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Abstract

The activity of play has been ever present in human history and the Internet has emerged as a playground increasingly populated by gamers. Research suggests that a minority of Internet game players experience symptoms traditionally associated with substance-related addictions, including mood modification, tolerance and salience. Because the current scientific knowledge of Internet gaming addiction is copious in scope and appears relatively complex, this literature review attempts to reduce this confusion by providing an innovative framework by which all the studies to date can be categorized. A total of 58 empirical studies were included in this literature review. Using the current empirical knowledge, it is argued that Internet gaming addiction follows a continuum, with antecedents in etiology and risk factors, through to the development of a "full-blown" addiction, followed by ramifications in terms of negative consequences and potential treatment. The results are evaluated in light of the emergent discrepancies in findings, and the consequent implications for future research.

Introduction

The activity of play has been ever present in human history. Playing games is pleasurable and entertaining, and it is a way of relaxation stepping out of the daily routine and enjoying something distinct from everyday life. In his cultural analysis of play, Huizinga (1938) refers to play as "a free activity (…) outside "ordinary" life as being "not serious", but at the same time absorbing the player intensely and utterly. (…) It proceeds within its own proper boundaries of time and space according to fixed rules and in an orderly manner. It promotes the formation of social groupings which tend to surround themselves with secrecy and to stress their difference from the common world by disguise or other means" (Huizinga, 1938, p. 13). Therefore, not only is play an enjoyable pastime activity, it is a social activity as well. It connects likeminded people, thereby fostering sociocultural protocols of behaviors associated with gameplay.

With the Internet, a new playground has emerged. In effect, the Internet offers a wide variety of games to play, which are distributed across a variety of game genres. These include (but are not restricted to) casual Browser Games (CBGs) such as *DarkOrbit*, First-Person or Ego-Shooters (FPSs) such as *Counterstrike*, Massively Multiplayer Online Role-Playing Games (MMORPGs) such as *World of Warcraft* (WoW), and Simulation Games (SGs) such as *Second Life*, to name but the most important. Furthermore, there exist hybrid forms, such as Massively Multiplayer Online Role-Playing First-Person Shooters (MMORPFPSs), such as *Neocron*, which combine distinct genres within one game. CBGs are played on an Internet browser and are free and easily accessible. FPSs are online tactics-shooters played from an ego-perspective in a 3D-game world. This is the game genre most frequently played in e-sports.

MMORPGs are played by hundreds of thousands of users throughout the world simultaneously. In-game, players frequently socialize in guilds[1] and cooperate in order to reach game-relevant goals. Moreover, they play roles by taking on virtual personae, so-called avatars, such as magicians or warriors. Finally, Simulation Games simulate real life in a metaverse where everything that can be done in actual life can be done in a virtual, second life as well. The broad appeal of these games is outlined by the NPD's 2009 software sales ranking: *The Sims 3* was sold most, followed by *WoW's Wrath of the Lich King* (The NPD Group, 2010). The next games in the ranking see an alteration between other versions of these two games, indicating that the public's current preference is for MMORPGs and real life simulations. This preference may be explained by the fact that "(p)lay enables the exploration of that tissue boundary between fantasy and reality, between the real and the imagined, between the self and the other. In play we have license to explore, both our selves and our society. In play we investigate culture, but we also create it" (Silverstone, 1999, p. 64). Therefore, the blurring of the boundaries between the real and the virtual appears particularly relevant for these two most frequently played game genres.

The latest software sale rankings demonstrate that Internet games attract many gamers. This appeal is even greater for a small minority of people who play excessively. Research suggests that this minority may experience symptoms traditionally associated with substance-related addictions, such as mood modification, tolerance, and behavioral salience (Hsu, Wen, & Wu, 2009; Ko, Liu, Hsiao, Yen, Yang, Lin, Yen, & Chen, 2009; Mehroof & Griffiths, 2010; Wölfling, Thalemann, & Grüsser-Sinopoli, 2008; Young, 2009). In order to avoid potential conceptual confusion, this review will refer to the phenomenon as Internet gaming addiction,

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[1] A guild is a social grouping of people in-game, usually established around common goals, such as accessing the respective game's high-end content collectively (Ducheneaut, Yee, Nickell, & Moore, 2007).

although researchers tend to use a variety of different conceptualizations. This topic will be addressed in more detail in the section on classification and assessment. Nonetheless, in the last few years, research on Internet gaming addiction has proliferated. A relatively large number of studies were published, addressing topics as diverse as classification, etiology, and phenomenology of this behavioral addiction. There have also been recent reviews on whether the concept of Internet gaming addiction is even a valid concept (e.g., Griffiths, 2010a) but such debate is not the focus of this paper. Because the current scientific knowledge of Internet gaming addiction is copious in scope and appears relatively complex, this literature review attempts to reduce this confusion by providing an innovative framework by which all the studies to date can be categorized.

Methodology

A comprehensive literature search was conducted using the database *Web of Knowledge*. The following search terms (and their derivatives) were entered in relation to online video gaming: 'excessive', 'problematic', 'compulsive', and 'addictive'. In addition, further studies were identified from supplementary sources, such as *Google Scholar*, and these were added in order to generate a more inclusive literature review. Studies were selected in accordance with the following inclusion criteria. Studies had to (i) contain empirical data (including everything from case studies through to surveys with thousands of participants), (ii) have been published after 2000 (as there were no studies on this topic prior to that date), and (iii) contain some kind of analysis relating to Internet gaming addiction. If studies referred to gaming addicts without specifying whether these were online and/or offline gamers, due to online games' popularity it was assumed that at least some of the participants

were online gamers and therefore these studies were included in the review. It should also be noted that studies investigating the playing of gambling games for free were excluded from the analysis as these have been examined in detail elsewhere in other reviews on internet gambling (e.g., Griffiths & Parke, 2010; King, Delfabbro & Griffiths, 2010).

Results

Three main categories of studies were identified, namely those concerned with (i) etiology, (ii) pathology and (iii) ramifications of Internet gaming addiction. Each of these also contained sub-topics that are conceptualized in the schematic framework in Figure 1. The findings within each of these categories are described. This is followed by an evaluation of these studies in the final section of the paper.

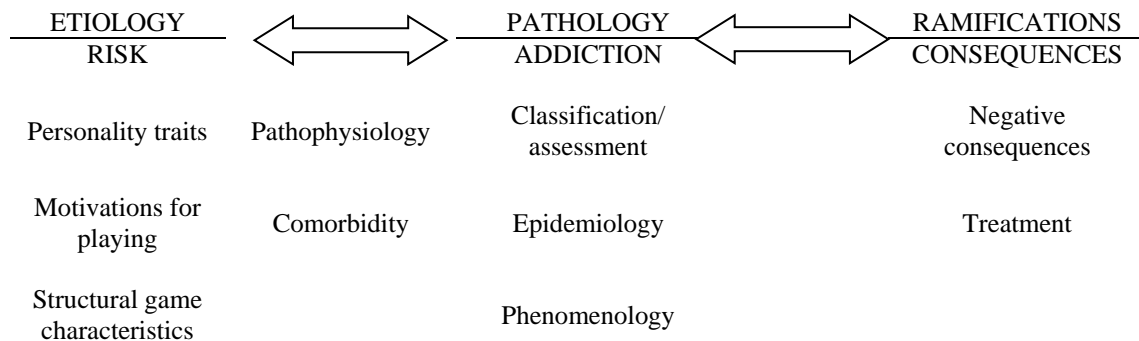| ETIOLOGY RISK		PATHOLOGY ADDICTION	RAMIFICATIONS CONSEQUENCES
Personality traits	Pathophysiology	Classification/ assessment	Negative consequences
Motivations for playing	Comorbidity	Epidemiology	Treatment
Structural game characteristics		Phenomenology	

Figure 1: *The Continuum of Internet Gaming Addiction*

Based upon the scientific empirical literature, it is argued that Internet gaming addiction appears to follow a continuum, with antecedents in etiology and risk factors, through to the development of a "full-blown" addiction, followed by ramifications in terms of negative consequences and potential treatment. These stages are interdependent as the risk factors influence the pathogenesis of addiction and the latter

may similarly reinforce the former. Likewise, addiction leads to clinically significant negative consequences for the individual, which in turn may augment the pathological status of the former, requiring the individual to seek professional treatment.

This conceptual framework is further developed by drawing upon the relevant studies identified from the empirical literature. It should also be noted that only a small number of the studies exclusively fell within only one of the main categories and the associated sub-categories. Accordingly, many of the studies listed below are included in more than one of the sub-categories. Likewise, the sub-categories of psychophysiology and comorbidity were not placed in one of the main three categories, because they appeared to more closely resemble the intersection between the etiology and pathology of Internet gaming addiction.

Etiology/risk

A number of studies have focused on illuminating the etiology of, and specifying risk factors for, Internet gaming addiction. These include internal factors, namely personality traits and motivations for playing, as well as an external factor, the structural game characteristics. Each of these is dealt with below.

Personality traits

The first internal risk factor identified in the review was personality traits of gamers, which has been investigated in twelve studies (Allison, von Wahlde, Shockley, & Gabbard, 2006; Caplan, Williams, & Yee, 2009; Chiu, Lee, & Huang, 2004; Chumbley & Griffiths, 2006; Jeong & Kim, 2010; Kim, Namkoong, Ku, & Kim, 2008; Ko, Yen, Chen, Chen, & Yen, 2005; Lemmens, Valkenburg, & Peter, 2010; Mehroof & Griffiths, 2010; Parker, Taylor, Eastabrook, Schell, & Wood, 2008; Peters

& Malesky, 2008; Porter, Starcevic, Berle, & Fenech, 2010). The methodologies employed ranged from a case study of an adolescent gamer (Allison, et al., 2006) to a larger sample of this population (Parker, et al., 2008), middle school and high school students (Chiu, et al., 2004; Jeong & Kim, 2010; Ko, et al., 2005), undergraduate students (Chumbley & Griffiths, 2006; Mehroof & Griffiths, 2010), and large samples of MMORPG players (Caplan, et al., 2009; Kim, et al., 2008; Peters & Malesky, 2008), as well as an unspecified sample of video gamers (Porter, et al., 2010).

Personality traits were assessed using a variety of measures, including the Minnesota Multiphasic Personality Inventory (Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989), the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1996), the NEO Personality Inventory (Costa & McCrae, 1985), a boredom inclination scale (Farrell, 1990), the Buss-Perry Aggression Questionnaire (Buss & Perry, 1992), the Narcissistic Personality Disorder Scale (Hwang, 1995), the Rosenberg Self-Esteem Scale (Rosenberg, 1965), the Self-Control Scale (Tangney, Baumeister, & Boone, 2004), emotional intelligence (Bar-On & Parker, 2000), self-efficacy (based on Muris, 2001; Sherer, Maddux, Mercandante, Prentice-Dunn, Jacobs, & Rogers, 1982), and the Arnett Inventory of Sensation-Seeking (Arnett, 1994).

In terms of the results, the following personality traits were found to be significantly related to Internet gaming addiction: avoidant and schizoid interpersonal tendencies (Allison, et al., 2006), loneliness and introversion (Caplan, et al., 2009), social inhibition (Porter, et al., 2010), aggression and hostility (Caplan, et al., 2009; Chiu, et al., 2004; Kim, et al., 2008; Mehroof & Griffiths, 2010), boredom inclination (Chiu, et al., 2004), sensation-seeking (Chiu, et al., 2004; Mehroof & Griffiths, 2010), diminished self-control and narcissistic personality traits (Kim, et al., 2008), low self-

esteem (Ko, et al., 2005), neuroticism (Mehroof & Griffiths, 2010; Peters & Malesky, 2008), state and trait anxiety (Mehroof & Griffiths, 2010), low emotional intelligence (Parker, et al., 2008), low self-efficacy in real life as opposed to high self-efficacy in the virtual world (Jeong & Kim, 2010), and diminished agreeableness (Peters & Malesky, 2008). In summation, Internet gaming addiction appears to be accompanied with a variety of personality traits, which can be subsumed under the key characteristics of introversion, neuroticism and impulsivity. However, it must be noted that the personality traits that appear to have an association with Internet gaming addiction may not be unique to the disorder, and therefore until further research has been undertaken, it is hard to assess the etiological significance of such findings.

Motivations for playing

A number of motivations for playing that put a player at risk for Internet gaming addiction were identified from the literature. In total, thirteen studies were identified (Beranuy, Carbonell, & Griffiths, 2010; Caplan, et al., 2009; Grüsser, Thalemann, Albrecht, & Thalemann, 2005; Hsu, Wen, & Wu, 2009; Hussain & Griffiths, 2009b; King & Delfabbro, 2009a, 2009b; King, Delfabbro, & Griffiths, 2011; Lu & Wang, 2008; Ng & Wiemer-Hastings, 2005; Wan & Chiou, 2006a, 2006b, 2007). These included qualitative studies of MMORPG players (Beranuy, et al., 2010), both adolescent and adult gamers (King & Delfabbro, 2009b), and adolescent online game addicts (Wan & Chiou, 2006b). Quantitative studies included large samples of MMORPG players (Caplan, et al., 2009; Hussain & Griffiths, 2009b; Ng & Wiemer-Hastings, 2005), online game players (Lu & Wang, 2008), video game players (King & Delfabbro, 2009a; King, et al., 2011), both adolescents and MMORPG players

(Wan & Chiou, 2006a), secondary school children (Grüsser, et al., 2005), adolescents (Wan & Chiou, 2007), and college students (Hsu, et al., 2009). Apart from the specification of MMORPGs as game genre a number of participants were playing as mentioned above, in the other studies no explicit reference to game type was discernible.

Motivations for playing were assessed by the following means: semi-structured interviews (Beranuy, et al., 2010; King & Delfabbro, 2009b; Wan & Chiou, 2006b) as well as theoretical frameworks (Choi, Kim, & Kim, 2000; Myers, 1990; Williams, Yee, & Caplan, 2008). In addition to this, a number of assessment instruments were used, namely a questionnaire for assessing computer game play behavior in children (CSVK; Thalemann, Albrecht, Thalemann, & Grüsser, 2004), an adapted version of the Exercise Addiction Inventory (Terry, Szabo, & Griffiths, 2004), the Video Game Playing Motivation Scale (PVGT; based on Young, 1998), the Two-Factor Evaluation on Needs for Online Games (TENO; Wan & Chiou, 2006a), and the Online Gaming Motivation Scale (Wan & Chiou, 2007).

The results of the studies indicated that Internet gaming addiction is related to the following motivations for playing: coping with negative emotions, stress, fear and escape (Grüsser, et al., 2005; Hussain & Griffiths, 2009b; King & Delfabbro, 2009a; Ng & Wiemer-Hastings, 2005; Wan & Chiou, 2006a, 2006b), dissociation (Beranuy, et al., 2010), virtual friendship/relationships (Beranuy, et al., 2010; Caplan, et al., 2009; Hsu, et al., 2009; King & Delfabbro, 2009a; Ng & Wiemer-Hastings, 2005), entertainment (Beranuy, et al., 2010; Wan & Chiou, 2006b), playfulness and loyalty (Lu & Wang, 2008), empowerment, mastery, control, recognition, completion, excitement and challenge (King & Delfabbro, 2009b; King, et al., 2011; Wan & Chiou, 2006b), curiosity and obligation (Hsu, et al., 2009), reward (Hsu, et al., 2009;

King, et al., 2010), immersion (Caplan, et al., 2009), and generally high intrinsic motivation to play as opposed to extrinsic motivation (Wan & Chiou, 2007). In summation, it appears that it is particularly motivations related to dysfunctional coping, socialization and personal satisfaction that serve as risk factors for developing Internet gaming addiction.

Structural characteristics of the game

Certain structural characteristics of the game itself are thought to make playing online games particularly appealing to persons who play excessively. A total of four studies were identified that have analyzed such characteristics (Chumbley & Griffiths, 2006; King, et al., 2010; Smahel, Blinka, & Ledabyl, 2008; Thomas & Martin, 2010). The samples included in the studies were MMORPG players (Smahel, Blinka, & Ledabyl, 2008), video game players (King, et al., 2010), and students within different stages in their education (Chumbley & Griffiths, 2006; Thomas & Martin, 2010). Again, for the last two participant groups, no specification with regards to game genre was referred to.

The methods employed to investigate structural characteristics of the game included: high and negative reinforcement of play via the game's structural characteristics as based on the skill for playing required and investigated via self-report, as well as affective and playability measurements scored on Likert scales (Chumbley & Griffiths, 2006), the Video Game Structural Characteristics Survey (King, et al., 2010), questions about the relationship of the gamers to their virtual characters (Smahel, et al., 2008), and game addiction with regards to different game genres (Thomas & Martin, 2010).

The results indicated that structural characteristics of games appear to be related to addiction. More specifically, Internet games and arcade games were found to be more addictive than offline video games although these three different types of games were inadequately defined by the authors particularly in relation to internet games (Thomas & Martin, 2010). Moreover, it has been found that structural characteristics affect players' mood. That is, negative reinforcement led to frustration, whereas positive reinforcement resulted in game persistence, hypothetically allowing to link positive reinforcement to addiction (Chumbley & Griffiths, 2006). In addition to this, particular game features were enjoyed significantly more by addicted players, namely adult content, finding rare in-game items, and watching videogame cut-scenes (King, et al., 2010). Finally, addicted players appeared to be particularly proud of their avatars, i.e., they wanted to be like their virtual characters, and viewed the latter as superior compared to themselves (Smahel, et al., 2008). In summation, certain structural characteristics of Internet games appear to put players at risk for developing an addiction to these games. Most notably, Internet games constructed in such a way so as to reinforce playing by various means appear to have a higher addictive potential than those that do not contain these structures, such as offline games.

Pathophysiology

Pathophysiology is one of the sub-categories that falls between etiology and pathology of Internet gaming addiction and thus it represents an aspect of the intersection between risk factors and the actual development of pathological behaviors and cognitions. Several studies have assessed the relationship between Internet gaming addiction and physiology. In total, seven such studies were identified (Cultrara & Har-El, 2002; Dworak, Schierl, Bruns, & Struder, 2007; Han, Hwang, &

Renshaw, 2010; Hoeft, Watson, Kesler, Bettinger, & Reiss, 2008; Ko, et al., 2009; Thalemann, Wölfling, & Grüsser, 2007). With regards to methods and participants, these studies included one case study of an adolescent role-playing gamer (Cultrara & Har-El, 2002), as well as a small sample of young teenagers (Dworak, Schierl, Bruns, & Struder, 2007), several studies comparing gaming addicts and healthy controls (Han, et al., 2010; Han, Lee, Yang, Kim, Lyoo, & Renshaw, 2007; Ko, et al., 2009; Thalemann, et al., 2007), as well as a student sample (Hoeft, Watson, Kesler, Bettinger, & Reiss, 2008).

The associations between Internet gaming addiction and physical problems were assessed by the following means: functional Magnetic Resonance Imaging (fMRI; Han, Hwang, & Renshaw, 2010; Hoeft, et al., 2008; Ko, Liu, Hsiao, Yen, Yang, Lin, Yen, & Chen, 2009), electroencephalography (EEG; Thalemann, Wölfling, & Grüsser, 2007), genotyping (Han, Lee, Yang, Kim, Lyoo, & Renshaw, 2007), polysomnographic measures and visual and verbal memory tests (Dworak, et al., 2007), and medical examinations including the patient's history, and physical, radiologic, intraoperative, and pathologic findings (Cultrara & Har-El, 2002).

The results of the fMRI studies conducted revealed that during computer game cue presentation, gaming addicts showed similar neural processes and increased activity in brain areas associated with substance-related addictions and other behavioral addictions, such as pathological gambling. Significantly stronger activation in addicts relative to healthy controls was found in the left occipital lobe, parahippocampal gyrus, dorsolateral prefrontal cortex, nucleus accumbens, right orbitofrontal cortex, bilateral anterior cingulate, medial frontal cortex, and the caudate nucleus (Han, et al., 2010; Hoeft, et al., 2008; Ko, et al., 2009). Moreover, the gaming

addicts' emotional processing of game-relevant cues was found to be increased relative to that of casual gamers (Thalemann, et al., 2007).

In a similar vein, those addicted to Internet gaming were found to have a higher prevalence of two polymorphisms of the dopaminergic system that are associated with substance-related addictions, namely the Taq1A1 allele of the dopamine D2 receptor and the Val158Met in the Catecholamine-O-Methyltransferase (COMT) genes (Han, et al., 2007). Additionally, excessive online game play was associated with significantly reduced amounts of slow-wave sleep and declines in verbal memory performance and a prolonged sleep-onset latency (Dworak, et al., 2007). Finally, it was reported that one patient excessively moved his jaw and tongue during online game play, to the end that he developed muscle hypertrophy and associated physical problems (Cultrara & Har-El, 2002).

However, it must also be noted that although gaming addicts displayed stronger activation compared to non-addicts in these studies, the question remains as to whether this is specific to gaming addiction, or general to any activity that generates arousal (e.g., gambling), and whether these findings reflect causes or effects. Based on the studies presented here, it cannot be proved that the findings reported attest to the severity of the mental health problem if effects found are the result of exposure, anymore than differences in dopaminergic activity between drug and non-drug users attest to the severity of mental health problems for society at large. Despite such limitations, these studies appear to show that neither the causes nor the consequences of Internet gaming addiction are restricted to psychosocial factors. More specifically, the results of scientific studies demonstrate that Internet gaming addiction is associated with a wide variety of physiological, biochemical and neurological

aberrations from the norm. This attests to the apparent severity of this mental health problem for society at large.

Comorbidity

Comorbidity was found to be one of the two categories that the current scientific literature focuses on that cannot adequately be subsumed under one of the main categories presented in the framework. The occurrence of further (sub)clinical symptoms can be a risk factor for Internet gaming addiction as well as an accompanying condition in such a way that they are interdependent. Therefore, in this review no claims regarding the direction of relationship are made.

A total of five studies assessing Internet gaming addiction and its comorbidity were identified (Allison, et al., 2006; Batthyány, Müller, Benker, & Wölfling, 2009; Chan & Rabinowitz, 2006; Han, Lee, Na, Ahn, Chung, Daniels, Haws, & Renshaw, 2009; Peng & Liu, 2010). With regards to methodology, the participant groups investigated in the studies were relatively diverse. One study included the case of an adolescent gamer (Allison, et al., 2006), and quantitative studies included high school students (Chan & Rabinowitz, 2006), college students (Batthyány, Müller, Benker, & Wölfling, 2009), online gamers (Peng & Liu, 2010), as well as children diagnosed with ADHD (Han, Lee, Na, Ahn, Chung, Daniels, Haws, & Renshaw, 2009).

Internet gaming addiction was found to be associated with symptoms of generalized anxiety disorder, panic disorder, depression, social phobia (Allison, et al., 2006), school phobia (Batthyány, et al., 2009), ADHD (Allison, et al., 2006; Batthyány, et al., 2009; Chan & Rabinowitz, 2006; Han, et al., 2009), as well as psychosomatic symptoms (Batthyány, et al., 2009). These results reflect some of the

findings of the section concerned with personality traits in that some of the latter may demarcate premorbid levels of diagnosed pathology.

Pathology/addiction

Several studies have assessed pathological characteristics of addiction to Internet gaming. This section is subdivided into three sub-categories, namely the classification and assessment, epidemiology and phenomenology of Internet gaming addiction.

Classification/assessment

A total of seven studies focusing on the classification and assessment of Internet gaming addiction were identified (Charlton & Danforth, 2007; Griffiths, 2010; Kim & Kim, 2010; King, et al., 2010; Salguero & Moran, 2002; Skoric, Teo, & Neo, 2009; van Rooij, Schoenmakers, van de Eijnden, & van de Mheen, 2010). In terms of methodology, two case studies of male online gamers were included (Griffiths, 2010), large samples of adult MMORPG players (Charlton & Danforth, 2007), elementary school video gamers (Skoric, et al., 2009), student and non-student video game players (King, Delfabbro, & Zajac, 2009), teenagers (Salguero & Moran, 2002), elementary and high school students (Kim & Kim, 2010), and secondary school adolescents (van Rooij, et al., 2010).

In each of the studies, different terminologies were applied for similar phenomena, ranging from compulsive Internet use (van Rooij, et al., 2010), problem video game playing (King, et al., 2009; Salguero & Moran, 2002) and problematic online game use (Kim & Kim, 2010) to video game addiction (Skoric, et al., 2009) and online gaming addiction (Charlton & Danforth, 2007; Griffiths, 2010). Similarly, a variety of measurement instruments was used in order to assess the specified

problematic/addictive behaviors, namely the Compulsive Internet Use Scale (Meerkerk, Van Den Eijnden, Vermulst, & Garretsen, 2009), the Problematic Video Game Playing Test (adapted from Young, 1998), the Problem Video Game Playing Scale (Salguero & Moran, 2002), the Problematic Online Game Use Scale (Kim & Kim, 2010), an assessment of addiction tendencies (based on American Psychiatric Association, 2000), the Addiction-Engagement Questionnaire (modified from Charlton, 2002), and the Game Addiction Scale (based on Lemmens, Valkenburg, & Peter, 2009).

The results of the studies indicate that Internet gaming addiction appears to be a viable construct worthy of individual and independent investigation (van Rooij, et al., 2010). It must be noted that the researchers working on this study used the terms addiction and compulsive use interchangeably, so that it seems appropriate to refer to addictions in this case. Furthermore, it was emphasized that addiction cannot be equated with problematic use. Some of the studies suggest that problematic game playing lies on a continuum towards addiction, as it can result in addiction symptoms, namely salience, mood modification, tolerance, withdrawal, conflict, and relapse (Griffiths, 2010b; King, et al., 2009; Salguero & Moran, 2002). Others adopt more detailed approaches to classification, claiming that problematic use is characterized by investing much time and energy in the game, euphoria, tolerance, denial, and a preference for online relationships (Kim & Kim, 2010). This finding is in line with the result that addiction core criteria (conflict, withdrawal symptoms, relapse, reinstatement, and behavioral salience) must be distinguished from peripheral criteria (cognitive salience, tolerance, and euphoria), for only the former were found to load on an addiction factor (Charlton & Danforth, 2007). In a similar vein, it was found that addiction does not equal excessive engagement: Only when significant negative

consequences of excessive gaming occur can one speak of an addiction (Griffiths, 2010; Skoric, et al., 2009). A more detailed evaluation of this finding will take place in the discussion.

Epidemiology

From the literature, ten studies were identified assessing the prevalence of Internet gaming addiction (Batthyány, et al., 2009; Grüsser, et al., 2005; Grüsser, Thalemann, & Griffiths, 2007a; Jeong & Kim, 2010; Ng & Wiemer-Hastings, 2005; Porter, et al., 2010; Rehbein, Psych, Kleimann, Mediasci, & Mossle, 2010; Thomas & Martin, 2010; Yee, 2006a, 2006b). The following samples were included: 1,231 students in grades 3 to 5 (Batthyány, et al., 2009), 323 children with a mean age of twelve years (Grüsser, et al., 2005), 44,910 9th graders (Rehbein, et al., 2010), 600 middle and high school students (Jeong & Kim, 2010), 2,031 secondary, college and university students (Thomas & Martin, 2010), 7,069 gamers with a mean age of 21 years (Grüsser, et al., 2007a), 91 MMORPG and offline game players (Ng & Wiemer-Hastings, 2005), 1,945 video gamers predominantly below thirty years (Porter, et al., 2010), and 30,000 MMORPG players (Yee, 2006a, 2006b). The prevalence of Internet gaming addiction was assessed with the measures referred to in the sections on motivations for playing and classification/assessment.

The results of the studies indicate that approximately 12% of students in third to fifth grades played computer games excessively (i.e., were classified as abusers and/or addicts), 10% abused these games (i.e., they scored between 7 and 13 on the Fragebogen zum Computerspielverhalten bei Kindern und Jugendlichen [CSVK-R]), and 3% could be categorized as being dependent upon engaging with them (i.e., they scored 13 and above on the CSVK-R) (Batthyány, et al., 2009). Furthermore, 9% of

12-year old children fulfilled the criteria for excessive computer and video game playing (Grüsser, et al., 2005). Three percent of male and 0.3% of female ninth graders could be diagnosed as being dependent on video games, while 5% of boys and 0.5% of girls were at risk for developing dependence (Rehbein, et al., 2010). Four percent of students met the criteria for addiction to video arcade games, and 5% for computer games and the Internet respectively (Thomas & Martin, 2010). Finally, 2.2% of middle and high school students were found to be addicted to Internet games (Jeong & Kim, 2010).

The studies including gamers specifically reveal higher prevalence rates. Problematic gaming behaviors were present in 8% of video gamers (Porter, et al., 2010). Other researchers claimed that 12% of online gamers met at least three criteria for addiction (Grüsser, et al., 2007a). In addition to this, the findings suggest that 12% of MMORPG players preferred to talk to people in game rather than in real life and were happier in game than anywhere else (Ng & Wiemer-Hastings, 2005). Furthermore, 8% of MMORPG players spent a minimum of 40 hours in game per week, 61% spent a minimum of ten hours in game continuously, 30% stayed in game although they did not enjoy it, 18% experienced academic, health, financial or relationship problems, and 50% considered themselves to be addicted (Yee, 2006a, 2006b). Nevertheless, although a number of studies have assessed the prevalence of Internet gaming addiction, they used dissimilar assessment instruments as well as cut-offs and included diverse participant groups. This may explain the large variability in prevalence percentages. Therefore, the quoted results do not allow for making definite overall claims with regards to epidemiology at this point in time.

Phenomenology

Ten studies have investigated the experience of Internet gaming addiction from a phenomenological perspective (Allison, et al., 2006; Chappell, Eatough, Davies, & Griffiths, 2006; Charlton & Danforth, 2007; Chou & Ting, 2003; Hussain & Griffiths, 2009a; Rau, Peng, & Yang, 2006; Seah & Cairns, 2007; Wan & Chiou, 2006a, 2006b; Wood & Griffiths, 2007). The methodologies used were qualitative, including a case study of an adolescent excessive MMORPG player (Allison, et al., 2006), ten adolescent online game addicts (Wan & Chiou, 2006b), and 12 *Everquest* players (Chappell, Eatough, Davies, & Griffiths, 2006), and quantitative, including 442 adult MMORPG players (Charlton & Danforth, 2007), adults (Chou & Ting, 2003; Hussain & Griffiths, 2009a), adult and teenage online gamers (Rau, Peng, & Yang, 2006), students (Seah & Cairns, 2007; Wood & Griffiths, 2007), and 16-24-year old adolescents and MMORPG players (Wan & Chiou, 2006a).

The experiences of different aspects of Internet gaming addiction were assessed using different methodologies, such as psychiatric interviews (Allison, et al., 2006), in-depth interviews assessed with interpretative phenomenological frameworks (Chappell, et al., 2006), and content analysis (Wan & Chiou, 2006b). In addition to this, several studies have assessed flow experience (Chou & Ting, 2003; Wan & Chiou, 2006a), immersion (Seah & Cairns, 2007) and associated time loss (Rau, et al., 2006; Wood & Griffiths, 2007) during game-play quantitatively, as based on Csikszentmihalyi's (1990) conceptualization of flow (i.e., the optimum experience a person achieves when performing an activity). Finally, the Addiction-Engagement Questionnaire (modified from Charlton, 2002) has also been used.

The results suggest that Internet gaming addiction is associated with large amounts of time, i.e., up to 16 hours per day, spent in game, lack of sleep and a shortage of social and romantic contacts (Allison, et al., 2006). Moreover, it is

experienced similarly to any other substance-related addiction (Hussain & Griffiths, 2009a), in such a way that salience, mood modification, conflict, withdrawal symptoms, cravings and relapse occurred (Chappell, et al., 2006; Charlton & Danforth, 2007). Additionally, online game addicts perceived gaming as providing compensation for needs which were not met in their real lives, and that it has become the focus of their lives (Wan & Chiou, 2006b).

In terms of flow and associated experiences, the studies found that the experience of flow and in-game immersion was associated with addiction (Chou & Ting, 2003; Seah & Cairns, 2007). Another study found that it was game novices who experienced more flow when playing for about one hour, whereas for expert players it took longer to experience flow (Rau, et al., 2006). In line with this and contrary to the results of the above mentioned studies, it was also found that flow negatively correlated with addictive inclination (Wan & Chiou, 2006a). Furthermore, it has also been found that the experience of time loss does not necessarily precipitate addiction (Wood & Griffiths, 2007). These findings will be evaluated in the discussion.

Ramifications

Several studies have assessed the ramifications of Internet gaming addiction. These can be summarized primarily as negative consequences that may require professional treatment. These topics are dealt with below.

Negative consequences

Nineteen studies have highlighted the negative consequences of Internet gaming addiction beyond the comorbidities outlined earlier (Allison, et al., 2006; Batthyány, et al., 2009; Chan & Rabinowitz, 2006; Chiu, et al., 2004; Chuang, 2006; Dworak, et

al., 2007; Griffiths, Davies, & Chappell, 2004; Grüsser, et al., 2007a; Hussain & Griffiths, 2009a, 2009b; Jeong & Kim, 2010; King & Delfabbro, 2009b; Lemmens, et al., 2010; Liu & Peng, 2009; Peters & Malesky, 2008; Rehbein, et al., 2010; Skoric, et al., 2009; Yee, 2006a, 2006b). These have been investigated in children (Batthyány, et al., 2009; Skoric, et al., 2009), teenagers (Allison, et al., 2006; Chan & Rabinowitz, 2006; Chiu, et al., 2004; Dworak, et al., 2007; Jeong & Kim, 2010; Lemmens, et al., 2010; Rehbein, et al., 2010), teenagers and adults (King & Delfabbro, 2009b), MMORPG players (Griffiths, et al., 2004; Grüsser, et al., 2007a; Hussain & Griffiths, 2009a, 2009b; Liu & Peng, 2009; Peng & Liu, 2010; Peters & Malesky, 2008; Yee, 2006a, 2006b), and epilepsy patients (Chuang, 2006).

The negative consequences were assessed via a variety of psychological tests and psychiatric interviews, academic achievement, EEG, MRI, polysomnographic measurements, visual and verbal memory tests, asking what was sacrificed for gaming, the psychosocial context of gaming behavior, social competence, preference for a virtual life, relationship formation, the Internet Addiction Scale modified for video games (Widyanto & McMurran, 2004), Conners' Parent Rating Scale (Conners, Sitarenios, Parker, & Epstein, 1998), Questionnaire on Computer Game Behavior of Children (Thalemann, et al., 2004), the Questionnaire for Differentiated Assessment of Addiction (Grüsser, Wölfling, Düffert, & et al., 2007b), the Exercise Addiction Inventory (adapted from Terry et al., 2004), the Game Addiction Scale (Lemmens, et al., 2009), the UCLA Loneliness Scale (Russell, 1996), the Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985), the Self-Esteem Scale (Rosenberg, Schooler, & Schoenbach, 1989), the Negative Life Consequences Scale (Liu, Ko, & Wu, 2008), the Generalized Problematic Internet Use Scale (Caplan, 2002), the social control subscale of the Social Skill Inventory (Riggio, 1989), the CES Depression

Scale (Mirowsky & Ross, 1992), and the Videogame Dependency Scale (adapted from Rehbein & Borchers, 2009).

The results of these studies show that Internet gaming addiction can lead to a wide variety of negative consequences. These include psychosocial problems, namely an obsession with gaming, no real life relationships (Allison, et al., 2006), inattention (Batthyány, et al., 2009; Chan & Rabinowitz, 2006), aggressive/oppositional behavior and hostility (Chan & Rabinowitz, 2006; Chiu, et al., 2004), stress (Batthyány, et al., 2009), maladaptive coping (Batthyány, et al., 2009; Hussain & Griffiths, 2009a, 2009b), decreased academic achievement (Chiu, et al., 2004; Jeong & Kim, 2010; Rehbein, et al., 2010; Skoric, et al., 2009), declines in verbal memory performance (Dworak, et al., 2007), sacrificing hobbies, sleep, work, education, socializing, time with partner/family as well as associated problems (Batthyány, et al., 2009; Griffiths, et al., 2004; King & Delfabbro, 2009b; Liu & Peng, 2009; Peng & Liu, 2010; Peters & Malesky, 2008; Rehbein, et al., 2010; Yee, 2006a, 2006b), dissociation (Hussain & Griffiths, 2009a), lower psychosocial well-being and loneliness (Lemmens, et al., 2010), maladaptive cognitions (Peng & Liu, 2010), and increased thoughts of committing suicide (Rehbein, et al., 2010). Moreover, psychosomatic problems were found to be consequences of Internet gaming addiction. These included psychosomatic challenges (Batthyány, et al., 2009), seizures (Chuang, 2006), and sleep abnormalities (Allison, et al., 2006; Dworak, et al., 2007). Altogether, the relatively long list of potential negative consequences clearly indicates that Internet gaming addiction is a phenomenon that cannot be taken lightly and deserves more extensive recognition.

Treatment

Three studies have particularly assessed the treatment of Internet gaming addiction (Beranuy, et al., 2010; Han, et al., 2010; Han, et al., 2009). These studies included a qualitative analysis of nine male MMORPG addicts aged 16-26 years (Beranuy, et al., 2010), a comparative study of video game addicts and healthy controls between 17 and 29 years of age (Han, et al., 2010), and a sample of 62 children with Internet video game addiction and comorbid ADHD (Han, et al., 2009).

With regards to methodology, one investigation (Beranuy, et al., 2010) was a descriptive analytic-relational study using semi-structured interview protocols including questions on sociodemographics, family, reasons for therapy, relationships, game usage, and symptom exploration. Its aim was to explore addictive playing of MMORPGs in players undergoing treatment for their gaming addiction. Another study (Han, et al., 2010) was experimental, using fMRI for assessing brain activation during game cue exposure in addicts compared to healthy controls, as well as psychometric measurements, including the Internet Addiction Test (Young, 1998), Beck's Depression Inventory (Beck & Steer, 1993), and the structured clinical diagnostic interview (First, Gibbon, Spitzer, & Williams, 1996; First, Gibbon, Spitzer, Williams, & Benjamin, 1997). Its aim was to investigate the effects of bupropin sustained release treatment on Internet video game addicts. The final study (Han, et al., 2009) used a computerized neurocognitive function test (Kim, Shin, Kim, Yang, Shin, & Yoon, 2006), the Internet Addiction Test (Young, 1998), and the ADHD Rating Scale (So, Noh, Kim, Ko, & Koh, 2002) to assess the effects of methylphenidate on Internet video game play in children with ADHD.

The results demonstrated that Internet gaming addiction develops as playing times increase significantly, as loss of control, a narrow behavioral focus and serious life conflicts appear. Moreover, the addiction symptoms were similar to those

experienced by persons addicted to substances, including salience, mood modification, loss of control, craving, and serious adverse effects, and a variety of further psychosocial problems (Beranuy, et al., 2010). Furthermore, following a six-week period of psychopharmacological treatment, craving for Internet video game play as well as brain activities associated with addictions in Internet video game addicts were significantly decreased, while daily life functioning was increased (Han, et al., 2010). Finally, an eight-week psychopharmacological treatment targeting ADHD symptoms resulted in a decrease in Internet gaming addiction and playing times (Han, et al., 2009). The efficacy of psychopharmacological treatment for treating Internet gaming addiction once again highlights the biochemical underpinnings of this disorder. This demonstrates not only that Internet gaming addiction is a potential mental health concern worthy of treatment, but also that this treatment may alleviate a wide variety of psychosocial problems as a result of the addiction to playing these games.

Discussion

This systematic review has demonstrated that research into Internet gaming addiction has proliferated over the last few years. From the published studies, it appears that the current scientific knowledge of Internet gaming addiction can be categorized into etiology, pathology, and associated ramifications. In terms of etiology, it would appear that personality traits, motivations for playing, and the structural characteristics of the games are of particular importance. Furthermore, pathophysiology and comorbidity appear to be intersections between risk factors and the actual development of pathological behaviors and cognitions. The analysis of pathology itself can be furthermore subclassified into its assessment and addiction

classification, as well as epidemiology and phenomenology. Finally, the ramifications of Internet gaming addiction were found to be negative consequences, which allow for the behavior to be classified as pathological as based on established clinical standards (American Psychiatric Association, 2000). In line with this, Internet gaming addiction may require professional treatment.

On a neuronal and biochemical level, Internet gaming addiction appears to be similar to other substance-related addictions, thus supporting the assumption that it is an addiction, albeit a behavioral one, like gambling addiction (Batthyány & Pritz, 2009; Grüsser & Thalemann, 2006). Firstly, the studies presented suggest that Internet gaming addicts' brains react to game-relevant cues the way that substance addicts' brains react to rewards associated with substance-related addictions (Kalivas & Volkow, 2005; Knutson & Cooper, 2005). Secondly, the efficacy of psychopharmacological interventions that may alleviate Internet gaming addiction symptoms, support its biochemical, cognitive, and behavioral basis. Thirdly, the genetic polymorphisms found in Internet gaming addicts are similar to those associated with reward dependence in alcohol (Blum, Noble, Sheridan, & et al., 1990), cocaine addictions (Noble, Blum, Khalsa, & et al., 1993), and pathological gambling (Comings, Rosenthal, Lesieur, & et al., 1996). To summarize, Internet gaming addiction is a behavioral addiction that appears to be similar to substance-related addictions and thus it supports the idea of a syndrome model of addiction. Put simply, Shaffer, LaPlante, LaBrie, Kidman, Donato and Stanton (2004) suggest that each addiction – whether it be to gambling, drugs, sex, or the Internet – might be a distinctive expression of the same underlying syndrome (i.e., addiction is a syndrome with multiple opportunistic expressions). These findings emphasize the pathological

status of Internet gaming addiction and demarcate the latter as a mental health concern that is increasingly gaining recognition.

Another aspect that deserves closer scrutiny is the dissimilarity of findings with regards to whether (and in how far) flow experience is associated with addiction to Internet games. Studies are ambiguous in suggesting that flow correlates with addiction, as some seem to suggest a relationship (Chou & Ting, 2003; Seah & Cairns, 2007), whereas other findings imply the opposite (Wan & Chiou, 2006b; Wood & Griffiths, 2007). From a theoretical perspective, flow is characterized as an optimal experience (Csikszentmihalyi, 1990). No one would disagree with the fact that addiction is anything but optimal. Therefore, being addicted to the flow state experienced during Internet gaming may carry with it the problems that addiction implies. The dissimilarity between the findings may be explained by different conceptualizations of addiction employed in such a way that excessive engagement is equated with pathology. However, it has been shown that a distinction between excess and addiction makes sense from a scientific point of view (Charlton & Danforth, 2007; Griffiths, 2010).

Against this background, it seems likely that excessive players experience flow because their game playing is principally characterized by excitement and challenge (Wan & Chiou, 2006b), which lies at the heart of flow experience. Flow occurs when a person is absorbed by a task in which the task's level of challenge and the individual's skill are matched (Csikszentmihalyi, 1990). Contrary to this, it seems unlikely that addicted players experience flow, for they tend to continue playing although they do not enjoy it (Yee, 2006a, 2006b), which attests to the compulsiveness of their behaviors. Therefore, it appears probable that addicts have already left the flow experience behind. This provides additional support to the idea

that some players who engage in Internet gaming excessively can develop a full-blown addiction to it.

In relation to this, another important finding from the studies is the distinction that has been made between excessive engagement and addiction (Charlton & Danforth, 2007; Griffiths, 2010; Skoric, et al., 2009). Excessive (problematic) engagement was found in approximately 8-12% of young persons, whereas addiction seems to be present in 2-5% of children, teenagers and students. Furthermore, one study found that 12% of online game players met at least three addiction criteria (Grusser et al, 2007). This is in line with adopting either monothetic or polythetic formats for addiction diagnosis, as set forth by Lemmens (2009). In the former, all addiction criteria must be met in order to diagnose someone with gaming addiction, whereas in the latter, only half of them need to be endorsed. What follows as a consequence of the utilization of these dissimilar frameworks is the apparent discrepancy between prevalence estimates.

From the studies reviewed, it furthermore appears that MMORPG players particularly experienced symptoms associated with addiction, such as tolerance, mood modification, and negative psychosocial consequences, and half of them acknowledged that they were addicted to playing these games. In comparison to the general population of youth and young adults, it may be deduced that the prevalence of Internet gaming addiction is relatively high in the collective population of the MMORPG players that were included in the studies referenced. It has also been claimed that "MMOGs are particularly good at simultaneously tapping into what is typically formulated as game/not game, social/instrumental, real/virtual. And this mix is *exactly* what is evocative and hooks many people" (Taylor, 2006, pp. 153-154). This emphasizes the importance of the particular game genre's structural

characteristics in the etiology of Internet gaming addiction, which may necessitate further scientific exploration.

Although this systematic literature review is specific in that it does not present Internet gaming addiction as a type of Internet addiction, it must be conceded that in the studies that were included, dissimilar foci were adopted with regards to the respective game genres analyzed. As mentioned in the introduction, a variety of games are accessible and playable via the Internet, each of which may entail dissimilar addictive potentials. For a number of studies, particularly those dealing with video games, it is unclear to what extent these games were specifically played on the Internet or offline. Furthermore, there are multiple forms of Internet gaming ranging from multi-player to single games, and complex to simple skills-based. In this review, no attempt was made to compare findings across similar types of gaming (often because the authors of the studies themselves had not made these distinctions), raising the question of the validity of combining studies reporting MMORPG, video games and other non-specified game genres. In light of this, researchers are advised to carefully describe the games their participants are playing in order to circumvent this difficulty and to increase the external validity of their findings to specific populations.

It should also be noted that there are different cultural and social factors associated with the environment that participants were recruited from in various studies that are outlined in this review. This could be highly relevant given that many studies on Internet gaming have been conducted in South East Asian countries where the social infrastructure fosters the promotion of professional competitions located in large venues that include social interactions among players, or where strong ego and image identities are derived from public recognition of gaming skills.

With regards to psychopathological status, it seems fruitful to distinguish between excessive engagement and addiction as suggested by past research (Charlton & Danforth, 2007). This is a requirement particularly when taking into consideration the context of the American Psychiatric Association's definition of what constitutes a mental disorder worthy of professional treatment. According to the APA, a mental disorder is a "clinically significant behavioral or psychological syndrome or pattern that occurs in an individual and that is associated with present distress (...) or disability (i.e., impairment in one or more important areas of functioning) or with a significantly increased risk of suffering death, pain, disability, or an important loss of freedom" (American Psychiatric Association, 2000, p. xxxi). Accordingly, only when the condition is experienced as significantly impairing can one speak of an addiction, which is clearly not the case for excessive gamers who enjoy themselves while playing their games and for whom their gaming does not result in significant negative consequences. In line with this, researchers must be cautious in deploying the label "addiction" for it does not merely denote the extreme utilization of substances or engagement in certain behaviors, but it demarcates a genuine mental health problem.

For that reason, future researchers are advised to properly investigate what they claim to be an addiction in order to make sure that their identification of pathology is commensurate with clinical parlance even within the confinements of research using surveys for diagnosis only. Related to this is the utilization of a wide variety of assessment instruments to diagnose addiction, most of which have not been validated. Likewise, many studies used non-representative self-selected samples and small sample sizes. This obstructs the comparability of results, but it also puts into question the validity of diagnosis. Clearly, future researchers are advised not to develop additional measurement instruments, but to assess the validity and reliability of those

already constructed against the official criteria of substance dependence as established

by the American Psychiatric Association (2000).

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