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Gender-specific motivational pathways in ADHD-related inattention and gaming disorder symptoms

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Abstract

Comorbidity between attention-deficit/hyperactivity disorder (ADHD) and gaming disorder (GD) is widely recognized in the literature. Previous research has indicated gender-dependent underlying mechanisms in the development and maintenance of problematic gaming. Motivational research presents an opportunity to provide further insight regarding the nature of this association. Self-report data were collected from videogame players (N=14,740) using an online survey in collaboration with a popular gaming magazine. The survey included items concerning symptoms of ADHD and GD, motives for gaming, and time spent playing videogames. Structural equation modeling was used to create two parallel mediation models (one for males, one for females), including motives to play games as mediators. This was done to potentially explain psychological drivers of the association between ADHD and GD. Results demonstrated a common pathway from inattention to GD symptom severity through the

immersion/escapism motivation for both males ($\beta = .068$; $p < .001$) and females ($\beta = .081$; $p < .05$), while the path from inattention to GD symptom severity through the habit/boredom motive ($\beta = .094$; $p < .001$) and competition motive ($\beta = .021$; $p < .001$) was only significant for males. Gamers experiencing symptoms of ADHD, especially inattentive symptoms, are at risk of the occurrence of GD symptoms through videogames becoming a source of maladaptive coping with daily psychological disturbances. Males experiencing inattentive symptoms tend to additionally develop problematic patterns of use through videogame playing, becoming a subjectively meaningless and boredom-reduction-oriented habitual activity or a platform of virtual competition. Unique differences suggest the necessity of different treatment approaches for males and females.

Keywords: ADHD, gaming disorder, motivation, escapism, boredom, gender differences

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Conflict of interest

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1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by inattention and hyperactivity/impulsivity symptoms. Apart from academic and occupational problems, ADHD is associated with difficulties in social relationships, higher tendency for accidents and obesity, development of conduct disorder and antisocial personality disorder, and higher risk of substance use disorders (APA, 2013). The range of addiction susceptibility is not limited to substance-related issues (Lee et al., 2011). Previous studies have found that problematic internet use and gaming disorder (GD) are associated with ADHD (Koncz et al., 2023; Werling et al., 2022).

GD has now been formally recognized as a mental health disorder by the World Health Organization (2019) and listed as a tentative disorder that requires further research by the American Psychiatric Association (2013). The rationale for researching comorbidities lies in the observation that co-existing symptoms of other mental health problems can affect the incidence of GD (Jeong et al., 2020; Liu et al., 2021) and the outcomes of GD treatment (Chang et al., 2020; Han et al., 2018; Lee et al., 2021). Although the time spent playing videogames is moderately related to symptom severity of GD (Pontes et al. 2022), high amounts of time spent gaming are not necessarily related to psychiatric symptoms (Griffiths, 2010; Király et al., 2017b).

1.1 Theories of gaming disorder and vulnerability factors

Several theories have emerged to explain the acquisition, development and maintenance of GD. In the self-medication hypothesis, Khantzian (1997) posited that addictive behaviors develop to alleviate painful current psychological states in the absence of effective alternative coping skills. The model of compensatory internet use (Kardefelt-Winther, 2014) posited that in the presence of unsatisfied needs as a result of psychosocial difficulties when individuals tend to use the internet in order to compensate for these deficiencies, negative outcomes occur. The Interaction of Person-Affect-Cognition-Execution (I-PACE) model (Brand et al., 2016, 2019) describes the temporal dynamic of the development and maintenance of specific internet use disorders, such as gaming disorder. The model describes the etiology of online addictive behaviors by identifying predisposing risk factors (e.g., genetics, psychopathology, needs, and motivation) and the process of gratification, reinforcing cognitive and affective response patterns (e.g., cue-reactivity and attentional biases) which as a consequence, form internet use-related behavioral decisions. The model has also integrated the idea of compensatory use, appearing in later stages of problematic use alongside craving, responsible for the maintenance and exacerbation of the disorder. Despite the differences among these theories, the common observations are that underlying psychological difficulties are important, and the behavior is engaged in to restore balance in these areas.

The addiction vulnerability of ADHD is not an exception, because social and emotional difficulties frequently appear among individuals with ADHD, including higher susceptibility to intrusiveness, aggression, social anxiety, and depression, which can lead to worse peer functioning, low self-esteem, and more frequent social withdrawal. Individuals with ADHD may tend to look for alternative ways to regulate their emotional burden, which when paired with negative urgency (an inclination to act immediately and inadequately when facing negative

emotions), can drive them to overuse videogames, which are widely accessible with great capacity for rapid immersion. Additionally, due to the characteristics of the online environments (e.g., anonymity), videogames can be used to meet social needs, which would be more difficult to satisfy in-person for individuals with ADHD (Koncz et al., 2023).

1.2 The role of motivations in gaming

Studies have consistently demonstrated the viability of studying motivations for gaming as potential correlates of GD (Bäcklund et al., 2022; Wang, Cheng 2022) and time spent gaming (Johnson, John, Penny, 2016; Király et al., 2017b; Ryan, Rigby, Przybylski, 2006). Kardefelt-Winther (2017) suggests that the exploration of GD-related risk factors should be in conjunction with motivations to play as mediators of these associations to describe why individuals are driven to overuse online applications (such as gaming). The role of motivations as mediators is also justified by being proximal factors for GD symptoms, according to the integrated network model of personality-emotion-motivation (Zhou et al., 2023).

Research has shown that the motives of escapism (playing as means of self-distraction to avoid emotional pain stemming from problems and difficulties experienced during daily life), fantasy (playing to experience narratives not possible in real life), coping (playing in order to regulate uncomfortable mood and emotions), competition (playing to compare skills and to experience victory over others) and habit/boredom (playing without intention, to pass time or get rid of boredom) can effectively mediate the association between psychiatric symptoms (e.g., symptoms of depression, anxiety) and psychosocial problems (e.g., loneliness) (Király et al., 2015, 2022; Montag et al., 2019).

To date, only two studies have explored the motivational differences in gaming among individuals with ADHD and those without, both finding higher videogame use motivation levels among those who experienced ADHD symptoms (Evren et al., 2021, Montag et al., 2019). Moreover, most of these motives mediate the effect of ADHD symptoms on GD symptom severity, except for social and fantasy motivations (Montag et al., 2019). Even though these studies hold great value, several motivational components were not included (e.g., obtaining status among the gamer community being an important aspect of competitive play, cooperation being an important aspect of social motivation, habitual/boredom-reduction-oriented videogame use being present among gamers). Therefore, a study including these features would complement earlier research findings.

1.3 Gender-specific processes

Dong and Potenza (2022) posited that different processes may be responsible for the development, maintenance, and successful recovery from GD for males and females. Impulsivity and impaired behavioral control, aggressivity, and stronger cue-elicited craving are factors that are more likely to play a role in the development of GD for males, while loneliness and psychological distress reduction-oriented gameplay is more likely to be a female characteristic (Király et al., 2015). Higher reward sensitivity has been associated with positive reinforcement processes and the reduction of inhibitory control and are also typical maintenance

factors for male gamers compared to females (Ko et al., 2023). The possibility of unique underlying psychosocial processes calls for further examination of this widely reported comorbidity.

1.4 The present study's hypotheses

Based on the previous literature, five hypotheses were proposed. More specifically, it was hypothesized that:

- H₁: Both subdomains of ADHD would be positively related to GD symptoms (based on Koncz et al. [2023]) (H₁).
- H₂: Inattention symptoms would positively predict all motivation factors (in accordance with Evren et al., 2021; Montag et al., 2019).
- All motivation factors would be positively related to GD symptoms (based on Bäcklund et al. [2022]) (H₃).
- More involved players would be characterized by higher levels of mastery, immersion/escapism, competition, and social motivation (based on Johnson et al. [2016]; Király et al. [2017b]; Ryan et al. [2006]) (H₄).
- H₅: There would be a positive indirect association between ADHD inattention symptoms and GD symptoms through motivations such as escapism and competition (based on Király et al. [2015]; Montag et al. [2019]) (H₅).
- There would be a stronger association between immersion/escapism and GD symptoms for females compared to males (based on Király et al. [2015]) (H₆).

2. Materials and methods

2.1. Participants and procedure

A sample of highly engaged gamers (i.e., playing videogames for 27 hours a week on average) was recruited through paid Facebook advertisements distributed in collaboration with a popular Hungarian gaming magazine (GameStar.hu) with a large follower base (over 100,000 individuals). Shopping vouchers of different values (€1500 total prize pool was separated into vouchers worth €30, €60, and €300) were distributed among those who completed the survey following a prize draw. Data were collected between March and April 2020, during a period when the first wave of COVID-19 restrictions were operating in Hungary and neighboring countries. Only Hungarian-speaking individuals were able to participate in the study. Confidentiality and anonymity were provided during the study, and participants were required to fill out an informed consent form to participate in the study. Only individuals older than 14 years old were allowed to participate. Those aged between 14 and 17 years were instructed to ask for parental permission before starting the survey. The present study is a part of a larger research project. Another publication using the same dataset but with a very different focus has also been submitted (blinded for review). This study was approved by the Institutional Review Board of (blinded for review), and the study was performed in line with the Helsinki Declaration.

2.2. Measures

Data regarding age, gender, marital status, number of years spent studying, current study and work status were collected. Participants were asked to rate what percentage of their gaming time (0-100%) was spent on 12 prespecified gaming genres (see Table 1). Similarly, participants reported the percentage of their gaming time spent on four different platform categories. Participants reported the average hours spent gaming during weekdays and weekend days (to one decimal place). A maximum of 12 hours daily gaming time was allowed to be reported. Those reporting higher daily amounts were instructed to report 12 hours. The average weekly gaming time was calculated from these data.

The six-item version of the Adult ADHD Self-Report Scale (ASRS) (Kessler et al., 2005) was used to assess the symptom severity of the two ADHD subdomains: inattention was assessed with four items, hyperactivity-impulsivity was assessed with two items. The scale is suitable for screening ADHD symptoms in both community and clinical samples, in unweighted form and has outperformed the full (18-item) version (Kessler et al., 2005). Based on previous studies, the Adult ADHD Self-Report Scale has been shown to be a psychometrically valid tool to assess ADHD symptoms among adolescents, and to differentiate between ADHD affected and non-affected adolescents (Adler et al., 2012; Somma et al., 2019). Participants were asked to report how frequently they experienced different symptoms of ADHD in the past six-month period on a five-point scale (0=never, 4=very often). To control the measurement error of the ADHD subdomains, inattention and hyperactivity/impulsivity were entered into the model as latent variables.

Motivations to play videogames were assessed using the Gaming Motivation Inventory (GMI) (Király et al., 2022). The GMI comprises 88 items assessing 26 gaming motivations. All motivations were assessed on a scale from 1 (*“It does not correspond at all”*) to 7 (*“It corresponds exactly”*). The 26 motivations were clustered into six higher-order motivational dimensions (i.e., mastery, immersion/escapism, competition, stimulation, social, habit/boredom) using a series of exploratory factor analyses and exploratory structural equation modeling (ESEM) analysis. In the present study, these six higher-order motivational factors were used as latent variables defined by their related first-order motivations (for more details, see Király et al., 2022).

GD symptoms were assessed using the Ten-Item Internet Gaming Disorder Test (IGDT-10) (Király et al., 2017a). Studies testing the psychometric properties of the scale have reported good validity and reliability (e.g., Chiu, Pan, Lin, 2018; Evren, 2020; Király et al., 2019; Männikkö et al., 2019). The IGDT-10 assesses the symptoms of IGD as proposed in the DSM-5 (APA, 2013). Participants rate the frequency of their symptoms during the past 12 months on a three-point scale (0=never, 1=sometimes, 2=often). Responses are then recoded into a binary variable to follow the dichotomous structure of the DSM-5, where answers of “never” and “sometimes” are coded as 0, and only answers of “often” are coded as 1 (meaning that the criterion is met). Two items (Items 9 and 10) assess the same symptoms (gaming leads to

negative consequences in social and educational/occupational functioning). Therefore, they are combined together for the estimation of GD symptom severity. One item, assessing the tendency to play videogames as an escape from emotional difficulties was not included during the calculation of the mean severity scores, due to the overlap between this item and the immersion/escapism higher-order motivational factor. Composite reliability of the IGDT-10 comprising only the eight dichotomized items in the present study was 0.88.

2.3. Statistical analysis

To test the association between the study variables, two similar models were created (one for males and one for females), where the predictors were inattention, hyperactivity/ impulsivity symptom severity, and the six higher-order gaming motivations. The outcomes of the models were GD symptom severity and time spent gaming. Both models were controlled for age. Due to the non-normal distribution of the scale scores in the present study, the robust maximum likelihood estimation (MLR) method was used. To estimate model fit, Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Comparative Fit Index (CFI) and chi-square values of model fit for baseline models were calculated. Values above 0.9 for the CFI, and values below 0.08 for the RMSEA and SRMR were considered to indicate acceptable fit of the models (Browne, 1993, Kline 2015). For descriptive statistics, independent samples t-tests and chi-square tests for group comparison between genders were used in SPSS Statistics version 28 (IBM, 2021). For analyses performed in SPSS, cases were removed analysis by analysis if there were missing data. Therefore, no data imputation was implemented. For analyses ran in Mplus, full information maximum likelihood (FIML) method was used to handle missing values. The eighth version of Mplus was used for model estimation (Muthén & Muthén, 1998-2017).

3. Results

3.1. Descriptive statistics

After data cleaning, responses from 14,740 individuals were analyzed. The majority of the sample was male (89.3%), with a mean age of 24.14 years (SD=6.95), ranging between ages of 14-75 years. Males reported lower frequency of being in a relationship, having a part-time job, using smartphones and other mobile devices for playing, and preferring role-playing games, MMORPGs, card games, simulators, or another type of games. On the other hand, males spent less time in education and reported higher time spent playing videogames. Males were also proportionally more likely to be single, had a full-time job, preferred PC/laptop and consoles for playing, and preferred shooter, battle royale and sports games. Descriptive statistics and group comparisons are reported in Table 1.

~ Table 1. ~

3.2. Mediation analysis

Subdomain scores of ADHD and gaming motivation scores were introduced in the model as continuous latent variables. Both GD symptom severity and weekly time spent gaming were introduced in the model as continuous observed variables. Two structural equation models were tested to explore potential underlying gender-specific mechanisms. Due to the lack of measurement invariance of the GMI scale, model parameters between male (N=13157) and female (N=1581) gamers could not be compared.

3.2.1. Mediation model for males

Analysis indicated that model fit was acceptable for male gamers ($\chi^2(407)=11881.420, p<.001$; CFI=0.934; RMSEA=0.046; SRMR=0.027). Inattention had a significant positive direct effect on GD symptoms ($\beta = .200, p<.001$), and a significant negative effect on time spent gaming ($\beta = -.096, p<.001$). Moreover, it had a considerable positive effect on habit/boredom ($\beta = .421, p<.001$), immersion/escapism ($\beta = .313, p<.001$) and competition ($\beta = .121, p<.001$) motives. Associations between inattention and the other motives were negligible (standardized beta coefficients <0.1). Associations between hyperactivity/impulsivity and all endogenous variables were non-significant or had negligible effect sizes. Regarding the associations between the motives and the two outcome variables, habit/boredom, immersion/escapism and competition motives had significant effects on GD symptoms ($\beta = .223, p<.001$; $\beta = .218, p<.001$; and $\beta = .172, p<.001$ respectively), and immersion/escapism, social, stimulation, habit/boredom and competition motives had non-negligible effects on time spent gaming ($\beta = .245, p<.001$; $\beta = .161, p<.001$; $\beta = .122, p<.001$; $\beta = .112, p<.001$ and $\beta = .105, p<.001$ respectively). ADHD subdomain scores were moderately positively correlated in the model ($r = .404, p<.001$), while GD symptom severity was weakly, positively associated with time spent gaming ($r = .169, p<.001$). The model explained 30.4% of the variance of GD symptoms and 19.6% of time spent gaming (see Figure 1 for the model and Supplementary Table S1 for the correlation coefficients between the included variables).

~ Figure 1. ~

Total, direct and indirect effects for the model among males are shown in Table 2. Considerable total effect size ($\beta = .385, p<.001$) was only found between inattention and GD symptom severity. The indirect effect ($\beta = .184, p<.001$) between these variables accounted for almost half of the total effect, and the main mediation pathways were via habit/boredom ($\beta = .094, p<.001$), immersion/escapism ($\beta = .068, p<.001$) and competition ($\beta = .021, p<.001$) motives.

~ Table 2. ~

3.2.2. Mediation model for females

Analysis also indicated that model fit was acceptable for female gamers ($\chi^2(407)=2195.9, p<.001$; CFI=0.918; RMSEA=0.053; SRMR=0.033). Inattention had a significant positive

direct effect on GD symptoms ($\beta = .138; p < .01$), and a significant negative effect on time spent gaming ($\beta = -.121; p < .01$). Moreover, it had a positive effect on the immersion/escapism ($\beta = .243; p < .001$) motive and a negative effect on the mastery ($\beta = -.145; p < .01$) motive. All remaining associations between inattention and other motives were not significant or negligible.

Only stimulation motivation had a significant, non-negligible association with hyperactivity/impulsivity ($\beta = .120; p < .01$) among all motivations. Significant, non-negligible associations were found between the motives and the two outcome variables: immersion/escapism and competition motives had positive effects on GD symptoms ($\beta = .336, p < .01$ and $\beta = .261, p < .001$) while immersion/escapism, social and competition motives had positive effects on time spent gaming ($\beta = .266, p < .001$; $\beta = .207, p < .001$ and $\beta = .139, p < .01$). Similar to the male model, ADHD subdomain scores were positively, weakly correlated in this model ($r = .361, p < .001$), and GD symptom severity was positively, weakly associated with time spent gaming ($r = .204; p < .001$). The model explained 26.1% of the variance of GD symptoms, and 16.3% of time spent gaming (see Figure 2 for the model and Supplementary Table S2 for the correlation coefficients between the included variables).

~ Figure 2. ~

Total, direct and indirect effects for the model among females are shown in Table 3. Similar to the male model, considerable total effect size ($\beta = .260; p < .001$) was only found between inattention and GD symptom severity. The indirect effect ($\beta = .122; p < .001$) between these variables accounted for almost half of the total effect, but the only significant mediation pathway was via the immersion/escapism ($\beta = .081; p < .05$) motive.

~ Table 3. ~

4. Discussion

The study's findings indicated that ADHD, and in particular inattention, predicted the symptoms of GD, which partially supported H_1 . Inattention symptoms also predicted specific motivations to play, especially immersion/escapism and habit/boredom (but the latter was only found for males), partially supporting H_2 . This aligns with the observation that poor emotional regulation is a central characteristic of children with ADHD (Graziano & Garcia, 2016) and coping difficulties are also frequently observed. The use of more emotion-oriented and less task-oriented coping strategies has been widely reported (Al-Yagon et al., 2020; Barra et al., 2021; Hampel et al., 2008; Young, 2005). Individuals with ADHD react to stress with greater levels of confrontation and aggression, as well as rumination, resignation, social withdrawal, self-pity and self-blame, and use more escape or avoidance-oriented coping strategies (Barra et al., 2021; Hampel et al., 2008; Young, 2005).

Significant associations were found between GD symptom severity and several motivations to play (immersion/escapism, competition in both models and habit/boredom in the male model), partially supporting H₃. This is in line with the findings showing that gaming disorder is also characterized by maladaptive coping strategies, such as denial and behavioral disengagement, as well as self-distraction or self-blame (Bányai et al., 2021; Schneider et al., 2017). Moreover, although most of the motivations predicted time spent gaming (in accordance with H₄), some important differences were also noticed between the two main outcomes. First, a greater proportion of GD symptoms compared to that of time spent gaming was explained by motivations to play and symptoms of psychopathology. This is in line with earlier research by Király et al. (2017). Second, for females, habit/boredom-oriented play was unrelated to time spent gaming, but a positive association was found with time spent gaming for males. These findings suggest that playing without motivation, or to get rid of boredom seems to determine both the intensity and the severity of problematic videogame use among males, but does not seem to predict gaming behavior among females, which may be due to the presence of female-oriented harassment in videogames provoking resistance toward and disengagement from daily habitual play (Kaye & Pennington, 2016; McLean & Griffiths, 2019).

Regarding the mediation effects, the association between inattention symptoms and GD symptom severity mostly mediated through immersion/escapism motivation among males and females, and through competition motivation among males, and confirmed H₅. Therefore, deficits in stress and emotion regulation, and to a lesser degree, the drive to compete and achieve social status among males in the gaming world, seem to be responsible for the emergence and maintenance of GD symptoms among ADHD-affected individuals.

Another considerable mediated path was found between inattention symptoms and GD symptoms among males, which can be characterized by a boredom-reduction-oriented routine associated with a psychological state lacking any substantial motivation to play. ADHD is generally portrayed as a disorder of attention and impulsivity, but motivational deficits have been found in school settings that seem to be responsible for the general low academic performance and the specific low reading performance (Smith & Langberg 2018). For ADHD-affected individuals, low motivational levels are present in all settings (Volkow et al., 2011), which does not explain how this contributes to the overuse of a recreational activity instead of more meaningful and future-oriented life goals. The possible explanation comes from experimental research which shows a greater tendency of ADHD-affected individuals to prefer immediate over delayed rewards (Luman et al., 2005) which is more likely to be attained in a videogame, than in the non-virtual world. This preference can lead to an escalating habitual retreat into videogame playing, resulting in real-life conflicts and dependence (Soares et al., 2023).

Even though H₆ could not be tested due to the lack of measurement invariance of the motivational scale, differences were found in the mediating motivational patterns between males and females. The most surprising difference was that habit/boredom motivation only mediated the association between inattention and GD symptoms severity among males, which may lie in the unique impact of ADHD on these two genders. Males with comorbid ADHD are more likely to be characterized by externalizing, rule-breaking behavior and impaired

educational functioning, while females show more internalizing symptoms and peer functioning deficits (Faheem et al., 2022; Gershon, Gershon, 2002; Skogli et al., 2013). The externalizing behavior of males may lead them to lower academic and vocational success (lower rates of graduation, postsecondary education and occupation, higher levels of job instability and job performance impairments) (Gordon & Fabiano, 2019; Loe & Feldman, 2007) which in turn with less purposeful opportunities to seek, can result in habitual, boredom-reduction-oriented videogame play. The more severe emotional difficulties and the lack of fulfilling social connections of females with ADHD symptoms can explain why they typically tend to use videogames in a problematic manner as an attempt to self-regulate their emotions.

Overall, the present study's results provide a foundation for personalized GD interventions recommended by Wang and Cheng (2022) including individuals with ADHD to provide specific care for specific needs (Király et al., 2023) and offer targeted replacement behaviors (Steadman, 2019). Techniques used to improve emotion regulation, such as mindfulness-based approaches (Chambers et al., 2009) could be a direction to mitigate the ADHD-affected problematic players' urge to be immersed and to escape by gaming. Moreover, existential therapy and logotherapy could support ADHD affected male players' need to find subjectively meaningful alternatives for gaming (Wong, 2016), while also beneficially affecting the symptoms of other comorbid disorders (Vos et al., 2015). In addition to common mechanisms among males and females, therapists informed about gender-specific processes can become more effective (Owen et al., 2009) by adjusting their approaches to the needs of their clients (Kiselica & Englar-Carlson, 2010).

4.1. Limitations, strengths and future directions

Some methodological and statistical limitations need to be mentioned. Due to the cross-sectional nature of the data, the directions of the presented model paths are only based on theoretical assumptions. The current results may not be generalizable to the whole gamer population, since recruitment was potentially affected by self-selection bias. The use of self-report data also carries some inevitable weaknesses due to social desirability and recall bias. The factor Hyperactivity/Impulsivity was defined by only two items, which may not be covering the complete content of that subdomain. Additionally, the seemingly differing model parameter estimates were not comparable statistically due to the lack of measurement invariance of the motivational scale (which is why H_6 could not be tested). It should also be noted that the different sample sizes of males and females resulted in a significantly stronger statistical power to detect mediation effects in the male sample. A significant strength of the present study was the large sample comprising highly engaged videogame players appropriate to examine the processes of problematic use and the boundary with healthy engagement. Additionally, the Gaming Motivation Inventory is a comprehensive and up-to-date psychometric instrument encompassing the full range of motivations to play videogames. Longitudinal studies focusing on the stability and change of underlying motivations and interventional studies with specific emphasis on modifying such drivers among ADHD affected individuals could be a direction for future research.

4.2. Conclusion

The present study showed that the risk contribution of ADHD was again demonstrated for the emergence of gaming disorder symptoms, with inattention symptoms appearing to have the most pronounced effect. Inattention symptoms may contribute to the development of the disorder in both sexes partly through reinforcing the motivation to use videogames as a tool for immersion and escapism. A significant additional mediating effect was also observed, suggesting that habitual, boredom management-oriented use of videogames may also contribute to the problematic pattern of use among males with attention difficulties. Although motivations account for a significant proportion of the association between the two disorders, there seem to be other effects of ADHD symptoms that are independent of motivational drivers, and it is therefore not enough to only identify and address the underlying causes of motivations without applying appropriate treatment for the symptoms of ADHD.

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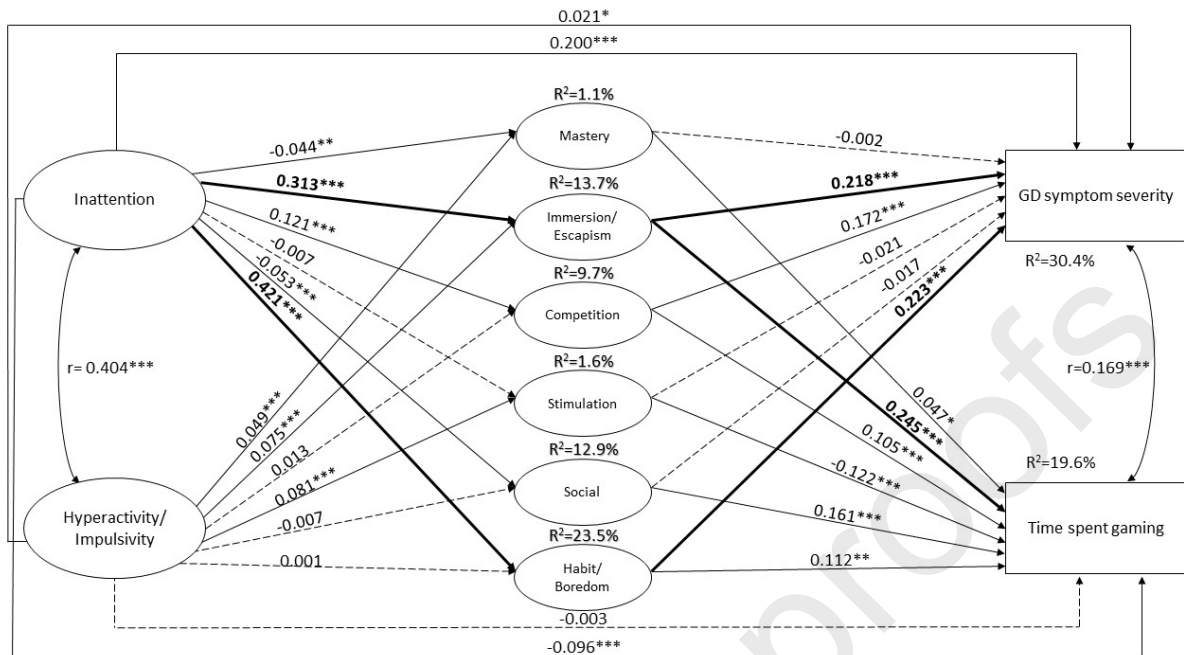
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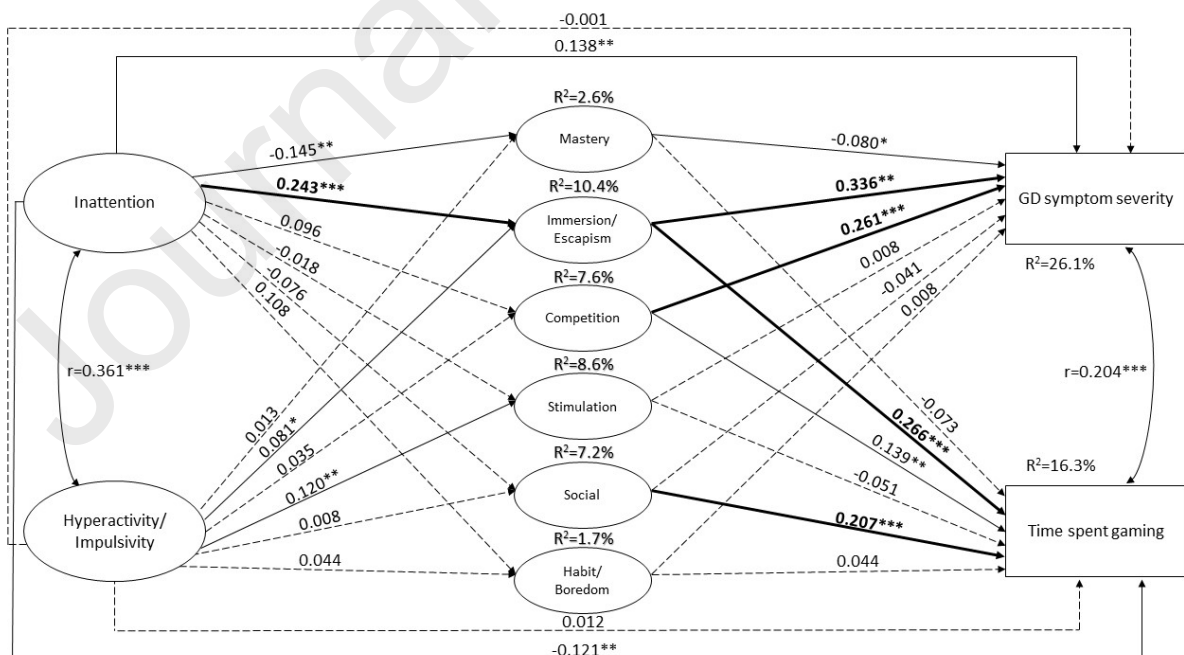
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Figure 1. The mediation model for males

Note: N=13,157; Both subdomains of attention-deficit/hyperactivity disorder (inattention and hyperactivity/impulsivity) were entered into the model as latent variables, assessed using their related Adult ADHD Self-Report Scale items (not represented in the figure). Gaming motives were also introduced in the model as latent variables. The explained variances of the endogenous variables and the standardized path coefficients for all associations are presented. This model was controlled for age (not represented in the figure). GD symptom severity score does not include the escape motive. Dashed lines represent non-significant path coefficients and simple lines represent significant path coefficients. Bold lines indicate standardized beta coefficients above 0.2. * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 2. The mediation model for females

Note: N=1,581; Both subdomains of attention-deficit/hyperactivity disorder (inattention and hyperactivity/impulsivity) were entered into the model as latent variables, assessed using their related Adult ADHD Self-Report Scale items (not represented in the figure).

on the figure). Gaming motives were also introduced in the model as latent variables. The explained variances of the endogenous variables and the standardized path coefficients for all associations are presented. This model was controlled for age (not represented in the figure). GD symptoms score does not include the escape motive. Dashed lines represent non-significant path coefficients and simple lines represent significant path coefficients for the model. Bold lines indicate standardized beta coefficients above 0.2. * $p < .05$, ** $p < .01$, *** $p < .001$.

Highlights

- ADHD, especially its inattention domain, is a risk factor for gaming disorder (GD).
- Players experiencing inattention become problematic users through escapism.
- GD develops among inattentive males due to habitual and competitive play.
- Motivational dynamics explain a considerable proportion of the comorbidity.

Table 1. Descriptive statistics for the male and female subsamples

		Male subsample (N=13,157)	Female subsample (N=1,581)	t/χ^2 (p)
Age (years), Mean (SD)		24.15 (7.0)	24.05 (6.0)	0.639 (0.523)
Education (number of years completed), Mean (SD)		12.94 (2.7)	13.74 (2.6)	-10.918 ($<.001$)
Marital status, N (%)	Single	6547 (50.0%) _a	530 (33.5%) _b	153.24 ($<.001$)*
	In a relationship but living separately	2913 (22.1%) _a	444 (28.1%) _b	
	Married/living in a partnership	3573 (27.2%) _a	593 (37.5%) _b	
	Divorced	64 (0.5%) _a	11 (0.7%) _a	
	Widowed	7 (0.1%) _a	0 (0.0%) _a	
Student status, N (%)	Studying currently	6988 (53.1%)	820 (51.9%)	0.90 (.343)
	Not studying currently	6166 (46.9%)	761 (48.1%)	
Work status, N (%)	Not working currently	4769 (36.2%) _a	609 (38.5%) _a	60.22 ($<.001$)
	Has a full-time job	6730 (51.2%) _a	718 (45.4%) _b	

	Has a part-time job	638 (4.8%) _a	144 (9.1%) _b	
	Has ad ad-hoc jobs	1015 (7.7%) _a	110 (7.0%) _a	
Average weekly gaming time, Mean (SD)		27.8 (14.9)	26.2 (14.3)	4.13 (<.001)
Platform preference for gaming, N (%)	PC/laptop	6361 (48.4%) _a	661 (41.8%) _b	100.53 (<.001)
	Console (e.g., <i>Xbox</i> , <i>PlayStation</i> , <i>Nintendo Wii</i>)	4804 (36.5%) _a	526 (33.3%) _b	
	Smartphone	1814 (13.8%) _a	358 (22.6%) _b	
	Other mobile devices (e.g. tablet)	176 (1.3%) _a	36 (2.3%) _b	
Game genre preference, N (%)	Shooter (FPS, TPS) games	3456 (26.3%) _a	241 (15.3%) _b	458.021 (<.001)
	Battle royale games	1387 (10.5%) _a	102 (6.4%) _b	
	MOBAs	885 (6.7%) _a	122 (7.7%) _a	
	Auto chess/auto battler games	296 (2.3%) _a	43 (2.7%) _a	
	Open world action-adventure games	2246 (17.1%) _a	258 (16.3%) _a	
	Role-playing games	1474 (11.2%) _a	293 (18.5%) _b	
	MMORPGs	670 (5.1%) _a	128 (8.1%) _b	
	Strategy (RTS, TBS) games	491 (3.7%) _a	48 (3.1%) _a	
	Card games	168 (1.3%) _a	32 (2.0%) _b	

	Sport games	1314 (10.0%) _a	67 (4.2%) _b	
	Simulators	446 (3.4%) _a	112 (7.1%) _b	
	Other (e.g. puzzle, platformer)	324 (2.5%) _a	135 (8.6%) _b	

Note: The reported numbers were rounded up in some cases for gaming-related variables. Therefore, the percentages in the table do not precisely add up to 100%. FPS=First-Person Shooter, TPS=Third Person Shooter, MOBA=Multiplayer Online Battle Arena, RTS=Real-Time Strategy, TBS=Turn-Based Strategy. $t/\chi^2(p)$ = This column contains t -values reported in the case of independent sample t -tests (used in the case of group mean comparisons) and chi-square values in the case of chi-square tests (for frequency data comparisons) and associated p -values to indicate statistical significance. The values presented in the table with different subscripts (a, b) indicate significant differences in column proportions, while the same subscripts indicate the absence of significant difference (a, a). *: Divorced and widowed categories are collapsed in the statistics.

Table 2. Total, direct, and indirect effects for the male model

Predictor: Inattention		GD symptom severity	Time spent gaming	Predictor: Hyperactivity/Impulsivity		GD symptom severity	Time spent gaming
Total effect		0.385** *	0.030*	Total effect		0.038**	0.015
Direct effect		0.200** *	-0.096** *	Direct effect		0.021*	0.003
Total indirect effect		0.184** *	0.127** *	Total indirect effect		0.017**	0.011*
Specific indirect paths	Via Mastery	0.000	-0.002*	Specific indirect paths	Via Mastery	0.000	0.002
	Via Immersion/escapism	0.068** *	0.077** *		Via Immersion/escapism	0.016** *	0.018** *

	Via Competitio n	0.021** *	0.013** *		Via Competitio n	0.002	0.001
	Via Stimulation	0.000	0.001		Via Stimulation	-0.002	- 0.010** *
	Via Social	0.001	0.009** *		Via Social	0.000	-0.001
	Via Habit/ Boredom	0.094** *	0.047** *		Via Habit/ Boredom	0.000	0.000

Note: N=13157. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 3. Total, direct, and indirect effect estimates for the female model

Predictor: Inattention		GD symptom severity	Time spent gaming	Predictor: Hyperactivity/ Impulsivity		GD symptom severity	Time spent gaming
Total effect		0.260***	-0.042	Total effect		0.035	0.035
Total direct effect		0.138**	- 0.121***	Total direct effect		-0.001	0.023
Total indirect effect		0.122***	0.078***	Total indirect effect		0.036	0.012
Specific indirect paths	Via Mastery	0.012	0.011	Specific indirect paths	Via Mastery	-0.001	-0.001
	Via Immersion/ escapism	0.081*	0.065***		Via Immersion/ escapism	0.027*	0.022*
	Via Competition	0.025	0.013		Via Competition	0.009	0.005

	Via Stimulation	0.000	0.001		Via Stimulation	0.001	-0.006
	Via Social	0.003	-0.016		Via Social	0.000	0.002
	Via Habit/ Boredom	0.001	0.005		Via Habit/ Boredom	0.000	0.002

Note: N=1581. * $p < .05$, ** $p < .01$, *** $p < .001$.