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Attention Deficit Hyperactivity Disorder : what are the relationships with Gaming Disorder Symptoms and the motivations to play?

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Abstract

Objectives: This study aim to evaluate the relationship between ADHD and Gaming Disorder symptoms (GDs) in an adult sample, taking inattention, hyperactivity and impulsivity dimensions into account. Secondly, this study explores the motivations for playing among gamers with a potential diagnosis of ADHD compared to non-ADHD gamers.

Method: 178 participants from the general population completed an online survey. They completed the Game Addiction Scale (GAS), Game Play Motivations (GPM) and the WHO Adult ADHD Self-Report Scale (ASRS).

Results: 57 participants (32%) had a probable diagnosis of ADHD, 55.1% (n = 98) had GD, including 40 with comorbid ADHD (40.8%). The inattention and impulsivity dimensions of ADHD predicted GDs. In the ADHD sample, the game mechanics and escapism motivations predicted GDs.

Conclusions: ADHD and GD are strongly related in our sample, and escapism predict GDs in both the ADHD and non-ADHD samples. Implications for prevention, psychotherapy and future directions are discussed.

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by excessive inattention and/or hyperactivity and impulsivity (American Psychiatric Association, 2013), and a persistent disorder into adulthood (Bonvicini et al., 2016). In adult populations, ADHD has a prevalence of 2.5 to 4.9% (Moffitt et al., 2015; Ramos-Quiroga et al., 2014; Simon et al., 2009). In most cases, ADHD is comorbid with other mental disorders (Kessler et al., 2006) and associated with substance use disorders (Moffitt et al., 2015; Wilens & Spencer, 2010) as well as behavioral addictions (Bielefeld et al., 2017; Blankenship & Laaser, 2004; Breyer et al., 2009; Brook et al., 2015; Fatséas et al., 2016; Leménager et al., 2018; Panagiotidi & Overton, 2018; Romo et al., 2018; Wéry et al., 2016; Yen et al., 2009). Internet Gaming Disorder is classified in section III of the DSM-5 and gaming has been recognized as a disorder by the World Health Organization (World Health Organisation, 2018). The prevalence of gaming disorder (GD) ranges from 0.7–15.6% depending on the country, the sample and the scales used (Feng et al., 2017).

1.1 Gaming Disorder symptoms (GDs) and ADHD

Most of the studies focusing on video games and ADHD were carried out in children and adolescents. Two reviews concluded that there is a strong relationship between ADHD, internet addiction and GD among children and adolescents (Weinstein & Weizman, 2012; Weiss et al., 2011). Adolescents with ADHD spend more time on the Internet for many reasons including to play online games (Bolic Baric et al., 2018), and in this population, ADHD was considered as a predictor and a comorbidity GD (Weinstein & Weizman, 2012; Weiss et al., 2011).

In adult samples, researchers have found an association between ADHD and Gaming Disorder symptoms (GDs) (Andreassen et al., 2016; Cabelguen et al., 2021; Dullur et al., 2021; Evren et al., 2018; González-Bueso et al., 2018; Lee et al., 2018; Mathews et al., 2019; Panagiotidi, 2017; Stockdale & Coyne, 2018). The prevalence of the comorbidity of ADHD among participants with GD was estimated to be 39% (Cabelguen et al., 2021; Yen et al., 2017). Adults with ADHD presented a higher risk of developing GD and a higher severity of GD (Evren et al., 2018; Mathews et al., 2019; Yen et al., 2017). The ADHD symptom that was the most related to Internet GD was inattention (Panagiotidi, 2017), and on clinical sample Cabelguen et al. (2021) found that the combined (2/3 of the patients with GD) and the inattention (1/3 of the patients with GD) types were predominant among patient with gaming disorder.

Several etiological explanations of the relationship between video gaming and ADHD were proposed in the literature. First, children and adults with ADHD may play video games as part of a self-medication process to cope with negative symptoms (Bielefeld et al., 2017; Han et al., 2009), and which involve the neurobiological dopaminergic and reward systems. This hypothesis remains speculative among adults with ADHD due to the small body of evidence (Bielefeld et al., 2017). A second possible explanation is that internet addiction or video gaming could exacerbate the symptoms of ADHD in adolescents (Weiss et al., 2011). A recent study showed that adult cases of ADHD occurred without a history of the disorder during childhood (Moffitt et al., 2015), thereby suggesting that environmental factors may influence the development or exacerbation of ADHD symptoms. GD could lead to the development of ADHD symptoms or even increase the intensity of existing ADHD symptoms. Third, some authors suggest a bidirectional relationship between ADHD and video gaming, where ADHD symptoms have an influence on the perceived attractiveness of video gaming, while gaming exacerbates certain ADHD symptoms by reinforcing them, e.g. such as inattention, disinhibition, impulsive answers, a need for an immediate reward or craving (Gentile et al., 2012; Weiss et al., 2011). Through its mechanics (immediate feedback, achievement), gaming reinforces the trend seen in children with ADHD with regards to impulsive, quick and hyper-focused reactivity (Weiss et al., 2011). A final explanation posits that GDs and ADHD may share common process characteristics (i.e. impulsivity), which thus consolidates the hypothesis of a common etiology and explains the strong relationship between GDs and ADHD.

1.2 Motivations for playing, GDs and ADHD

The motivations for playing are closely involved in the development and maintenance of Internet GD (Billieux et al., 2013; Yee, 2006). Yee (2006) described three main motivation components for playing: achievement, social support and immersion. Each motivation component is broken into subcomponents: advancement, mechanics and competition for the achievement motive; socializing, relationships and teamwork for the social motive; and discovery, role playing, customization and escapism for the immersion motive (Yee, 2006). Researchers have concluded that the achievement motive and its advancement subcomponent (i.e. the desire to gain power, progress rapidly, and accumulate in-game symbols of wealth or status) and mechanics subcomponent (i.e. having an interest in analyzing the underlying rules and system in order to optimize character performance) were related to problematic online gaming and gaming related problems (Billieux et al., 2013, 2015; Kuss et al., 2012; Yee, 2006;

Zanetta Dauriat et al., 2011). The immersion motive and its role playing subcomponent (creating a persona with a background story and interacting with other players to create an improvised story) and, even more so, its escapism subcomponent (using the online environment to avoid thinking about real-life problems) were also related to problematic gaming and gaming related problems (Billieux et al., 2013, 2015; Király et al., 2015; Kuss et al., 2012; Zanetta Dauriat et al., 2011). It was found that social motives either reduced the probability of negative social consequences or were not associated with problematic gaming (Hellström et al., 2012).

Within the context of ADHD, some authors have suggested that the motivations for playing may lead individuals with ADHD to gaming and GDs. Yen et al. (2017) hypothesized that the feeling of achievement and pleasure experienced in the game may help gamers to cope with psychosocial problems and ADHD-related difficulties in real life and could lead to an immersion motive for gaming such as escapism. Moreover, gamers with ADHD may play in order to obtain social support that they are not getting in real life (Yen et al., 2017). In a clinical sample studies, Bielefeld et al. (2017) asked 25 gamers with ADHD to provide their motives for gaming. Patients reported that their major motives were gaming for stimulation, to deal with loneliness, for socialization needs and/or to relax (Bielefeld et al., 2017). Cabelguen et al. (2021) compared the motivations for gaming between ADHD and non ADHD patients diagnosed for GD. They reported higher scores of coping and social motives among GD/ADHD patients. But to date, no study has investigated the motivations for online gaming among participants with probable ADHD using Yee's (2006) model.

1.3 Current study

Several recent studies have investigated the relationship between ADHD and GDs in adults (Andreassen et al., 2016; Evren et al., 2018; González-Bueso et al., 2018; Lee et al., 2018; Panagiotidi, 2017; Stockdale & Coyne, 2018). Studies investigated the prevalence of the co-occurrence of the two disorders (Evren et al., 2018; Yen et al., 2017), i.e. ADHD symptoms related to GD, using the DSM-IV definition of ADHD (Panagiotidi, 2017) and considered the mediator effect of the personality traits (impulsivity, hostility, low extraversion and neuroticism) in the relationship between ADHD and GDs (Evren et al., 2018; Yen et al., 2017).

In light of these results, it seems necessary to confirm the association between ADHD and GDs considering the three-factor structure of the Adult ADHD Symptoms Rating Scale (ASRS), which differentiates between hyperactivity and impulsivity, in line with the ICD-10 classification (Morin et al., 2016). Given that ADHD and GD may share common characteristics, such as impulsivity, it is relevant to determine how each dimension of ADHD (inattention, hyperactivity and impulsivity) contributes to GD symptomatology. Thus, the first aim of this study is to evaluate the association between ADHD, GD and GDs in an adult sample considering the three dimensions of ADHD. In line with Panagiotidi (2017) and considering the common impulsive trait of ADHD and GD (Yen et al., 2017), we hypothesize that inattention and impulsivity will predict the severity of GDs.

The motivation for playing is linked to the development and maintenance of GDs. Until now, motivations for playing among adult ADHD gamers have only been either hypothesized (Yen et al., 2017) or explored among 25 gamers diagnosed with ADHD (Bielefeld et al., 2017). Yee's model of motivation for gaming (Yee, 2006) has never been applied to a sample of adult gamers potentially diagnosed with ADHD, or compared with a sample of non-ADHD gamers. The second and aim of this study is to explore the motivations for playing in gamers with a potential ADHD diagnosis and non-ADHD gamers. First, we will compare the level of motivation for playing between ADHD and non-ADHD participants. We hypothesized that the gamers with a potential ADHD diagnosis will report a higher rate of achievement, socialization and immersion motives than the non-ADHD participants. Secondly, we will explore the motivations for playing that predicted GD symptoms in the ADHD sample versus the non-ADHD sample.

2. Method

2.1 Participants

In order to be included in this study, the participants had to be 18 years old or over and play online video games at least once a week. Two hundred and nine participants took the survey; among these 209 questionnaires, 31 were excluded from the analysis because they were incomplete or did not meet the inclusion criteria. The final sample included 178 participants aged between 18 and 50 years (mean age = 24.6; SD = 5.32) and mostly men (n = 122; 68.5%).

2.2 Material

The first part of the questionnaire included sociodemographic information (e.g. gender, age, profession) and information related to the practice of gaming such as the frequency of online video gaming by week, the number of hours spent gaming per week and the type of game played (MMORPG, FPS, MOBA, RPG). The second part of the questionnaire comprises three scales:

The Game Addiction Scale (GAS) (Gaetan et al., 2014; Lemmens et al., 2009) evaluates video game addiction symptoms with seven items measuring salience, tolerance, mood modifications, relapse, avoidance, conflict and problems that the subject experiences in relation to gaming. The participants were asked to indicate the frequency of the behaviors described on a five-point Likert scale (from 1 "never" to 5 "very often"). The scores ranged between 7 and 35, and Cronbach's α was 0.795 in our sample. Gaming is considered to be problematic when the participants obtain a score of above three (sometimes) for at least four items (Lemmens et al., 2009).

The Game Play Motivation (GPM) was developed by Yee (2006) to evaluate the motivations for playing online video games (Yee, 2006). This scale is divided into three dimensions: Accomplishment, Socialization and Immersion. Each dimension comprises several factors. Achievement (Cronbach α = 0.855) includes three factors: Advancement, Mechanics and Competition. Socialization (Cronbach α = 0.851) includes three factors: Socializing, Relationship and Teamwork. Immersion (Cronbach α = 0.849)

includes four factors: Discovery, Role playing, Customization and Escapism. The GPM comprises 39 items rated on a Likert scale from 1 to 5.

Adult ADHD Symptoms Rating Scale (ASRS) was created to enable adults to perform a self-evaluation of the ADHD symptoms (Kessler et al., 2005). The ASRS is based on the DSM-IV and the ICD conceptualization of ADHD. Each of the 18 items is rated on a five-point Likert scale from 0 (never) to 4 (very often). To classify the Screen Positive result for the screening test, we used the six questions from the ASRS screener. A score between 4 and 6 indicates a potential ADHD diagnosis. As proposed in the validation of the French factorial structure of the ASRS, the 18 dichotomized items were summed up in order to assess the inattention (items 1–4 and 7–11), hyperactivity (items 5–6 and 12–14) and impulsivity (items 15–18) dimensions (Morin et al., 2012).

2.3 Procedure

The online survey was distributed on social networks from February 2017 to April 2017. All the participants agreed to participate in the online study by completing an informed consent form. The study followed the ethical guidelines given in the Helsinki declaration.

2.4 Statistical analysis

Independent t-tests and Chi-squared tests were carried out to determine differences between ADHD and non-ADHD subjects in terms of gender, duration and frequency of the game sessions and type of game played. To evaluate the association between ADHD and GDs, we performed a logistic regression in order to predict GDs with the three dimensions of the ASRS scale (inattention, hyperactivity and impulsivity) in order to evaluate their contributions.

Independent t-tests were performed to evaluate and to compare the level of motivations to play between ADHD and non-ADHD gamers. Cohen's d was applied to assess the size effect of the t-test: a d value of 0.20–0.50 is considered a small effect; a value between 0.50–0.80 is a medium effect; and a value above 0.80 is a large effect (Cohen, 1988). Lastly, in order to evaluate which motivations to play predicted GDs in gamers with and without ADHD, we first performed Pearson's correlations and then two multiple linear regressions to predict the GAS score in the two groups of gamers. Only the motivations that were correlated to the GAS score were entered in the multiple linear regressions. The statistical analyses were performed using the R package Jamovi (The Jamovi Project, 2021).

3. Results

3.1 Descriptive statistics.

The sample comprised mostly men (68.5%; $n = 122$). Students made up more than half of the sample (56.5%, $n = 100$). Among the participants, 28.2% ($n = 50$) were employed. 38.2% ($n = 68$) of the participants played less than 15 hours a week, 44.4% ($n = 79$) played between 15 and 30 hours a week and 17.4% ($n = 31$) played more than 30 hours per week. The participants played RPG (47.7%; $n = 83$), FPS

(43.2%; n = 76), MMORPG (41.5%; n = 73) and MOBA (36.9%; n = 65) games. The comparisons between gamers with and without ADHD are reported in Table 1. The two groups are significantly different with regards to gender and the number of hours played per week.

Table 1
Comparisons between gamers with and without ADHD

	ADHD (n = 57) n (%) or m (SD)	Non ADHD (n = 121) n (%) or m (SD)	χ^2	t	p
Gender					
<i>Women</i>	10 (17.9%)	46 (82.1%)	5.965		0.006
<i>Men</i>	47 (38.5%)	75 (61.5%)			
Age	24.2 (5.4)	24.8 (5.3)		0.733	0.465
Number of hours played per week			9.76		0.008
<i>Less than 15 hours</i>	16 (28.1%)	52 (43%)			
<i>Between 15 and 30 hours</i>	24 (42.1%)	55 (45.5%)			
<i>More than 30 hours</i>	17 (29.8%)	14 (11.6%)			
Number of days played per week			2.02		0.364
<i>One day</i>	5 (8.8%)	10 (8.3%)			
<i>2 to 3 days</i>	10 (17.5%)	33 (27.3%)			
<i>4 to 7 days</i>	42 (73.7%)	78 (64.5%)			
Types of games played					
MMORPG	26 (46.4%)	47 (39.2%)	0.830		0.362
FPS	21 (37.5%)	55 (45.8%)	1.08		0.299
MOBA	25 (44.6%)	40 (33.3%)	2.10		0.148
RPG	33 (60%)	50 (42%)	4.88		0.027

3.2 Association between ADHD symptoms and GDs

32% (n = 57) and 55.1% (n = 98) of the sample reported enough symptoms to suspect ADHD and GD, respectively. Lastly, 40.8% (n = 40) of the problematic gamers had a comorbid ADHD.

A logistic regression was performed to predict the score whether the subject had GDs or not based on the ASRS subscales (inattention, hyperactivity and impulsivity). The model with the three predictors was statistically significant [$\chi^2(3) = 21.7; p < .001$]. Nagelkerke's R^2 value of 0.154 indicated a weak relationship between prediction and grouping. This model was able to classify 69.66% of the observations correctly. Inattention and impulsivity were significant predictors and each of them contributed to the fit of the model with the data (the p-values of the log likelihood for the two significant predictors were less than .005). The participants showing impulsivity were more likely to report a GDs, with an odds ratio of 1.891 ($p = .006$; 95% CI [1.205–2.968]). Furthermore, inattention symptoms increased the risk of GDs by 1.22 ($p = .017$; 95% CI [1.037–1.437]).

3.3 ADHD versus non-ADHD, comparisons of the motivations for playing online video games.

Table 2. presents the means comparisons of the motivations for playing online video games between participants with a potential diagnosis of ADHD ($n = 57$) and participants without ADHD ($n = 121$). Participants with a potential diagnosis of ADHD had significantly higher scores on the achievement and socialization dimensions and on the following factors of motivations for playing: Advancement, Competition and Socialization.

Table 2
Comparison of the motivation for playing in ADHD and non-ADHD gamers

	Non-ADHD (n = 121) Mean (SD)	ADHD (n = 57) Mean (SD)	<i>t</i>	<i>p</i>
Achievement	39.93 (9.88)	44.02 (8.53)	-2.683	0.008*
Advancement	17.78 (4.96)	19.30 (4.10)	-2.015	0.045*
Mechanics	12.41 (3.18)	13.28 (2.86)	-1.753	0.081
Competition	9.74 (3.83)	11.44 (3.88)	-2.743	0.007*
Socialization	32.39 (8.38)	34.96 (6.67)	-2.035	0.043*
Socializing	13.47 (3.81)	14.93 (3.33)	-2.478	0.014*
Relationship	7.00 (3.20)	7.98 (2.94)	-1.961	0.051
Teamwork	11.92 (3.44)	12.05 (2.74)	0.260	0.795
Immersion	44.41 (10.10)	47.19 (8.24)	-1.812	0.072
Discovery	13.74 (4.05)	13.91 (3.71)	-0.266	0.791
Role Play	11.11 (3.66)	12.11 (3.02)	-1.793	0.075
Customization	9.56 (2.70)	10.33 (2.28)	-1.863	0.064
Escapism	10.00 (2.83)	10.84 (2.60)	-1.899	0.059

3.4 Motivations for playing that predicted GDs in the ADHD sample versus the non-ADHD sample

First, correlations were performed between the GAS score and the motivations for playing in both the ADHD and non-ADHD sample. In the non-ADHD sample, the advancement ($r = 0.275$, $p < .01$), mechanics ($r = 0.289$, $p < .001$), competition ($r = 0.305$, $p < .001$), relationship ($r = 0.389$, $p < .001$), escapism ($r = 0.532$, $p < .001$), role playing ($r = 0.257$, $p < .01$) and customization ($r = 0.217$, $p < .05$) motivations were significantly correlated to the GAS score. In the ADHD sample, the advancement ($r = 0.344$, $p < .01$), mechanics ($r = 0.470$, $p < .001$), competition ($r = 0.358$, $p < .01$), relationship ($r = 0.289$, $p < .05$) and escapism ($r = 0.484$, $p < .001$) motivations were significantly correlated to the GAS score.

Only the motivations for playing correlated with the GAS score were entered in the multiple linear regression analysis for the ADHD sample and then for the non-ADHD sample. These results are presented in Table 3. In the ADHD sample, the model explained 42% of the variance of the GAS score. Only the mechanics and escapism motivations were significant predictors of the GAS score ($F_{(5,51)} = 7.40$; $p < 0.001$). Among the non-ADHD sample, the model explained 38.2% of the variance of the GAS score.

Competition, relationship and escapism were significant predictors of the GAS score ($F_{(7,113)} = 9.97$; $p < 0.001$)

Table 3

Linear regression of the motivations correlated with the GAS score, in the ADHD sample and the non-ADHD sample.

	ADHD			Non-ADHD		
	B	t(57)	p	B	t(121)	p
Advancement	0.039	0.220	0.827	-0.0114	-0.111	0.912
Mechanics	0.651	2.751	0.008*	0.093	0.616	0.539
Competition	0.231	1.301	0.199	0.281	2.417	0.017*
Relationship	0.0486	0.222	0.825	0.2430	1.809	0.073
Escapism	0.800	3.364	0.001*	0.799	5.144	< 0.001*
Role Playing				-0.080	-0.631	0.529
Customization				0.066	0.407	0.685
	$R^2 = 0.420$; $F(5,51) = 7.40$; $p < 0.001$			$R^2 = 0.382$; $F(7,113) = 9.97$ $p < 0.001$		

4. Discussion

4.1 Relationship between ADHD symptoms and GDs

In our sample, 40.8% ($n = 40$) of problematic gamers had a probable comorbidity with ADHD, providing supplementary data that supports a strong comorbidity between these disorders in an adult sample. Yen et al. (2017) found a similar prevalence (39%) (Yen et al., 2017); in addition, previous studies carried out in adults (Andreassen et al., 2016; Evren et al., 2018; González-Bueso et al., 2018; Lee et al., 2018; Panagiotidi, 2017; Stockdale & Coyne, 2018), children and adolescents (Weinstein & Weizman, 2012; Weiss et al., 2011) concluded to a strong relationship between ADHD and GD. As we hypothesized and in line with previous studies (Panagiotidi, 2017; Yen et al., 2017), inattention and impulsivity were significant predictors of GDs whereas hyperactivity was not a predictor. Several assumptions explain the relationship between ADHD symptoms and GDs. First, a longitudinal study reported that most of the adults with ADHD did not report ADHD symptoms during childhood (Moffitt et al., 2015). This suggests that the syndrome in adulthood might not result exclusively from a childhood-onset neurodevelopmental disorder. Moffitt et al. (2015) partly explained their results by evoking the relationship with addictive behaviors; however, this only concerns half of the sample and these authors cannot determine the temporal sequence, i.e. whether the addiction was preexisting or came after the development of ADHD symptoms

(Moffitt et al., 2015). Weiss et al. (2011) suggest that an internet addiction or time spent playing video games would exacerbate the symptoms of ADHD in adolescents. Moreover, some researchers have suggested that the adult ADHD symptoms observed in the comorbidity between ADHD and the severity of the internet use should be considered as cognitive symptoms related to an internet addiction, rather than an independent ADHD disorder (Kim et al., 2017). Kim et al. (2017) speculate that functional and structural brain abnormalities related to an excessive and pathological use of the internet may explain the ADHD symptoms and this high comorbidity. More studies are required in order to investigate this hypothesis.

Second, ADHD and GDs share several factors that could explain their relationship. Impulsivity is a common process and may have something to do with the coexistence of these two disorders (Yen et al., 2017). Impulsivity plays a role in the development and maintenance of addictions in individuals with ADHD (Shirley & Sirocco, 2014). Yen et al. (2017) demonstrated that young adults with comorbid ADHD and GD reported a higher level of dysfunctional impulsivity (tendency to act with less forethought when it is not appropriate) compared to the non-ADHD/GD group, and that dysfunctional impulsivity mediated the relation between GD and ADHD. Gaming provide immediate and quick rewards and a succession of activities and stimuli which may interact with the gamer's impulsivity and could result in difficulties controlling the time spent playing as well as increase their vulnerability to internet addiction and Internet GD (Li et al., 2016; Yen et al., 2017). Yen et al. (2017) support the idea that impulsivity is involved in the relationship between ADHD and Internet GD and these authors suggested the use of a tailored prevention program focused on impulsivity in order to prevent the association between ADHD and GD (Yen et al., 2017). Future studies should target which factor of the UPPS impulse model is involved in the relationship between ADHD and GD symptoms.

Lastly, Gentile et al. (2012) and Weiss et al. (2011) described a bidirectional relationship between ADHD and video gaming where ADHD symptoms have an influence on the attractiveness of video gaming, while gaming exacerbates certain ADHD symptoms by reinforcing them, e.g. such as inattention, disinhibition, impulsive answer, a need for an immediate reward or craving (Gentile et al., 2012; Weiss et al., 2011). Online video games provide immediate and quick rewards and a succession of activities which can explain why players with ADHD can be so focused and can immerse themselves in the game over long sessions. The dynamic of the game itself helps to counteract inattention disabilities by increasing the motivation to finish the game, using short-term task planning in the game and short-term rewards as well as social and narcissistic gratifications.

4.2. Motivations for playing among potential ADHD and non-ADHD gamers.

The second aim explored the motivations for playing in potential ADHD and non-ADHD gamers. Gamers with potential ADHD reported a higher level of motivation for the achievement and socialization dimensions and more specifically for the advancement, competition, socializing subcomponents. Yen et al. (2017) described a vicious circle in which individuals with comorbid ADHD and GD have higher

impulsivity levels. These individuals may play in order to obtain achievement, social support and gratification that they cannot find in the real world. As they develop GDs they will be unable to identify its negative outcomes in their daily life due to impulsivity (Yen et al., 2017).

In the ADHD sample, the Mechanics and Escapism subcomponents predicted the level of gaming addiction. Mechanics motives are described as *“having an interest in analyzing the underlying rules and system in order to optimize character performance”* (Yee, 2006). Mechanics motives may be associated with the immediate rewards provided by the game and individuals. By optimizing their own character, gamers may perform better in the game and consequently obtain more social recognition by other players that would then in turn influence the player’s self-esteem.

Escapism motives are described as *“using the online environment to avoid thinking about real life problems”*; this includes relaxation. Escapism is both a common and the main predictor of GD symptoms in the two samples. In children with ADHD, playing video games could be considered as a self-medication process to cope with the negative symptoms of ADHD and to relax (Bielefeld et al., 2017; Han et al., 2009). Striatal dopamine could help players improve their performances and their ability to focus while gaming (Weinstein et al., 2017). Individuals with ADHD may be compensating for their attention and performance failures that they encounter in their everyday life while playing online video games (Evren et al., 2018). Moreover, Bielefeld et al. (2017) proposed that gaming could be considered as a way to relax, which could be explained as the emotional outcome of dopamine release while gaming. More evidence is needed to confirm this hypothesis in samples of adults with ADHD.

4.3 Limitations

Our results should be interpreted with several limitations in mind. First, we could not confirm the diagnosis of ADHD via a clinical interview, and we do not ask if the gamers have other addictions or the duration of video game use. The study needs to be replicated in clinical and non-clinical samples in order to investigate the prevalence of ADHD symptoms that are preexisting during childhood and ADHD symptoms that are probably related to online gaming. Then, the cross-sectional design cannot be used to draw conclusions about the causal relationship between ADHD and GDs. A longitudinal study should investigate their development and determine the similar characteristics between ADHD and GDs that act on or influence each other over time.

4.4 Clinical and scientific implication

ADHD or GDs should be systematically evaluated in adult patients either with ADHD or who exhibit excessive video gaming behavior. By identifying the comorbidity, this should help therapists to better adapt the protocol to his patient. In prevention, patient with ADHD should be cautious when using online video games.

4.5 Conclusion

This study confirms the strong relationship between ADHD and GDs and is the first to focus on the motivations for playing in individual with probable ADHD. The mechanism and escapism motivations

predict the level of GDs, which is consistent with the literature. In clinical practice, ADHD and GD should be systematically evaluated as a possible comorbidity between the two disorders. Future studies should determine the similar characteristics shared by ADHD and GD or which may influence each other (motivation, impulsivity, cognitive distortions, social anxiety, etc.), and focus on the influence of gaming on ADHD symptoms in adults.

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all patients for being included in the study.'

Declarations

Statement of Ethics

The study was conducted in accordance with Good Clinical Practice Guidelines and the Declaration of Helsinki. Approval of an ethics committee is not mandatory for non-interventional research in France. The online data collection ensured the anonymity of the participants in accordance with the recommendations of the French National Committee of computing and freedoms (CNIL). All participants provided electronic informed consent. No compensation was given for participation.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

EC, AS and AM designed the study.

EC was responsible for the project management and supervision.

AS created the Internet survey, conducted the data collection.

EC, LP and AM performed the statistical analysis.

EC, AM, LP, CG wrote the first draft of the manuscript and all authors approved the final manuscript.

All authors had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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