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Gaming disorder: A summary of its characteristics and aetiology

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ABSTRACT

The emergence, development, and maintenance of gaming disorder (GD) is the result of an interplay between gaming-related factors, individual factors, and environmental factors. None of these alone are sufficient to cause a disordered state, but it is the interactive co-occurrence of all these factors, which in some cases leads to GD. The goal of the present paper is to discuss in detail these three factors based on relevant and recent findings of the literature. Among gaming-related factors, we discuss online vs. offline videogames, the role of game genres, structural characteristics, game design elements, as well as some important monetization techniques. Among individual factors demographic risk factors, personality traits, motivational factors, comorbid psychopathology, genetic predisposition, and neurobiological processes are considered. Finally, among environmental factors we discuss family factors, early life experiences, the role of peers and school-related factors, as well as the broader context of culture including the popularity of esports.

1. Introduction

In the past 60 years, videogame playing has gone from a leisure activity pursued by a narrow group of young males to one of the most popular hobbies across gender and age groups [1]. Although for most individuals gaming is a recreational activity or even a passion, a small group of gamers experiences negative symptoms which impact their mental and physical health and cause functional impairment [2]. To stimulate research in the field and help develop efficient prevention and treatment measures, the World Health Organization formally recognized gaming disorder (GD) by including it in the International Classification of Diseases 11th Revision [ICD-11]. According to the ICD-11 [3] GD is a *"persistent or recurrent gaming behaviour, which results in marked distress or significant impairment in personal, family, social, educational, occupational, or other important areas of functioning"*.

It is also worth to be noted that videogame playing is not the only activity which may cause severe harm for the individuals. Other common activities such as gambling, exercise, work, and internet use can also become unhealthy activities that take over individuals' lives [e.g., [4–6]] resulting in 'behavioural addictions' [7]. While there is an ongoing debate whether other problematic behaviours such as the problematic engagement in pornography, social media use, and buying/shopping should be defined as mental health disorders or not [8–10], the inclusion of GD in the ICD-11 is the result of a fairly broad expert consensus [11].

One of the most important research topics in the field of GD is its aetiology. To prevent and treat the problem effectively, it is of key importance to have robust empirical knowledge concerning the course of its development. Similar to other addictions, it is the interactive co-occurrence of three factors, which in some cases leads to GD. These three factors are (i) the gaming-related factors (i.e., structural characteristics), (ii) the individual factors (i.e., person-based characteristics), and (iii) the environmental factors (i.e., situational characteristics) [12]. None of these alone are sufficient to cause a disordered state, only specific patterns of their co-occurrence. For instance, individuals with low self-esteem may chase in-game success and high status to feel better about themselves which may lead to disordered gaming [13], while players with impulse control problems may be especially susceptible to gambling-like mechanisms built in videogames and may end up spending large amounts of money through microtransactions [14].

In the case of substance use disorders, Khantzian [15] argued that drug addicts select their main substance in a way that its psychopharmacological effect matches the type of pain that dominates their lives (e.g., heroin and other opiates have their appeal because of their strong

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muting action on emotions such as rage and aggression). It was also suggested that this may be similar for behavioural addictions, namely that activities (e.g., pornography use, gambling, social media use, shopping) are purposely chosen and adjusted to personal vulnerabilities [16]. This may even be the case for gaming. Specific videogames or game genres may be preferred to cope with specific pathologies. However, this assumption needs to be investigated in future studies.

While there are reviews discussing specific topics of GD aetiology such as the role of structural game characteristics [17], personality traits [18], depression and depressive symptoms [19], gaming motivations [20], and gender [21], comprehensive reviews are lacking. Therefore, the goal of the present paper is to provide a broad overview by discussing in detail the three factors that can influence GD, namely the gaming-related factors, the individual factors, and the environmental factors. By doing so, this will provide a general picture of the current state of aetiological research regarding GD, its most important findings, and main directions for future research.

2. Gaming-related factors

Videogames are the products of a profit-oriented and continuously growing industry. To maximize their revenue, companies aim to create games that are engaging and keep as many players as possible for long periods. To secure continuous play, developers use game design elements based on psychological mechanisms such as operant conditioning that foster player engagement on a long-term basis [22]. Consequently, videogames are highly rewarding experiences and as such they have a significant addictive potential [23]. This does not mean that videogames alone can make specific individuals addicted, as the media-induced moral panic suggests [24], but it means that videogames have several structural characteristics that make them "addictive" in a way that vulnerable individuals may develop GD [25]. In the following sections, we discuss some of the most important game-related factors (e.g., structural characteristics, game design elements, monetization techniques), which increase player involvement.

2.1. Online vs. offline games

The aim of differentiating online and offline games is to divide games based on their social aspects, since online games often (although not always) permit playing together with others, while offline games (in general) do not. Research has consistently found that GD is more prevalent among online game players than players of offline games [26–29]. However, offline games have also been linked to GD [30,31]. Given that loneliness, social anxiety, lower social competence, and low self-esteem are associated with the risk of GD [32–34], the most plausible explanation is that online multiplayer games provide safe environments, in which players can fulfil their social needs [35], while remaining invisible and anonymous, decreasing their anxiety from face-to-face interactions in this way [34,36]. Therefore, players with psychosocial vulnerabilities tend to have a preference for online social interactions compared with traditional face-to-face social activities because they feel more socially competent and efficacious in these virtual environments [37] and therefore, seem particularly susceptible to problematic engagement with multiplayer online games involving social interaction [27].

2.2. Game genres, structural characteristics, and game design elements

Videogames can be classified into different genres such as shooter, strategy, role-playing, multiplayer online battle arena (MOBA) games, etc. although there are many different game genre classifications. There are many genres and there is much overlap between them. Moreover, a great number of games belong to simultaneous genres and due to the increasingly advanced technological development in the videogame industry, new game genres are continuously appearing, often from the fusion of existing ones. Development and change are fast. Moreover, new and popular genres sometimes emerge so suddenly that research struggles to keep pace with them. Consequently, some research findings regarding game genres may even be outdated by the time of their publication. Nevertheless, there are several genres and standalone games that have maintained their popularity and some of these genres have higher addictive potential than others, according to the literature.

Massively multiplayer online role-playing games (MMORPGs) are by far the most researched game type genre and the one that was consistently found as being associated with problematic gaming alongside first-person/third person shooter (FPS/TPS) games, real-time strategy (RTS) games, and multiplayer online battle arena (MOBA) games [17,38]. MMORPGs are immersive 3D virtual environments (often fantasy or science-fiction-themed worlds) that enable a considerable number of users to interact with each another via the internet, and which are permanent. This means that the world continues to exist and evolve while users are away from the game. The player takes the role of a character and competes and cooperates with other players in real-time to advance in the game by completing quests and achieving different goals. FPS games are centred on gun-based and other weapon-based combat in a first-person perspective and are usually match-based games, where players cooperate with members of their team and compete with other teams in real time in virtual environments. RTS games require commanding large medieval, fantasy or sci-fi-themed armies and often include military base or settlement creation and resource management. Lastly, MOBAs, similar to shooter games, are match-based, where two teams compete with each other, demand high cooperativeness. The players usually use spells and skills to combat each other and during the course of the game, they can purchase special equipment to enhance and personalize their fighting style.

These genres include a combination of structural characteristics that makes them particularly appealing to players. Structural characteristics refer to those features of videogames that may facilitate initiation, development, and maintenance of playing over time and include specificities such as the permanent nature of the game world, the advancement and complex reinforcement systems and/or the social interactions aspects [17,39,40]. MMORPGs are particularly successful at inducing operant conditioning via intermittent reinforcement, meaning that rewards are not administered every time the desired response is performed [22], or players keep getting worthless virtual items before a big reward is provided at an unpredictable moment. These virtual rewards release dopamine in the brain [41] facilitating a euphoric state among players, and the variable-ratio reinforcement schedules keep players coming back in the hope of repeating such states and feelings. The social interactions aspect in these game genres is also very effective. In MMORPGs, players join big groups called guilds to achieve in-game goals, and form meaningful and deep relationships with fellow players while playing [42]. In FPS games, players often play in permanent teams in tight cooperation with others improving their skills both individually and as a team. Moreover, character customizations in videogames provide a way to create unique virtual avatars that can be experienced as extensions of the self, which through identification can be used to reduce self-discrepancy between the real and ideal self. This compensatory mechanic is a tool for videogame users with higher body dissatisfaction to boost their self-esteem and fulfil their social needs without the emergence of social anxiety [43]. Such structural characteristics increase involvement and may contribute to the development of GD in the case of psychologically vulnerable players [22].

Finally, it should also be noted that several game genres (especially MOBA games and the 'Battle Royale' genre) have recently become extremely popular and although these have not yet been extensively studied, there is a high probability that these also have high addictive potential due to a good combination of structural features they include [44,45].

2.3. Monetization techniques

The videogame industry has undergone a marked growth since its foundation becoming a multi-billion-dollar global industry. Several innovations have fuelled this growth. Perhaps the biggest one was the integration of internet technology in videogames resulting in the appearance of multiplayer online games, which permit large numbers of individuals from all over the world playing together in the same virtual space. Two other important innovations from an economic point were (i) increasing smartphone use and their use as the most accessible gaming platform, and (ii) the introduction of digital purchase options in games. Free-to-play gaming has quickly become one of the most widespread business models [46] in which revenues are secured from microtransactions (i.e., the purchase of additional game content in the form of virtual items such as textures/skins, weapons, currency, or levels). King and Delfabbro [47] argue that some of the monetization practices often used in the free-to-play business model can be considered "predatory" because *"they involve in-game purchasing systems that disguise or withhold the true long-term cost of the activity until players are already financially and psychologically committed."*

Perhaps the most relevant and highly debated monetization scheme to date is the "loot box". This refers to an in-game reward system, a consumable virtual item usually in the form of a box or crate that can be purchased for real-world money (through microtransactions), which provides players with randomized rewards of unclear value. The psychological mechanism underlying microtransactions is linked to the so-called "sunk-cost effect". The sunk-cost refers to the tendency to continue a behaviour because investments in money, effort or time have been made previously [48]. Thereby, if players have already spent money on loot boxes and did not get what they wished for, they are more likely to make further purchases to get the desired item(s). Occasionally receiving the rare, high-quality rewards they wished for acts as an intermittent reinforcement, meaning that the players get strongly reinforced to continue buying loot boxes for other valuable rewards. Furthermore, free loot boxes are usually provided at the beginning of games to get players familiar with the experience. Moreover, research shows that dopamine is released when anticipating a reward, not only when actually getting it [49]. More specifically, in the case of loot boxes, it is assumed that the brain is already flushed with "joy hormones" at the moment of opening the loot box irrespective of its content [50].

Similarities between loot boxes and slot machines have raised severe concerns, especially because unlike most slot machines, loot boxes are available to children and adolescents and they may provide a gateway to gambling [51,52]. While some studies indicate that microtransaction spending in general is related to problematic gambling severity [53], the findings concerning the relationship between loot box expenditure and problematic gambling [51,54–56] and excessive gaming [57] are much more consistent [58]. Based upon these findings it can be concluded that individuals who spend a lot of money on loot boxes, often called "whales" [46] are not wealthy gamers but more likely to be problematic users [59]. Consequently, it seems that gaming companies (unintendedly or not) are disproportionately profiting from vulnerable individuals (i.e., problem gamblers), rather than high-income customers, which has implications for harm reduction and policy debates regarding loot boxes and other monetization techniques in videogames [59]. In addition to the problems caused by loot box consumption, many sites allow the use of virtual skins (i.e., a graphic download which changes the appearance of in-game items or characters) in gambling activity, further raising the risk of problematic gambling [60]. Various countries are considering regulating loot boxes after Belgium banned them in 2018 [61]. Nevertheless, besides regulation, screening and public education concerning the risks should be implemented to mitigate harm [62].

Another predatory monetization technique worth mentioning is the personalization of offers and pricing. Companies use in-game behaviour tracking to collect data about players, their playing, and spending habits [63]. Based on these data, they carry out behavioural and psychological profiling and use these profiles to tailor offers and even pricing to individual players [see patents no. US9138639B1 and US9623335B1 in 63]. More specifically, this means that the same virtual item with production costs close to zero may be offered and bought for different prices by different players. Furthermore, games may use pressuring tactics to encourage spending. One such technique is the use of "limited time offers", which influences players to purchase items by creating artificial scarcity and making them believe that the opportunity will never be available again. Another pressuring tactic was patented by *Activision Publishing Inc.* in 2015 (Patent no. US20160005270A1). According to the patent, the system identifies an in-game item (e.g., weapon, armour) that may be relevant for a novice player, then it identifies an experienced player owning such an item, and matches the two players (i.e., places them in the same match), so that the novice player sees how good/efficient that particular item is and therefore, they are encouraged to buy it to increase their chances of winning in the subsequent matches [63].

Based on the aforementioned literature, it can be claimed that videogames have a high addictive potential and together with other factors (i.e., environmental, and individual) can contribute to the emergence, development, and maintenance of GD. Consequently, it is crucial for research to be constantly updated to understand newer genres, game design elements, and monetization techniques. Only this way it can provide policymakers the necessary information to make effective policies for prevention and harm-reduction.

3. Individual factors

In addition to gaming-related factors and environmental factors, individual factors play a key role in the aetiology of GD. These include demographic risk factors, personality traits, motivational factors, comorbid psychopathology, genetic predisposition, and neurobiological processes. Ultimately, it is always the players and their individual vulnerabilities, which determine whether videogame playing remains a healthy passion or develops into a pathology.

3.1. Demographic risk factors

According to two recent meta-analyses involving tens of thousands of individuals from a large number of geographic regions, males are more likely to exhibit GD symptoms than females across all age groups with a 2.5:1 rate or with a moderate effect size, respectively [21,64]. Similarly, Pontes and colleagues [65] found higher rates of problematic users among males in a large-scale worldwide study of gamers interested in esports. A plausible explanation for more GD symptoms among male players is their greater interest in videogames, which may be explained from an evolutionary perspective. More specifically, aggressiveness and inclination to fight is a masculine trait in most cultures and even though videogames are becoming more diverse, competition is still their major design element and therefore, they are more attractive to males than females. Accordingly, the gaming industry identifies males as their main target group, and keeps designing games for them, which further reinforces male dominance among videogame users [66-]. In addition, differences have been found in neural activation to gaming cues between the two genders, with males demonstrating higher cue-elicited cravingrelated neural responses [67,68], which indicates that different processes may be responsible for the emergence of GD among males and females.

Younger participants (especially adolescents) have reported higher prevalence rates of GD [64]. On the one hand, a higher proportion of younger individuals play videogames [1] and are also more motivated to play videogames than older individuals [69]. On the other hand, transitional traits such as impaired impulse control and novelty seeking, which are key risk factors for addictions including GD [70,71], characterize adolescents due to maturational changes in specific brain

regions characteristic to this age group [72].

The role of ethnicity is an understudied topic [73] and the few studies reporting such results are contradictory. For instance, Desai [74] reported that white boys in Connecticut had lower rates of GD symptoms than non-whites and Asian boys. Wittek et al. [75] reported that respondents living in Norway but born in Asia, Africa, Central America or South America were more likely to exhibit GD symptoms compared to those born in Norway. On the contrary, Gentile [76] found no significant differences according to the ethnicity of adolescents. Although race and ethnicity might have some importance regarding the aetiology of GD, it is very difficult to study it due to its different meaning in each culture and its strong relationship with several other relevant factors such as the socio-economic and migration status. Furthermore, findings regarding socio-economic variables are also inconsistent. A number of studies did not find any significant associations between education level, employment, marital status, income and GD symptoms [75,77,78], while others have reported lower prevalence rates for those who are better educated, employed, and married (e.g., [79,80] and a negative association with income [81]. One longitudinal study examined the association with parental education and family income with 6- and 12-month follow-up periods [82], only found significant predictive effect of higher family income at 6-month follow-up. Inconsistent findings indicate that further studies are required, and possible cultural differences may also be present.

3.2. Personality traits

A fairly large number of research studies have examined the association between GD symptoms and the so-called "Big Five personality traits" based on the Five-Factor Model [83]. To synthetize all available findings of the relationship between GD and Big Five personality traits, two meta-analyses have been carried out [18,84], demonstrating negative association with extraversion, conscientiousness and agreeableness and positive association with neuroticism. A plausible explanation for the association between GD symptoms and neuroticism is that neurotic individuals are prone to anxiety, depression, and stress and may use virtual game worlds as an escape because they perceive these digital environments as more controllable and safer than their everyday lives. However, if they keep escaping in games to avoid negative affective states, gaming might become problematic [75,85]. Individuals scoring low on conscientiousness have difficulties with being dutiful and self-disciplined, tend to be unstructured and less persistent in pursuing their goals and may therefore find games attractive due to the clear rules and constant positive reinforcement [75,85]. Turning to games to satisfy their need for structure and being easily rewarded may also lead to a greater risk of developing GD. Extraversion may be negatively associated with GD symptoms because videogames provide various non-social opportunities for entertainment, while the negative association with agreeableness may be due to the conflict-avoidance of highly agreeable individuals because playing videogames online can involve stressful social situations and problematic videogame use can also cause interpersonal conflicts during everyday life [84].

Among personality factors, impulsivity stands out due to its relation with addictive behaviours in general [86]. Survey studies examining large-scale adolescent and gamer samples, as well as treatment seeking clinical samples reported a significant association between trait impulsivity and GD symptoms [32,87–89]. Furthermore, studies with experimental design have also found significant associations between experimental impulsivity-related measures (e.g., go/no-go task, impaired ability to postpone rewards) and GD symptoms [90,91]. A study combining survey and experimental assessment in a longitudinal setting found that more GD symptoms at T1 predicted more impulsive decision-making at T2 with a moderate effect size. Moreover, a lower inhibitory control at T2 predicted more time spent on gaming at T3 with a weak effect size [92]. Other associations were not reported. These results suggest that impulsivity may not only be a predisposing risk factor for GD, but the disorder once developed may also further decrease the decision-making abilities of individuals due to a general overvaluation of immediate rewards and/or a reduced valuation of long-term rewards. Finally and relatedly, attention-deficit hyperactivity disorder (ADHD) has also been reported as an important comorbid disorder with GD [e.g., [93]] and impulsivity is assumed to be a common explanatory factor for both disorders [94,95].

The association between GD and other personality traits has also examined in numerous studies. For example, sensation seeking has been positively associated with GD symptoms in some studies, while other studies reported no significant association [96]. It is plausible to think that seeking novel stimuli through videogame adventures and challenges can drive individuals to be addicted to such games. Additionally, narcissism was also found to be positively related to GD symptoms in several studies [96], which may be due to the reinforcing nature of several online games, where social status can be achieved through videogame-related achievements.

3.3. Individual vulnerabilities

Research suggests that similar to other addictions, comorbidity is the norm rather than the exception in the case of gaming disorder [97]. Among psychopathological conditions, depression and depression symptoms, as well as generalized anxiety disorder and anxiety symptoms have been consistently related to GD [19,98,99]. Effect sizes reported vary between weak and moderate. Players experiencing depression and anxiety symptoms may be prone to escape into videogames to avoid facing everyday difficulties and negative affective states [98,100]. Gaming in such cases serves as a form of distraction (instead of a real solution to problems) and may lead to disordered gaming, which in turn may further increase psychopathological symptoms due to impaired functioning, decreased performance, and social isolation [32]. Relatedly, another severe concern regarding GD and comorbid depression is the heightened risk for suicidal ideation [101,102]. In addition, comorbid polysubstance use and substance misuse have also been reported in the case of GD [103–105].

Another comorbid condition thoroughly studied is ADHD. According to a recent meta-analysis [106], both symptoms of inattention and hyperactivity, as well as the combined ADHD symptoms were moderately associated with GD. Several factors may contribute to the development of GD among individuals experiencing ADHD symptoms such as impaired social and affective functioning and/or impulsivity [106]. Furthermore, videogame players with autism spectrum disorder are also more likely to show GD symptoms with varying effect sizes [107,108]. Proposed explanations are similar to those provided in the case of ADHD. Both disorders involve impulse control and response inhibition deficits, which may lead to the development of GD [109]. Given the preponderance of cross-sectional design in the studies examining comorbidity of GD, the direction of the associations is uncertain. Longitudinal studies are much needed. However, most likely the association is reciprocal.

In addition to psychopathology, there are many other individual vulnerabilities. Among these, self-esteem and social competencies are of particular importance. Low self-esteem has been reported as a risk factor in developing GD symptoms in numerous studies [104,110], as are social anxiety or poor social skills [104,111]. Relatedly, a one-year follow up study reported the predictive effect of social vulnerability (i.e., a difficulty in establishing and maintaining close relationships) on GD symptoms, even in interaction with attention problems [112]. For individuals with low self-esteem and/or low social competence, gaming may be an easy and efficient way to compensate for these deficiencies [113], which in turn heightens the risk to develop GD.

3.4. Motivational factors

A lot of research has examined the role of motives in GD. Several

studies reported moderate to strong associations of escapism (playing videogames to avoid everyday problems), as well as weak or moderate associations of achievement-related motives (e.g., advancement, competition) with GD [114–117]. Furthermore, several studies have reported a significant and considerable mediation effect of escapism between different psychiatric symptoms (e.g., depression) and GD [116–118]. These findings suggest that those who play solely for entertainment purposes are very unlikely to develop GD. However, those who have psychiatric difficulties may use gaming as a means to avoid everyday problems or to compensate for their deficiencies, which appears to work as a maladaptive coping mechanism and if pursued for long, it may cause negative (addiction-like) consequences. The same findings were reported in two recent meta-analyses. In the first, the strongest positive association was found with escapism, followed by achievement motivation, while also weak, but positive association was found with immersion and social motivation [119]. In the other meta-analysis [120], the association of GD with escapism was also the strongest, followed by achievement motivation and immersion. Social motivation was only significantly related to GD when a specific measurement tool (i.e., the Motives for Online Gaming Questionnaire [MOGQ; [121]]) was used, but not in case of another popular tool (i.e., the Motivations for Play in Online Games Questionnaire [114]). An additional finding of this meta-analysis was that a positive association was found in the case of several motivations (introjected regulation, external regulation, amotivation, autonomy and relatedness) of two self-determination theory based scales [120].

Given that escapism involves diverting attention away from an emotionally demanding situation, it can be considered a form of distraction – a strategy of emotion regulation [122]. When facing high intensity negative emotions, a powerful strategy requiring minimum effort is to obstruct the information related to the aversive affect, by distracting attention to neutral stimuli unrelated to the original emotions [123]. For instance, individuals who have experienced a family conflict may immerse themselves in videogame playing to divert attention away from uncomfortable thoughts and feelings. The problem is that this strategy hinders the elaborated processing of the negative emotional event [122,123] and therefore, it is expected to be inefficient in the long run [124]. The gamer may feel relieved while playing. However, the aversive emotions related to the conflict persist and reappear as soon as they cease the activity. According to Sheppes and Gross [122], *"distraction can be considered as a 'bandage' regulation strategy that can stop the 'bleeding' but not offer actual remedy."* What is crucial, is how often the individual uses distraction to avoid negative emotions, and whether this is their only strategy to ease the feelings of distress. Those individuals who have a rich variety of different emotion regulation strategies and can use these flexibly according to the circumstances [125], are unlikely to develop GD. However, this argument needs further investigation.

The act of seeking in-game achievements is driven by the rewarding nature of videogames [23] and the process of operant conditioning [22]. Furthermore, these achievements may additionally result in higher recognition and status within the gaming community [96], which cannot be achieved by some individuals during their everyday lives. Finally, social motivation can lead to excessive use through creating an obligation to play because virtual team membership can be as important as belonging to any other groups [119]. In addition, videogames can also serve as safe environments to fulfil social needs [43]. Overall, research greatly supports the idea that it is not gaming time in itself, which predicts GD [126], but the way gamers play, their motives, and the degree they can integrate this leisure time activity in their lives.

Neurobiological processes and genetic predisposition

Research suggests that neural mechanisms underlying GD resemble those of other addictions such as substance use disorder, alcohol use disorder, and gambling disorder [127]. More specifically, GD shares many of the cognitive-affective alterations typical for other addictions such as impaired decision-making, emotion processing, impulsivity, and executive functioning related to different functioning in prefrontal areas and the temporoparietal, frontolimbic and subcortical regions [128]. Besides these functional brain mechanisms, there are also structural changes associated with GD, mainly reduction in grey-matter volume in the ventromedial and dorsolateral prefrontal areas, the anterior cingulate and premotor cortices which are responsible for decision-making, emotion regulation, and cognitive/motor control [129]. Additionally, altered white-matter density has been found in several brain regions involved in behavioural inhibition, decision-making, and emotional regulation [130].

According to an early experimental study, dopamine is released in the ventral striatum during videogame play in a similar magnitude to amphetamine-induced dopamine release [41]. Studies have also reported alterations in the volume of the ventral striatum, which could reflect altered reward processing and indicate adaptive neural plasticity among highly engaged videogame players. Relatedly, research suggests that GD is associated with dysfunction in the dopaminergic brain systems and involves changes in loss of control and reward inhibitory mechanisms [131]. Additional similarities have been found with other addictions, such as with stronger activation in the dorsolateral prefrontal cortex (which was associated with higher level of craving) and different activation of the orbitofrontal cortex (indicating lower level of punishment sensitivity), when individuals with GD were compared to controls using functional near-infrared spectroscopy [132]. Finally, according to comorbidity studies, altered executive control mechanisms in ADHD may increase the vulnerability to develop GD. Relatedly, research suggests that patients with GD, ADHD, and major depressive disorder may share specific characteristics in terms of neurochemical changes in frontal and temporal cortices [131].

Genetic factors also play an important role in the aetiology of substance use disorders [133]. Recent genome-wide linkage and association studies have identified numerous genes in relation to addictive disorders such as alcohol and tobacco [134]. Given the similar neurobiological basis of substance use disorders and GD, it is assumed that some individuals are genetically more vulnerable to develop GD than others. However, to date, there are few studies investigating this. For instance, a recent study found an association between the nicotinic acetylcholine receptor α4 subunit gene (CHRNA4) rs1044396 and GD among Korean male adults [135]. Another study investigating Korean male adolescents reported that the polymorphism of the corticotropin-releasing hormone receptor 1 (CRHR1) gene may play an important role in GD susceptibility [136]. Therefore, future research, on one hand, should examine the association of other genes and variants previously linked to addictive disorders with GD, while on the other hand, it should replicate previous findings in independent samples, and also try to determine the functional mechanisms of these genes and variants.

4. Environmental factors

Finally, environmental factors are influences that do not occur from within the individual but from elsewhere in the environment. Examples of environmental factors are the family and peers, work and school, and also the culture in which the gamer lives in. Besides game-related and individual factors, situational and environmental factors also play an important role in the aetiology of GD.

4.1. Family factors and early life experiences

As in the case of substance use and other potentially addictive behaviours, familial influences and early life experiences affect the likelihood of an individual developing GD. According to a systematic review of 14 studies examining family factors in adolescent problematic gaming [137], the majority of studies have focused on parent-child relationships (e.g., warmth, conflict, abuse) and they reported a negative association between the quality of relationships and severity of problematic gaming.

Similar findings were reported by studies not included in the review [28,138]. A more recent systematic review focusing on associated parental and family factors [139] also reported similar findings. Positive family functioning, characterized by good parent-child communication, common social activities, cohesion, connectedness, acceptance, secure attachment, warmth, and affectivity were protective factors, while poor family functioning, conflicts, hostility and demanding, authoritarian, neglectful or permissive parenting style were risk factors for problematic gaming. More recent findings confirmed that in addition to the low quality parent-child relationship, lack of monitoring, and violent disciplining have deleterious effect [140].

Moreover, studies suggest the mediating effect of specific variables. For instance, it has been found that core-self evaluations mediate the effect of parental rejection on GD [141]. Another study reported that the relationships between attachment styles (anxious and avoidant) and GD were fully mediated by stressful events [142]. Furthermore, the importance of father-child relationship as a possible protective factor for problematic gaming has also been noted in several studies [137,141,143].

A two-wave longitudinal study [144] examining a sample of German students from Grades 4 to 9 ($N = 406$) found that 15-year-old adolescents' problematic gaming have already shown several risk factors at the age of 10 years. One important risk-factor was growing up in a single-parent family, in agreement with the results of other studies [137,145]. The effect stayed stable with time even when controlling for parental devotion and supervision, which suggests that the risk is not due to a lack of parental care in single-parent families but the insufficient time and fewer resources to provide alternative leisure time activities for the children in a balanced way. A 12-month prospective study among 9–10-year-old children [146] showed that earlier parental marital conflict directly predicted GD symptoms at follow-up. Additionally, an indirect path was also identified. More specifically, parental marital conflict influenced GD severity of children one year later via poor father-child attachment and impaired self-esteem. Another longitudinal study found that parental involvement can attenuate the harmful effect of bullying on GD severity by preventing the development of present-oriented consideration of future consequences and promoting the development of future-orientation [147].

Review findings suggest that parental monitoring and regulation of the gaming behaviour are effective strategies for GD prevention [148]. Parents who regulate their children's gaming are also more likely to help them find and practice alternative leisure time activities [149], which is crucial in maintaining a healthy balance and is recommended as a prevention strategy [149,150]. Another risk factor for the onset and maintenance of GD is childhood maltreatment [e.g., [139,151,152]], which refers to emotional, sexual, or physical abuse and physical or emotional neglect. In the case of maltreatment, parents or caregivers who fail to satisfy the basic physical and psychological needs of their children (e.g., nurturing, belonging), may produce severe and long-lasting negative consequences like feelings of guilt and shame, poor self-esteem, psychological functioning and social relationships [148]. These children may use videogame playing to compensate for their unmet needs (e.g., achievement, relatedness) or cope with psychological symptoms like depression or anxiety [113].

Another relevant aspect is the ownership of gaming equipment (e.g., personal computer, videogame consoles) and its availability in adolescents' rooms. Both adolescents' access to their own gaming devices, as well as gaming in their bedrooms have been linked to increased hours of gaming [153] and to problematic gaming [144]. However, when other factors (i.e., media usage and school-related variables) were included in the model in a longitudinal design, having gaming consoles in the children's rooms at age 10 years no longer predicted problematic use five years later [144]. This suggests that seemingly simple preventive solutions such as banning gaming devices from children's rooms are not enough in themselves. Most probably, reasons underlying the development of GD are of a fundamental nature, related mostly to the personality and motives of the players. Nevertheless, keeping gaming devices in the shared spaces to ease monitoring may be a useful recommendation [149].

Findings regarding the familial influences emphasize the importance to involve families in the intervention programs targeting adolescents with GD. The efficacy of interventions involving families is less researched than interventions focusing on the individuals but there are some successful outcomes. A study by Liu et al. [154] assessed the efficacy of the multi-family group therapy (i.e., a combination of family and group psychotherapy in which several families meet in the presence of therapists) to reduce problematic internet use among adolescents. According to the findings, the therapy was highly successful, mostly due to the improvement of the adolescents' satisfaction of their psychological needs and parent-child communication and closeness. A family approach to GD prevention and treatment recognizes the importance of dysfunctional family dynamics, an aspect also emphasized in the case of substance use disorders [155]. Relatedly, prevention programs which focus only on adolescents may be perceived as blaming by the target group and fail to address family-related issues, which may be one of the main reasons for using games excessively and problematically [137]. Consequently, prevention programs should also target parents and caregivers to reduce possible negative attitudes, unreasonable expectations, and criticism towards adolescents' videogame use.

4.2. Peers and school-related factors

Relationships with peers and the school environment are also crucial environmental factors in the aetiology of GD. Social integration in one's environment and peer group is of special importance for adolescents, who are in the life stage of identity formation and individuation from the family of origin [156]. Research shows that self-reported well-being at school, as well as social integration in class are protective factors [144] and these results are in agreement with other studies reporting a relationship between poor social skills and problematic gaming [32,157,158]. Furthermore, according to a systematic review [159], GD symptoms among adolescents were correlated with problems with peers (both being bullied and bullying others), having friends whose gaming was also problematic, having low educational and career achievements (skipping school classes, truancy, and having low school grades), and having poor social skills, low competence, and a low level of integration. These findings were supported by a recently published meta-analysis [160], showing that interpersonal problems, bullying perpetration, and victimization are all important risk factors for GD. Additionally, the importance of peer relationships were reported in a one-year longitudinal study [161], where the possible bidirectional effect of perceived parent-adolescent and peer attachment were tested. In this study, father or mother attachment did not predict GD at the follow-up, while peer attachment had a bi-directional association with GD.

Findings suggest that children and adolescents who have difficulties with making friends and who reported low levels of school-related well-being may use gaming as a compensation. The invisibility, anonymity, and equal/fair chances provided by virtual game worlds may be very tempting for children who are otherwise excluded and harassed by their peers because they can experience self-efficacy while playing and feel recognized by fellow gamers [144]. However, such a compensation might increase the risk of long-term psychological consequences (including the risk for GD) because real life difficulties and failures are not addressed but avoided [113].

In addition to peers, teachers also play an important role in adolescents' lives, psychosocial well-being, and identity formation. One important responsibility of teachers is to provide autonomy support for children, which refers to the extent to which students feel that their teachers offer opportunities for choice and decision-making regarding learning and classroom life (e.g., teachers ask their students what they want to learn about). According to a longitudinal study conducted among Chinese students [162], teacher autonomy support perceived in

7th grade increased basic psychological needs satisfaction (i.e., the need for competence, autonomy, and relatedness) in the 8th grade, which in turn increased school engagement (i.e., behavioural, emotional, and cognitive engagement) in 9th grade, which ultimately decreased problematic gaming in 9th grade. Additionally, teacher autonomy support in 7th grade had a direct effect on school engagement two years later, which in turn decreased problematic online gaming. These findings suggest that teacher autonomy support is also an important protective factor for the risk of adolescent GD, and school engagement and basic psychological needs satisfaction are important mediators in this association.

4.3. The broader context of culture

Research shows that GD is a global concern. Indeed, research related to GD has been carried out worldwide [163] (although there is a lack of research conducted in Africa, the continent with the lowest internet penetration rate, with the exception of few epidemiological studies [164]). In the meta-analysis by Stevens et al. [64], higher pooled prevalence rate was found for the prevalence of gaming disorder in Asian countries (5.08%) compared to Europe (2.72%). Cultural differences appear to determine the prevalence rates of GD, but mainly not affecting the gender ratio of GD, as it seems to be maledominated in almost all countries, with the exception of India, where more females were reported as experiencing GD symptoms [21]. Furthermore, according to a meta-analysis of 84 independent samples comprising almost 60,000 participants from 20 countries and seven geographic regions, the associations between GD symptoms and psychological problems were moderately strong across the countries suggesting the universality of this association [163]. In line with this finding, a cross-cultural study of gamers from ten cultures (from Europe, Iran, Peru and Korea) found similar patterns of associations between variables such as GD, psychiatric symptoms, gaming motives, and gaming time across cultures [165,166].

Nevertheless, even if the disorder is a global phenomenon and some of the major links of it appear to be global, culture most certainly plays an important role in the emergence, development, and maintenance of the disorder, as well as in the efficiency of prevention and treatment practices. For instance, Asian and Western cultures tend to view and address GD differently. While the former considers it a major public health threat, the latter are far less coercive. This disparity has deep cultural roots. In Asian countries, there is a particularly strong pressure on children and adolescents regarding academic performance because competition in employment is high. Given that videogame playing is an immersive and time-consuming leisure time activity, parents, educators, and policymakers view gaming as a severe threat for academic performance and as therefore, a dangerous activity, which may undermine an individual's career chances. In contrast, in Western cultures, academic pressure is less severe and therefore, gaming is not concerned as a public "enemy", but as a common hobby. Accordingly, in Asian countries, several policy actions have been taken at governmental level, which mostly target adolescents regardless of their degree of problematic involvement and usually aim to decrease time spent on gaming [167]. Moreover, there are numerous state-financed treatment centres across Asia. In Western countries, on the other hand, the problem is mostly addressed by the private sector, which provides expensive treatment programs for those who can afford them [23].

Some papers (seemingly using the same dataset) examined the assumed moderating role of vertical individualism (one type of cultural orientation which refers to the acceptance of social inequality as a by-product of perceived hierarchical structures within a society), on the association between GD symptoms and comorbid stress, inattention, and depression symptoms, respectively, in a sample of massively multiplayer online (MMO) game players mostly from the US and Australia [168–170]. Results showed that gamers with a more vertically individualistic cultural orientation had stronger links between GD symptoms and comorbid stress, inattention, and depression symptoms, respectively, than gamers, who reported lower vertical individualism scores. A plausible explanation may be that more vertical individualism stresses competition and achievement as the measure of personal value, and therefore such individuals are more disposed to engage excessively in MMO games which offer the opportunity to gain recognition among peers by being a successful gamer. These players may use videogames as a means to cope with their comorbid stress, inattention, and depression symptoms, which in turn may increase the risk of problematic use [e.g., 116]. Furthermore, in a large European study [171], the protective effect of social policies (i.e., benefits for families and children such as child payments, allowances and parental leave payments) were found, while economic inequality was a risk factor for GD at the cross-national level.

To gain insight in the role of sociocultural factors on the empirical applicability of different hypotheses derived from three major theoretical perspectives on GD, Cheng et al. [163] performed a meta-analysis of 20 countries from seven geographic regions. Based on the literature, the authors claimed that GD has been defined by researchers in three different ways. According to the comorbidity hypothesis, GD is a pathology, which co-occurs with psychological problems and poor psychological well-being. According to the interpersonal impairment hypothesis, GD is a maladaptive coping with interpersonal problems rather than a pathology per se. Finally, the dilution effect hypothesis states that GD is a deficient self-regulation with the underlying motive to restore psychological and social well-being. As aforementioned, the results of the meta-analysis provided some support for the globality of the comorbidity hypothesis because moderately strong positive associations between GD symptoms and psychological problems were found across countries. However, the other two hypotheses appear to be impacted by cultural factors differently. The interpersonal impairment hypothesis was more defensible in countries lower in power distance (democratic countries) than in countries with higher acceptance of status differences and stronger social hierarchy. The dilution effect hypothesis, on the other hand, was more sustainable in countries higher in national life satisfaction and lower in cultural masculinity (i.e., the extent to which members of a society embrace success and achievement as key values).

4.4. International growth of esports

Finally, the phenomenon and fast increasing popularity of esports needs to be mentioned. Esports is an abbreviation of 'electronic sports' and refers to the professional competitive videogame playing where teams or individuals compete against each other [172]. Esports started to gain popularity in the 2000s and has skyrocketed since then with an estimated audience of 532 million individuals in 2022. Revenues in the esports sector globally were estimated to $1.38 billion (US) in 2022. However, this immense popularity is not unified, and varies across regions. Asia, and especially China, has the most esports players and viewers, and the hype surrounding the esports phenomenon is also the highest in this part of the world [173]. Although information regarding the impact of esports on GD is scarce, Chung et al. [174] argued that the further promotion of videogame playing under the umbrella of esports would likely increase the prevalence of hazardous gaming and GD. Indeed, an environment, in which electronic sports is a national sport and esports players are highly paid celebrities, may further increase youth's interest in gaming, both as a leisure time activity and as a career opportunity [175]. Montag and colleagues [176] investigated this and found that professional gamers as well as videogame users with the intention to become esports players reported slightly higher level of GD severity and also higher levels of gaming motives then non-professional gamers without a plan to become one. Thereby attention should be paid to children and adolescents pursuing esports career to prevent possible future impairment.

To sum up, there is evidence that culture plays a role in the aetiology and maintenance of the disorder and may also influence the efficiency of prevention and intervention practices. While GD is a global concern with

seemingly global symptoms, its manifestation, evaluation, and management vary across cultures. Therefore, it is essential for prevention and treatment programs to be adjusted to local circumstances to maximize efficiency. Nevertheless, more research is needed in this area, both regarding general cultural aspects and regarding the impact of esports.

5. Future research directions

Based on the gaps identified in the present review, future studies should focus on specific aspects of aetiology. For instance, there is a great need for studies exploring structural game characteristics and monetization techniques because videogames are continually changing and advancing using newer behavioural mechanics that appear to manipulate gamers to play more and spend more. Relatedly, neurobiological processes associated with these seemingly manipulative techniques should also be further investigated alongside other individual factors such as genetic predisposition, motivational factors, and comorbid psychopathology. The latter is crucial in terms of treatment because comorbid disorders can significantly hinder recovery if not treated in parallel. In addition, cultural aspects such as the parental attitude towards gaming as a hobby, the esports environment, and local policy measures are all important aspects which influence the aetiology of GD and need to be further examined empirically.

Moreover, future research needs to explore the specific interactions between the three aetiological factors outlined in the present review. It is plausible to assume that there are particular interactional profiles which need specific types of prevention and treatment. This is in line with Ko et al.'s [177] clinical observations who argued that there are common types of GD patients, such as male patients with ADHD, patients with dysphoria and dysfunctional coping skills, or isolated patients with social anxiety. Future studies should be conducted to explore such profiles to help develop personalized treatment protocols.

6. Conclusion

Three interrelated factors play a role in the development and maintenance of gaming disorder: gaming-related factors, individual factors, and environmental factors. Videogames are designed in a way to maximize player engagement by involving numerous psychological mechanisms such as operant conditioning. Individual factors play a crucial role in the development and maintenance of gaming disorder through the individual's psychological and neurobiological vulnerabilities. Last, environmental factors such as the family or even the broader cultural environment heavily influence how individuals play and whether gaming may become problematic. Consequently, prevention and intervention of gaming disorder at both the community level and the individual level require multi-professional action (e.g., from caregivers, educators, researchers, therapists, policymakers) due to its multifactorial nature regarding aetiology.

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