

Internet gaming addiction: current perspectives

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Abstract: In the 2000s, online games became popular, while studies of Internet gaming addiction emerged, outlining the negative consequences of excessive gaming, its prevalence, and associated risk factors. The establishment of specialized treatment centers in South-East Asia, the US, and Europe reflects the growing need for professional help. It is argued that only by understanding the appeal of Internet gaming, its context, and neurobiologic correlates can the phenomenon of Internet gaming addiction be understood comprehensively. The aim of this review is to provide an insight into current perspectives on Internet gaming addiction using a holistic approach, taking into consideration the mass appeal of online games, the context of Internet gaming addiction, and associated neuroimaging findings, as well as the current diagnostic framework adopted by the American Psychiatric Association. The cited research indicates that the individual's context is a significant factor that marks the dividing line between excessive gaming and gaming addiction, and the game context can gain particular importance for players, depending on their life situation and gaming preferences. Moreover, the cultural context is significant because it embeds the gamer in a community with shared beliefs and practices, endowing their gaming with particular meaning. The cited neuroimaging studies indicate that Internet gaming addiction shares similarities with other addictions, including substance dependence, at the molecular, neurocircuitry, and behavioral levels. The findings provide support for the current perspective of understanding Internet gaming addiction from a disease framework. The benefits of an Internet gaming addiction diagnosis include reliability across research, destigmatization of individuals, development of efficacious treatments, and the creation of an incentive for public health care and insurance providers. The holistic approach adopted here not only highlights empirical research that evidences neurobiologic correlates of Internet gaming addiction and the establishment of a preliminary diagnosis, but also emphasizes the necessity of an indepth understanding of the meaning, context, and practices associated with gaming.

Keywords: Internet gaming, Internet gaming addiction, current perspectives, context, neuroimaging, diagnosis

Introduction: the mass appeal of Internet gaming

Internet gaming is a booming market. In 2012, more than one billion individuals played computer games, which fuelled the 8% growth of the computer gaming industry in the same year.¹ A recent report by the market research company Niko Partners has estimated the People's Republic of China's online gaming market at \$12 billion in 2013.² Massively Multiplayer Online games (MMOs) offer the possibility to play together with many other players and can be differentiated based on game content and player experience. A latent profile analysis of survey data from 4,374 Hungarian online gamers (91% male, mean age 21±6 years) indicated that the most prominent MMOs were role-

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playing games, first-person shooters, real-time strategy, and other games.³ First-person MMO shooter games are based on skill because they require good reaction time and attention, and competition is a key aspect of these games. In real-time MMO strategy games, players organize teams, develop their skills, and play for status in the game.⁴

Massively Multiplayer Online Role-Playing Games (MMORPGs), on the other hand, appear of particular interest to players because they offer a variety of incentives for play relative to other game genres. Of all online gamers, 46% play MMORPGs,³ confirming their position as the most popular online games. MMORPGs are game universes inhabited by thousands of players at the same time (massively multiplayer) with no spatial or temporal boundaries because they are played online, and they allow players to adopt various virtual personas vis-à-vis their avatars (role playing).⁵ Today's most popular MMORPG is "World of Warcraft", the latest game in Blizzard's Warcraft series, situated in the fantasy world of Azeroth that is populated by members of the opposing factions of the Alliance and the Horde.⁶ According to a recent report published by the Entertainment Software Association,⁷ World of Warcraft's extension "Cataclysm" was among the top five selling computer games in 2011. In 2013, eight million players immersed themselves in the world of Azeroth,⁸ clearly demonstrating the game's mass appeal. The game tailors to most age groups, both sexes, and various player interests and preferences,⁶ making it an MMORPG success story par excellence.

Online games such as World of Warcraft satisfy various gaming motivations. The analysis by Yee⁹ of 3,000 MMORPG players' gaming motivations revealed that MMORPGs allow players to achieve game goals, be social, and immerse in the game. Each of these factors is composed of a number of subcomponents as particularized by the gamers. First, achievement includes advancing in the game, namely progressing via leveling up, acquiring status and power in the game, the game's mechanics, including the possibilities for optimizing game play, and competition, including challenging and dominating others.⁹ Reputation and admiration from the gaming community for gaming achievements are further key factors motivating players to keep playing.⁶ The game mechanics or structural characteristics have been claimed to reinforce the potentially addictive qualities of games because they contribute to initiation, development, and maintenance of gaming.¹⁰

Second, the social factor is composed of socializing, including chatting and making new friends in the game, forming new relationships, and working in a team.⁹

Research¹¹ suggests that the social element in MMORPGs is particularly important for gamers because it is an integral component of the enjoyment of playing. Moreover, it denotes a complex interaction between real and virtual social networks, further blurring the boundaries between these networks, making MMORPGs inherently social spaces.¹²

Third, immersion in the game is denoted by discovery, ie, exploring the game and "hidden" game content, role-playing via one's avatar, customization of one's online character (such as sex, race, profession, appearance), and escapism, ie, playing in order to avoid real life.⁹ Escapism is an aspect of mood modification whereby individuals suffering from addictions induce a subjective shift in their mood by way of engaging in an addictive behavior, making the latter a coping strategy to deal with everyday problems.¹³

The variety of gaming motivations satisfied by MMORPGs indicates that these types of games are particularly versatile because they can be tailored to individual players with different game preferences. Consequently, one could assume that there are many ways that might lead some individuals to get hooked on MMORPGs. In a sample of 696 MMORPG players (93% male, mean age 26±7.4 years), achievement, socializing, and escapism motivations were found to be predictive of addictive play, together with sex accounting for 19% of variance in the MMORPG addiction score.¹⁴ Similarly, in a sample of 175 primarily Dutch MMORPG players (87% male, mean age 21±6.5 years), escapism and game mechanics predicted excessive gaming over and above the contribution of the time spent gaming, together explaining 46% of the variance in problematic gaming.⁵ In a nutshell, the mass appeal of MMORPGs rests on their versatility because they are tailored to gamers young and old, male and female, who have different game preferences. MMORPGs are particularly good at meeting various players' different needs. This mass appeal may have contributed to findings from research which indicate that online games, and specifically MMORPGs, are more addictive than any other types of both offline and online games¹⁵ because they reward players on partial reinforcement schedules, leading to maintenance of play.¹⁶

Internet gaming addiction

In recent years, research about Internet gaming addiction has increased both in quantity as well as in quality. Research on gaming addiction dates back to 1983, when the first report emerged suggesting that video gaming addiction is a problem for students.¹⁷ Shortly thereafter, the first empirical study on gaming addiction was published by Shotton,¹⁸ based on

self-reports of young male players who claimed they were “hooked” on their games. The early studies suffered from a lack of standardized psychometric instruments used for assessing gaming addiction.¹⁹ However, research²⁰ indicates that self-reports correlate with standardized measures. Following on from that, further studies were carried out in the 1990s, initially assessing gaming addiction based on the criteria for pathologic gambling as stipulated in the third and fourth editions of the *Diagnostic and Statistical Manual for Mental Disorders* (DSM).²¹ Although similar, pathological gambling and excessive gaming do not present with the same clinical picture, and some have argued that using the diagnostic criteria for pathological gambling in order to diagnose pathological gaming only taps into obsessive use and preoccupation rather than actual psychopathology.²² In the 2000s, online games became popular, while studies of Internet gaming addiction emerged.^{23,24}

The studies on Internet gaming addiction in the new millennium reported prevalence estimates which vary significantly and range from 0.2% in Germany^{25,26} to 50% of Korean teenagers.²⁷ This discrepancy in estimates is due to various conceptualizations, diverse measurement instruments, as well as the different cutoff points used. Further, dissimilar constructs (“Internet gaming addiction”, “dependence”, “problematic”, and “excessive play”) are measured in various samples (children, adolescents, gamers) and cultures. In most studies, self-reports have been used, which puts the reliability and validity of the potential diagnosis in question.²⁸ However, research²⁰ indicates that self-diagnosis correlates with standardized measures of addiction, suggesting that the individual’s perception of problems can be relatively accurate.

In South-East Asian countries, the negative impacts of Internet gaming addiction have led governments and health care providers to take the problem seriously and to develop a series of initiatives to curb and alleviate the problem. In South Korea, Internet gaming addiction is viewed as a significant concern for public health,²⁹ and up to 24% of children who have been diagnosed with Internet addiction are hospitalized.³⁰ In Japan, the government has recognized the problem following a study by the Ministry of Education, which has led to the development of “fasting camps” where individuals suffering from Internet and gaming addiction are helped by being cut off from technology completely.³¹ It has been stated that the higher the Internet penetration and social acceptance of gaming, the higher the prevalence of gaming problems,³² partially explaining the higher prevalence rates reported in South-East Asian countries. In addition to this, there is good reason to think that the lower acceptance of

excessive gaming in a culture, the more distress (not less) gamers experience in engaging in the activity, potentially fuelling problem perception. Therefore, a lack of acceptance of excessive gaming and thus stigmatization of the behavior might contribute to higher rates of addiction and problematic play in some way. Following growing concern, specialized treatment centers and programs have been established in Europe (including the outpatient clinic for behavioral addictions in Mainz, Germany, and the Catio Nightingale Hospital in London, UK) and the US (including the inpatient centers RESTART Internet Addiction Recovery Program in Seattle and the recently opened digital detoxification and recovery center in Pennsylvania), reflecting the growing need for professional help.

The concerns appear to be grounded as a growing number of studies indicate that Internet gaming addiction is associated with various negative consequences.¹⁵ The psychological consequences include the following: sacrificing real-life relationships, other pastime activities, sleep, work, education, socializing, and relationships,^{33–40} obsession with gaming and a lack of real-life relationships,⁴¹ lack of attention,^{33,42} aggression and hostility,^{42,43} stress,³³ dysfunctional coping,^{33,44,45} worse academic achievement,^{38,46} problems with verbal memory,⁴⁷ and low well-being and high loneliness.⁴⁸ Moreover, psychosomatic consequences have been found in a number of studies. These included problems with sleeping,^{41,47} seizures,⁴⁹ and psychosomatic challenges.³³ This long list indicates that Internet gaming problems must be taken seriously as they can affect the individual negatively in a variety of ways.

Internet gaming addiction is a behavioral problem that has been classified and explained in numerous ways. According to Griffiths,¹³ biopsychosocial processes lead to the development of addictions, such as Internet gaming addiction, which include the following components. First, the behavior is salient (the individual is preoccupied with gaming). Second, the individual uses the behavior in order to modify their mood (ie, gaming is used to escape reality or create the feeling of euphoria). Third, tolerance develops (the individual needs increasingly more time to feel the same effect). Fourth, withdrawal symptoms occur upon discontinuation of the behavior (the individual feels anxious, depressed, and irritable if they are prevented from playing). Fifth, interpersonal and intrapersonal conflict develops as a consequence of the behavior (the individual has problems with their relationship, job, and hobbies, and lack of success in abstinence). Finally, upon discontinuation of the behavior, the individual experiences relapse (they reinitiate gaming).¹³

Although the core criteria appear to be established, the etiology of Internet gaming addiction has yet to be studied in detail. Research¹⁵ indicates that a number of risk factors are associated with Internet gaming addiction. These risk factors include certain personality traits, gaming motivations, and structural game characteristics. The personality traits most commonly associated with Internet addiction include neuroticism,^{37,50} aggression and hostility,^{43,50-52} and sensation-seeking.^{43,50} Factors that appear to protect frequent online gamers from developing problems with their gaming were found to be conscientiousness and extraversion,⁵³ suggesting that for different individuals the same behavior can have different psychological repercussions.

In addition to this, the following gaming motivations were found to be most commonly associated with gaming addiction: coping with daily stressors and escapism,^{5,16,44,54-57} online relationships,^{16,51,57-59} and mastery, control, recognition, completion, excitement, and challenge.^{34,56,60} This indicates that the reasons for game play may be an important indicator of potential risk for Internet gaming addiction. Specifically, in comparison with non-MMORPG players, MMORPG players preferred their online friends over their real-life friends.¹⁶ Similarly, significantly more dependent gamers were found to prefer spending time with their online friends than their offline friends relative to nondependent gamers and felt their social needs were met better online than offline.⁴⁴ Moreover, while online games provide nonaddicted players with satisfaction, addicted players play to avoid dissatisfaction,⁵⁵ which can be an indication of withdrawal symptoms they want to overcome by engaging in gaming compulsively. The motivational differences to play games between dependent and nondependent as well as MMORPG and other gamers appear to be useful clinical information because these motivations can be specifically targeted in treatment sessions. For instance, elements of exposure therapy may be used for the socially fearful in order to decrease discomfort and reintroduce clients to real-life social environments. Also, alternative pastime activities that are perceived as satisfying can be encouraged specifically in group therapy sessions. Encouraging engagement in group sports might satisfy both the need to engage in competitive and satisfying activities and the need to interact with peers in real life.

Moreover, a number of structural game characteristics have been found to increase the risk for developing Internet gaming addiction, namely online relative to offline gaming,⁶¹ positive reinforcement,⁶² the enjoyment of particular game features, such as adult content, finding rare in-game items, and watching game cut scenes,⁶³ and viewing one's virtual

persona as better than oneself.⁶⁴ These characteristics indicate that particular games can be more addictive than others,¹⁵ which appears important for game developers and public prevention campaigns that focus on decreasing risk and raising awareness of potential problems. Prevention campaigns could target school-aged children, teachers, and parents in education settings. They could be based on the principles of providing information and a discussion platform concerning Internet and gaming use and possible negative consequences via psychoeducation, with the ultimate goal of encouraging healthy media use. Success could be determined over the long term using triangulation of data and reports obtained from the targeted populations.

Most reviews to date have primarily focused on specific aspects of Internet gaming addiction, including methods used to assess gaming addiction,^{65,66} structural characteristics,⁶⁰ and treatment.⁶⁷⁻⁶⁹ In light of this, the aim of this review is to provide an insight into current perspectives on Internet gaming addiction using a holistic approach, taking into consideration the mass appeal of online gaming, the context of Internet gaming addiction, and associated neuroimaging findings, as well as the current diagnostic framework adopted by the American Psychiatric Association.⁷⁰ It is argued that only by understanding the appeal of Internet gaming, its context, and neurobiologic correlates can the phenomenon of Internet gaming addiction be understood comprehensively. An evaluation of the findings will be presented in the overall discussion.

Gaming addiction: context

Research on gaming addiction has paid little attention to the context of online gaming. However, a few studies have now shed some light on the embedding of Internet gaming addiction in the context of the individual,⁷¹ the game and gaming environment,^{6,72} and the broader framework of culture.⁷³ Each of these will be addressed in turn.

Griffiths⁷¹ provided case study evidence of two young men who spent an average of 14 hours a day playing MMORPGs in order to emphasize that the context of the individual's life is an important factor demarcating gaming excess from gaming addiction. Aged 21 years, unemployed and single, "Dave" reported that gaming had a positive influence on his life because his social life revolved almost exclusively around the game, and playing boosted his self-esteem and gave structure to his everyday life. Dave did not perceive that his excessive gaming impacted upon his life negatively at all. For Dave, his extensive gaming did not lead to significant distress or have a negative impact in his daily life, and therefore his behav-

ior cannot be classified as a condition that would fulfill the requirements of a mental disorder classification as outlined in the DSM-5.⁷⁴ Upon starting a new job and entering into a relationship with a woman he met in-game, his excessive gaming decreased significantly.

The second case reported was that of “Jeremy”, a 38-year old financial accountant who was married with two children and experienced detrimental consequences due to his “severe gaming addiction”, namely a relationship breakdown, lack of time for family activities, and loss of his job. Moreover, his playing time, craving for the game, and feelings of low mood and anxiety had increased dramatically. He used gaming to escape from his real-life problems and tried to quit on several occasions, but was unsuccessful in staying abstinent. This led to a number of relapse episodes.⁷¹ The examples of Dave and Jeremy make a compelling case for how the same behavior (namely regular online gaming for excessive periods of time) can have almost diametrically opposed consequences due to different individual contexts, with one experiencing gaming as pleasurable and ultimately beneficial, whereas the other’s entire life was negatively affected by his excessive gaming.

In addition to the individual context, the context of the game appears important in determining the extent to which excessive gaming can truly be an addiction.^{6,72} Karlsen⁷² conducted 12 interviews with online gamers (75% male, mean age 23±2.4 years) who play World of Warcraft and used virtual ethnography⁷⁵ in order to assess the consequences of their excessive gaming. The results indicated that some of the players experienced behavioral addiction symptoms as specified by Griffiths,¹³ namely salience, mood modification, tolerance, withdrawal, conflict, and relapse, with the latter two demarcating excessive from potentially addictive play. However, rather than advocating current diagnostic frameworks for “pathologizing” gaming, Karlsen⁷² advocates to view gaming excess from the vantage point of game structure and gaming context, including the social practice and cultural meaning of games as well as the individual’s connection to the game from the perspective of game and media studies. This understanding entails a move away from the overly simplistic approach of focusing on the psychological rewards that reinforce gaming to include an in-depth exploration of gaming motivations, gaming structure and mechanics, as well as the meaning of gaming for the individual.⁷²

Kuss⁶ analyzed online gaming and potential gaming excess by interviewing eleven World of Warcraft players (72% male, mean age 27±7.3 years) and used virtual ethnography⁷⁵ as well as ludology principles⁷⁶ to understand how

playing this particular game mirrors participation in popular media culture. In this context, media culture is understood as a flexible and evolving area of engagement that requires active participation. Potential gaming addiction was found to be associated with escapist motivations and in this context gaming was understood as fulfilling a “narcotic” function. The game context gained particular significance in one participant’s life because of two features of the game. First, he was able to enact heroic tales through his avatar and faction membership. As a member of the Horde, he fought the opposing faction, the Alliance, and was involved in killing their king, an episode “he would not forget until the end of his life”. Second, he was enabled to return to a familiar cultural context by means of his guild which consisted of fellow countrymen, after he had physically migrated to a foreign country. In this way, the provisions of the game (namely participation in the game’s narrative,⁷⁷ community, and belonging)⁷⁸ were utilized to a problematic extent, leaving the participant feeling “addicted to wow [World of Warcraft]”. Eventually, the analysis revealed that the meaning that is attached to the game can lead to excessive play which may cause a retreat from real life.⁶

Snodgrass et al⁷³ surveyed 252 respondents (78% male, mean age 27±9.0 years) using Yee’s⁹ motivational factors achievement, social and immersion to assess problematic MMORPG play in World of Warcraft from the perspective of culture under the supposition that gaming allows for formation of communities and cultures.^{12,79,80} The cultural context situates the individual and his potentially addictive game play (assessed using Young’s Internet Addiction Test)⁸¹ within the framework of commonly shared beliefs and practices.⁸² Snodgrass et al⁷³ used an anthropological approach focusing on meaning, practice, and experience, mirrored in their understanding of gaming motivations and problematic play. They found that achievement motivation may lead to problematic play if players are less successful in real life (ie, less “culturally consonant”) and use game success to compensate,⁷³ causing stress and negative health outcomes.⁸³ In terms of social motivation, the extent to which online relationships gain significance over offline relationships was analyzed⁷³ because research indicates that lack of cultural consonance regarding social networks impacts negatively upon health.⁸⁴ Regarding immersion, the amalgamation of online and offline life and identities was assessed,⁷³ because association of the self with the game and the avatar could lead to dissociation.^{85,86} The results indicated that game play in World of Warcraft mirrors cultural models of success regarding objectives and responsibilities, indicating that the game world can in some ways

substitute the real world. Moreover, the culturally sensitive motivations achievement, social and immersion significantly predicted problematic MMORPG play if they were incongruent with real life, that is, if the game was used to compensate for lack of success and relationships in real life, and to dissociate from real life.⁷³

Taken together, the individual, game, and cultural contexts appear to have a significant impact upon the extent to which problems occur as a consequence of excessive gaming in terms of how Internet gaming addiction is conceptualized. In this way, the cultural context can be seen as a lens through which individuals and others around them perceive and give meanings to behaviors and their consequences. It is critical to understand gaming problems not only by means of the observable symptoms, but to situate them within the broader context of the game, the individual, and culture.

Gaming addiction: neuroscience

In the last decade, psychiatry has increasingly made use of neuroscientific evidence to understand and conceptualize mental disorders.⁸⁷ The major funding body for mental health research, the National Institute of Mental Health, has recently introduced research domain criteria to reclassify mental disorders as based on neuroscience and shared underlying pathophysiology rather than the more subjective approach of phenomenology and clinical presentation that has been utilized previously.⁸⁸ The ultimate aim is to improve the reliability and validity of clinical diagnosis and accordingly to deliver optimal treatment.⁸⁹ In accordance with this approach, research on Internet gaming addiction is now increasingly making use of neuroimaging techniques to allow for analysis of neurobiological changes due to excessive gaming and neurochemical correlates of addiction.⁹⁰

Some studies have shown that changes in brain activity and structure related to addiction are relevant for brain regions involved in reward, motivation, and memory, as well as cognitive control.⁹¹ It has been hypothesized that initially the prefrontal cortex and ventral striatum are involved in the decision to initiate the addictive behavior. Over time, the individual habituates to the behavior and develops a compulsion to engage in it, which is accompanied by alterations of activity in the dorsal striatum as it becomes activated through dopaminergic innervation. There is some evidence for the idea that dopamine is released.⁹² The longer the engagement continues, the more permanent the changes in the dopaminergic pathways become. It has been suggested that activity in the anterior cingulate, orbitofrontal cortex, and nucleus accumbens is modified in such a way that

natural rewards are experienced as less pleasurable, further reducing control over the behavior.^{93,94} Research suggests that over time, synaptic activity is reduced, leading to long-term depression and neuroadaptation,⁹⁵ as well as behavioral sensitization. The synapses in the ventral tegmental area become stronger, glutamate in the nucleus accumbens is reduced, and activity in the amygdala and hippocampus (related to memory) is increased, which can in turn result in craving^{91,96} and increased response to the availability and particular context of the addictive behavior.^{93,97} Some studies have shown that the addictive behavior becomes associated with these cues through activity in the nucleus accumbens, which reinforces the effects of the behavior.⁹⁸ With time, tolerance to the addictive behavior develops and natural rewards are depreciated, resulting in a reward system deficiency and activation of the anti-reward system.⁹⁹ The consequent lack of dopamine in mesocortical brain regions can lead to withdrawal symptoms, and in order to overcome these, renewed engagement in the addictive behavior ensues, and may ultimately impact upon the functions of the orbitofrontal cortex and cingulate gyrus.^{91,100,101}

Over the last decade, a number of neuroimaging techniques have been applied to Internet gaming research, allowing for an analysis of addiction correlates regarding both brain function as well as brain structure. Electroencephalograms measure brain activity via changes in voltage in the cerebral cortex via electrodes,¹⁰² and were used in six studies of Internet and gaming addiction.^{103–108} Positron emission tomography measures neuronal metabolism through photons from positron emissions via positively charged electrons.¹⁰⁹ Two studies^{110,111} made use of positron emission tomography to measure Internet and gaming addiction. Like positron emission tomography, single photon emission computed tomography measures metabolic activity in the brain at the level of individual photons,¹¹² and was applied in one study of Internet addiction.¹¹³ Eight studies^{114–121} used functional magnetic resonance imaging to measure changes in blood oxygen levels in order to indicate brain activity in individuals with Internet and gaming addiction.¹²² Finally, structural magnetic resonance imaging uses methods such as voxel-based morphometry¹²³ and diffusion-tensor imaging¹²⁴ to image brain morphometry,¹²⁵ and was used in two studies^{126,127} in order to assess Internet addiction.

A systematic review of all Internet and gaming addiction studies using neuroimaging methods until 2012⁹⁰ revealed that Internet gaming addiction appears similar to other addictions, including substance-related addictions, at the molecular, neurocircuitry, and behavioral levels. From a

molecular perspective, gaming results in the release of striatal dopamine.¹¹¹ On the other hand, it has been suggested that, in small samples, Internet and gaming addiction is associated with a reward deficiency whereby dopaminergic transporters in the brain are reduced.^{110,113} In order to reinstate a biochemical equilibrium,⁹⁹ individuals whose reward system is deficient seek substances and activities which result in the release of dopamine. Under normal circumstances, pleasure drives (including eating and reproduction) are natural rewards that are craved, whereas unnatural rewards include psychoactive substances and addictive behaviors.¹²⁸ Over time, the individual habituates to the hedonic feelings produced by Internet gaming and develops abstinence symptoms, tolerance, and withdrawal.¹²⁹ Internet gaming addiction is initiated and maintained.⁹⁰ The decreased dopaminergic transporters in Internet gaming addiction may explain its frequent co-occurrence with depression,¹³⁰ bipolar disorder,¹³¹ and borderline personality disorder and dissociative symptoms.¹³²

With regards to neural circuitry, when gaming, brain areas associated with addictions are frequently utilized and therefore the activity in regions such as the orbitofrontal cortex and cingulate gyrus is high, which over time can lead to significant alterations in neuronal connectivity^{114,116,118,119} and brain structure.^{115,126,127} Internet gaming becomes increasingly salient and individuals lose control over their gaming.⁹⁰ The individual is immanently motivated to play online games as they have learned the behavior, eventuating in continuous engagement.¹³³

In terms of behavior, excessive Internet gaming can result in problems with impulse control, behavioral inhibition, executive functioning, attention, and general cognitive functioning.^{103,104,107,115,126,127} However, there are plus sides as well, in that the frequent gamer develops and improves a number of other capabilities, namely the integration of perceptual information into the brain and hand-eye coordination.^{118,120}

Taken together, research on Internet gaming addiction has made use of various neuroimaging techniques in order to shed light upon the neurochemical and neuroanatomic correlates of addiction. Although in most studies the direction of the relationship has not been investigated (ie, it is unclear whether Internet gaming addiction causes changes in brain structure and activity or vice versa), the current evidence suggests a relationship between brain alterations and Internet gaming addiction. Neuroimaging studies of Internet gaming addiction contribute to the current understanding of addiction as based on a disease framework.^{128,134} This indicates that, similar to cardiovascular diseases, lifestyle (ie, excessive gaming) can

result in changes to underlying neurobiology. Moreover, the utilization of sophisticated imaging methods in Internet gaming addiction research is in line with research domain criteria,⁸⁸ which makes a significant contribution to our understanding of Internet gaming addiction as a chronic neurobiological disease requiring professional care and adequate treatment.¹³⁵

Gaming addiction: clinical diagnosis

Following nearly two decades of research, the American Psychiatric Association has now officially recognized Internet Gaming Disorder as a condition that requires consideration by clinicians and researchers. In June 2013, Internet gaming disorder appeared in the appendix of the updated version of the *Diagnostic and Statistical Manual for Mental Disorders* (DSM-5) for the first time.⁷⁰ It stands alongside the only other behavioral addiction, ie, pathological gambling, situating it clearly within the diagnostic category of Substance-Related and Addictive Disorders. Internet gaming disorder has pulled ahead of other behaviors that can become addictive, such as exercise,^{136,137} work,¹³⁸ and shopping.¹³⁹

Up until now, researchers have understood Internet addiction or Internet gaming addiction as similar to either impulse control disorders in general or pathological gambling specifically,^{140–142} substance dependence,^{33,38} or a combination of the two.^{143,144} This has led to the development of multiple psychometric instruments, each measuring different aspects associated with Internet gaming problems and addiction.^{144–153} The multiplicity of conceptualizations used for Internet gaming addiction have led to a diagnostic conundrum leading some researchers to question its existence,²⁹ and have called for commonly agreed upon criteria which increase reliability across studies and advocate adequate and efficacious treatment.¹⁵

Under the new DSM-5 framework, Internet gaming disorder refers to the “persistent and recurrent use of the Internet to engage in games, often with other players, leading to clinically significant impairment or distress as indicated by five (or more) [criteria] in a 12-month period”.⁷⁰ The diagnostic criteria are a preoccupation with gaming, withdrawal symptoms, tolerance (ie, spending more time gaming), lack of control, loss of other interests, use despite negative consequences, deception, mood modification, and losing a relationship, job, and similarly important aspects of life.⁷⁰ From a public health perspective, an official diagnosis of Internet gaming addiction is necessary for a number of reasons. First, it will encourage individuals who suffer from associated symptoms to ask for professional help, decreasing morbidity rates, hospitalizations, and potential legal and medical problems.³⁰ Second, the diagnosis may

decrease barriers to care and stigmata with regards to public perception of problematic Internet and gaming use. Third, the diagnosis will support research efforts.¹³⁴ Fourth, a diagnostic category will provide the necessary incentive for health care and insurance providers to develop, test, and finance adequate treatment. Ultimately, individuals who require professional care because of substantial distress, suffering, and individual impairment must be helped in an appropriate way.⁷⁴ Accordingly, an official diagnosis of Internet gaming addiction is critical for a number of reasons, further emphasizing the need to fully acknowledge and utilize it.

Discussion

The aim of this review was to provide an insight into current perspectives on Internet gaming addiction using a holistic approach encompassing gaming appeal, context, neuroimaging research, and the diagnostic framework adopted for Internet gaming addiction. It has been shown that Internet gaming has gained increasing popularity since the new millennium, and has led to a substantial growth of the gaming industry and the player fan base. MMORPGs have further been highlighted as offering a wide variety of incentives for players to initiate and maintain playing because they satisfy a variety of needs and tailor to various gaming motives relative to alternative online game genres. Some of these motives, especially escapism, the game's mechanics, achievement and socializing have been found to be indicative of gaming addiction,⁵ suggesting that MMORPGs are more addictive than other offline and online games.¹⁵

This review further shows that until now few studies have investigated the gaming context. Therefore, the context of the individual, the game and gaming environment, and the broader framework of culture are specifically addressed. It has been shown that the individual's context is a significant factor that marks the dividing line between excessive gaming and gaming addiction.⁷¹ Moreover, it has been emphasized that gaming cannot simply be medicalized if done in excess, but it must be understood from within the context of gaming and the meanings the individual attaches to it.⁷² The game context can gain particular importance for players, depending on their life situation and gaming preferences, including the enactment of heroic tales as well as the re-embedding in a (virtual) cultural context that differs from the players' real-life context. Ultimately, this may lead to a retreat from real life for some individuals.⁶ In addition to this, the cultural context is significant because it embeds the gamer in a community with shared beliefs and practices, endowing their gaming with particular meaning. If gaming is used to

compensate for lack of success and relationships in real life and to dissociate from real life, Internet gaming addiction can be the consequence.⁷³ In this context, the "disease" model of addiction can be viewed from the perspective of diseases other than those based on Mendelian genetic mutations or other simple biologically determined pathways. Cardiovascular diseases or adult onset diabetes appear as better models/prototypes for Internet gaming addiction, because these are medical conditions where lifestyles and experiences systematically reshape the body and thus "get under the skin". That is, the cultural context can become the disease (here addiction) through repeated experiences. Alternatively, cultural norms related to how acceptable game-play is might structure the appeal of the game, which in turn promotes addictive play patterns, which would not be the case in places without such norms.

The cited neuroimaging studies of Internet gaming addiction and associated changes in brain structure and function furthermore correspond with the research domain criteria developed by the National Institute of Mental Health⁸⁸ because they emphasize a move away from phenomenology to focus on pathophysiology for clinical diagnosis. Internet gaming addiction was found to share similarities with other addictions, including substance dependence, at the molecular, neurocircuitry, and behavioral levels. These similarities include altered dopaminergic and neuronal activity and brain morphometry, as well as deficient impulse control, behavioral inhibition, and general cognitive functioning. However, there are no known biomarkers of Internet addiction at this point in time. Indeed, there are no known biomarkers of any mental disorder. Ever since Kraepelin,¹⁵⁴ and thus for a century, psychiatrists have been searching to understand mental disorders as underlying physiological diseases, providing an additional incentive to continue research on the neurobiological underpinnings of mental health problems, including Internet gaming addiction.

The findings provide support for the current perspective of understanding Internet gaming addiction from a disease framework.^{128,134} The dependence classification adopted in previous classification systems^{74,155} is stigmatizing to patients who require medication because dependence refers to a normal physiological response to the use of a substance (including medication) which, when discontinued, can lead to withdrawal symptoms.⁷⁴ The term addiction, on the other hand, denotes a chronic neurobiological disease,¹³⁵ which is less stigmatizing because it does not suggest that patients who require medication become "addicted" to their required psychopharmacological

treatment.¹⁵⁶ Addiction, unlike dependence, leads to compulsively pursuing rewarding behaviors irrespective of associated biological, psychological, and social problems.¹³⁵ Ultimately, the current research base on Internet gaming addiction has led the American Psychiatric Association⁷⁰ to include Internet gaming disorder in the appendix of the DSM-5 as the second behavioral addiction alongside pathological gambling, suggesting that the problem is taken seriously. The benefits of such a diagnosis include comparability across research, destigmatization of individuals, development of efficacious treatment, and creation of an incentive for public health care and insurance providers. Once the behavioral problem has an official code, it is worthy of being taken seriously and treated adequately.

However, research concerning the natural course of Internet gaming addiction, the most appropriate interventions, and large-scale epidemiology is scarce,¹⁵⁷ suggesting that more work needs to be done to understand this behavioral problem more fully. King and Delfabbro¹⁵⁸ further question the blurring of the boundaries between Internet addiction and video gaming addiction, as this may “promote further confusion”. Instead, they advocate a conceptualization of Internet addiction which incorporates various subtypes of online behavior, and establishing a diagnostic category of “video gaming disorder” which applies to both online and offline gaming addiction. Ultimately, however, King and Delfabbro¹⁵⁸ concede that the research diagnosis has sparked discussion regarding the nature of behavioral addictions, which testifies to a move away from acknowledging substances only as potentially addictive, and to broaden our understanding of addiction in general.

Moreover, there appear to be problems with regards to the criteria for Internet gaming disorder adopted by the DSM-5 taskforce. Starcevic²⁹ points out that there exists a debate of whether tolerance is a valid criterion as researchers have validated scales on problematic video game use¹⁵⁹ and compulsive Internet use¹⁶⁰ that do not contain tolerance as a symptom, and some question whether tolerance is a factor involved in gaming.⁴⁴ This exemplifies the intricacy of measuring Internet gaming addiction, particularly in light of the reliability of studies as well as the equivalence of findings across studies. Based on these issues, Starcevic²⁹ recommends the following research approaches: understand when online gaming can be considered a mental disorder; study risk factors and comorbidities, and its position as primary or secondary condition; test a continuum of video gaming problems and video gaming disorder; and revisit its classification as “addiction” rather than an impulse control disorder.¹⁶¹ Moreover, Pies¹³⁴ specifies further that only if the following criteria are satisfied, the condition would qualify to be understood as

disease: identify a pattern of genetic transmission; understand its etiology, pathophysiology and/or pathological anatomy; and its course, prognosis, stability, and response to treatment. The current review indicates that research on Internet gaming addiction is on its way to fulfilling these requirements. In terms of understanding the context of Internet gaming addiction, more research is necessary.

Limitations, implications, and suggestions for future research

This review has shown that research on Internet gaming addiction has increased in quality and quantity, particularly over the last decade. Future research is required to overcome the limitations of current research, including closer scrutiny of gaming context (including the individual, game, and culture) and the direction of the relationship between Internet gaming addiction, as well as neuroanatomical and neurochemical changes. Specifically, the following research question requires further exploration: How do individual, game-related, and cultural factors contribute to the etiology, phenomenological experience, and treatment approaches of Internet gaming addiction? Furthermore, the causality of the relationship between neurobiological alterations and neurostructural abnormalities and Internet gaming addiction symptoms should be explored. The further exploration of these issues will enhance our understanding of this potential mental health concern. Moreover, a solid and unequivocal research base will enable the American Psychiatric Association and the World Health Organization to include Internet gaming addiction as an actual diagnosis in their diagnostic systems, which will in turn facilitate future research endeavors as well as clinical parlance.

The context appears crucial to the meaning of the game for the player, and is influenced by individual characteristics, the gaming culture, and the broader society that gamers are situated in. Ultimately, this will allow for developing treatment approaches which can be tailored to different individuals and meet idiosyncratic needs most effectively. The reviewed literature can inform procedures for improving the current treatment of Internet gaming addiction because it puts an emphasis on exploring the life and cultural context of the individual. In terms of neuroimaging studies, the reviewed empirical research has revealed associations between excessive online gaming and alterations in brain structure and function associated with substance addictions. However, understanding the direction of this relationship is crucial because it will provide invaluable insights into the etiology of Internet gaming addiction as well as its status as a primary or secondary disorder. In terms of treatment, establishing the treatment seeker’s most pressing

present problem will allow an efficient and efficacious treatment plan to be developed and structuring of treatment sessions. Overall, this literature review suggests that targeting pathogenic neurobiological mechanisms and associated neurological and neurochemical alterations only does not suffice when the clinician's goal is to alleviate the individual's idiosyncratic problems. It indicates that Internet gaming addiction must be viewed from a holistic perspective, integrating the neurobiological, individual, game-related, and cultural factors contributing to pathogenesis and symptom experience.

Conclusion

The present review of current perspectives on Internet gaming addiction has shown that research has progressed significantly over the last decade, leading to a larger evidence base which includes important findings from neuroimaging research. Further, it indicates that contextual factors play an important part in our understanding of Internet gaming addiction as a holistic phenomenon. It is suggested that an official diagnosis of Internet gaming addiction must regard embedding of the problematic behavior within the context of the individual, the game, and gaming practices, as well as the broader sociocultural environment as the meaning of the gaming behavior derives from its context. The holistic approach adopted here not only highlights empirical research that confirms neurobiological correlates of Internet gaming addiction and establishment of a preliminary diagnosis, but also emphasizes the need for an indepth understanding of meaning, context, and practices associated with gaming. Ultimately, a holistic understanding will benefit individuals who seek professional help for problematic online gaming as treatment approaches become more targeted and consequently more efficacious.

Disclosure

The author reports no conflicts of interest in this work.

References

1. PC Gaming Alliance. PC Gaming Alliance releases two member-exclusive reports covering all aspects of the still-dominant PC gaming industry. 2013. Available from: <http://pcgamingalliance.org/press/entry/pc-gaming-alliance-releases-two-member-exclusive-reports-covering-pc-gaming>. Accessed July 31, 2013.
2. Takahashi D. China's PC online game market to hit \$11.9B in 2013. Available from: <http://venturebeat.com/2013/05/02/chinas-pc-online-game-market-to-hit-11-19b-in-2013/>. Accessed August 22, 2013.
3. Nagygyörgy K, Urbán R, Farkas J, et al. Typology and sociodemographic characteristics of massively multiplayer online game players. *Int J Hum Comput Interact*. 2013;29:192–200.
4. Rice RA. *MMO Evolution*. Raleigh, NC: Lulu Press; 2006.
5. Kuss DJ, Louws J, Wiers RWW. Online gaming addiction? Motives predict addictive play behavior in massively multiplayer online role-playing games. *Cyberpsychol Behav Soc Netw*. 2012;15:480–485.
6. Kuss DJ. *For the Horde! How Playing World of Warcraft Reflects our Participation in Popular Media Culture*. Saarbrücken, Germany: LAP Lambert Academic Publishing; 2013.
7. Entertainment Software Association. Essential facts about the computer and video game industry. 2012. Available from: http://www.theesa.com/facts/pdfs/esa_ef_2012.pdf. Accessed October 15, 2013.
8. Goldfarb A. World of Warcraft loses 1.3 million subscribers. Down to 8 million. 2013. Available from: <http://uk.ign.com/articles/2013/05/08/world-of-warcraft-loses-13-million-subscribers>. Accessed July 30, 2013.
9. Yee N. Motivations for play in online games. *Cyberpsychol Behav*. 2006;9:772–775.
10. King DL, Delfabbro P, Griffiths MD. Video game structural characteristics: a new psychological taxonomy. *Int J Ment Health Addict*. 2010;8:90–106.
11. Cole H, Griffiths MD. Social interactions in massively multiplayer online role-playing gamers. *Cyberpsychol Behav*. 2007;10:575–583.
12. Taylor TL. *Play Between Worlds. Exploring Online Game Culture*. Cambridge, MA: Massachusetts Institute of Technology; 2006.
13. Griffiths MD. A “components” model of addiction within a biopsychosocial framework. *J Subst Use*. 2005;10:191–197.
14. Zanetta Dauriat F, Zermatten A, Billieux J, et al. Motivations to play specifically predict excessive involvement in massively multiplayer online role-playing games: evidence from an online survey. *Eur Addict Res*. 2011;17:185–189.
15. Kuss DJ, Griffiths MD. Internet gaming addiction: a systematic review of empirical research. *Int J Ment Health Addict*. 2012;10:278–296.
16. Ng BD, Wiemer-Hastings P. Addiction to the Internet and online gaming. *Cyberpsychol Behav*. 2005;8:110–113.
17. Soper WB, Miller MJ. Junk-time junkies: an emerging addiction among students. *Sch Couns*. 1983;31:40–43.
18. Shotton M. *Computer Addiction? A Study of Computer Dependency*. London, UK: Taylor and Francis; 1989.
19. King DL, Haagsma MC, Delfabbro PH, Gradisar M, Griffiths MD. Toward a consensus definition of pathological video-gaming: a systematic review of psychometric assessment tools. *Clin Psychol Rev*. 2013;33:331–342.
20. Widyanto L, Griffiths MD, Brunsten V. A psychometric comparison of the Internet Addiction Test, the Internet-Related Problem Scale, and self-diagnosis. *Cyberpsychol Behav Soc Netw*. 2011;14:141–149.
21. American Psychiatric Association. *Diagnostic and Statistical Manual for Mental Disorders IV*. Washington, DC: American Psychiatric Association; 1994.
22. Charlton JP. A factor-analytic investigation of computer ‘addiction’ and engagement. *Br J Psychol*. 2002;93:329–344.
23. Griffiths MD, Kuss DJ, King DL. Video game addiction: past, present and future. *Curr Psychiatry Rev*. 2012;8:308–318.
24. Lortie CL, Guitton MJ. Internet addiction assessment tools: dimensional structure and methodological status. *Addiction*. 2013;108:1207–1216.
25. Festl R, Scharnow M, Quandt T. Problematic computer game use among adolescents, younger and older adults. *Addiction*. 2013;108:592–599.
26. Petry NM. Commentary on Festl et al. Gaming addiction – How far have we come, and how much further do we need to go? *Addiction*. 2013;108:600–601.
27. Hur MH. Demographic, habitual, and socioeconomic determinants of Internet addiction disorder: an empirical study of Korean teenagers. *Cyberpsychol Behav*. 2006;9:514–525.
28. Kuss DJ, Griffiths MD, Karila L, Billieux J. Internet addiction: a review of epidemiological research for the last decade. *Curr Pharm Des*. August 29, 2013. [Epub ahead of print.]
29. Starcevic V. Is Internet addiction a useful concept? *Aust N Z J Psychiatry*. 2012;47:16–19.
30. Ahn DH. Korean policy on treatment and rehabilitation for adolescents' Internet addiction. In: Commission NY, editor. *2007 International Symposium on the Counseling and Treatment of Youth Internet Addiction*. Seoul, Korea: National Youth Commission; 2007:49.

31. Majumdar A. Japan plans 'fasting camps' for Web-addicted children. *Tech 2*. 2013. Available from: <http://tech2.in.com/news/general/japan-plans-fasting-camps-for-webaddicted-children/912284>. Accessed September 2, 2013.
32. King DL, Delfabbro PH, Griffiths MD. Clinical interventions for technology-based problems: excessive Internet and video game use. *Journal of Cognitive Psychotherapy: An International Quarterly*. 2012;26:43–56.
33. Batthyány D, Müller KW, Benker F, Wölfling K. Computer game playing: clinical characteristics of dependence and abuse among adolescents. *Wien Klin Wochenschr*. 2009;121:502–509.
34. King DL, Delfabbro P. Understanding and assisting excessive players of video games: a community psychology perspective. *Aust Community Psychol*. 2009;21:62–74.
35. Liu M, Peng W. Cognitive and psychological predictors of the negative outcomes associated with playing MMOGs (massively multiplayer online games). *Comput Human Behav*. 2009;25:1306–1311.
36. Peng W, Liu M. Online gaming dependency: a preliminary study in China. *Cyberpsychol Behav Soc Netw*. 2010;13:329–333.
37. Peters CS, Malesky LA. Problematic usage among highly-engaged players of massively multiplayer online role playing games. *Cyberpsychol Behav*. 2008;11:480–483.
38. Rehbein F, Kleimann M, Mößle T. Prevalence and risk factors of video game dependency in adolescence: results of a German nationwide survey. *Cyberpsychol Behav Soc Netw*. 2010;13:269–277.
39. Yee N. The psychology of MMORPGs: emotional investment, motivations, relationship formation, and problematic usage. In: Schroeder R, Axelsson A, editors. *Avatars at Work and Play: Collaboration and Interaction in Shared Virtual Environments*. London, UK: Springer-Verlag; 2006.
40. Yee N. The demographics, motivations and derived experiences of users of massively-multiuser online graphical environments. *PRESENCE: Teleoperators and Virtual Environments*. 2006;15:309–329.
41. Allison SE, von Wahlde L, Shockley T, Gabbard GO. The development of the self in the era of the Internet and role-playing fantasy games. *Am J Psychiatry*. 2006;163:381–385.
42. Chan PA, Rabinowitz T. A cross-sectional analysis of video games and attention deficit hyperactivity disorder symptoms in adolescents. *Ann Gen Psychiatry*. 2006;5:16–26.
43. Chiu SI, Lee JZ, Huang DH. Video game addiction in children and teenagers in Taiwan. *Cyberpsychol Behav*. 2004;7:571–581.
44. Hussain Z, Griffiths MD. Excessive use of massively-multi-player online role-playing games: a pilot study. *Int J Ment Health Addict*. 2009;7:563–571.
45. Hussain Z, Griffiths MD. The attitudes, feelings, and experiences of online gamers: a qualitative analysis. *Cyberpsychol Behav*. 2009;12:747–753.
46. Jeong EJ, Kim DW. Social activities, self-efficacy, game attitudes, and game addiction. *Cyberpsychol Behav Soc Netw*. 2011;14:213–221.
47. Dworak M, Schierl T, Bruns T, Struder HK. Impact of singular excessive computer game and television exposure on sleep patterns and memory performance of school-aged children. *Pediatrics*. 2007;120:978–985.
48. Lemmens JS, Valkenburg PM, Peter J. Psychosocial causes and consequences of pathological gaming. *Comput Human Behav*. 2011;27:144–152.
49. Chuang YC. Massively multiplayer online role-playing game-induced seizures: a neglected health problem in Internet addiction. *Cyberpsychol Behav*. 2006;9:451–456.
50. Mehroof M, Griffiths MD. Online gaming addiction: the role of sensation seeking, self-control, neuroticism, aggression, state anxiety, and trait anxiety. *Cyberpsychol Behav*. 2010;13:313–316.
51. Caplan SE, Williams D, Yee N. Problematic Internet use and psychosocial well-being among MMO players. *Comput Human Behav*. 2009;25:1312–1319.
52. Kim EJ, Namkoong K, Ku T, Kim SJ. The relationship between online game addiction and aggression, self-control and narcissistic personality traits. *Eur Psychiatry*. 2008;23:212–218.
53. Kuss DJ, van Rooij A, Shorter GW, Griffiths MD, van de Mheen D. Internet addiction in adolescents: prevalence and risk factors. *Comput Human Behav*. 2013;29:1987–1996.
54. Grüsser SM, Thalemann R, Albrecht U, Thalemann CN. [Excessive computer use in childhood - Results of a psychometric study]. Exzessive Computernutzung im Kindesalter – Ergebnisse einer psychometrischen Erhebung. *Wien Klin Wochenschr*. 2005;117:188–195.
55. Wan CS, Chiou WB. Psychological motives and online games addiction: a test of flow theory and humanistic needs theory for Taiwanese adolescents. *Cyberpsychol Behav*. 2006;9:317–324.
56. Wan CS, Chiou WB. Why are adolescents addicted to online gaming? An interview study in Taiwan. *Cyberpsychol Behav*. 2006;9:762–766.
57. King DL, Delfabbro P. Motivational differences in problem video game play. *Journal of CyberTherapy and Rehabilitation*. 2009;2:139–149.
58. Hsu SH, Wen MH, Wu MC. Exploring user experiences as predictors of MMORPG addiction. *Comput Educ*. 2009;53:990–999.
59. Beranuy M, Carbonell X, Griffiths M. A qualitative analysis of online gaming addicts in treatment. *Int J Ment Health Addict*. 2012;11:149–161.
60. King DL, Delfabbro PH, Griffiths MD. The role of structural characteristics in problematic video game play: an empirical study. *Int J Ment Health Addict*. 2011;9:320–333.
61. Thomas NJ, Martin FH. Video-arcade game, computer game and Internet activities of Australian students: participation habits and prevalence of addiction. *Aust J Psychol*. 2010;62:59–66.
62. Chumbley J, Griffiths M. Affect and the computer game player: the effect of gender, personality, and game reinforcement structure on affective responses to computer game-play. *Cyberpsychol Behav*. 2006;9:308–316.
63. King D, Delfabbro P, Griffiths M. The convergence of gambling and digital media: implications for gambling in young people. *J Gambl Stud*. 2010;26:175–187.
64. Smahel D, Blinka L, Ledabyl O. Playing MMORPGs: connections between addiction and identifying with a character. *Cyberpsychol Behav*. 2008;11:715–718.
65. King DL, Delfabbro PH, Griffiths MD. The psychological study of video game players: methodological challenges and practical advice. *Int J Ment Health Addict*. 2009;7:555–562.
66. Griffiths MD. The use of online methodologies in data collection. *Int J Ment Health Addict*. 2010;8:8–20.
67. Liu C, Liao M, Smith DC. An empirical review of Internet addiction outcome studies in China. *Res Soc Work Pract*. 2012;22:282–292.
68. King DL, Delfabbro PH, Griffiths MD, Gradisar M. Assessing clinical trials of Internet addiction treatment: a systematic review and CONSORT evaluation. *Clin Psychol Rev*. 2011;31:1110–1116.
69. Winkler A, Dorsing B, Rief W, Shen Y, Glombiewski JA. Treatment of Internet addiction: a meta-analysis. *Clin Psychol Rev*. 2013;33:317–329.
70. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)*. Arlington, VA: American Psychiatric Association; 2013.
71. Griffiths MD. The role of context in online gaming excess and addiction: some case study evidence. *Int J Ment Health Addict*. 2010;8:119–125.
72. Karlsen F. *A World of Excesses. Online Games and Excessive Playing*. Ashgate, UK: Farnham; 2013.
73. Snodgrass JG, Dengah HJF, Lacy MG, Fagan J. A formal anthropological view of motivation models of problematic MMO play: achievement, social, and immersion factors in the context of culture. *Transcult Psychiatry*. May 20, 2013. [Epub ahead of print.]

74. American Psychiatric Association. *Diagnostic and Statistical Manual for Mental Disorders IV, Text-Revision*. Washington, DC: American Psychiatric Association; 2000.
75. Hine C. *Virtual Ethnography*. London, UK: Sage; 2000.
76. Aarseth E. Playing research: methodological approaches to game analysis. Melbourne DAC Papers 2003. Available from: <http://hypertext.rmit.edu.au/dac/papers/Aarseth.pdf>. Accessed October 15, 2013.
77. Ryan M-L. Computer games as narrative: the ludology versus narrativism controversy. In: Ryan M-L, editor. *Avatars of Story*. Minneapolis, MN: University of Minnesota Press; 2006.
78. Wellman B, Gulia M. Net surfers don't ride alone: virtual communities as communities. In: Kollock P, Smith M, editors. *Communities and Cyberspace*. New York, NY: Routledge; 1999.
79. Nardi BA. *My Life as a Night Elf Priest. An Anthropological Account of World of Warcraft*. Ann Arbor, MI: University of Michigan; 2010.
80. Castronova E. *Synthetic Worlds: The Business and Culture of Online Games*. Chicago, IL: University of Chicago Press; 2005.
81. Young K. *Caught in the Net*. New York, NY: Wiley; 1998.
82. Ross N. *Culture and Cognition: Implications for Theory and Method*. New York, NY: Sage; 2006.
83. Dressler WW, Borges CD, Balieiro MC, Dos Santos JE. Measuring cultural consonance: examples with special reference to measurement theory in anthropology. *Field Methods*. 2005;17:331–355.
84. Gravlee CC, Dressler WW, Bernard HR. Skin color, social classification, and blood pressure in southeastern Puerto Rico. *Am J Public Health*. 2005;95:2191–2197.
85. Bartle R. *Designing Virtual Worlds*. Indianapolis, IN: New Riders Games; 2003.
86. Seligman R, Kirmayer L. Dissociative experience and cultural neuroscience: narrative, metaphor and mechanism. *Cult Med Psychiatry*. 2008;32:31–64.
87. Kupfer DJ, Regier DA. Neuroscience, clinical evidence, and the future of psychiatric classification in D SM-5. *Am J Psychiatry*. 2011;168:1–3.
88. National Institute of Mental Health. The National Institute of Mental Health Strategic Plan. 2008. Available from: <http://www.nimh.nih.gov/about/strategic-planning-reports/index.shtml#strategic-objective1>. Accessed October 15, 2013.
89. Insel T, Cuthbert B, Garvey M, et al. Research domain criteria (RDoC): toward a new classification framework for research on mental disorders. *Am J Psychiatry*. 2010;167:748–751.
90. Kuss DJ, Griffiths MD. Internet and gaming addiction: a systematic literature review of neuroimaging studies. *Brain Sci*. 2012;2:347–374.
91. Volkow ND, Fowler JS, Wang GJ. The addicted human brain: insights from imaging studies. *J Clin Invest*. 2003;111:1444–1451.
92. Everitt BJ, Robbins TW. Neural systems of reinforcement for drug addiction: from actions to habits to compulsion. *Nat Neurosci*. 2005;8:1481–1489.
93. Kalivas PW, Volkow ND. The neural basis of addiction: a pathology of motivation and choice. *Am J Psychiatry*. 2005;162:1403–1413.
94. Goldstein RZ, Volkow ND. Drug addiction and its underlying neurobiological basis: neuroimaging evidence for the involvement of the frontal cortex. *Am J Psychiatry*. 2002;159:1642–1652.
95. Craven R. Targeting neural correlates of addiction. *Nat Rev Neurosci*. 2006;7:1.
96. Brebner K, Wong TP, Liu L, et al. Nucleus accumbens long-term depression and the expression of behavioral sensitization. *Science*. 2005;310:1340–1343.
97. Wilson SJ, Sayette MA, Fiez JA. Prefrontal responses to drug cues: a neurocognitive analysis. *Nat Neurosci*. 2004;7:211–214.
98. di Chiara G. Nucleus accumbens shell and core dopamine: differential role in behavior and addiction. *Behav Brain Res*. 2002;137:75–114.
99. Koob GF, Le Moal M. Addiction and the brain antireward system. *Annu Rev Psychol*. 2008;59:29–53.
100. Prochaska JO, DiClemente CC, Norcross JC. In search of how people change. applications to addictive behaviours. *Am Psychol*. 1992;47:1102–1114.
101. Potenza MN. Should addictive disorders include non-substance-related conditions? *Addiction*. 2006;101:142–151.
102. Niedermeyer E, da Silva FL. *Electroencephalography: Basic Principles, Clinical Applications, and Related Fields*. Philadelphia, PA: Lippincott Williams & Wilkins; 2004.
103. Dong G, Zhou H, Zhao X. Male Internet addicts show impaired executive control ability: evidence from a color-word Stroop task. *Neurosci Lett*. 2011;499:114–118.
104. Dong G, Lu Q, Zhou H, Zhao X. Impulse inhibition in people with Internet addiction disorder: electrophysiological evidence from a Go/NoGo study. *Neurosci Lett*. 2010;485:138–142.
105. Dong G, Zhou H. Is impulse-control ability impaired in people with Internet addiction disorder: electrophysiological evidence from ERP studies. *Int J Psychophysiol*. 2010;77:334–335.
106. Ge L, Ge X, Xu Y, Zhang K, Zhao J, Kong X. P300 change and cognitive behavioral therapy in subjects with Internet addiction disorder: a 3-month follow-up study. *Neural Regeneration Research*. 2011;6:2037–2041.
107. Littel M, Luijten M, van den Berg I, van Rooij A, Keemink L, Franken I. Error-processing and response inhibition in excessive computer game players: an ERP study. *Addict Biol*. 2012;17:934–947.
108. Yu H, Zhao X, Li N, Wang M, Zhou P. Effect of excessive Internet use on the time-frequency characteristic of EEG. *Progress in Natural Science*. 2009;19:1383–1387.
109. Bailey DL, Townsend DW, Valk PE, Maisey MN. *Positron Emission Tomography: Basic Sciences*. Secaucus, NJ: Springer; 2005.
110. Kim SH, Baik SH, Park CS, Kim SJ, Choi SW, Kim SE. Reduced striatal dopamine D2 receptors in people with Internet addiction. *Neuroreport*. 2011;22:407–411.
111. Koeppe MJ, Gunn RN, Lawrence AD, et al. Evidence for striatal dopamine release during a video game. *Nature*. 1998;393:266–268.
112. Meikle SR, Beekman FJ, Rose SE. Complementary molecular imaging technologies: high resolution SPECT, PET and MRI. *Drug Discov Today Technol*. 2006;3:187–194.
113. Hou H, Jia S, Hu S, et al. Reduced striatal dopamine transporters in people with Internet addiction disorder. *J Biomed Biotechnol*. 2012;2012:ID 854524.
114. Dong G, Huang J, Du X. Enhanced reward sensitivity and decreased loss sensitivity in Internet addicts: an fMRI study during a guessing task. *J Psychiatr Res*. 2011;45:1525–1529.
115. Han DH, Lyoo IK, Renshaw PF. Differential regional gray matter volumes in patients with on-line game addiction and professional gamers. *J Psychiatr Res*. 2012;46:507–515.
116. Han DH, Hwang JW, Renshaw PF. Bupropion sustained release treatment decreases craving for video games and cue-induced brain activity in patients with Internet video game addiction. *Exp Clin Psychopharmacol*. 2010;18:297–304.
117. Han DH, Kim YS, Lee YS, Min KJ, Renshaw PF. Changes in cue-induced, prefrontal cortex activity with video-game play. *Cyberpsychol Behav Soc Netw*. 2010;13:655–661.
118. Hoefl F, Watson CL, Kesler SR, Bettinger KE, Reiss AL. Gender differences in the mesocorticolimbic system during computer game-play. *J Psychiatr Res*. 2008;42:253–258.
119. Ko CH, Liu GC, Hsiao SM, et al. Brain activities associated with gaming urge of online gaming addiction. *J Psychiatr Res*. 2009;43:739–747.
120. Liu J, Gao XP, Osunde I, et al. Increased regional homogeneity in internet addiction disorder: a resting state functional magnetic resonance imaging study. *Chin Med J (Engl)*. 2010;123:1904–1908.
121. Yuan K, Qin W, Wang G, et al. Microstructure abnormalities in adolescents with Internet addiction disorder. *PLoS One*. 2011;6:e20708.
122. Huettel SA, Song AW, McCarthy G. *Functional Magnetic Resonance Imaging*. 2nd ed. Sunderland, MA: Sinauer; 2008.

123. Ashburner J, Friston KJ. Voxel-based morphometry – the methods. *NeuroImage*. 2000;11(6 Pt 1):805–821.
124. Le Bihan D, Mangin JF, Poupon C, et al. Diffusion tensor imaging: concepts and applications. *J Magn Reson Imaging*. 2001;13:534–546.
125. Symms M, Jäger HR, Schmierer K, Yousry TA. A review of structural magnetic resonance neuroimaging. *J Neurol Neurosurg Psychiatry*. 2004;75:1235–1244.
126. Zhou Y, Lin F-C, Du Y-S, et al. Gray matter abnormalities in Internet addiction: a voxel-based morphometry study. *Eur J Radiol*. 2011;79:92–95.
127. Lin F, Zhou Y, Du Y, et al. Abnormal white matter integrity in adolescents with Internet addiction disorder: a tract-based spatial statistics study. *PLoS One*. 2012;7:e30253.
128. Comings DE, Blum K. Reward deficiency syndrome: genetic aspects of behavioral disorders. In: Uylings HBM, VanEden CG, DeBruin JPC, Feenstra MGP, Pennartz CMA, editors. *Cognition, Emotion and Autonomic Responses: The Integrative Role of the Prefrontal Cortex and Limbic Structures*. Amsterdam, The Netherlands: Elsevier; 2000.
129. Solomon RL. Addiction: an opponent process theory of acquired motivation: the affective dynamics of addiction. In: Maser JD, editor. *Psychopathology: Experimental Models*. San Francisco, CA: Freeman; 1977.
130. Morrison CM, Gore H. The relationship between excessive Internet use and depression: a questionnaire-based study of 1,319 young people and adults. *Psychopathology*. 2010;43:121–126.
131. Di Nicola M, Tedeschi D, Mazza M, et al. Behavioral addictions in bipolar disorder patients: role of impulsivity and personality dimensions. *J Affect Disord*. 2010;125:82–88.
132. Bernardi S, Pallanti S. Internet addiction: a descriptive clinical study focusing on comorbidities and dissociative symptoms. *Compr Psychiatry*. 2009;50:510–516.
133. Volkow ND, Fowler JS, Wang GJ. The addicted human brain viewed in the light of imaging studies: brain circuits and treatment strategies. *Neuropharmacology*. 2004;47 Suppl 1:3–13.
134. Pies R. Should DSM-V designate “Internet addiction” a mental disorder? *Psychiatry (Edgmont)*. 2009;6:31–37.
135. American Society of Addiction Medicine. The voice of addiction medicine. 2012. Available from: <http://www.asam.org/>. Accessed August 29, 2013.
136. Adams J, Kirkby R. Exercise dependence: a problem for sports physiotherapists. *Aust J Physiother*. 1997;43:53–58.
137. Griffiths MD, Szabo A, Terry A. The exercise addiction inventory: a quick and easy screening tool for health practitioners. *Br J Sports Med*. 2005;39:e30.
138. Andreassen CS, Griffiths MD, Hetland J, Pallesen S. Development of a work addiction scale. *Scand J Psychol*. 2012;53:265–272.
139. Clark M, Calleja K. Shopping addiction: a preliminary investigation among Maltese university students. *Addict Res Theory*. 2008;16:633–649.
140. Dongdong L, Liao A, Khoo A. Examining the influence of actual-ideal self-discrepancies, depression, and escapism, on pathological gaming among massively multiplayer online adolescent gamers. *Cyberpsychol Behav Soc Netw*. 2011;14:535–539.
141. Gentile DA, Choo H, Liao A, et al. Pathological video game use among youths: a two-year longitudinal study. *Pediatrics*. 2011;127:E319–E329.
142. Kwon J-H, Chung C-S, Lee J. The effects of escape from self and interpersonal relationship on the pathological use of Internet games. *Community Ment Health J*. 2011;47:113–121.
143. Bear S, Bogusz E, Green DA. Stuck on screens: patterns of computer and gaming station use in youth seen in a psychiatric clinic. *J Can Acad Child Adolesc Psychiatry*. 2011;20:86–95.
144. Skoric MM, Teo LLC, Neo RL. Children and video games: addiction, engagement, and scholastic achievement. *Cyberpsychol Behav*. 2009;12:567–572.
145. Charlton JP, Danforth IDW. Distinguishing addiction and high engagement in the context of online game playing. *Comput Human Behav*. 2007;23:1531–1548.
146. Kim MG, Kim J. Cross-validation of reliability, convergent and discriminant validity for the Problematic Online Game Use Scale. *Comput Human Behav*. 2010;26:389–398.
147. King DL, Delfabbro PH, Zajac IT. Preliminary validation of a new clinical tool for identifying problem video game playing. *Int J Ment Health Addict*. 2011;9:72–87.
148. Salguero RAT, Moran RMB. Measuring problem video game playing in adolescents. *Addiction*. 2002;97:1601–1606.
149. van Rooij AJ, Schoenmakers TM, van den Eijnden RJ, van de Mheen D. Videogame Addiction Test (VAT): validity and psychometric characteristics. *Cyberpsychol Behav Soc Netw*. 2012;15:507–511.
150. Demetrovics Z, Urban R, Nagygyorgy K, et al. The development of the Problematic Online Gaming Questionnaire (POGQ). *PLoS One*. 2012;7(5):e36417.
151. Gentile DA. Pathological video-game use among youth ages 8 to 18: a national study. *Psychol Sci*. 2009;20:594–602.
152. Choo H, Gentile DA, Sim T, Li D, Khoo A, Liao AK. Pathological video-gaming among Singaporean youth. *Ann Acad Med Singapore*. 2010;39:822–829.
153. Lemmens JS, Valkenburg PM, Peter J. Development and validation of a game addiction scale for adolescents. *Media Psychol*. 2009;12: 77–95.
154. Kraepelin E. [100 years of psychiatry: A contribution to the history of human behavior] *Hundert Jahre Psychiatrie: Ein Beitrag zur Geschichte menschlicher Gesittung*. Saarbrücken, Germany: VDM, Müller; 2006.
155. World Health Organization. ICD 10: the ICD-10 classification of mental and behavioral disorders: Clinical descriptions and diagnostic guidelines. Geneva, Switzerland: World Health Organization; 1992. Available from: <http://www.who.int/classifications/icd/en/bluebook.pdf>. Accessed October 15, 2013.
156. Kuss DJ. Substance and behavioral addictions: beyond dependence. *J Addict Res Ther*. 2012;S6:e001.
157. Petry NM, O’Brien CP. Internet gaming disorder and the DSM-5. *Addiction*. 2013;108:1186–1187.
158. King DL, Delfabbro PH. Issues for DSM-5: video-gaming disorder? *Aust N Z J Psychiatry*. 2012;47:20–22.
159. Porter G, Starcevic V, Berle D, Fenech P. Recognizing problem video game use. *Aust N Z J Psychiatry*. 2010;44:120–128.
160. Meerkerk GJ, Van Den Eijnden RJ, Vermulst AA, Garretsen HFL. The Compulsive Internet Use Scale (CIUS): some psychometric properties. *Cyberpsychol Behav*. 2009;12:1–6.
161. Sim T, Gentile DA, Bricolo F, Serpelloni G, Gulamoydeen F. A conceptual review of research on the pathological use of computers, video games, and the Internet. *Int J Ment Health Addict*. 2012;10:748–769.

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