the knowledge base on Internet addiction and its neurobiological correlates have progressed considerably over the last 15 years (Pontes, Kuss & Griffiths, 2015), research in this field comes with a caveat in terms of definition and characterisation of the phenomenon, ultimately leading to inadequate psychometric assessment on the basis of extant assessment tools (Pontes & Griffiths, 2015a). A review conducted by Király, Nagygyörgy, et al. (2014) on the nine most used instruments for assessing Internet addiction found several inconsistencies and limitations among them. According to these authors, most of the discrepancies identified concerned the (i) theoretical basis of instruments, (ii) factor structures, (iii) and psychometric properties. Additionally, the majority of these instruments were based on either the DSM-IV criteria for pathological gambling and/or substance dependence (American Psychiatric Association, 1994). The review also found that while the factor structure information of some instruments were not consistently reported, they generally comprised of one or up to seven factors, and only a few psychometric properties were assessed.

As noted a number of times in this thesis, Internet Gaming Disorder was included in the Section III of the latest (fifth) edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) by the American Psychiatric Association (American Psychiatric Association, 2013) as a condition in need of further study (see page 146, Chapter 6 for further details on each diagnostic criteria).

Although the theoretical framework proposed by the American Psychiatric Association for Internet Gaming Disorder somewhat confusingly refers to both online and offline gaming addiction, several recent studies on technological addictions (e.g., Cho et al., 2014; Pontes & Griffiths, 2015a; Van den Eijnden, Lemmens, & Valkenburg, 2016) have adapted the Internet Gaming Disorder theoretical framework to understand other potential behavioural addictions. This is because it provides an opportunity to formally standardise the operational definition of the main construct under investigation, and potentially unify the area in terms of psychometric assessment by adopting a more agreed upon assessment criteria, which is key for advancing the field since it facilitates comparison across studies. The Internet Gaming Disorder framework proposed by the American Psychiatric Association has helped researchers around the world develop numerous psychometric instruments for a number of different technological addictions, such as gaming addiction (e.g., Pontes & Griffiths, 2015a; Pontes, Király, et al., 2014), social networking addiction (e.g., Van den Eijnden et al., 2016), and generalised Internet addiction (Cho et al., 2014; Pontes & Griffiths, 2015a).

More recently, a few studies applied this rationale to the case of generalised Internet addiction in cross-sectional research. For instance, Cho et al. (2014) conducted a survey in a sample of 1.192 South Korean adolescents to develop and validate a standardised self-diagnostic Internet addiction scale based on the diagnostic criteria for Internet Gaming Disorder as defined

in the DSM-5 (American Psychiatric Association, 2013). According to the authors, 41 items grouped into nine latent factors selected from previous Internet addiction assessment tools were used to develop a new tool. After analysing the data, the authors concluded that the model based on the DSM-5, which comprised nine factors, was not appropriate for the instrument in question, and led the authors to restructure their theoretical model according to statistical results obtained in the original model. As the new instrument developed presented with several shortcomings, such as inconsistent factor structure and relative lack of brevity, Pontes and Griffiths (2017) recruited a heterogeneous sample of 1.105 Internet users (age range 16 to 70 years; $M_{age} = 33$ years) to develop and analyse the psychometric properties of the Internet Disorder Scale (IDS-15), which defines generalised Internet addiction via four main latent domains: (i) '*Escapism and Dysfunctional Emotional Coping*', (ii) '*Withdrawal Symptoms*', (iii) '*Impairments and Dysfunctional Self-Regulation*', and (iv) '*Dysfunctional Internet-related Self-Control*'. The IDS-15 was developed to assess the severity of Internet addiction and the impact of its detrimental effects during a 12-month time frame. The results of the study found that at the construct validity level, the IDS-15 provided robust evidence in terms of factorial, convergent, and discriminant validity. Evidence on the instrument's criterion validity and reliability was also satisfactory according to the authors.

To date, and to the best of this author's knowledge, only two studies (i.e., Cho et al., 2014; Pontes & Griffiths, 2017) have been conducted using this strategy to develop Internet addiction psychometric tools. Although other researchers have suggested that it might be beneficial in adopting such an approach to understand and assess Internet addiction (Rumpf et al., 2015), little research has been carried on this issue, and the existing evidence remains unclear. For instance, the study by Cho et al. (2014) represented an important effort and contribution, but several limitations emerged as the psychometric properties of their instrument remain questionable

because the new instrument (i) was arguably lengthy, which is problematic for time-limited research, (ii) had its items lifted from previous problematic Internet addiction instruments, (iii) was developed using a limited sample of adolescents, thus limiting its generalisability to other segments of the population (i.e., adults and elderly), and (iii) lacked robust psychometric properties (e.g., low reliability, $\alpha = .49$ and $\alpha = .65$ in two factors). On the other hand, although the results obtained in the study of the IDS-15 (Pontes & Griffiths, 2017) were robust and promising, the IDS-15 still needs to be refined both in terms of latent factors and number of items because the scale presents with a relatively complex factor structure while most new tools adopting the Internet Gaming Disorder framework are unidimensional in nature.

In light of the conceptual and methodological issues raised, the present study seeks to add to the current debates on the viability of adapting the nine Internet Gaming Disorder criteria outlined by the American Psychiatric Association (2013) to assess generalised Internet addiction by being the first study to develop a new standardised psychometric tool for measuring generalised Internet addiction using the nine criteria for Internet Gaming Disorder slightly modified to reflect generalised Internet use instead of gaming. Thus, the main goal of this study is to expand the findings reported by Pontes and Griffiths (2017) by developing and exploring the psychometric properties of the Internet Disorder Scale – Short Form (IDS9-SF), a short version of the IDS-15 (Pontes & Griffiths, 2017). By developing a brief psychometric test to assess generalised Internet addiction may facilitate access to larger pools of participants and reduce attrition rates in future longitudinal studies.

Method

Participants and Procedures

A convenience sample of Internet users was recruited from several online forums (e.g., *Something Awful*, *The Student Room*, etc.) and social networking websites (e.g., *Facebook* and *LinkedIn*). Participants were sent out invitations via forum threads to participate in the study over a period of six months spanning from February to July 2014. Personalised feedback was provided to participants' questions and issues encountered during survey administration on a regular basis during the data collection process.

To participate in the study, participants had to (i) be at least 16 years of age, and (ii) provide individualised online written informed consent. The recruited sample comprised 1,107 Internet users that filled out the study's questionnaires. After cleaning the data, the final sample of the study comprised 1.100 Internet users. The majority of the sample (91%) were either from the United States of America 36.9% (n = 406), India 30.1% (n = 331), or from the United Kingdom 24.5% (n = 270), with a small minority (n = 100; 9%) from other countries. The sample was predominantly male (n = 673, 61.2%) with ages ranging from 16 to 70 years (M_{age} = 33 years, SD = 12.33). All participants were assured of anonymity and confidentiality, and the study was granted with approval of Nottingham Trent University's College Research Ethics Committee.

Measures

Socio-demographics and Internet use. A questionnaire was developed in order to collect data on gender, age (year at the time of survey completion), relationship status (in or not in a relationship), weekly Internet usage (average weekly hours spent on the Internet for leisure purposes), cigarette usage (smoke cigarettes more than three times a week - yes/no) and alcohol usage (drink alcohol more than three times a week – yes/no), age of Internet use initiation (age

participant remembers first using the Internet), and ownership of Internet-enabled electronic devices (yes/no).

The Internet Disorder Scale – Short Form (IDS9-SF). The IDS9-SF is a unidimensional (see Figure 7.1) standardised psychometric tool developed by the author of the present study by slightly modifying the wording of the original nine Internet Gaming Disorder criteria outlined in the DSM-5 (American Psychiatric Association, 2013) to adjust to the case of Internet addiction. Although the nine items of the IDS9-SF were essentially derived from the nine Internet Gaming Disorder criteria, the scale represents the short version of the IDS-15 (Pontes & Griffiths, 2017) and can be similarly used to estimate the severity of generalised Internet addiction and the impact of its detrimental effects by only focusing upon users' online leisure activity (i.e., excluding academic and/or occupational Internet use) from any device with Internet access during the past year. The nine questions comprising the IDS9-SF are answered using a 5-point scale: 1 ('*Never*'), 2 ('*Rarely*'), 3 ('*Sometimes*'), 4 ('*Often*'), and 5 ('*Very often*'). The scores are obtained by summing the responses, and total scores can range from 9 to 45, with higher scores being indicative of a higher degree of Internet use disorder. Although this author discouraged using only this tool to diagnose cases of Internet addiction in isolation, a strict diagnostic approach of endorsement of five or more of the nine items as assessed by the IDS9-SF on the basis of answering "*Very often*" should only be considered if there is a need to differentiate between likely disordered and non-disordered cases. The IDS9-SF is presented on Appendix VI.

The Internet Disorder Scale (IDS-15). The IDS-15 (Pontes & Griffiths, 2017) is a 15-item psychometric tool used to assess Internet addiction based on the modified nine Internet Gaming Disorder criteria outlined in the DSM-5 (American Psychiatric Association, 2013). The scale assesses the severity of Internet addiction and the impact of its detrimental effects by only focusing

upon users' online leisure activity (i.e., excluding academic and/or occupational Internet use) from any device with Internet access during the past year. The IDS-15 includes items that can be grouped at the theoretical level, into four main and qualitatively distinct Internet addiction-related domains: (i) '*Escapism and Dysfunctional Emotional Coping*' (e.g., "*I go online to help me cope with any bad feelings I might have.*"), (ii) '*Withdrawal Symptoms*' (e.g., "*I tend to get anxious if I can't check what's happening online for any reason.*"), (iii) '*Impairments and Dysfunctional Self-Regulation*' (e.g., "*I think the amount of time I spend online is negatively impacting on important areas of my life.*"), and (iv) '*Dysfunctional Internet-related Self-Control*' (e.g., "*I am able to control and/or reduce the time I spend online.*"). All items are responded to on a 5-point Likert scale: 1 ('*Strongly disagree*'), 2 ('*Disagree*'), 3 ('*Neither agree nor disagree*'), 4 ('*Agree*'), or 5 ('*Strongly agree*'). The total IDS-15 score is obtained by summing up participants' responses and can range from 15 to 75, with higher scores being an indication of higher degrees of Internet addiction.

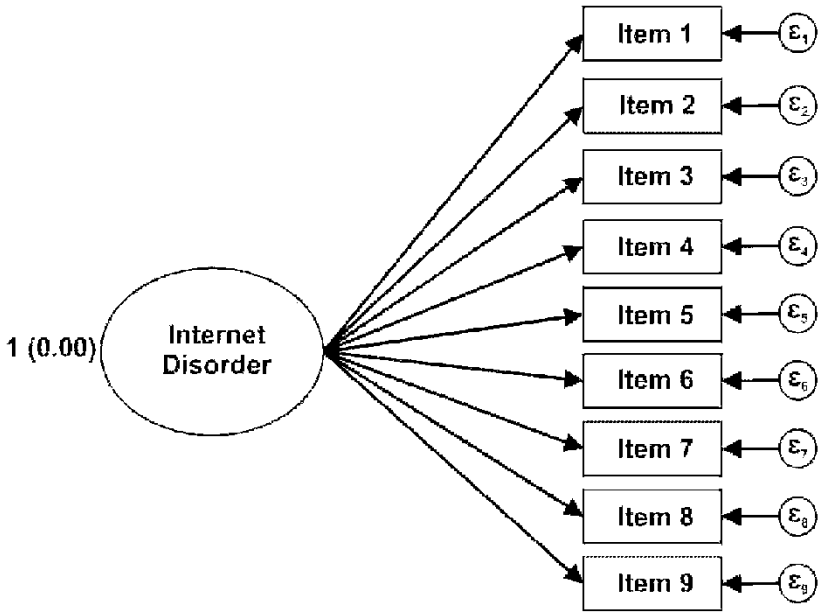

Figure 7.1. Measurement model of the Theoretical Factor Structure of the Internet Disorder Scale – Short Form (IDS9-SF)

Data Analytic Strategy and Statistical Analysis

Prior to the statistical analyses, the data were cleaned in two steps. The first step included cleaning the data via a thorough analysis of each case presenting with missing values above the threshold of 10% in all relevant instruments of the study, which resulted in no case being excluded. The second step of the data management process involved the analysis of the (i) univariate normality of all nine items of the IDS9-SF, (ii) univariate outliers, and (iii) multivariate outliers cases in the dataset. As for the univariate normality, no item of the IDS9-SF had absolute values of Skewness > 3.0 and Kurtosis > 8.0 (Kline, 2011), thus warranting univariate normality of the study's main measure. In order to screen for univariate outliers, a standardised composite sum score of the IDS9-SF using all nine items was created and participants were deemed univariate outliers if they scored ± 3.29 standard deviations from the IDS9-SF z-scores as this threshold includes around 99.9% of the normally distributed IDS9-SF z-scores (Field, 2013). Based on this analysis, no cases of univariate outliers were found and therefore, no further cases were excluded. Finally, the data were also screened for multivariate outliers using Mahalanobis distances and the critical value for each case based on the chi-square distribution values, which resulted in seven cases being excluded from the dataset. Thus, the final sample size for all subsequent analyses was N = 1.100.

After cleaning the dataset, the statistical analysis of the present study included (i) descriptive statistics of the main sample's characteristics (i.e., frequencies and percentages), (ii) assessment of the dimensionality and factorial structure of the IDS9-SF with confirmatory factor analysis (CFA), (iii) nomological validation of the IDS9-SF to strengthen the case of construct validity by performing a full structural equation modelling (SEM) analysis for the coefficient estimates of a theoretical model reflecting a nomological network that replicates the pattern of

association known for each construct in the model with Internet addiction; (iv) concurrent and criterion validity analysis by investigating the bootstrapped correlation coefficients with 95% Bias-corrected and accelerated (BCa) confidence intervals between the IDS9-SF the IDS-15 total scores and time spent on the Internet weekly, (v) analysis of the reliability of the IDS9-SF using different coefficients and indicators of internal consistency (i.e., Cronbach's alpha, factor determinacy, composite reliability, and correct item-total correlation coefficients). All the analyses were performed using MPLUS 7.2 (Muthén & Muthén, 2012) and SPSS Statistics v.20 (IBM Corp, 2011).

Results

Characteristics of the Sample

Table 7.1 summarises participants' main socio-demographic characteristics, substance use, and Internet use patterns. Two-thirds of the participants reported being in a relationship (n = 746, 67.8%). Two-fifths of the participants started using the Internet after the age of 18 years (n = 447; 40.6%), followed by those that started to use the Internet between 13 and 17 years (n = 314; 28.5%), between 7 and 12 years (n = 284; 25.8%), and before the age of 6 years (n = 25, 2.3%). Only 2.7% of the participants (n = 30) reported not remembering their age of Internet use initiation at the time they filled out the survey. The vast majority of the sample (90.4%; n = 994) reported owning Internet-enabled electronic devices (see Table 7.1).

Table 7.1. Sample's main Socio-demographic Characteristics, Substance, and Internet use Patterns

N	1.100
Gender (male, %)	673 (61.2)
Age (years) (mean, S.D.)	33 (12.3)
Country of origin (n, %)	
United States of America	406 (36.9)
India	331 (30.1)
United Kingdom	270 (24.5)
Other Countries	93 (8.5)
Relationship status (In a relationship, %)	746 (67.8)
Weekly Internet usage (n, %)	
Less than 7 hours	48 (4.4)
Between 8 and 14 hours	142 (12.9)
Between 15 and 20 hours	188 (17.1)
Between 21 and 30 hours	230 (20.9)
Between 31 and 40 hours	170 (15.5)
More than 40 hours	322 (29.3)
Cigarette consumption (> 3 times a week, %)	211 (19.2)
Alcohol consumption (> 3 times a week, %)	248 (22.5)
Age of Internet use initiation (n, %)	
Before 6 years old	25 (2.3)
Between 7 and 12 years old	284 (25.8)
Between 13 and 17 years old	314 (28.5)
After 18 years old	447 (40.6)
Do not remember	30 (2.7)
Ownership of Internet-enabled electronic devices (yes, %)	994 (90.4)

Construct Validity: Confirmatory Factor Analysis (CFA)

A CFA was performed on the nine items of the IDS9-SF using the theoretical model shown in Figure 7.1 with maximum likelihood with robust standard errors estimation method (MLR) on the whole sample (N = 1.100). Since there is no consensus on the fit indices for evaluating structural equation models (see Bollen & Long, 1993; Boomsma, 2000; Hoyle & Panter, 1995), the goodness of fit was based on several fit indices using the following thresholds: $\chi 2$/d.f. [1;4], Root Mean Square Error of Approximation (RMSEA) [0.05;0.08], RMSEA 90% confidence interval with its lower limit close to 0 and the upper limit below .08, *p-close* > .05, Standardised Root Mean Square Residual (SRMR) [0.05;0.08], Comparative Fit Index (CFI) and Tucker-Lewis Fit Index (TLI) [.90;.95]. All nine indicators were entered into a unidimensional factorial solution reflecting the nine criteria outlined by the American Psychiatric Association. The results obtained for the one-factor model provided an acceptable model fit for the IDS9-SF ($\chi 2$ [25] = 110.1, $\chi 2$/d.f. = 4.4; RMSEA = 0.056 [90% CI: 0.045–0.066], *p-close* = .18; SRMR = 0.023, CFI = .98; TLI = .97) with acceptable standardised item loadings (i.e., $\lambda_{ij} \geq .50$) (see Table 7.2). These results warrant the factorial validity of the IDS9-SF given that the obtained fit indices were acceptable, and that all standardised factor loadings were relatively high (i.e., $\lambda_{ij} \geq .50$).

Table 7.2. Summary of the Confirmatory Factor Analysis (CFA) and Overall Item-related Descriptive Statistics Results of the Internet Disorder Scale – Short Form (IDS9-SF)

Item	*λ**	*Min*	*Max*	*Me*	*M*	*SD*	*Sk*	*Ku*
1. Do you feel preoccupied with your online behaviour? (Some examples: Do you think about previous sessions online or anticipate the next online session? Do you think being online has become the dominant activity in your daily life?)	.76	1	5	2	2.53	1.15	0.23	-0.90
2. Do you feel more irritability, anxiety and/or sadness when you try to either reduce or stop using the internet?	.81	1	5	2	2.19	1.14	0.65	-0.50
3. Do you feel the need to spend increasing amount of time engaged online in order to achieve satisfaction or pleasure?	.81	1	5	2	2.30	1.22	0.50	-0.90
4. Do you have difficulties in trying to control, cut down, and/or cease your online usage?	.77	1	5	2	2.24	1.17	0.62	-0.60
5. Have you lost interest in previous hobbies and other leisure activities as a result of being online?	.77	1	5	2	2.21	1.24	0.62	-0.80
6. Have you continued to go online despite knowing it was causing problems between you and other people?	.81	1	5	2	2.02	1.18	0.86	-0.39
7. Have you deceived any of your family members, therapists or other people because the amount of time you spend online?	.73	1	5	1	1.78	1.14	1.26	0.39
8. Do you go online in order to escape or feel better (e.g., helplessness, guilt, anxiety)?	.66	1	5	3	2.54	1.23	0.24	-0.94
9. Have you jeopardized or lost an important relationship, career or an educational opportunity because of your online usage?	.72	1	5	1	1.79	1.16	1.19	0.12

*****: All factor loadings were statistically significant at $p < .001$

Note: λ = standardised factor loadings; **Min** = Minimum value observed; **Max** = Maximum value observed; **Me** = Median; **M** = Mean; **S.D.** = Standard deviation; **Sk** = Skewness; **Ku** = Kurtosis

Scale instructions: "*Instructions: **These questions relate to your Internet usage during the past year** (i.e., 12 months). By Internet usage we mean **any activity performed online** on either a **computer** or a **laptop**, or **any other kind of portable device** with Internet access.***"**

Participants' rating scale: 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Very Often

Construct Validity: Nomological Validation

Assessing construct validity of Internet addiction also involves identifying a relevant network of key constructs associated with the construct and to explicate the pattern of interrelationships that exist among them (Bryant, King, & Smart, 2007). This procedure has been elaborated and discussed by Cronbach and Meehl (1955) who argued that it is necessary to understand the nature of a construct through the statistical or deterministic laws underlying the network of key constructs, often referred to as nomological network. The nomological network is considered an aspect of construct validity of a given phenomenon that in the context of the present study was assessed by replicating the structural and causal relationships between Internet addiction and age, age of Internet use initiation, and time spent on the Internet weekly because several studies (e.g., Pontes & Griffiths, 2015c; Siciliano et al., 2015; Tsitsika et al., 2014; Vink et al., 2016) have found these variables to be associated with the phenomenon of addictive Internet use. For this reason, a full SEM analysis was performed on the data to investigate the nomological validity of the Internet addiction construct. The structural model included Internet addiction as the outcome of age, age of Internet use initiation, and time spent on the Internet weekly. The results produced an adequate fit to the data ($\chi 2$ [49] = 213.3, $\chi 2$/d.f. = 4.3; RMSEA = 0.055 [90% CI: 0.048–0.063], *p-close* = .12; SRMR = 0.031, CFI = .97; TLI = .96). In terms of the variance explained (R^2) for each outcome in the model, age explained 38% of the variance in age of Internet use initiation (R^2 = .38, $p < .0001$), and 3% of the variance on time spent on the Internet weekly (R^2 = .03, p = .004). The total variance explained in the outcome (i.e., Internet addiction) by all three predictors was and 18% (R^2 = .18, $p < .0001$) (see Figure 7.2).

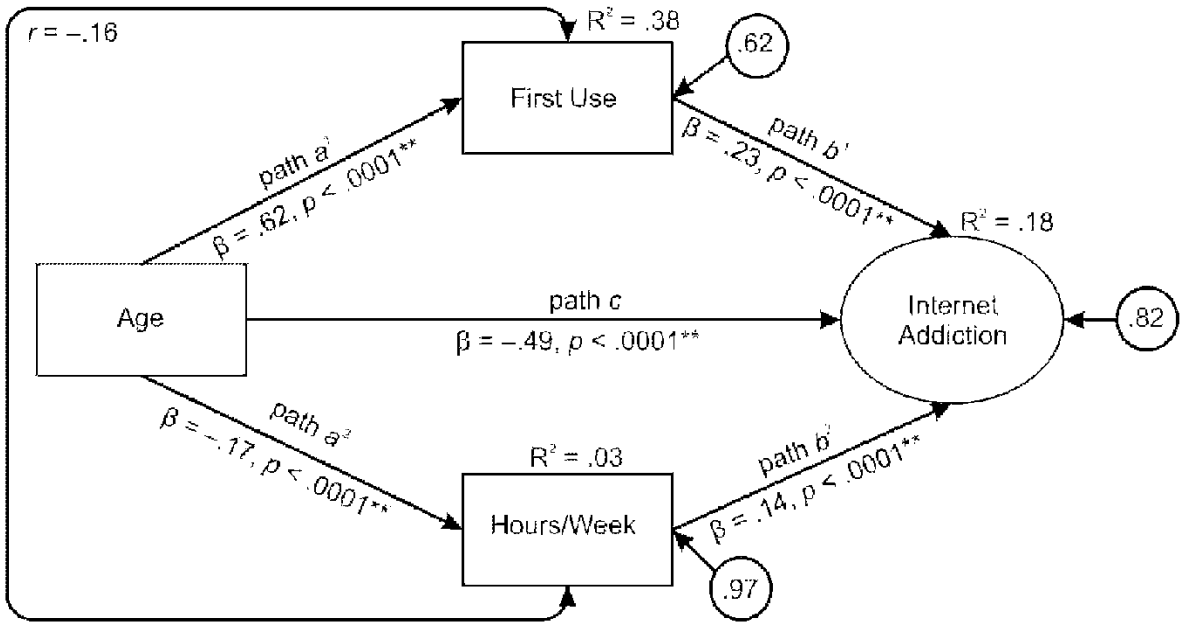

Figure 7.2. Summary of the Nomological Validation Analysis of the Internet Disorder Scale – Short Form (IDS9-SF)

Note: ** $p < .0001$; β: standardised beta coefficient; Overall goodness of fit $\chi 2$ [49] = 213.3, $\chi 2/df = 4.3$; RMSEA = 0.055 [90% CI: 0.048–0.063], p-close = .12; SRMR = 0.031, CFI = .97; TLI = .96. ***Acronyms***: **CFI**: Comparative Fit Index; **RMSEA**: Root Mean Square Error of Approximation; **SRMR**: Standardised Root Mean Square Residual; **TLI**: Tucker-Lewis Fit Index.

Concurrent and Criterion Validity Analysis

Concurrent validity was investigated by examination of the bootstrapped Pearson's correlation coefficient with 10.000 bootstrap samples and 95% BCa CI between the IDS-15 and IDS9-SF's total scores, which yielded adequate results (r = .80, R^2 = .64, p < .0001, 95% BCa CI [.78–.82]) warranting the scale's concurrent validity. Furthermore, criterion validity was ascertained by demonstration of a statistically significant association between Internet addiction and a reliable and recognised indicator of the construct. To achieve this goal, bootstrapped Spearman's rho correlation coefficient with 10.000 bootstrap samples and 95% BCa CI between IDS9-SF's total scores and time spent on the Internet weekly (r_s = .18, R^2 = .03, p < .0001, 95% BCa CI [.12–.24]) was estimated, and the results provided further support for the IDS9-SF's criterion validity.

Reliability Analysis

The reliability of the IDS9-SF was assessed using several indicators of reliability. The Cronbach's alpha reliability coefficient was relatively high (a = .93) and could not be improved upon deletion of any item. The factor determinacy of the IDS9-SF was .96, which is well above the desired threshold of .80 (Muthén & Muthén, 2012). The analysis of the composite reliability provided a coefficient of .93, which is also beyond the accepted threshold of .70 (Fornell & Larcker, 1981; Hair et al., 2010). Finally, the item/domain discriminating power was assessed using the corrected item-total correlations. Accordingly, all the items were statistically significant and positively associated with the total score, with correlation coefficients ranging from .63 to .79 (see Table 7.3). Overall, these results strongly support the adequacy and reliability of the unidimensional factor solution of the IDS9-SF in the present sample.

Table 7.3. Summary of the Reliability Results of the Internet Disorder Scale – Short Form (IDS9-SF)

Reliability Coefficients			*Correct Item-Total Correlation* [a]								
α	FD	CR	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9
.93	.96	.93	.72	.77	.77	.73	.74	.79	.74	.63	.73

[a]**:** All correlation coefficients were statistically significant ($p \leq .001$)
Note: ***α***: Cronbach's alpha; **FD**: Factor Determinacies; **CR**. Composite Reliability; **AVE**: Average Variance Extracted.

Discussion

The main aim of the present study was to develop a new psychometrically validated instrument to assess Internet addiction and further investigate its psychometric properties in several distinct domains using the theoretical framework outlined by the American Psychiatric Association regarding the nine DSM-5 criteria for Internet Gaming Disorder (American Psychiatric Association, 2013). To achieve the study's goals, the IDS9-SF underwent rigorous psychometric scrutiny. With regards to the instrument's construct validity, the results from the CFA and the nomological validation provided adequate results warranting the instrument's construct validity. In terms of the factor structure of the IDS9-SF, the results obtained in the present study mirrored those reported in previous studies (Pontes & Griffiths, 2015a, 2016) that found a unidimensional factor structure for the nine Internet Gaming Disorder criteria. The analysis of both concurrent and criterion validity also yielded satisfactory results that further highlighted the new instrument's concurrent and criterion validity in light of the variables investigated. It is worth noting that the correlation coefficient obtained for the criterion validity analysis was relatively weak, which might be a result of the non-parametric analysis conducted due to the ordinal operationalisation of the variable (i.e., time spent on the Internet weekly). However, the results obtained for the concurrent validity analysis provided strong evidence in this regard. In relation to the reliability of the IDS9-SF, the results supported its adequacy concerning its internal

consistency as assessed by several indicators such as the Cronbach's alpha, factor determinacy, composite reliability, and corrected item-total correlation.

In light of the findings obtained, future studies could expand on these results by further examining how well these results hold in different samples and cultural contexts. Even though the results obtained here appear promising, they are preliminary in nature because the scale still needs to be tested using a clinical sample, which can provide useful results to help confirm or disconfirm the suggested cut-off point for the IDS9-SF. Although the present study provided robust findings, it is not without its limitations due to several reasons. First, the study was conducted using a convenience sample of Internet users that was not necessarily representative of all Internet users. Therefore, the present findings should be cautiously interpreted and not generalised to all Internet users. Another aspect that might have negatively impacted on this study was the use of self-report questionnaires and their associated possible biases such as social desirability biases and short-term recall biases. Finally, although several forms of validity were examined, other types of validity could also have been assessed, such as predictive validity.

Taken as a whole, the findings of the present study support the concept of Internet addiction and its psychometric assessment when using the modified Internet Gaming Disorder criteria as outlined in the DSM-5 (American Psychiatric Association, 2013). Furthermore, the IDS9-SF may prove to be a psychometrically robust tool to assess Internet addiction provided that future studies can replicate and expand the present findings in different research settings and using clinical samples.

PART III: GENERAL DISCUSSION AND CRITICAL EVALUATION

CHAPTER 8: Conclusions, Implications and Future Research

The overarching aim of the present thesis was to devise an updated strategy to psychometrically assess the constructs of Internet addiction and Internet Gaming Disorder in a valid and reliable way by adopting the latest theoretical framework developed by the American Psychiatric Association in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) (American Psychiatric Association, 2013). By utilising an agreed upon theoretical framework (i.e., Internet Gaming Disorder) to conceptualise and develop the new psychometric tools, this thesis made a unique contribution to knowledge in the field of behavioural addictions by fostering and promoting a much-needed unified approach to the field of psychometric assessment of both Internet addiction and Internet Gaming Disorder. This was a shortcoming extensively highlighted and widely reported by numerous authors that argued that the use of many different understandings, conceptualisations, and inconsistent assessment tools and non-validated criteria to assess these two behavioural addictions has hindered progress in the field (e.g., Griffiths et al., 2014; King et al., 2013; Petry, Rehbein, Ko, & O'Brien, 2015; Pontes & Griffiths, 2014; Pontes, Kuss, et al., 2015; Thorens et al., 2014; Tokunaga, 2015).

The main rationale underlying the present thesis relates to the fact that the inclusion of Internet Gaming Disorder as a potential disorder and a research category in the DSM-5 (American Psychiatric Association, 2013) represents a major advance, allowing researchers and clinicians a standardised direction for researching and treating this condition, and making the development of psychometrically sound clinical interviews and screening tools necessary to firmly establish and improve the criteria for this condition (Petry, Rehbein, Ko, et al., 2015).

In order to achieve the main aim of this thesis, two steps were taken throughout this project. Firstly, the first part of this thesis (i.e., Introduction; Chapters 1, 2, and 3) extensively reviewed the literature related to the issue of psychometric assessment of Internet addiction and Internet Gaming Disorder to illustrate how methodological drawbacks and hindrance in research emerged as a result of the adoption of inconsistent and non-standardised assessment tools in the evaluation process of these two behavioural addictions. Secondly, the second part of this thesis (i.e., Empirical Studies; Chapters 4, 5, 6, and 7) developed four psychometric tools that can be employed by researchers and clinicians as an alternative and also as a way to promote a unified strategy regarding the assessment of both Internet addiction and Internet Gaming Disorder that is capable of bridging the gaps widely reported in the literature. To further illustrate the unique contributions to knowledge and insights the present thesis offers, the main findings of each chapter will be briefly summarised.

Chapter 1 aimed to further elaborate and clarify the main issues that are relevant to Internet addiction research in a number of areas, including the definition and characterisation of the construct; incidence and prevalence rates; associated neuronal processes; and implications for treatment, prevention, and patient-specific considerations. Based on the results obtained from this review, the following conclusions were drawn: (i) there is currently no consensual definition for Internet addiction. Thus, the need to develop a unified solid theoretical and unified assessment framework is of utmost importance; (ii) prevalence rates among nationally representative samples across several countries vary greatly, from 1% in Germany (Rumpf et al., 2014) to 18.7% in Taiwan (I-H Lin et al., 2014), which reflects the lack of methodological consistency and conceptual rigour in the definition and psychometric assessment of the main construct; (iii) in terms of neuronal processes associated with Internet addiction, the extant research provides small,

but compelling support in favour of a link between biological brain abnormalities in patients addicted to substances and similar brain abnormalities in Internet addicts, suggesting the existence of overlaps between the two conditions in terms of the neural substrates implicated; (iv) with regards to the treatment of Internet addiction, psychological and pharmacological therapies appear to be the most popular treatment approaches used by clinicians, and in some cases a combination of both may be more effective.

Chapter 2 focused specifically on the issue of Internet Gaming Disorder and demonstrated how the adoption of inconsistent criteria and psychometric tools used in the past to assess the construct has negatively influenced the field while also providing an overview of how the field evolved in terms of its historical developments; current definitions and theoretical frameworks; developments in the neurobiological research; psychometric assessment, and; emerging trends in the assessment of Internet Gaming Disorder. One of the key findings of this chapter was that, similar to what has been found in previously (e.g., King et al., 2013; Király, Nagygyörgy, et al., 2014), most of the existing psychometric tools used to assess Internet Gaming Disorder present a wide range of methodological shortcomings since they were based on theoretically inconsistent frameworks that resulted in diagnostic and conceptual confusion, further supporting the previous call (Griffiths et al., 2014; Kuss, 2013b) for the adoption of a more commonly agreed upon criteria and the development of an updated and unified psychometric assessment framework in which both validity and reliability can be better ascertained across studies.

The final chapter of the Introduction section (i.e., Chapter 3) systematically reviewed a set of fourteen empirical neuroimaging studies on Internet Gaming Disorder and their key methodological and psychometrics assessment aspects. To the best of this author's knowledge, this was the first systematic review study that attempted to summarise and critique the existing

evidence regarding the psychometric assessment of Internet Gaming Disorder in neuroimaging studies, which represents a novel and important contribution to the field by providing a critical discussion on the current practices in the assessment of the main construct under analysis, and future avenues for new methodologically sound and robust research. Despite the trend observed suggesting an increase in the publication rates of Internet Gaming Disorder studies using neuroimaging techniques, a series of limitations regarding the methodology and type of assessment strategy used in such studies were observed. More specifically, some of the main methodological issues raised related to (i) limitations present in the process of recruitment of gamers for such studies and also (ii) the lack of use of heterogeneous neuroimaging techniques other than the ones traditionally adopted to allow new potentially meaningful evidence regarding the neurobiological aetiology and clinical course of Internet Gaming Disorder to be gathered.

Most importantly, the main problems identified by the review regarding the practices in the assessment of Internet Gaming Disorder in this type of research, related to the fact that most studies diagnosed Internet Gaming Disorder adopting assessment instruments that were either designed to assess generalised Internet addiction or had their theoretical framework rooted on the concept of Internet addiction and/or other non-validated diagnostic criteria. This latter finding supports the arguments raised in the previous chapters regarding how the use of different, inconsistent, non-specific, and/or psychometrically weak tools to assess Internet Gaming Disorder not only represents a threat to the call for unification in the assessment of the construct (Griffiths et al., 2016), but also hinders the progress of research in the field as cross-cultural comparisons between studies are virtually impossible to be achieved under such circumstances (Kuss, Griffiths, et al., 2014).

In addition to the novel findings and systematic theoretical insights provided in the first part of this dissertation (i.e., Introduction; Chapters 1, 2, and 3), which have helped reinforce and strengthen the rationale for the second part of this dissertation (i.e., Empirical Studies; Chapters 4, 5, 6 and 7), the present thesis also made significant new contributions to knowledge by developing a potential unified framework for the assessment of Internet Gaming Disorder and Internet addiction throughout a series of robust and large-scale empirical studies that were reported in the second part of this dissertation. These findings will be briefly summarised below alongside their impact and implications for future research in the field.

The two empirical studies reported on Chapters 4 and 5 aimed at developing two new valid and reliable psychometric tool to assess the construct of gaming addiction based on the theoretical framework put forth by the American Psychiatric Association in the DSM-5 (American Psychiatric Association, 2013). The necessity to develop such tools was largely derived from the already noted need to unify the field of assessment of behavioural addictions, namely Internet Gaming Disorder in order to overcome the issues related to conceptual and methodological heterogeneity aforementioned, and help the field to move forward. More specifically, Chapter 4 described the development process of the Internet Gaming Disorder Test (IGD-20 Test) (Pontes, Király, et al., 2014), which was the first-ever psychometric tool devised to assess Internet Gaming Disorder according to the nine official criteria detailed in the DSM-5 by the American Psychiatric Association (2013). The study of the IGD-20 Test was carried out in a large sample consisting of 1,003 gamers from 57 different countries that were recruited online. Based on the data collected and results obtained, it was demonstrated that the IGD-20 Test presented with adequate levels of validity (i.e., construct validity, criterion-related validity, and concurrent validity) and reliability, making the IGD-20 Test a suitable and promising standardised psychometrically robust tool for

assessing Internet Gaming Disorder. On the other hand, Chapter 5 explained in greater detail the development process of the Internet Gaming Disorder Scale–Short-Form (IGDS9-SF) (Pontes & Griffiths, 2015a). This study, which involved a large-scale survey in a sample of 1,060 gamers, added to the literature on Internet Gaming Disorder by being first-ever to develop a short valid and reliable psychometric instrument entirely derived from the nine official criteria established by American Psychiatric Association (2013) defining the main construct. The IGDS9-SF is therefore a viable alternative psychometric tool to be used in time-limited surveys aiming to assess all aspects of the Internet Gaming Disorder construct in a brief way while also maintaining a high degree of validity and reliability.

Taken together, the findings of Chapters 4 and 5 not only offer preliminary support in favour of the recognition of Internet Gaming Disorder as a *bona fide* behavioural addiction that should be acknowledged by official medical bodies worldwide (e.g., American Psychiatric Association, World Health Organisation, etc.) since it has implications for both mental and physical health of those affected by this disorder, but also offer a context whereby researchers can benefit from using these tools in order to facilitate unified research in the field, which is one of the key areas that need to be improved if this condition is to be better understood and be officially recognised in the future as an independent clinical entity. In fact, although these psychometric tools were developed relatively recently, they are the only ones that have been validated in cross-cultural research. For instance, the IGD-20 Test has now been adapted and validated to be used in Spain (Fuster et al., 2016) and Arabic (Hawi & Samaha, 2017), and the IGDS9-SF has been successfully adapted and validated in Slovenia (Pontes, Macur, et al., 2016b) and Portugal (Pontes & Griffiths, 2016), further validating the high quality and adequacy of the present thesis and its contribution to international research.

Notwithstanding the novel findings regarding the phenomenon of Internet Gaming Disorder, the present thesis also investigated the concept of generalised Internet addiction in terms of how the issues encountered in the literature that were highlighted on Chapters 1 and 3 regarding its conceptualisation and psychometric assessment could be overcame. In order to achieve this goal, two psychometric tools were developed across two-large scale surveys rooted on the theoretical framework provided by the American Psychiatric Association (2013) defining the construct of Internet Gaming Disorder. This strategy for conceptualising generalised Internet addiction was adopted for two main reasons. On the one hand, since Internet addiction is not yet an official diagnosis, better psychometric tools are needed to screen potential patients (Thorens et al., 2014) and help overcome the issues related to the inconsistencies found in the assessment of this disorder. On the other hand, following the latest major developments in the field of addiction (e.g., official recognition by the American Psychiatric Association of behavioural addictions and the inclusion of Internet Gaming Disorder as a potential disorder), it has been suggested by several authors in the field (Cho et al., 2014; Pontes & Griffiths, 2017; Rumpf et al., 2015) that the theoretical framework developed for Internet Gaming Disorder may represent a fruitful way to tackle these issues, and help advance the field of Internet addiction by facilitating consensus in the assessment of this disorder.

Accordingly, the first of these two psychometric tools was the Internet Disorder Scale (IDS-15) (Pontes & Griffiths, 2017), which had its development process explained on Chapter 6. The study of the IDS-15 included a heterogeneous sample of 1,105 Internet users recruited online. In this study, it was demonstrated that the IDS-15 is a valid and reliable tool that can be used to assess generalised Internet addiction as it presented satisfactory levels of construct validity at different levels (i.e., factorial, convergent, and discriminant validity) and criterion-related level.

Moreover, the IDS-15 also exhibited adequate levels of internal consistency as indicated by several reliability coefficients. Furthermore, Chapter 7 also detailed the development process of the Internet Disorder Scale – Short Form (IDS9-SF) (Pontes & Griffiths, 2016), a shorter version of the IDS-15 aimed at assessing generalised Internet addiction based on the theoretical framework of the Internet Gaming Disorder construct as developed by the American Psychiatric Association (2013) on the DSM-5. The study of the IDS9-SF was also conducted on a large heterogeneous sample comprising 1,100 Internet users recruited online, and the findings of this study suggested that the IDS9-SF presented with adequate levels of both validity (i.e., construct validity, concurrent validity, and criterion-related validity) and reliability and that this short psychometric tool is an excellent assessment tool to be employed in large-scale surveys with limited resources. In sum, the findings of the Chapters 6 and 7 support the viability of using the nine Internet Gaming Disorder criteria as outlined by the American Psychiatric Association in the DSM-5 (American Psychiatric Association, 2013) to assess the construct of generalised Internet addiction in a parsimonious and unified fashion that may have the potential to curb the heterogeneity issues in this area of research aforementioned, ultimately facilitating unification in the assessment field.

The empirical studies presented in Chapters 4, 5, 6, and 7 support the common notion that gaming addiction and generalised Internet addiction may be adequately conceptualised and validly and reliably assessed under the latest framework developed by the American Psychiatric Association in the DSM-5 (American Psychiatric Association, 2013) related to the construct of Internet Gaming Disorder. This overall finding represents a common thread between the empirical studies conducted in the context of this thesis. However, it is worth noting that this is not to say that both constructs represent the same phenomenon. Although this thesis offers an alternative way to facilitate unification in the field of assessment of these two behavioural addiction, several

authors have argued in favour of the idea that there are significant idiosyncratic differences that need to be acknowledged between gaming addiction and generalised Internet addiction (Griffiths & Pontes, 2014; Király, Griffiths, et al., 2014; Montag et al., 2014; Rehbein & Mößle, 2013). Nevertheless, the findings of this thesis add to this ongoing discussion by providing robust and convincing empirical evidence supporting the use of an underlying common theoretical framework (i.e., Internet Gaming Disorder) to conceptualise and assess psychometrically both types of behavioural addictions, while also providing preliminary support to the findings of more recent studies on the topic (e.g., Li, O'Brien, Snyder, & Howard, 2016).

In addition to establishing a unified psychometric assessment framework for Internet addiction and Internet Gaming Disorder, the present thesis also provided useful and novel insights in terms of the risk factors associated with these two types of behavioural addictions based on the findings of the Chapters 4 and 6. Accordingly, with regards to Internet Gaming Disorder, based on the statistical analyses conducted (i.e., Latent Profile Analysis and Wald's Chi-square Tests) and reported on Chapter 4, it was found that for a tiny minority of disordered gamers (i.e., 5.3%), a profile of potential risk factors variables involving players' gender and game-frequency was identified. More specifically, disordered gamers had greater likelihood to be (i) male; (ii) play for more than 30 hours per week; (iii) and consequently, display greater levels clinical symptoms related to disordered gaming (i.e., behavioural and cognitive salience, mood modification, tolerance, withdrawal symptoms, conflicts, and relapse). Furthermore, the shared risk factors encountered for Internet addiction included: (i) younger age; (ii) not being involved in a romantic relationship; (iii) smoking cigarettes; (iv) using the Internet for leisure purposes for more than 30 hours a week; (v) using the Internet before the age of six years; (vi) greater incidence of symptoms of Internet addiction and Internet-related problems (i.e., escapism and dysfunctional emotional

coping, withdrawal symptoms, impairments and dysfunctional self-regulation, dysfunctional Internet-related self-control). Overall, these research findings suggest that Internet Gaming Disorder and Internet addiction can have serious negative and dysfunctional consequences in terms of mental and physical health for a tiny minority of people that are affected by these disorders, which puts into question the current unofficial status of these two phenomena.

To conclude, the reported presenting problems of Internet Gaming Disorder and Internet addiction appear to fulfil the necessary conditions for a mental disorder classification that merits official status by recognised mental health and medical bodies, which is finding that has been backed by many experts in the field (Block, 2008; Griffiths, 2000b; Pontes & Griffiths, 2016; Pontes, Kuss, et al., 2015; Pontes, Macur, et al., 2016b; Young, 1998b).

Methodology: Discussion of Potential Limitations

In this section, the aspects related to the methodology adopted across this thesis will be briefly discussed. In addition to explaining the methodological aspects of the present research, this section will also highlight and discuss a number of limitations present in each particular aspect of the methodology of this research, in addition to the ones presented in each of the previous empirical chapters.

Quantitative Research Methods

Throughout this thesis, quantitative research methods were employed with the aid of robust and sophisticated statistical modelling such as structural equation modelling (e.g., measurement model, latent profile analysis, etc.). As a consequence, large amounts of survey data were collected and analysed across the studies conducted. Quantitative research was the most suitable method for

the present thesis because it allows the analysis of large datasets, which is necessary for psychometric validation studies as they often require large amounts of data to be collected. Moreover, this type of research presents with two key advantages (among others): (i) quantitative research can reliably determine whether one concept or theory is better than alternatives via empirical hypothesis testing, and (ii) the results generated can be projectable to the wider population under certain sampling circumstances (Nykiel, 2007). However, the primary disadvantages of quantitative research are that the variables are only investigated if they are known prior to the beginning of the survey, and therefore have been taken into account into the questionnaire (Nykiel, 2007). Although the use of qualitative research methods is commonly used to investigate behavioural addictions and many other psychological phenomena, this type of research methodology was not applied to the present thesis due to the objectives that have been established at the beginning of the project (i.e., conduct a psychometric validation of Internet Gaming Disorder and Internet addiction psychometric tools). However, there are inherent advantages that need to be acknowledged when it comes to the employment of qualitative research methods. For example, in this type of research (i) participants' own words can be captured; (ii) the interview can focus on issues salient to the participants, rather than being driven by the researcher's agenda; (iii) clarification can be sought; (iv) they allow opportunities to prove and explore in greater depth; (v) non-verbal behaviours can be noted and recorded; (vi) it requires little specialist equipment; and (vii) the process draws on existing skills of conversation and communication (Taylor, 2005).

Cross-sectional Research Designs

For the most part of this thesis, a cross-sectional research design was adopted for the empirical studies conducted since this research design is the most adequate for psychometric validation studies as it can help effective investigation of instruments' psychometric properties and also provide evidence for possible risk factors for disease outcomes (Gordis, 2004; Yamamoto, 2008). Furthermore, cross-sectional designs allow the researcher to measure a group of subjects at approximately the same point in time, making both the exposure to a particular risk factor and disease outcome (i.e., case status) to be determined at the same time (Gordis, 2004; Yamamoto, 2008). Although cross-sectional designs are commonly used for descriptive studies, they can also provide suggestive analytic information that can pave the way to future research in a certain field. In addition to this, the utilisation of cross-sectional designs presents with several advantages since they are relatively simple and inexpensive as neither follow-up measures nor treatment are necessary to be in place (Yamamoto, 2008). However, the disadvantages include limited utility in establishing causal inferences as the measurements are made only at one point, and the temporal relationship between exposure and disease outcomes cannot be tested empirically across time (Yamamoto, 2008). Moreover, reverse causality bias can occur where the disease outcome appears to precede the exposure in time (Gerstman, 2003). Despite these potential problems, the studies conducted in this thesis are likely to not be affected by such issues as the types of studies conducted (i.e., validation studies) did not imply generating holistic and causal inferences or theories to be generalised to the broader population.

Psychometric Assessment: Online and Offline Questionnaires

When interpreting the results obtained in the studies conducted, it is worth noting that caution is advised when it comes to actual diagnosis of Internet Gaming Disorder and Internet addiction using the psychometric tools developed here. The reason for this is that establishing a '*gold standard*' for such disorders is still an ongoing work. Moreover, in order to ascertain the efficacy of the cut-off points suggested for the tools developed, in-depth analysis using actual clinical cases of disorder gaming and Internet addicts would be necessary, which is something beyond the scope and purpose of the present thesis. Although this is not a limitation in and of itself as the primary aim was to develop a psychometric assessment capable of unifying the field of assessment of these two behavioural addictions, further testing on clinical samples using the tools developed here should be carried out as a next step that will indeed complement the present research. Notwithstanding this, it has been suggested that the use of self-reports may effectively reflect the symptom experience of individuals suffering from psychopathology (Kuss, 2013a). Additionally, the use of psychometric tools to evaluate patients' mental health status prior to treatment initiation is common practice in modern clinical psychology (Cheshire & Pilgrim, 2004; Kuss, 2013a; Ruben, 1999). Moreover, previous research shown that self-reported symptom severity is capable of distinguishing individuals with mental disorders from those without a mental disorder (Jackson, O'Malley, & Kroenke, 1998), lending support to the usefulness of self-reports for initial psychiatric assessment of a patient's mental health status and indicating that self-reports are a valuable resource that can be used in initial psychopathology evaluation situations (Kuss, 2013a).

It should also be noted in favour of the use of online surveys that they have the ability to reduce potential biases stemming from the researcher, are anonymous, cost-effective, and allow

for the recruitment of significantly large sample pools and underrepresented vulnerable sociological groups that would be otherwise impossible to reach out. The use of online data collection methods constitutes one of the best methods for data collection in the cyberspace and has been widely advocated by many researchers (Griffiths, 2010b, 2012; Mathy, Schillace, Coleman, & Berquist, 2002; Wood & Griffiths, 2007; RTA Wood, Griffiths, & Eatough, 2004). Moreover, the use of online surveys might also increase participants' self-disclosure (Joinson, 2001) and disinhibition (Suler, 2004), helping to decrease social desirability. In addition to this, web-based assessment techniques do not appear to differ significantly from more traditional paper-and-pencil methods of different measures of Internet attitudes and behaviours (Riva, Teruzzi, & Anolli, 2003), and a large body of empirical studies have shown that the use of online self-report questionnaires is as efficient and valid as paper-and-pencil survey methods (Pettit, 2002; Ramsey, Thompson, McKenzie, & Rosenbaum, 2016; Weigold, Weigold, & Russell, 2013).

Nonprobability Sampling Techniques: Online Convenience Sampling

The recruitment of convenience samples was common practice across all empirical studies reported on Chapters 4, 5, 6, and 7. Convenience sampling (also called accidental sampling) is the selection of a sample of participants from a population based on how convenient and readily available that group of participants is, and is a type of nonprobability (Ellison, Farrant, & Barwick, 2009; Salkind, 2010). The main advantage of convenience sampling is that the cost for recruiting participants is relatively low as this is the simplest form of sampling, requiring essentially no planning (Ellison et al., 2009; Salkind, 2010). However, the disadvantages are mainly statistical since the results from studies using convenience sampling are not very generalizable to other settings, given the narrow focus of the technique (Salkind, 2010). Notwithstanding this,

convenience sampling is a very effective sampling method to be used in pilot settings when psychometric instruments are still under development and interventions are yet to be fully designed and approved (Salkind, 2010).

Traditionally, questionnaires designed to assess sensitive topics have been administered via written, telephone, in-person interview, automated telephonic data collection, and computer methods, and the results generally indicate that differing methodologies do not yield unique reports of sensitive information (Brock et al., 2015). Furthermore, when applied to the virtual setting, the recruitment of samples online using convenience sampling strategy has been demonstrated to be reliable in several ways and capable of not introducing additional biases or noise to the data collected (Brock et al., 2015; Remillard, Mazor, Cutrona, Gurwitz, & Tjia, 2014; Rouse, 2015). Moreover, recent empirical studies on addiction have concluded that the use of social networking websites are efficient and cost-effective ways to recruit large numbers of participants, with relevant behaviours and conditions to addiction research (Thornton, Harris, Baker, Johnson, & Kay-Lambkin, 2015). In light of the present research, it is safe to conclude that convenience sampling method was employed adequately to recruit an underrepresented segment of the population (i.e., individuals with problems related to videogame play and Internet use) as Internet Gaming Disorder and Internet addiction only affect a tiny minority of its users.

Statistical Analyses: Structural Equation Modelling

Methods of covariance structure modelling are frequently applied in psychological research. These methods merge the logic of confirmatory factor analysis, multiple regression, and path analysis within a single data analytic framework (Breckler, 1990). Among many applications are estimation of disattenuated correlation and regression coefficients, evaluation of multitrait-

multimethod matrices, assessment of hypothesised causal structures, and development or refinement of standardised psychometric assessment tools (Breckler, 1990). In order to achieve the established aims of this thesis, the data were analysed using advanced structural equation modelling as this is one of the best and most complete strategies in latent variable modelling and also widely used in the process of questionnaire development and construct validity assessment.

Although there are several distinct advantages of using structural equation modelling, this statistical procedure does not provide definite evidence of causality, and it does not '*prove*' the superiority of one model over all possible alternative models (Breckler, 1990; Cliff, 1983). With respect to the latter issue, which is of relevance to the present thesis, although this modelling technique can show that certain models are superior to specific alternatives, this is not to say that the universe of alternative models were eliminated (Hull, Tedlie, & Lehn, 1995). For this reason, it is possible that future research may find other types of factor structure and levels of construct complexity in relation to Internet Gaming Disorder and Internet addiction. This is not a limitation *per se* but rather illustrates the complexity of such phenomena and how they can be differently understood in other settings given certain conditions.

Theoretical Framework: Discussion of Potential Limitations

Although the overall results of the present thesis reported throughout all empirical chapters of this thesis are statistically robust, there are a few aspects related to potential biases emerging from the underlying theoretical framework employed worth mentioning.

Behavioural Addiction: A Controversial Concept

The present work focused on behavioural addictions, namely Internet Gaming Disorder and generalised Internet addiction, two types of non-substance based addictions involving

excessive and harmful technology use. Although the term behavioural addictions encompass a number of potentially problematic behaviours (e.g., gambling behaviour, Internet use, videogame play, social networking use, pyromania, kleptomania, skin picking, etc.), in many of these behaviours, there is still limited scientific and empirical support as to their inclusion as a behavioural addiction (Demetrovics & Griffiths, 2012). Furthermore, there are currently many deficiencies in the exploration of their symptomatology, validation measures, and scarcity of studies investigating the epidemiological and aetiological aspects of these disorders (Demetrovics & Griffiths, 2012). Additionally, early views on addiction used to define the construct as dependence on a psychoactive substance as evidenced by craving, increased tolerance, and withdrawal, but even some seemingly classical addictions do not follow that pattern (e.g., cocaine addiction causes little withdrawal symptoms) (Holden, 2001). For this reason, numerous contemporary authors have argued that addiction goes beyond the ingestion of psychoactive substances, and that it can include problematic and pathological behaviours that may be able to activate and alter the reward system in the brain. There are no shortages on the number of reports suggesting that behavioural addictions exist and that they can negatively affect people's lives (e.g., Griffiths, 1995, 1996b, 2000a; Kuss, Griffiths, et al., 2014; Pontes, Kuss, et al., 2015).

Despite the debates surrounding the concept of addiction, it worth noting that the it is not static in nature. In fact, theories and perspectives defining addiction are abundantly in the literature, and it is also apparent that there is still mileage in discussing the concept itself (West, 2001). Indeed, given that addiction is a socially defined construct, one might expect the definition to continue to vary across culture and time (West, 2001).

Internet Gaming Disorder and Generalised Internet Addiction: Debates and Controversies

The theoretical framework developed by the American Psychiatric Association in the DSM-5 (American Psychiatric Association, 2013) regarding the official nine criteria for Internet Gaming Disorder was adopted as the starting theoretical point and the very foundation of this work. However, uncertainties still remain regarding the applicability and usefulness of this theoretical framework. Although researchers generally agree that excessive and problematic videogame play can be a harmful activity for a minority of people, the definition of the concept has been rather controversial, and an international consensus on the nine Internet Gaming Disorder criteria amongst experts in the field remains elusive (Griffiths et al., 2016). Moreover, the overall validity of the Internet Gaming Disorder construct has been put into question and it has been argued that at present, there is no certainty about what the Internet Gaming Disorder official criteria assess (Kardefelt-Winther, 2015a).

In regards to generalised Internet addiction, concerns have also emerged in the literature as in most cases, the Internet appear to be a tool whereby users can access specific online contents (Griffiths & Szabo, 2014; Pontes, Szabo, et al., 2015). Furthermore, Starcevic and Aboujaoude (2016) argued that the term generalised Internet addiction and the corresponding concept are not adequate for several reasons. First, addiction may be a correct designation only for those individuals who meet the general criteria for addiction as the majority of people considered to be Internet addicts may not have an addiction disorder. Second, there is no evidence that addiction to the Internet as such (i.e., as a medium) exists, even though the Internet as a medium may play an important role in making some online behaviours addictive (Griffiths, 1999). Third, generalised Internet addiction should be replaced by addictions to the specific behaviours, regardless of whether these are performed online or offline. However, this may be done only if such behaviours

follow a pattern of an addiction disorder and meet the general criteria for it. Fourth, generalised Internet addiction is a vague and over-inclusive term because it refers to the endless variety of behaviours performable online, making the concept too heterogeneous (Starcevic & Aboujaoude, 2016).

In addition to this, recent debates on the role of each Internet Gaming Disorder criterion have also emerged, and the overall results of these studies appear to support the idea that some criterion may be more relevant than others towards a positive diagnosis (e.g., Király, Sleczka, et al., 2017; Rehbein, Kliem, Baier, Mößle, & Petry, 2015). For instance, Kardefelt-Winther (2015b) noted that some of the proposed criteria for Internet Gaming Disorder arguably make little sense within the context of gaming, and seem to be included as residuals from other existing disorders. More specifically, Kardefelt-Winther (2015b) argued that the criterion 'deception' is socially or culturally subjective, and therefore varies depending on people close to the player rather than the player itself. Moreover, he also argued that symptoms like 'preoccupation', 'withdrawal', 'tolerance' and a 'loss of interest in other activities' may all be preceded by legitimate explanations for excessive use following widespread popularity of online gaming, which makes them unreliable in an assessment instrument. Given the aforementioned, Starcevic and Aboujaoude (2016) argued that the DSM-5, in its inclusion of a rather confusingly defined Internet Gaming Disorder, missed an opportunity to offer diagnostic clarity and consistency and may be contributed to the disorientation in the field.

Implications and Future Research

As highlighted on Chapters 1, 2, and 3, terminological and conceptual conundrums regarding both Internet Gaming Disorder and Internet addiction conceptualisation have hindered

the field as they were arguably responsible for the variety of assessment instruments developed to measure both Internet Gaming Disorder frequent lack of concordance between them (Starcevic & Aboujaoude, 2016). This view is supported by the increasing number of psychometric validation studies that were recently published.

As shown on Table 8.1, a total of six standardised psychometric tools were developed after the publication of the first two standardised tools developed by the author of this thesis (i.e., the IGD-20 Test and the IGDS9-SF), and that followed the publication of the DSM-5. On the one hand, this proliferation of psychometric tools to assess Internet Gaming Disorder confirms the lack of agreement as to how to assess this phenomenon at best. On the other hand, this also indicates that this area of research is rapidly becoming popular, and also shows that Internet Gaming Disorder may be a serious disorder affecting a minority of individuals that is being researched internationally. It is the view of the present author that in order for the field to further progress in a way that unification in the assessment of this disorder can be achieved, researchers should now focus on how to improve the theoretical framework for Internet Gaming Disorder and put to halt the development of further psychometric tools.

Table 8.1. Current Available Psychometric and Clinical Assessment Tools to Evaluate Internet Gaming Disorder (IGD) According to the American Psychiatric Association's Theoretical Framework

Instrument	*Reference*	*Number of items*	*Type of scale*	*Time-scale*	*Addiction criteria*	*Clinical validation*	*Cross-cultural validation*
The Internet Gaming Disorder Test (IGD-20 Test)	Pontes, Király, et al. (2014)	20	Continuous	12-month	Scoring ≥ 71 points	No	Spain
Internet Gaming Disorder Scale–Short-Form (IGDS9-SF)	Pontes and Griffiths (2015a)	9	Continuous	12-month	Endorsing ≥ 5 criteria[a]	No	Portugal, Slovenia & Italy
The Internet Gaming Disorder Scale (IGDS)[b]	Lemmens et al. (2015)	27	Dichotomous and Continuous	12-month	NR	No	No
The Internet Gaming Disorder Scale (Short Scales)[b]	Lemmens et al. (2015)	9	Dichotomous and Continuous	12-month	Endorsing ≥ 5 criteria	No	No
The Ten-Item Internet Gaming Disorder Test (IGDT-10)	Király, Sleczka, et al. (2017)	10	Ordinal	12-month	Endorsing ≥ 5 criteria[c]	No	No

Clinical Assessment Tool (C-VAT 2.0)[d]	Van Rooij, Schoenmakers, and Van de Mheen (2015)	14	Dichotomous[e]	12-month	Endorsing ≥ 5 criteria[f]	Yes	No
The Personal Internet Gaming Disorder Evaluation-9 (PIE-9)	Pearcy, Roberts, and McEvoy (2016)	9	Continuous	12-month	Endorsing ≥ 5 criteria[g]	No	No
The Internet Gaming Disorder Questionnaire (IGDQ)	Jeromin, Rief, and Barke (2016)	9	Dichotomous	Not Reported	Endorsing ≥ 5 criteria	No	No

[a]:A criterion is endorsed when a participant provides the maximum response possible in that item (i.e., 'very often').
[b]: Both the IGDS and its shorter version were developed in the same study.
[c]: Endorsement of each criterion is assessed upon conversion of the original three-point response scale (i.e., "never", "sometimes", and "often") each item into yes/no
[d]:The C-VAT 2.0 is a clinical assessment tool, therefore its administration is made by a trained clinician.
[e]: Only the nine items referring to the nine IGD criteria.
[f] : For diagnostic purposes, only the nine items referring to the nine IGD criteria are considered.
[g]: A criterion is endorsed when a participant respond with either 'very often' or 'often' to an item.

In terms of the implications and future research avenues, the present thesis may offer some fruitful directions. At the empirical level, much work still needs to be done so a better understanding of Internet Gaming Disorder and Internet addiction can be accumulated. Given that the development of psychometrically sound assessment tools for Internet Gaming Disorder and generalised Internet addiction were already developed, more focus should be given to the clinical validation of the existing psychometric tools as this is the best way in which the real efficacy (i.e., specificity and sensitivity) of a psychometric tool can be ascertained. Moreover, once the methods for diagnosis and screening tools are properly developed, large-scale epidemiological surveys are needed to determine prevalence rates in countries throughout the world, and care should be taken upfront to ensure that similar and clinically relevant constructs are evaluated, so that cross-cultural comparisons are valid (Petry, Rehbein, Ko, et al., 2015).

Studies using other designs such as longitudinal are severely lacking in the field. In fact, more longitudinal studies are required to ascertain the natural course of the condition as well as risk and protective factors as better knowledge about the course of the condition will be critical to guide both prevention and treatment efforts (Petry, Rehbein, Ko, et al., 2015). At the conceptual level, future studies should scrutinise each individual Internet Gaming Disorder criterion in order to accumulate solid evidence regarding the weighting each criterion should have in terms of a final diagnosis and also the relevance and appropriateness of including new criteria while excluding existing ones since much debate has been generated regarding the usefulness of each Internet Gaming Disorder criterion. Only after thorough investigation of the existing theoretical framework developed by the American Psychiatric Association can researchers gather a consistent meaning of what is videogame addiction and Internet addiction. To achieve such goals, qualitative research

will be of utmost importance since more complex and elaborated perspectives could be gathered from individuals affected by these disorders.

Future research on disordered videogame play should be conducted to help ascertain how online and offline videogame addiction develop and how they may differ in terms of their addictive potential. Recent studies (e.g., Lemmens & Hendriks, 2016; Tejeiro et al., 2016) suggest that disordered gaming occur in both online and offline gaming contexts, but that online games have greater addictive potential than offline games. Therefore, offline gaming addiction should not be overlooked due to extant evidence that offline gaming can also cause addiction. For this reason, some authors have argued that the term Internet Gaming Disorder is rather inaccurate, and that 'Gaming Disorder' may be a more appropriate term to describe disordered gaming behaviour (Lemmens & Hendriks, 2016; Pontes & Griffiths, 2014).

Regardless of the existing debates and criticisms surrounding the constructs of Internet Gaming Disorder and Internet addiction, it is generally agreed that the inclusion of Internet Gaming Disorder as a research category in the DSM-5 is a major advance, allowing researchers and clinicians a standardised direction for studying and treating this condition (Petry, Rehbein, Ko, et al., 2015). In light of this, it can be concluded that one of the key implications of the present thesis is that excessive and harmful videogame play and Internet use may pose as a serious health hazard for a minority of people, and therefore these two categories should be recognised as distinct behavioural addictions (i.e., *bona fine* addictions). However, the utility of the Internet Gaming Disorder theoretical framework is still uncertain, and will largely depend on its ability to generate novel hypotheses capable of leading to useful predictions about this disorder. Consequently, as suggested by West (2001), a successful theory should enable prediction of circumstances in which

addiction is more likely to occur and give insights into how it can be prevented, controlled or treated.

Final Remarks

The present thesis highlighted the main issues surrounding the conceptualisation and psychometric assessment of both Internet Gaming Disorder and Internet. Inconsistencies regarding these two aspects were illustrated across the Part I: Introduction (i.e., Chapters 1, 2, and 3) of this thesis, and an alternative potentially unifying theoretical framework for conceptualising and assessing these disorders were developed across a series of large-scale empirical studies involving large numbers of participants and presented on Part II: Empirical Studies (i.e., Chapters 4, 5, 6, and 7). Similar to previous research, the overall findings of this project suggest that Internet Gaming Disorder and Internet addiction may pose as a health hazard for a minority of affected individuals, and efforts to provide official status to these disorders as *bona fide* addictions should be made by official medical bodies to help shape new policies, prevention schemes, and treatment programs for such technology-related addictive disorders.

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Appendices

Appendix I: Declaration of Collaborative Work

Part I: Introduction (Chapters 1, 2, and 3)

Pontes, H. M., Kuss, D. J., & Griffiths, M. D. (2015). Clinical psychology of Internet addiction: a review of its conceptualization, prevalence, neuronal processes, and implications for treatment. *Neuroscience and Neuroeconomics*, *4*, 11-23. doi:10.2147/NAN.S60982 (Chapter 1).

Pontes, H. M., & Griffiths, M. D. (2014). Assessment of Internet Gaming Disorder in clinical research: Past and present perspectives. *Clinical Research and Regulatory Affairs, 31*(2-4), 35-48. doi:10.3109/10601333.2014.962748 (Chapter 2).

Pontes, H. M., Kuss, D. J., & Griffiths, M. D. (in press). Psychometric assessment of Internet Gaming Disorder in neuroimaging studies: A systematic review. In C. Montag & M. Reuter (Eds.), *Internet and Smartphone addiction: Neuroscientific approaches*. London: Springer. (Chapter 3).

Overall contributions of the first author (HM Pontes) to each of these literature reviews:

- Development of main ideas and design for each review study
- Initiation of the review process
- Data collection from the literature
- Organisation of the literature
- Analysis of the literature
- Write-up of the initial draft of the manuscripts
- Integration of all feedbacks provided by the co-authors of the studies

Part II: Empirical Studies (Chapters 5, 6, and 7)

Pontes, H. M., Király, O., Demetrovics, Z., & Griffiths, M. D. (2014). The conceptualisation and measurement of DSM-5 Internet Gaming Disorder: The development of the IGD-20 Test. *PLoS ONE, 9*(10), e110137. doi:10.1371/journal.pone.0110137 (Chapter 4).

Pontes, H. M., & Griffiths, M. D. (2015). Measuring DSM-5 Internet Gaming Disorder: Development and validation of a short psychometric scale. *Computers in Human Behavior, 45*, 137-143. doi:10.1016/j.chb.2014.12.006 (Chapter 5).

Pontes, H. M., & Griffiths, M. D. (2015). The development and psychometric evaluation of the Internet Disorder Scale (IDS-15). *Addictive Behaviors*. doi:10.1016/j.addbeh.2015.09.003 (Chapter 6).

Pontes, H. M., & Griffiths, M. D. (2016). The development and psychometric properties of the Internet Disorder Scale-Short Form (IDS9-SF). *Addicta: The Turkish Journal on Addictions, 3*(2), 1-16. doi:10.15805/addicta.2016.3.0102. (Chapter 7).

Overall contributions of the first author (HM Pontes) to each of these empirical studies:

- Development of the rationale, key ideas, and design for each study
- Application for ethical approval within Nottingham Trent University
- Creation of the research protocols featuring all psychometric instruments used
- Upload of the research protocols and psychometric instruments to an online data collection platform (i.e., SurveyMonkey)
- Data collection for all studies
- Application of data cleaning strategies on all datasets
- Analysis of the data on all datasets

- Write-up of the initial draft of the manuscripts
- Integration of all feedbacks provided by the co-authors of the studies
- Online submission and resubmission of the manuscripts
- Write-up of the initial draft for the rebuttal letter containing the authors' reply to the reviewers' feedback and concerns

All research stages and tasks listed above have been carried out by HM Pontes.

Appendix II: Internet Gaming Disorder Test (IGD-20 Test)

Instructions: These questions relate to your gaming activity during the past year (i.e., 12 months). By gaming activity we mean any gaming-related activity that was played on either a computer/laptop, gaming console and/ or any other kind of device online and/or offline.

	Strongly Disagree	Disagree	Neither agree or disagree	Agree	Strongly Agree
1. I often lose sleep because of long gaming sessions.					
2. I never play games in order to feel better. [R]					
3. I have significantly increased the amount of time I play games over last year.					
4. When I am not gaming I feel more irritable.					
5. I have lost interest in other hobbies because of my gaming.					
6. I would like to cut down my gaming time but it's difficult to do.					
7. I usually think about my next gaming session when I am not playing.					
8. I play games to help me cope with any bad feelings I might have.					
9. I need to spend increasing amounts of time engaged in playing games.					
10. I feel sad if I am not able to play games.					
11. I have lied to my family members because the amount of gaming I do.					
12. I do not think I could stop gaming.					
13. I think gaming has become the most time consuming activity in my life.					
14. I play games to forget about whatever's bothering me.					
15. I often think that a whole day is not enough to do everything I need to do in-game.					
16. I tend to get anxious if I can't play games for any reason.					

17. I think my gaming has jeopardised the relationship with my partner.					
18. I often try to play games less but find I cannot.					
19. I know my main daily activity (i.e., occupation, education, homemaker, etc.) has not been negatively affected by my gaming. [R]					
20. I believe my gaming is negatively impacting on important areas of my life.					

[R]: Reversely scored item.

Appendix III: Modified *Diagnostic Criteria for Internet Gaming Disorder in DSM-5 (DCIGD)*

Instructions: These questions will ask you about your gaming activity during the past year (i.e., last 12 months). By gaming activity we understand any gaming-related activity that has been played either from a computer/laptop or from a console or any other kind of device (e.g., mobile phone, tablet, etc.) both online and/or offline.

	Never	Rarely	Sometimes	Often	Very Often
1. Do you feel preoccupied with your gaming behaviour? (Some examples: Do you think about previous gaming activity or anticipate the next gaming session? Do you think gaming has become the dominant activity in your daily life?)					
2. Do you feel more irritability, anxiety or even sadness when you try to either reduce or stop your gaming activity?					
3. Do you feel the need to spend increasing amount of time engaged gaming in order to achieve satisfaction or pleasure?					
4. Do you systematically fail when trying to control or cease your gaming activity?					
5. Have you lost interests in previous hobbies and other entertainment activities as a result of your engagement with the game?					
6. Have you continued your gaming activity despite knowing it was causing problems between you and other people?					
7. Have you deceived any of your family members, therapists or others because the amount of your gaming activity?					
8. Do you play in order to temporarily escape or relieve a negative mood (e.g., helplessness, guilt, anxiety)?					
9. Have you jeopardised or lost an important relationship, job or an educational or career opportunity because of your gaming activity?					

Appendix IV: *Internet Gaming Disorder Scale–Short-Form (IGDS9-SF)*

Instructions: These questions will ask you about your gaming activity during the past year (i.e., last 12 months). By gaming activity we understand any gaming-related activity that has been played either from a computer/laptop or from a gaming console or any other kind of device (e.g., mobile phone, tablet, etc.) both online and/or offline.

	Never	Rarely	Sometimes	Often	Very Often
1. Do you feel preoccupied with your gaming behaviour? (Some examples: Do you think about previous gaming activity or anticipate the next gaming session? Do you think gaming has become the dominant activity in your daily life?)					
2. Do you feel more irritability, anxiety or even sadness when you try to either reduce or stop your gaming activity?					
3. Do you feel the need to spend increasing amount of time engaged gaming in order to achieve satisfaction or pleasure?					
4. Do you systematically fail when trying to control or cease your gaming activity?					
5. Have you lost interests in previous hobbies and other entertainment activities as a result of your engagement with the game?					
6. Have you continued your gaming activity despite knowing it was causing problems between you and other people?					
7. Have you deceived any of your family members, therapists or others because the amount of your gaming activity?					
8. Do you play in order to temporarily escape or relieve a negative mood (e.g., helplessness, guilt, anxiety)?					
9. Have you jeopardised or lost an important relationship, job or an educational or career opportunity because of your gaming activity?					

Appendix V: *The Internet Disorder Scale (IDS-15)*

Instructions: These questions relate to your Internet usage during the past year (i.e., 12 months). By Internet usage we mean any activity performed online for leisure purpose only on either a computer or a laptop, or any other kind of portable device with Internet access.

	Strongly Disagree	Disagree	Neither agree or disagre	Agree	Strongly Agree
1. I never go online to feel better. [R]					
2. I think that being online can greatly change my mood for the better.					
3. I go online to help me cope with any bad feelings I might have.					
4. I go online to forget about whatever's bothering me.					
5. When I am not online I feel irritable, restless, anxious and/or frustrated.					
6. I feel sad if I am not able to go online.					
7. I tend to get anxious if I can't check what's happening online for any reason.					
8. I feel restless every time I am unable to go online.					
9. I think the amount of time I spend online has jeopardised the relationship with my partner.					
10. I think the amount of time I spend online is negatively impacting on important areas of my life.					
11. I would like to cut down the amount of time I spend online but it's difficult for me to do.					
12. I often try to spend less time online but find I cannot.					
13. I could easily stop spending time online if I wanted to without any problem. [R]					
14. I can easily cut down the time I spend online any time that I want to. [R]					
15. I am able to control and/or reduce the time I spend online. [R]					

[R]: Reversely scored item.

Appendix VI: *The Internet Disorder Scale-Short Form (IDS9-SF)*

Instructions: These questions relate to your Internet usage during the past year (i.e., 12 months). By Internet usage we mean any activity performed online on either a computer or a laptop, or any other kind of portable device with Internet access.

	Never	Rarely	Sometimes	Often	Very Often
1. Do you feel preoccupied with your online behaviour? (Some examples: Do you think about previous sessions online or anticipate the next online session? Do you think being online has become the dominant activity in your daily life?)					
2. Do you feel more irritability, anxiety and/or sadness when you try to either reduce or stop using the Internet?					
3. Do you feel the need to spend increasing amount of time engaged online in order to achieve satisfaction or pleasure?					
4. Do you have difficulties in trying to control, cut down, and/or cease your online usage?					
5. Have you lost interest in previous hobbies and other leisure activities as a result of being online?					
6. Have you continued to go online despite knowing it was causing problems between you and other people?					
7. Have you deceived any of your family members, therapists or other people because the amount of time you spend online?					
8. Do you go online in order to escape or feel better (e.g., helplessness, guilt, anxiety)?					
9. Have you jeopardised or lost an important relationship, career or an educational opportunity because of your online usage?					