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Gaming: from Addiction Mechanisms to Clinical Practices

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Clinical Medicine Section
Department of Mental Health
and Psychiatry
Addictology

GAMING: FROM ADDICTION MECHANISMS TO CLINICAL PRACTICES

Thesis submitted to the Faculty of Medicine of
the University of Geneva

for the degree of Privat-Doctent

by

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1. **Thorens G.**, Wullschleger A., Khan R., Achab S., Zullino D. *What is Addictive in Internet?* The Open Addiction Journal. 2012; 5(1), 14-19.
2. Billieux, J., Van der Linden M., Achab S., Khazaal Y., Paraskevopoulos L., Zullino D., **Thorens G.** *Why do you play World of Warcraft? An in-depth exploration of self-reported motivations to play online and in-game behaviours in the virtual world of Azeroth.* Computers in Human Behavior. 2013; 29, 103-109.
3. **Thorens G.**, Khan R., Khazaal Y., Zullino D. *World of Warcraft and alcohol: a secret love story?* Education, prevention and policy. 2012; 19(1), 27-31.
4. **Thorens G.**, Khazaal Y., Billieux J., Van der Linden M., Zullino D. *Swiss Psychiatrists' Beliefs and Attitudes About Internet Addiction.* Psychiatry Quarterly. 2009; 80(2), 117-123.
5. **Thorens G.**, Achab S., Billieux J., Khazaal Y., Khan R., Pivin E., Gupta V., Zullino D. *Characteristics and treatment response of self-identified problematic Internet users in a behavioral addiction outpatient clinic.* Journal of Behavioral Addiction. 2014; 3(1), 78-81.

Introduction

Contextualization: new media, old fears

“It was the telegraph that, more than any other technology, first marked a separation between transportation and communication”¹

When speaking about problematic use of the Internet or Internet addiction, a glimpse into the history of media is a safeguard for not reinventing the wheel. In media history, there was a time when old media were new. For some authors, the invention and rapid spread of the telegraph marks the first separation between transportation and communication, leading to the creation of so-called cyberspace. Cyberspace can be defined as the reduction in time needed for a communication from one person to another so that it becomes negligible compared with the distance separating these individuals. This principle nowadays remains the same, but it is associated with tremendous technological progress (instant high-definition live video communication on your mobile phone from anywhere in the world).

Wartella [1] described three steps in how the public and scholars perceive the arrival of new media:

First step: Legacy of previous studies. The arrival of new media is compared with what already exists: for the Web, this means comparing the Internet to television.

Second step: Finding specific effects of new media on exposed persons. In this second phase, scholars tend to demonstrate that these new media have their own characteristics and have a specific impact on the population.

Third step: Fear related to new media until they become familiar. Fear of new technologies has been observed throughout history, and cheap glamorous novels in the early 20th century portrayed this fear as being a great concern about the ability of new media to corrupt youth. Radio, photography, and later, television were predicted to annihilate the classic arts. Nowadays these fears remain vivid, but take other, more suitable, cultural forms.²

Therefore, it is important to understand how and why people apprehend new technologies. Previous media such as television was more of a social issue than a medical or psychiatric condition. Why do scholars now consider Internet use to possibly lead to psychiatric or medical disorders? One explanation might be the great advancements in neuroscience and the understanding of the brain

¹ Technology and Ideology: The Case of the Telegraph By James W. Carey. Prospects / Volume 8 / October 1983, pp 303-325 Cambridge University Press 1983

² http://www.huffingtonpost.com/2013/05/22/people-getting-dumber-human-intelligence-victoria-era_n_3293846.html

mechanism for rewards (wanting, liking, etc.), as well as the overall interest in mechanisms of addiction that are now understood as a malfunction of reward mechanisms, or as a disconnection between rational intentions and behaviors. Another explanation is that it might reflect the tendency of our society to be more concerned by issues related to health (pollution, transport safety, food, etc.).

With these concepts in mind, the following are the objectives of this work. After a brief definition of addiction, the focus will be on the specific addictive properties of Internet and games. Massively multiplayer online role-playing games (MMORPGs) will be described, as they tend to be the most addictive type of game, with a specific focus on World of Warcraft (WoW). Issues of diagnostic criteria for Internet addiction and Internet gaming disorder (IGD) will also be presented.

Definition of addiction

Substance use and abuse definitions are evolving along with social and scientific knowledge. For example, the perception of alcohol-related problems changed from a moral, medical, psychiatric model to a neuropsychiatric model. All explanations still coexist, depending on cultural or personal beliefs.

The definition of addiction shifted from a product-centered issue to a behavioral one. The definition of dependence in the *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed.; *DSM-III*) considered tolerance and withdrawal to be the core of the diagnosis. Addiction can nowadays also be considered as a behavioral problem: gambling disorder is a non-substance-related disorder, as classified in the addiction chapter of the *DSM-5*.

The shift from a substance-oriented definition to a behavioral definition is related to the understanding of the reward/fear brain mechanism (ventral tegmental area [VTA], nucleus accumbens [NAc]) as a common pathway for all potential addictive products and behaviors [2, 3].

Nowadays, there is a consensus that the rewarding effects of drugs are linked to their ability to increase dopamine, particularly in the NAc. Recent studies have also shown the role of other neurotransmitters (i.e. glutamate, GABA, serotonin, cannabinoids, opioids) in the neuroadaptations associated with addiction and reward processing. The implication of these other neurotransmitters and their better understanding will be a key to dissociate for example hedonic pleasure and reward [4]. The neurobiological differences between behavioral addiction and substance addiction are based on indirect finding, such as differences in cortical activation in gamblers and cocaine users when exposed to salient cues in a craving state[5].

Another issue is the differences between behavioral addictions where the neurotransmitters implicated in the rewards system are endogenously released as a so called “natural reward systems” opposed to substances such as cocaine triggering “unnatural dopamine release”. Opposite to drug addiction models, reliable animal models for behavioral addictions are difficult to develop. The neurobiological differences between behavioral addiction and substance addiction are based on indirect finding such as differences in cortical activation in gamblers and cocaine users[6].

Besides the neuroscientific explanation, it is important to consider the social vision of behavioral addictions and the potential pitfall of such definitions. A key question when considering human behaviors as part of abnormal behaviors (diseases) is their global impact on health. If cigarette smoking is nowadays unanimously considered a harmful behavior (at least in the medical and scientific community), Internet use is yet another challenge.

The concept of behavioral addiction should be carefully applied, as a fundamental question arises: what are the differences between passion, addiction, or basic needs when speaking about normal or fundamental human behaviors such as sex, eating, working, or exercising? A pitfall of definitions of behavioral addiction could be the risk of transforming every possible behavior into an addiction; researchers in the field are aware of this potential risk [7]. The rapid growth in the scientific literature on Internet addiction reflects these questions.

It is extremely important to avoid repeating what has been done with substance addiction policies. They were implemented before scientific knowledge was available on the real impact of substances and have been extremely difficult to modify afterwards. The goal of the present compilation of articles is to develop the notion of behavioral addictions with a focus on gaming addiction.

What is addictive on the Internet?

Vectors and products

To understand what is addictive on Internet, a comparison with tobacco is useful. The addictive product is nicotine. Cigarettes, pipes, and chewing tobacco are the vectors of nicotine. A cigarette without nicotine is not addictive. The vectors serve to deliver the drugs in different manners and at different speeds (pharmacokinetics). Absorption of nicotine from smoking is more effective than it is from chewing, and tobacco can have different concentrations of nicotine. Cigarette additives also change nicotine absorption, for example, by changing the acidity to enhance absorption.

In reference to the Internet, different vectors can also be identified: hardware (pipes, cigarettes) and software (tobacco). Hardware (computers, cellphones, gaming consoles, etc.) are the electronic devices that “read” the software (games, social network, browsers, etc.). What has to be determined in Internet addiction is the “nicotine” in the software that can potentially produce addiction.

A comparison with gambling in terms of reward is also useful. As described by Griffiths [8], the addictive properties of a slot machine depend on several factors, such as redistribution rates. These redistribution rates need to be as close as possible to the best conditioning scheme available. As described by Skinner [9], several conditioning schemes exist. One of the most rewarding is the variable ratio schedule in which a reward is randomly attributed to an action. According to the pioneer work of Schultz [10] on dopamine reward neurons in monkeys, the anticipation of the reward (the percentage chance of obtaining the reward) can be as important or more important than the reward itself.

All games (online or offline) use these reward schedules. In gambling, the outcome of the reward is determined only by chance, whereas in video games, the player's skills usually influence the reward rate. An illustration of these mechanisms can be found in MMORPGs, in which the main goals are to gain experience points, levels, and weapons. These rewards are distributed in variable schedule conditioning schemes. For example, killing a monster gives a player a fixed percentage chance of receiving a common reward (high percentage) or a special reward (low percentage). This is the identical principle to that for slot machine jackpots.

In MMORPGs, skill factors (the player's dexterity to press specific triggers in an adequate amount of time) are combined with random rewards. Poker might be a good comparison, in which players have limited control (knowing the odds, bluffing, etc.) and a random chance of drafting good cards.

Going back to our analogy with tobacco, the "nicotine" of the Internet is not one substance, but a combination of multiple strong incentives delivered in different ways, depending on the software vector (games, social media, etc.).

When introducing the concept of Internet addiction, a central question is what people are doing in front of their screen. Imagine an unemployed middle-aged man living alone. He mostly plays games on his computer, his favorite game being WoW, but he also owns a PlayStation 4 for exclusive content such as Gran Turismo (a race-simulation game). When he is in front of his computer, he regularly checks his Facebook account for new messages while having an open window on YouPorn. When he opens his computer or PlayStation 4, he uses the loading time to play Sugar Crush on his iPhone. His open webpage on Firefox is Wikipedia, and he sometimes reads articles on astrophysics while having a Skype conversation with his mother. This might seem like a caricature, but the reality of Internet usage is that people multitask. This example illustrates that reducing Internet addiction to a single addictive behavior is reductive.

The question of vectors is important to differentiate types of Internet addiction. In his article, Davis [11] described *specific pathological Internet use*, in which the Internet is used as a means of expressing and heightening the intensity of a preexisting pathological condition (such as pathological gambling or sex addiction), and *generalized pathological Internet use* (GPIU), which is a primary addiction. The new technologies can be considered as vectors to facilitate access to existing addictive products through the AAA concept (the Internet is **a**vailable, **a**ffordable, and **a**nonymous). Online gambling and online sex addiction are good illustrations of this concept. The Internet is a vector to enhance the availability of preexisting disorders.

In GPIU, there is no direct existing addictive behavior that is enhanced by easy access. It is a de novo combination of multiple factors that leads to an addictive behavior. As described earlier, the multitasking user is exposed to large numbers of salient rewards as incentives while using online content. In this heterogeneous content, similarities in terms of addictive rewards can be found.

As described earlier, every drug that has addictive properties has direct or indirect pharmacological effects on the reinforcement center: the NAc and the VTA. Addiction is roughly compared with the

hijacking of normal learning and reinforcing processes primarily meant to enhance the survival and fitness of the species. Salient stimuli are fundamental stimuli for survival (food seeking, reproduction, novelty seeking, danger avoidance, etc.). In animal studies, the intensity of the reward (generally food rewards) and the behavior produced have been extensively described as the ability of different addictive products (i.e., cocaine) to trigger the same behaviors as those produced by food rewards (consuming and seeking drugs) [12].

As trivial as it is, the major difference between animals and humans is the intelligence, and therefore the capacity, in humans to have abstract thought. Therefore, salient stimuli are not only basic stimuli such as food or sex, but can also be highly symbolic rewards such as money in research studies) [13] or social rewards (being accepted as a privat-docent) [14]. This explains why a two-dimensional pixelated screen might have strong addictive powers.

In conclusion, “the nicotine” that is the addictive product of the Internet is a mixture of reinforcing schedules and salient stimuli. All software that combines these two components might have the properties to trigger an addictive behavior in vulnerable individuals. As described earlier, the most successful software, MMORPGs (i.e., WoW), and social media (i.e., Facebook) contain the most addictive properties.

What is addictive in gaming?

If playing video games was considered a niche phenomenon 40 years ago, nowadays it is a mainstream leisure activity in every industrialized country. It is a well-known fact that the gaming industry has outreached the movie industry. One game blockbuster, Grand Theft Auto V, generated one billion USD in revenue 3 days after its commercial launch.³ In a 2015 US survey, it was found that 42% of the population plays video games regularly, or at least 3 hours per week. The average gamer is 35 years old, 74% are age 18 or older, and 44% are female.⁴

Compared with the movie or TV industry, in which only the audience can be measured as an indicator of success, the success and improvement of games is directly influenced by the players. WoW has 10 million active players constantly testing the game’s attractiveness. This is an efficient selection process of the most successful part of the game (the most addictive?). This process might be compared with selection by multiple trials of the best conditioning reward ratio schedules. And as soon as a game declines, hundreds of new games are ready to replace it. The never-ending 24-hour-a-day availability of these games—as well as the constant self-selection of the most rewarding processes by the players themselves— is powerful.

³ https://en.wikipedia.org/wiki/Grand_Theft_Auto_V

⁴ <http://www.theesa.com/about-esa/industry-facts/>

As in the gambling industry, the reward mechanism is surrounded and blurred by visuals and auditory stimuli, making the process more appealing for gamers. It is of course reductive to compare every video game to a slot machine with reward schedules. The unique goal of a slot machine is to hook customers onto an endless “money vacuum system” by luring them into the illusion of control and false winning [15], whereas video games have multiple purposes, and the social rewards, such as game power, glory, or simple gratitude, are the motives for playing. These concepts are detailed in the article included in this work: “What is addictive on the Internet?”

The addictive properties of games could be used for positive purposes. So-called serious games (reeducation, diabetes control games) use the addictive properties of video games to enhance participants’ motivation for good causes (to improve the time or energy spent in reeducation through a video game coupled to an exercise device).

WoW as a model of gaming addiction

It is important to describe MMORPGs and Wow in more detail.

Game history and game theory are relevant for understanding the roots of MMORPGs. War games were described as early as the 18th century. They are simulations of real battle conditions with war figurines (soldiers, tanks, etc.) and complex rules based on probabilities. These board games were popular in the 1960s and 1970s. Role-playing games (RPGs) are based on war games. One of the first and most popular RPGs was Dungeons and Dragons, published in 1974.⁵ The setting of the game is not much different from MMORPGs: the purpose is to incarnate a single hero/avatar with different characteristics (agility, strength, magical skills, etc.) and to interact with other players (who are in the same room physically). A Dungeon Master leads the story scenario and applies the rules (on the basis of your characteristics, your odds to succeed or fail are computed and dice are used to calculate a score). The success of the game depends on the ability of the players to interact together and create stories from the Dungeon Master’s instructions. Play can last for hours and can continue for years.

In the early 1980s at the peak of popularity of RPGs, the media began to report on concerns about possible negative consequences on youth, such as risk for delusional thought and suicides. Patricia Pulling,⁶ after the suicide of her son, started lawsuits and campaigns against RPGs and founded Bothered About Dungeons and Dragons, claiming that the “satanic influence of role playing games” can lead youth to suicide and schizophrenia.

Game creators such as Michael A. Stackpole responded to critics in several articles and books.⁷ Thirty years later, this controversy seems anecdotal, but it shows different perspectives of people confronted

⁵ <http://dnd.wizards.com/>

⁶ <http://www.kismetrose.com/antirpg/PullingObituary091997.html>

⁷ <http://www.featherlessbiped.com/6696/RPGSATAN/rpgsatan.htm>

with extreme danger warnings against MMORPGs in the media. The chances are good that people who were afraid of youth gathering together to play RPGs would now view this activity as a good way to socialize and read books instead of being alone in front of a computer screen.

MMORPGs evolved in parallel with new media technology. The first versions, called MUDs (Multi-User Dungeons), were text-based games played through inter/intranet university networks. With the rapid rise of domestic computers and gaming consoles and the development of the Internet, commercial versions of MMORPGs were released in the early 1990s. Popular titles such as Ultima Online (1997), EverQuest, and Asheron's Call (1999) reached millions of players worldwide and provided large profits for game development companies.

In the definition of MMORPGs, the MM stand for Massive Multiplayer, as there is no define number from which the word Massive could be used, it refers to the possibility to have thousands of players in the same virtual environment interacting together in a persistent world.

An non massive online role playing game refers mainly to a game played alone where the player interact with so called "Non-player character" controlled by the artificial intelligence of the game. In these online role playing games, the story is linear, predetermined by the game developers and the world is not persistent.

Activision Blizzard Inc. launched WoW in November 2004. The game concept is as follows. Players buy the initial game and pay a monthly fee to continue playing (about 15 USD per month, depending on where they live). Roughly once per year, the game is enhanced with an extension, giving players the ability to discover new content and achievements.

At the beginning of the game, players choose a character with various attributes: sex, race (dwarf, elf, human, etc.), allegiance (horde or alliance), and competence (mage, priest, warrior, etc.). Players also have to choose a server based on their language, country, and different game mechanics (players can choose PvE [player versus environment] in which the player mainly collaborates, or PvP [player versus player], which is based on competition or role playing in which "acting" is important).

Every player starts at level 1 and progresses through quests that are based on the same model: perform action X to gain Y (gain experience points and virtual money). Players go through the leveling phase until they reach the maximum level (depending on which expansion is played). For example, the maximum level players can now reach is 90. During the leveling phase, they are encouraged to collaborate and to join a guild: a community of players (30 to 100) that gives characters advantages such as sharing resources with guild members, or the possibility of joining raids (part of the game in which players have to be 5 or 10 participants to complete quests). When players reach this level, they can access the so-called high-level content consisting of raids. A raid is a 10- or 25-player quest in which players generally collaborate with the members of their guild to defeat monsters. A raid is a highly structured task with a raid leader and avatars with specific tasks, depending on their classes (priest are healing, warriors are shielding, etc.).

WoW is still the most popular MMORPG, with active subscriptions reaching 12 million worldwide in 2011⁸ (now the game has slowly started to decline). It has generated new social phenomena such as semiprofessional players with cash money prizes and sponsorships, as well as much attention by the general media and the scientific community.

MMORPGs are an extension of leisure activities that took root in war games and RPGs. The differences, which are mainly due to technological progress, include the much broader audience, the worldwide continuous availability, and the capacity of thousands of players to interact simultaneously. In this respect, it can be claimed that MMORPGs are a new type of social activity in which the constant interaction of players—chatting, competing, and exploring together—cannot be compared with previous passive mass media such as television. The future of video games is discussed in the Conclusion.

Internet addiction

If the starting point of the field of Internet addiction could be defined, it would be related to the work of Dr. Kimberly Young. In her book *Caught in the Net* [16], she chronicles how she started to be concerned about Internet addiction after hearing stories of relatives and friends describing themselves as having negative consequences from their Internet use. She asked for testimonies in online forums and received hundreds of responses from individuals claiming to have Internet addiction problems and struggling to find help. She developed a questionnaire that was based on the *DSM-IV-TR* criteria for pathological gambling and the Goodman behavioral addiction criteria [17]. It consists of 20 items that measure the degree of concern related to Internet use, compulsive use, associated behavior disorders, emotional changes, and the impact of Internet use on overall quality of life.

As shown in Figure 1, the number of scientific publications addressing the topic of Internet addiction has grown exponentially in the last decade. This book chapter [18] and these reviews [19, 20] summarize the evolution of the epidemiological and diagnostic views of Internet addiction. In the present work, the focus is on gaming addiction, including a discussion of key issues in Internet addiction.

⁸ <http://mmodata.blogspot.ch/>

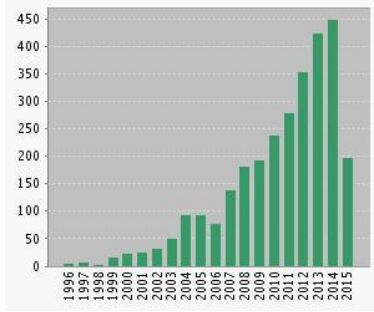


Figure 1: Number of studies published by year that contain the keywords “Internet addiction” (in <http://apps.webofknowledge.com>)

Gaming addiction

Gaming can be considered as an addiction if the following key points are fulfilled.

Validated diagnostic criteria and evaluation tools

Gaming addiction conceptualization is a major issue. Substance addiction concerns distinct substances with specific pharmacological targets. As described earlier, Internet addiction can be divided into several subcategories: gaming, sex addiction, chatting, and surfing. Gaming can also be divided into categories that depend on the type of games played: first-person shooter or MMORPG. It is therefore useful to define limits in terms of specifications. In alcohol addiction, there is no distinction between whiskey addiction, vodka addiction, or beer addiction. But it is clinically relevant to ask which types of alcohol patients are drinking. Similarly, distinctions are nowadays made between types of Internet use, but not between types of game.

Experts disagree on the validity of a gaming addiction diagnosis [21, 22]. Disagreements arise regarding whether gaming addiction should be considered an emerging primary mental health disorder or a dysfunctional coping mechanism as part of another mental health disorder (such as attention deficit hyperactivity disorder or social phobia).

Two different approaches have been proposed to define gaming addiction. The first is to adapt the criteria from the pathological gambling model to gaming. This approach has its limitations, however; for example, in pathological gambling, extensive money losses with potential legal issues cannot be compared with serious involvement in a game. Another approach is to focus on the interfering nature of gaming behavior (deprivation of sleep, missed work or school, loss of social interaction). However, issues regarding potential positive effects of gaming complicate the task of proposing diagnostic criteria. The notion of a continuum between non-problematic use and severe symptoms has been proposed, but in *DSM* classification, a threshold is needed.

Those involved in the ongoing debate on the most pertinent criteria for gaming addiction are far from reaching a definitive consensus. But a major step in the attempt to propose criteria was taken when Internet gaming disorder (IGD) was included in the appendix of the fifth addition of the DSM (*DSM-5*) [23] as a condition requiring further studies. It is conceptually important that the term *addiction* or *dependence* is not mentioned, but that criteria are derived from substance addiction and pathological gambling. Table 1 presents the proposed *DSM-5* criteria:

Table 1: Internet gaming disorder criteria in the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)*

Internet Gaming Disorder

Proposed Criteria

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) of the following in a 12-month period:

1. *Preoccupation with Internet games. (The individual thinks about previous gaming activity or anticipates playing the next game; Internet gaming becomes the dominant activity in daily life).*

Note: This disorder is distinct from Internet gambling, which is included under gambling disorder.

2. *Withdrawal symptoms when Internet gaming is taken away. (These symptoms are typically described as irritability, anxiety, or sadness, but there are no physical signs of pharmacological withdrawal.)*

3. *Tolerance—the need to spend increasing amounts of time engaged in Internet games.*

4. *Unsuccessful attempts to control the participation in Internet games.*

5. *Loss of interests in previous hobbies and entertainment as a result of, and with the exception of, Internet games.*

6. *Continued excessive use of Internet games despite knowledge of psychosocial problems.*

7. *Has deceived family members, therapists, or others regarding the amount of Internet gaming.*

8. *Use of Internet games to escape or relieve a negative mood (e.g., feelings of helplessness, guilt, anxiety).*

9. *Has jeopardized or lost a significant relationship, job, or educational or career opportunity because of participation in Internet games.*

Note: Only nongambling Internet games are included in this disorder. Use of the Internet for required activities in a business or profession is not included; nor is the disorder intended to include other recreational or social Internet use. Similarly, sexual Internet sites are excluded.

Specify current severity:

Internet gaming disorder can be mild, moderate, or severe depending on the degree of disruption of normal activities. Individuals with less severe Internet gaming disorder may exhibit fewer symptoms and less disruption of their lives. Those with severe Internet gaming disorder will have more hours spent on the computer and more severe loss of relationships or career or school opportunities.

In Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5). 2013, American Psychiatric Association. p. 795-6.

Although these criteria are controversial, they can serve as a common base for epidemiological and clinical studies; controversial criteria such as withdrawal and tolerance are discussed in the Conclusion.

The lack of consensus criteria translates into an important heterogeneity in evaluation tools. A recent review shows that at least 18 evaluation questionnaires have been developed and used in research studies [24]. Nowadays, the Young questionnaire is broadly used in clinical trials. Several validated translations also exist [25]. As the Young questionnaire was developed for Internet addiction nearly 20 years ago, it must be adapted for the technological evolution. For example, because online communication mainly occurred through email at that time, the questionnaire does not take into account instant messaging and social media. Questions about topics such as how often individuals check their email have become irrelevant.

The question of whether to develop specific questionnaires for every online activity (online sex addiction questionnaires, online social media addiction questionnaires, MMORPG questionnaires, etc.) or to find a common evaluation tool is also being discussed. Regarding IGD, on the basis of the *DSM-5* appendix, a consensus of nine questions (Table 2), with a positive threshold at five out of nine, has been proposed [26]. This proposal is still controversial (see Conclusion).

Table 2: Proposed items for Internet gaming disorder in Petry et al. (2014)

1. *Do you spend a lot of time thinking about games even when you are not playing, or planning when you can play next?*
2. *Do you feel restless, irritable, moody, angry, anxious or sad when attempting to cut down or stop gaming, or when you are unable to play?*
3. *Do you feel the need to play for increasing amounts of time, play more exciting games, or use more powerful equipment to get the same amount of excitement you used to get?*
4. *Do you feel that you should play less, but are unable to cut back on the amount of time you spend playing games?*
5. *Do you lose interest in or reduce participation in other recreational activities (hobbies, meetings with friends) due to gaming?*
6. *Do you continue to play games even though you are aware of negative consequences, such as not getting enough sleep, being late to school/work, spending too much money, having arguments with others, or neglecting important duties?*
7. *Do you lie to family, friends or others about how much you game, or try to keep your family or friends from knowing how much you game?*
8. *Do you game to escape from or forget about personal problems, or to relieve uncomfortable feelings such as guilt, anxiety, helplessness or depression?*
9. *Do you risk or lose significant relationships, or job, educational or career opportunities because of gaming?*

Similarities to validated addictions (neurobiological, psychological, and behavioral patterns)

Similarities between gambling and substance addiction have been well described in terms of responses to craving stimuli and neurobiological pathways [27]. Imagery studies tend to confirm [28] [29] similar observations in gaming-addicted subjects, but there are two main concerns with such studies: 1) Subjects are selected in the absence of definitive diagnostic criteria; and 2) although studies focusing on attentional bias related to drug cues and the craving state in addicts are important for assessing the severity of addiction and indirect neurobiological change markers [30], in studies that show abnormal functional imagery in gamers, investigators are prone to conclude that there is a causal relation between abnormal findings and IGD, with an evident lack of proof [31].

A causal relation between gaming investments and clinical negative impacts

As described earlier, one of the most important questions about gaming is related to its potential impact on individuals and on public health. In developed countries, surveys on video gaming habits show, especially in youth, that video gaming is the rule more than the exception. Real consequences should, however, be balanced against moral, ideological, or alarming forecasts.

For example, a comparison from the Swiss population between casualties in sport practices (ski practice resulted in 22 deaths and 3430 severe injuries in 2011⁹) and in video game practice (no official death or injuries described so far) raises questions about the overall impact of video game play.

Longitudinal studies are controversial. Gentile showed a high prevalence rate and clinical consequences of gaming in a cohort of Singapore adolescents [32]. A German longitudinal study [33] on adolescents and adult gamers found (based on the Gaming Addiction Short Scale) a very low prevalence of problematic gamers (1%) and no participants fulfilling gaming addiction criteria.

Studies compiled below demonstrate that video game practice is heterogeneous by nature and can have different consequences on different subgroups of individuals (problematic use in a vulnerable population can lead to addiction, as seen in our retrospective study in a clinical population).

⁹ <http://www.bfu.ch/fr>

Articles: introduction and summary

1) What is addictive on the Internet?

This article focuses on a description of the addictive components found in MMORPGs, with specific examples in Wow.

First, the differences between products and vectors (see Introduction) are described. Then, on the basis of human studies on the role of salient stimuli activating the reward pathways (VTA, NAc), this article lists all potential salient stimuli present in Wow.

Unconditional stimuli (food, for example) obviously are not present in the game, but the article describes a list of conditioned stimuli that have been demonstrated to activate reward pathways in humans. The article demonstrates that it is not a single aspect of the game that could potentially be addictive; rather, multiple aspects contribute to the addictive potential. Two main types of stimuli are described in detail: social stimuli and the in-game reward mechanism.

Social stimuli

1. Sexual stimuli: The possibility to incarnate female or male characters with different appearances and the opportunity to communicate with other player can lead to in-game seductive behaviors.
2. Cooperation: The game is articulated around the possibility of playing a specific role in a social environment (guilds).
3. Fairness: The rules of the game encourage collaboration and fair competition.
4. Social hierarchies: Rank (based on an avatar's level) and equipment play preeminent roles in the game.
5. Reputation: The in-game avatar's reputation is also central.
6. Humor: The game contains hidden jokes called Easter eggs (references to popular culture, anachronisms).

The in-game reward mechanism is compared with gambling rewards in which the gamblers win money according to a specific distribution rate. These distribution rates are based on reinforcement schedules, as described originally by Skinner. In Wow, reward stimuli are obtained according to two categories of schedules:

1. Continuous reinforcement
2. Intermittent or partial reinforcement

In intermittent reinforcement, the variable ratio schedule occurs when a behavior is reinforced after an unpredictable number of responses. It is the most prevalent reinforcement mechanism in Wow. An in-game example is the action of killing an enemy (the most common action in Wow), yielding a statistically determined chance to gain a reward, for example, a 50% chance of winning a common

object and a 0.005% chance of winning a so-called legendary object. The mechanism is the same as the probability of winning the jackpot from a slot machine.

The article summarizes the main ingredients that could be addictive in a MMORPG such as Wow. It shows that a combination of social stimuli with conditioned reward mechanisms is similar to gambling rewards and that the vector delivering these stimuli tends to be more and more effective: broader accessibility, low cost, and constant technical improvement.

2) Why do you play WoW? An in-depth exploration of self-reported motivations to play online and in-game behaviors in the virtual world of Azeroth

The study had two main objectives: 1) to explore the motivations to play Wow and 2) to investigate potential correlations between the declared players' motivations and in-game behavior.

These two questions are relevant in order to differentiate problematic from non-problematic involvement, especially to determine whether specific motivations to play are correlated with higher levels of problematic use.

This study is based on a sample of WoW players. In 2010, an online questionnaire was proposed to every French-speaking WoW player. The questionnaire was promoted through the official Blizzard forum, a specialized game forum, and word of mouth. The authors asked for permission to use the main avatars (the in-game character defined by the player as the most significant) and to collect information on self-described motivation to play and actual in-game involvement.

The Blizzard's armory website¹⁰ was consulted to study the avatars' progression. This database contains all of the information on the progression of avatars in the game. Information can be classified according to motivation to play. For example, a player who likes competition will engage an avatar much more in combat-related quests and challenges. A longitudinal measure was included: T0 (June to December 2010), during which participants completed the questionnaire and gave their avatars names (N = 690), and T1 (June 2011), a second measure on only the armory progression of avatars (N = 516).

At T0, the following information was collected: sociodemographic data, score on the French version of the Internet Addiction Test (IAT), completed MPOCQ (a questionnaire on motivation to play online games), type of server chosen (game servers are divided into pro-social servers, where players collaborate; competition-oriented servers; and role-play-oriented servers), and players' guild affiliation.

Results showed several relations at T0, the most robust being that the number of hours played was strongly related to advancement motives. An addictive usage pattern was related to advancement and escapism motives. Self-reported motives and avatars in game progression were consistent: i.e., competition motives were related to PvP achievement. The choice of a specific server was also correlated with motivation: competitive players favored a PvP server.

Longitudinal data showed that the rate of progression in the game was predicted by discovery and teamwork motives, affiliation to a guild, and time spent playing. No relation between problematic involvement and progression motives were observed.

¹⁰ <http://eu.battle.net/wow/fr/>

This study confirmed the link between self-reported motivation to play and actual in-game behavior and showed that certain types of motivation predict the rate of progression in the game.

This study contributes to an understanding of the specific motivations to play MMORPGs. It is particularly important for the broader debate on the diagnosis of game addiction and its clinical implications. One of the key questions is to determine whether there is an addictive, unhealthy way of playing versus a “normal” involvement in games. Such a determination could further clarify the debate between normal game use and addiction.

3) WoW and alcohol: a secret love story?

This article continues to focus on the specific content of the game Wow, with an emphasis on the depiction of alcohol in the game.

Comorbidity between behavioral addiction and substance addiction has largely been described. Epidemiological studies found strong links between substance use disorder and pathological gambling [34]. IGD also had a probable highest comorbidity with substance use disorder. It is therefore important to study whether links can be established between 1) alcohol overrepresentation in games because of the natural tendencies of gamers and game developers to be attracted by alcohol and 2) the impact of alcohol and other drugs represented in new media and games on their consumption.

The article briefly reviews studies on the effects of alcohol advertising on alcohol consumption and its positive representation for youth.

Wow contains in-game consumables: food, drinks, potions, etc. All consumables have specific effects on the avatars, such as enhancing certain characteristics or restoring energy. Alcoholic drinks are part of the game. In 2009, this study counted, through a specialized website listing all available consumables in the game, all alcoholic drinks and their effects. Results showed that one fifth of all drinks were described as alcoholic drinks, with beer being the most prevalent type. Regarding the depiction of the effects: one quarter of alcoholic drinks had positive effects and none had only negative effects (2% had positive and negative effects).

The article also shows, through several in-game examples, that alcohol is depicted as being fun (strong association with partying and friendly looking avatars such as dwarfs). "Brewfest" is an example of an in-game seasonal event inspired by Munich Oktoberfest. Avatars can accomplish quests related to beer drinking and doing things while intoxicated.

The conclusion is that alcohol is not central to the game, but its representation is largely positive and associated with fun social events and characters.

These findings raise the broader question of the influence of specific content (i.e., related to alcohol) in the media and in video games in particular. A parallel is proposed with the long-running and controversial debate on the depiction of violence in video games and its impact on violent behavior. A clear trend shows that media exposure to alcohol and tobacco advertisements enhance their consumption in youth. On the basis of this study, two questions arise:

- a) Are video games more or less persuasive or efficient than traditional media when providing a positive message on consumption?
- b) Is the alcohol industry already using video games to promote alcohol consumption by sponsoring games?

Comments are made on the legislation informing consumers about the content of video games. American and European norms are compared that show discrepancies in WoW, as the alcoholic

content in the game was described by the US video game rating system (Entertainment Software Rating Board¹¹) but not by the European system (Pan European Game Information; PEGI¹²).

The same research was replicated in 2013 [35] to evaluate the evolution of alcohol representation in Wow 4 years after the first study. In 2013, 9.3% of all virtual drinks were alcoholic beverages, and compared with June 2009, the total number of alcoholic beverages dropped from 93 to 71, but the representation of alcohol remained positive. PEGI has not implemented a warning on alcohol content since 2009.

¹¹ <http://www.esrb.org/index-js.jsp>

¹² <http://www.pegi.info/en/index/>

4) Swiss psychiatric beliefs and attitudes about Internet addiction

This study, performed 6 years ago, is important because, as described earlier, the lack of clinical data on Internet and gaming addiction is a barrier to relevant diagnosis criteria. One way to obtain more information on the reality of the problem is to ask clinicians who are in contact with the general psychiatric population about their perception of this problem in their everyday clinical practice. At the time of this research, most studies on Internet addiction were done on nonclinical groups (mainly students). It was therefore crucial to evaluate the psychiatrists' perceptions regarding Internet addiction, in particular:

- a) whether they consider Internet addiction to be a clinical entity
- b) whether they encounter these problems in their clinical population
- c) whether they had a screening and/or evaluation tool and whether they felt able to treat Internet addiction

In 2009, a survey was proposed to 94 Swiss psychiatrists in a general psychiatric symposium about their perception of Internet addiction. The sociodemographic data showed a good representation of Swiss psychiatrists: 40% women, age range 26 to 65 years old, 63% working in hospitals or clinics, and 37% working in private practice. Of the respondents, 68% answered the German questionnaire and 32% the French questionnaire. Their own Internet use was monitored, and the majority (69%) spent less than an hour per day online.

Among this group, 77% reported having encountered patients with Internet addiction, the most frequently cited problems being chatting/blogging (58%), gaming (50%), cybersex (37%), surfing (29%), and gambling (28%). The majority of respondents (32%) described having between 0 and 2% of Internet-addicted patients in their practice.

Descriptive results showed that a large majority (82%) of respondents acknowledged Internet addiction as a clinical relevant entity and 94% were convinced that the problem will increase in the future.

The sample was divided into three groups, labeled as follows:

1. *The nosology treatment believers* (n=8) were convinced of the existence of Internet addiction, regularly screened for it, and felt able to treat it.
2. *The nosology believers* (n=66) were also convinced of the existence of Internet addiction and its increase in future, but did not regularly screen for it and thought that treatment consisted mainly of treating comorbidities.
3. *Disbelievers* (n=20) were not convinced that Internet addiction was a problem and, accordingly, did not screen their patients for Internet addiction and did not think that validated treatments existed.

5) Characteristics and treatment response of self-identified problematic Internet users in a behavioral addiction outpatient clinic

As described earlier, Internet addiction and gaming addiction have mainly been studied in nonclinical samples. It is therefore important to obtain clinical samples of people who self-identify as having Internet-related problems in dedicated clinics.

In 2007, Geneva University Hospital opened a behavioral addiction clinic (as there was an increasing demand) for every patient who claimed to have problems related to Internet addiction. The clinic was a multidisciplinary team with psychiatrists, nurses, and psychologists. All employees were addiction specialists with psychotherapeutic training. Every patient was evaluated by a psychiatrist. As the demand was new, there were no particular treatment protocols, and best practices for addiction treatment were applied (motivational interview, cognitive behavioral therapy, relapse prevention, etc.). All patients were treated with individual psychotherapy sessions, but the clinic lacked the critical number of patients to propose group therapy.

In 2010, a retrospective study was done on the files of patients who consulted the behavioral addiction program and self-identified as having problematic Internet use. The main goal of the study was to characterize this population in terms of sociodemographic data, psychiatric comorbidities, and main problematic Internet usage. Clinical severity, length of treatment, and overall clinical evolution were measured. Evaluation of the comorbidities was based on the clinical diagnosis. The only systematic evaluation performed was the French version of the IAT [25].

The main results were as follows: patients were all men except one, and the mean age was 24 years old. The main motive for referral was gaming. Striking results were found for the prevalence of a diagnosis of Internet addiction. A positive diagnosis was defined as an IAT cutoff score of more than 70 of 100. Only 18.7% of patients fulfilled the Internet addiction criteria. These results questioned the validity of the IAT and suggested that it was necessary to develop more precise diagnosis criteria. Comorbidities were high. Only 30.4% of patients had no current psychiatric diagnosis. Social phobia, psychosis, substance addiction (tobacco, alcohol, and cannabis), and anxiety disorder were the most prevalent comorbidities.

Baseline severity, evolution, and dropout rates showed that the severity of clinical symptoms was generally in the lower range and the overall evolution was favorable: an average of 19 weeks of treatment and six sessions.

A strong link between pathological gamblers and our clinical population was found regarding the motive for consultation: the majority did not come on their own initiative, but were forced into it by family, friends, or their school/workplace.

Articles: conclusions and perspectives

The choice of these five articles was meant to cover key issues on the emerging gaming use disorder. The first study is a review of the principal addictive factors present in online games, more precisely in Wow. It showed that the combination of social incentives such as competition, collaboration, and fairness with standard reinforcement is the core trigger for potential addictive behaviors.

The second article, through Wow players and their avatars, focused on the motivations to play and on the essential concept that specific motivations must be understood to define normal versus problematic engagement in games.

The third article illustrates how substances such as alcohol could be positively represented in Wow and insists that there is a potential link between substance addiction and IGD, as well as the gaming industry being a new platform for alcohol advertising. This article demonstrates the complex boundaries between behavioral addictions and substance addictions. It shows the potential impact of a positive depiction of an addictive substance such as alcohol in a potentially addictive virtual environment leading to substantial changes in substance use.

The fourth article asked Swiss psychiatrists about their perception of Internet addiction, finding that a large majority of caregivers considered Internet addiction to be a valid clinical entity that was expected to increase in the future.

The last study described a clinical sample of self-identified Internet/game addicts, their sociodemographic characteristics, comorbid disorders, and severity of addiction.

As demonstrated in these articles, the field of Internet/gaming addiction is recent and evolving rapidly, with multiple challenges awaiting researchers.

The following sections describe important issues that could guide future hypotheses and research.

Constant technological evolution

Considering the vectors and products metaphor, and comparing alcohol to gaming addiction, the product will always be the alcohol molecule in alcohol addiction, but the vectors may vary (beer, wine, etc.) and the main consumption route is oral alcohol intake. Of course, access to alcoholic drinks, advertising, cultural background, and consumption policies play a major role in problems associated with alcohol addiction, but it cannot be compared with behavioral addiction, in which the “product” is different and evolving.

Examples of the evolution of vectors and products are multiple. Virtual reality is one such example: predicted long ago, but posing multiple technological difficulties, it seems to have breached the

hurdles to its dissemination to the public (Oculus, an immersive virtual reality device company, will commercialize the Rift model in 2016¹³). Its use in gaming will enhance the feeling of immersion and therefore potentially strengthen the addictive game components (salient stimuli). It is therefore necessary to study the inherent mechanisms that could potentially lead to addiction and not to continue using vague and superficial terminologies such as Internet addiction, but to develop accurate distinctions among reinforcement mechanisms specific to type of activity. The current study tends to demonstrate that complex games such as MMORPGs cannot be compared with Tetris, for example; in consideration of the rapid evolution of technology, future studies could focus on MMORPGs and their specific addictive components and mechanisms.

Video games: risk or opportunity?

Apart from the risk of developing addiction, the broader impact of video games on social and health issues should be mentioned. Of great concern, as it becomes a generalized practice, is the impact of regular video game play on cognitive functions, development, and scholarly performance. As is the case for addiction, debate is lively regarding whether video games worsen performance or whether low performers tend to play more video games. Several studies report that youth with a poor academic performance and low socioeconomic status tend to play more and have higher negative impacts [36, 37], as well as a longitudinal bidirectional pattern (at-risk individuals play more and have greater negative consequences from their play) [38].

On the other hand, cognitive enhancement from video game play is also described. Specific games, such as fast-paced action games, could have an impact on cognitive functions [39], but the outcomes are still highly uncertain, as shown in a recent negative study showing that these games had no impact on cognitive function [40]. A meta-analysis [41] on the effect of video game play on information processing shows a negligible effect on executive functions and a small-to-modest effect on auditory, visual, spatial imagery, and motor skills.

An important question is the specific impact of intense video games practices over the years on the brain functions. A study [42] on resting-state functional magnetic resonance imaging investigated whether functional connectivity is altered in adolescents with Internet gaming addiction compared to a control group. Results suggested a different resting-state pattern of brain activity in adolescents with gaming addiction. These alterations were described as partially consistent with those seen in patients with substance addiction. This study is cross sectional, and the obvious limitation is whether the psychological features preceded the development of gaming addiction or were a consequence of gaming addiction. Prospective studies are needed to have a better understanding on the effect of video game practices on brains functions.

¹³ <https://www.oculus.com/en-us/>

Another broadly debated subject is the impact of video games on violent behavior and the possible link between violent video game play and violent behaviors. A recent meta-analysis tends to confirm the link [43], but again, it is reductive to isolate one risk factor (violent video game play) among those in the broader environment, such as socioeconomic conditions and global exposure to violence in the media and in real life.

Regarding addiction risks, in studies on motivation to play and player characteristics, the distinction between problematic, neutral, and even positive involvement is fundamental for identifying the population that is at risk of developing IGD. Another study on the same sample of Wow players [44] aimed to characterize subtypes of problematic gamers with a cluster analytic approach. The investigators studied established psychological risk factors (impulsivity, self-esteem, and motivation to play) and potential consequences (addiction symptoms and positive and negative affects).

Five clusters of gamers were identified, three of which were problematic in terms of addiction symptoms and negative affect: “unregulated achievers,” “unregulated escapers” (low achievement, high escapism motives, low self-esteem), and “hard-core gamers” (high achievement, high escapism motives, high self-esteem). It can be hypothesized that the first two groups play the game to avoid difficult psychological or social situations, and the game can be used as a maladaptive coping strategy (escapism). The hard-core gamers group, however, tends to represent the addicted profile: highly motivated (achievers) with in-game high self-esteem. They could have cognitive distortions about the negative impact of their behavior, which could be compared with so-called denial seen in addicted individuals.

The “regulated social role players” and the “regulated recreational gamers” express no negative consequences and could be described as recreational or passionate gamers.

Differences between online addiction (gaming versus gambling)

If behavioral addictions can be divided into several defined entities such as gaming addiction, pornography addiction, or addiction to social networks, multiple usage is the norm. Furthermore, within activities, differences tend to fade. Examples include the overlaps observed between video games and online gambling. The video game market is becoming more and more competitive, with developers implementing game mechanisms that are similar to gambling mechanisms in order to attract consumers.

The emergence of “free-to-play” games on mobile phones, such as “Game of War,” illustrates the lack of clear boundaries between gaming and gambling: players can progress through the game without buying virtual army units or power, but a substantial money investment is required to become competitive. Other well-known reinforcing mechanisms, such as loss aversion (normal individuals tend to consider losing the same amounts/rewards more disadvantageous than winning them) and illusion of control [45] (to induce the player to believe that the game is a skill game and not a type of lottery in which you are asked to spend money as your only way to progress), are also part of developers’

strategies. At-risk users will invest a considerable amount of money (competing with other problematic users), with consequences that are similar to pathological gambling.

Another emerging phenomenon is betting on e-sports. Similar to the ability to bet on video game players and tournaments, this new feature could potentially lead video game players who would normally not be interested in betting to develop pathological gambling.

An important question concerns the link between video gaming and online gambling. Recent studies [46, 47] tend to show that if the risk to switch from gaming to gambling exists, it is not a frequent occurrence. Of course, the more that boundaries become blurred, the greater the risk.

Policy

Taking the example of the history of heroin use, tolerance policies have greatly evolved. In contrast to the late 19th century when the consumption and commercialization of heroin was legal, today, its production and consumption is globally severely repressed. The laws have also changed for other addictive substances such as alcohol, which had a period of prohibition in the United States in the 1930s. These legal changes caused a sharp rise in criminal activity, but a decline in overall consumption.

The question arises about future laws in the regulation of video games. Their use and production are now legal, but important questions about market regulation emerge. Currently, the debate is focused on the violent content of video games and how to control youth access to this content.

If governments are led to consider game addiction as a public health problem, strict regulation of the use of video games or even prohibition could be enforced, potentially leading to criminal activities and a black market. Asian countries already consider Internet addiction to be a public health issue and some politicians would like to implement laws and recommendations in this direction, for example, in Korea: *“In the proposed act, Internet games and other digital media content are categorized as one of the four major sources of addiction, along with alcohol, drugs and gambling, and subjected to tougher government controls”*¹⁴.

It will be important for researchers to inform policy makers on the real risk of gaming addiction to avoid the establishment of confusing laws. A good example to adapt from the substance addiction field is the risk reduction policies promoting safe usage without strict interdictions [48].

¹⁴ <http://www.koreaherald.com/view.php?ud=20131113001080> (accessed July 2015)

Diagnostic and clinical challenges

Obviously, addiction models of MMORPGs and video games are not sufficient to wholly explain their impacts on individuals. A review of other models is beyond the scope of this work. It is nevertheless important to mention that models based, for example, on psychological ownership theory or social identity theory have been developed [49, 50]. And as mentioned before, the popularity of the topic and the bulk of information available make it indispensable to distinguish reviews and opinion-based commentaries versus models based on useful empirical studies.

The concepts of Internet addiction and gaming addiction are derived from the definitions of substance addiction. As described earlier, adapting diagnostic criteria that are strictly derived from substance abuse could lead one to miss important clinical issues. The discussion about which symptoms are relevant to gaming addiction is a good example of these challenges, and ongoing discussions in the scientific community [7, 51-53] on the validity of specific diagnostic criteria are crucial. Criteria such as giving up other activities, withdrawal, and tolerance could reflect, not an addiction, but a highly engaged person in an activity driven by passion, without any negative health consequences. For example, heroin consumption can lead to physical tolerance, withdrawal, and giving up of other activities while engaging in illegal activities. The same is not true for gaming, as high involvement in the game can lead to social and financial advantages. For example, the total prize money in the Defense of the Ancients gaming competition was US \$18 million¹⁵ (August 2015) and the winning team of five players shared US \$6 million. Becoming a professional gamer and make a living from it is a reality that can be compared with sport professionals, with strict training and coaching, as cited from a comment on a gaming website:

“Unfortunately, competing at high level is nothing like playing games you love. At that level, you no longer reach a point where you're playing the game. It becomes work and you spend all day, every day, working, practicing, researching, etc. It's more demanding than regular jobs. By comparison, a job where I worked 60-hours and 6-days a week was less demanding than when I competed at high level play in video games. Though I'm sure there are plenty of pros who truly enjoy competing, it's nothing like playing games for fun.”¹⁶

¹⁵ <http://dota2.prizetrac.kr/international2015> (accessed August 2015)

¹⁶ <http://www.gamespot.com/articles/meet-the-16-year-old-professional-dota-2-player-wh/1100-6429598/>(accessed August 2015)

Again, the quality of involvement in an activity is the key to understanding the difference between an addictive behavior and passionate/professional involvement. Sport or exercise addiction [54] has been described, illustrating the difference between professional and addictive engagement.

Clinical research should carefully measure the impact of high engagement in gaming in order to adjust and define the most relevant diagnostic criteria. These criteria should correlate to negative consequences.

Tolerance is a good example of the limitations involved in adapting substance abuse criteria to gaming addiction. Tolerance is a biological adaptation mechanism (progressive increase in addictive substance intake to obtain the same psychotropic effect). A strict adaptation of the substance abuse tolerance criteria to IGD would mean that players need an increased amount of game practice in order to achieve the same effect and abruptly stopping would lead to withdrawal symptoms. If there are quantity parameters in substance addiction (increase in the amount or power of a substance), they could be translated into the amount of time the game is played or the intensity of involvement in the game. This leads to limitations: if the amount of time played is indeed a criterion, but if it does not interact with health or normal daily life, it cannot be compared, for example, to alcohol consumption, in which there are exponential health risks related to the daily quantity ingested [55].

A better definition of tolerance in IGD would be a progressive decrease in pleasure and excitement related to game play, replaced by an automatic way of playing without gratification and persistent gaming activity despite the passion and pleasure being gone.

These fundamental issues—finding good psychometric instruments for screening and making accurate diagnoses—appear in the field of gaming addiction. Our team translated and validated the IAT in French [25], and the questions about clinical pertinent criteria led us to adapt and develop this instrument and to test it in different populations (gamers versus poker players) [56]. An ongoing project is to develop and test an 18-question version of the IAT, taking into account the tolerance issues for other parameters.

Broader epidemiological issues also arise. A large study of the general population in different countries and cultures that quantified Internet use, its subcategories, and its consequences would also help clinicians to have a better understanding of the prevalence of IGD and Internet addiction.

Our team mainly studied self-identified game users, and bias selection has to be accounted for. This concern is addressed in a comparison [57] of avatars from the Wow player sample and avatars from a random sample drafted from the Wow armory. The comparison shows that the self-selected sample is more involved in the game and comes from a smaller number of guilds. These results emphasize that caution must be taken when using epidemiological results from a self-selected sample and applying them to the general population.

Future clinical challenges are multiple. One of them is to better characterize the IGD and Internet addiction clinical population. Longitudinal prospective studies are scarce and cohort studies mandatory. Our team is currently developing a protocol for a cohort study of patients seen in our

behavioral outpatient clinic. Measures will include the new IAT version, the Petry IGD criteria [26], and a modified Mini-Mental State Examination for behavioral addictions. Impulsivity will also be monitored with the UPPS questionnaire and behavioral tasks. Impulsivity and its different components (urgency, lack of planning, lack of perseverance, and sensation seeking) play a key role as risk factors for addictions [58] and for IGD, as demonstrated in our study [44]. Longitudinal data should help to clarify a) the role of psychiatric comorbidity as a maintenance or risk factor for IGD/Internet addiction and b) the course of addiction. This last issue is of great importance and should help to clear up the controversies between the theory that IGD is a transient symptom [33] and that it is an addiction, in which an individual must have chronic evolution with persisting behavior, despite negative consequences.

Conclusion

It is a critical period for researchers, clinicians, and policy makers to consider Internet addiction or IGD as a strong working hypothesis, but not as an established fact. Jumping to conclusions, following media sensationalism, or offering ready-made opinions, both pro and con, would lead to counterproductive decisions. With rational decisions, a “war against video games,” like the failed “war on drugs,” may be avoided.

The tremendous progress that has recently been made in understanding addiction mechanisms, particularly its behavioral aspects, is an opportunity to develop accurate evaluation methods and treatments. On the other hand, applying the substance addiction model to the field of behavioral addiction too rigidly could lead to an underestimation of the potential positive impact of new behaviors and the stigmatization of an entire population.

References

1. Wartella, E.A. and N. Jennings, *Children and computers: New technology - Old concerns*. Future of Children, 2000. **10**(2): p. 31-43.
2. Volkow, N.D. and R.D. Baler, *Addiction science: Uncovering neurobiological complexity*. Neuropharmacology, 2014. **76**: p. 235-249.
3. Luthi, A. and C. Luscher, *Pathological circuit function underlying addiction and anxiety disorders*. Nature Neuroscience, 2014. **17**(12): p. 1635-1643.
4. Berridge, K.C. and M.L. Kringelbach, *Pleasure Systems in the Brain*. Neuron, 2015. **86**(3): p. 646-664.
5. Doyle, S.E., et al., *A Shift in the Role of Glutamatergic Signaling in the Nucleus Accumbens Core With the Development of an Addicted Phenotype*. Biological Psychiatry, 2014. **76**(10): p. 810-815.
6. Kober, H., et al., *Brain Activity During Cocaine Craving and Gambling Urges: An fMRI Study*. Neuropsychopharmacology, 2016. **41**(2): p. 628-637.
7. Billieux, J., et al., *Are we overpathologizing everyday life? A tenable blueprint for behavioral addiction research*. J Behav Addict, 2015: p. 1-5.
8. Griffiths, M., *Gambling Technologies: Prospects for Problem Gambling*. Journal of Gambling Studies, 1999. **15**(3): p. 265-283.
9. Skinner, B.F., *Science and human behavior*. 1953, New York: Macmillan.
10. Schultz, W., P. Dayan, and P.R. Montague, *A neural substrate of prediction and reward*. Science, 1997. **275**(5306): p. 1593-1599.
11. Davis, R.A., *A cognitive-behavioral model of pathological Internet use*. Computers in Human Behavior, 2001. **17**(2): p. 187-195.
12. Deroche-Gamonet, V., D. Belin, and P.V. Piazza, *Evidence for addiction-like behavior in the rat*. Science, 2004. **305**(5686): p. 1014-1017.
13. Breiter, H.C., et al., *Functional imaging of neural responses to expectancy and experience of monetary gains and losses*. Neuron, 2001. **30**(2): p. 619-639.
14. Izuma, K., D.N. Saito, and N. Sadato, *Processing of social and monetary rewards in the human striatum*. Neuron, 2008. **58**(2): p. 284-294.
15. Clark, L., et al., *Learning and Affect Following Near-Miss Outcomes in Simulated Gambling*. Journal of Behavioral Decision Making, 2013. **26**(5): p. 442-450.
16. Young, K.S., *Caught in the net: how to recognize the signs of Internet addiction--and a winning strategy for recovery*. 1998: John Wiley and Sons.
17. Goodman, A., *Addiction: definition and implications*. Br J Addict, 1990. **85**(11): p. 1403-8.
18. Achab, S., et al., *Internet Addiction in Textbook of Addiction Treatment: International Perspectives*, Springer-Verlag, Editor. 2015. p. 2700.
19. Cheng, C. and A.Y. Li, *Internet addiction prevalence and quality of (real) life: a meta-analysis of 31 nations across seven world regions*. Cyberpsychol Behav Soc Netw, 2014. **17**(12): p. 755-60.
20. Durkee, T., et al., *Prevalence of pathological internet use among adolescents in Europe: demographic and social factors*. Addiction, 2012. **107**(12): p. 2210-2222.
21. Auriacombe, M., C. Denis, and M. Fatséas, *Commentary on Scharkow et al. (2014): Welcomed and yet to come. Are we looking at what we are looking for?* Addiction, 2014. **109**(11): p. 1918-1919.
22. Paul, W., *Internet and Video Game Addiction: Evidence & Controversy*. Adolescent Psychiatry, 2014. **4**(2): p. 81-91.
23. in *Diagnostic and Statistical Manual of Mental Disorders, 5 th Edition (DSM-5)*. 2013, American Psychiatric Association. p. 795-798.
24. King, D.L., et al., *Toward a consensus definition of pathological video-gaming: A systematic review of psychometric assessment tools*. Clinical Psychology Review, 2013. **33**(3): p. 331-342.

25. Khazaal, Y., et al., *French validation of the internet addiction test*. *Cyberpsychology & Behavior: The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society*, 2008. **11**(6): p. 703-706.
26. Petry, N.M., et al., *An international consensus for assessing internet gaming disorder using the new DSM-5 approach*. *Addiction*, 2014.
27. Goudriaan, A.E., M. Yucel, and R.J. van Holst, *Getting a grip on problem gambling: what can neuroscience tell us?* *Frontiers in Behavioral Neuroscience*, 2014. **8**.
28. Kim, H., et al., *Resting-state regional homogeneity as a biological marker for patients with Internet gaming disorder: A comparison with patients with alcohol use disorder and healthy controls*. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 2015. **60**: p. 104-111.
29. Meng, Y.J., et al., *The prefrontal dysfunction in individuals with Internet gaming disorder: a meta-analysis of functional magnetic resonance imaging studies*. *Addiction Biology*, 2015. **20**(4): p. 799-808.
30. Wilson, S.J. and M.A. Sayette, *Neuroimaging craving: urge intensity matters*. *Addiction*, 2015. **110**(2): p. 195-203.
31. Yuan, K., et al., *Amplitude of Low Frequency Fluctuation Abnormalities in Adolescents with Online Gaming Addiction*. *Plos One*, 2013. **8**(11).
32. Gentile, D.A., et al., *Pathological video game use among youths: a two-year longitudinal study*. *Pediatrics*, 2011. **127**(2): p. 319-29.
33. Scharkow, M., R. Festl, and T. Quandt, *Longitudinal patterns of problematic computer game use among adolescents and adults—a 2-year panel study*. *Addiction*, 2014. **109**(11): p. 1910-1917.
34. Blanco, C., et al., *Towards a comprehensive developmental model of pathological gambling*. *Addiction*, 2015. **110**(8): p. 1340-1351.
35. Thorens, G. and S. Achab, *Virtual alcohol exposure: A real policy challenge*. *Alcohol and Alcoholism*, 2013. **48**: p. 57.
36. Bijvank, M.N., E.A. Konijn, and B.J. Bushman, *"We don't need no education": Video game preferences, video game motivations, and aggressiveness among adolescent boys of different educational ability levels*. *Journal of Adolescence*, 2012. **35**(1): p. 153-162.
37. Peiro-Velert, C., et al., *Screen Media Usage, Sleep Time and Academic Performance in Adolescents: Clustering a Self-Organizing Maps Analysis*. *Plos One*, 2014. **9**(6).
38. Gentile, D.A., et al., *Video game playing, attention problems, and impulsiveness: Evidence of bidirectional causality*. *Psychology of Popular Media Culture*, 2012. **1**(1): p. 62-70.
39. Green, C.S., A. Pouget, and D. Bavelier, *Improved Probabilistic Inference as a General Learning Mechanism with Action Video Games*. *Current Biology*, 2010. **20**(17): p. 1573-1579.
40. van Ravenzwaaij, D., et al., *Action Video Games Do Not Improve the Speed of Information Processing in Simple Perceptual Tasks*. *Journal of Experimental Psychology-General*, 2014. **143**(5): p. 1794-1805.
41. Powers, K.L., et al., *Effects of video-game play on information processing: A meta-analytic investigation*. *Psychonomic Bulletin & Review*, 2013. **20**(6): p. 1055-1079.
42. Ding, W.N., et al., *Altered Default Network Resting-State Functional Connectivity in Adolescents with Internet Gaming Addiction*. *Plos One*, 2013. **8**(3).
43. Anderson, C.A., et al., *Violent Video Game Effects on Aggression, Empathy, and Prosocial Behavior in Eastern and Western Countries: A Meta-Analytic Review*. *Psychological Bulletin*, 2010. **136**(2): p. 151-173.
44. Billieux, J., et al., *Problematic involvement in online games: A cluster analytic approach*. *Computers in Human Behavior*, 2015. **43**(0): p. 242-250.
45. King, D.L., A. Ejova, and P.H. Delfabbro, *Illusory Control, Gambling, and Video Gaming: An Investigation of Regular Gamblers and Video Game Players*. *Journal of Gambling Studies*, 2012. **28**(3): p. 421-435.

46. Delfabbro, P., et al., *Is Video-Game Playing a Risk Factor for Pathological Gambling in Australian Adolescents?* Journal of Gambling Studies, 2009. **25**(3): p. 391-405.
47. Forrest, C.J., D.L. King, and P.H. Delfabbro, *The Gambling Preferences and Behaviors of a Community Sample of Australian Regular Video Game Players.* J Gambli Stud, 2015.
48. Thorens, G., et al., *Is harm reduction a valid concept in gaming addiction?* Journal of Behavioral Addictions, 2015. **4**: p. 40.
49. Cole, H. and M.D. Griffiths, *Social interactions in massively multiplayer Online role-playing gamers.* Cyberpsychology & Behavior, 2007. **10**(4): p. 575-583.
50. Moon, J., et al., *Player Commitment to Massively Multiplayer Online Role-Playing Games (MMORPGs): An Integrated Model.* International Journal of Electronic Commerce, 2013. **17**(4): p. 7-38.
51. Rehbein, F., et al., *Prevalence of internet gaming disorder in German adolescents: diagnostic contribution of the nine DSM-5 criteria in a state-wide representative sample.* Addiction, 2015. **110**(5): p. 842-851.
52. Rehbein, F., et al., *Systematic Validation of Internet Gaming Disorder Criteria Needs to Start Somewhere: A Reply to Kardefelt-Winther.* Addiction, 2015. **110**(8): p. 1360-1362.
53. Kardefelt-Winther, D., *Assessing the diagnostic contribution of internet gaming disorder criteria requires improved content, construct and face validity—a response to Rehbein and colleagues (2015).* Addiction, 2015. **110**(8): p. 1359-1360.
54. Egorov, A.Y. and A. Szabo, *The exercise paradox: An interactional model for a clearer conceptualization of exercise addiction.* Journal of Behavioral Addictions, 2013. **2**(4): p. 199-208.
55. Rehm, J., et al., *The relation between different dimensions of alcohol consumption and burden of disease: an overview.* Addiction, 2010. **105**(5): p. 817-843.
56. Rothen, S., et al., *Factor structure of the Internet Addiction Test in online gamers and poker players.* Journal of Behavioral Addictions, 2015. **4**: p. 34-34.
57. Khazaal, Y., et al., *Does self-selection affect samples' representativeness in online surveys? An investigation in online video game research.* J Med Internet Res, 2014. **16**(7).
58. Dawe, S., M.J. Gullo, and N.J. Loxton, *Reward drive and rash impulsiveness as dimensions of impulsivity: implications for substance misuse.* Addict Behav, 2004. **29**(7): p. 1389-405.