EÖTVÖS LORÁND UNIVERSITY FACULTY OF EDUCATION AND PSYCHOLOGY

Theses of the Doctoral Dissertation

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Attention-deficit/hyperactivity disorder (ADHD) symptoms and gaming motivations underlying problematic video game use

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1. General introduction

Approximately one third of the global population plays videogames and it the most popular among young males (Fabio, 2024). Video game use shows similar patterns in the Hungarian population: based on surveys from 2019, 71.8% of adolescents (86.3% of males and 55.7% of females) (Király, Demetrovics, 2020), but only 10.7% of adults (14.9% of males and 7.1% of females) (Király, Demetrovics, Paksi 2021) reported video game use during the past month. Despite the benefits of video game use in promoting goals in education, physical activity (Sailer, Homner 2020; Mazeas et al., 2022), cognitive development (Green, Bavelier, 2015) and therapeutic interventions (Kollins et al., 2020), problematic pattern of video game use was recognized in ICD-11 (World Health Organization, 2019) referred to as Gaming disorder (GD). The ICD-11 defines GD as a continuous or episodic and recurrent pattern of gaming behavior present over at least a 12-month period (which in case of serious symptoms can be lowered) which causes significant impairment in important areas of life (social, education, occupation). All three of the following symptoms must be present to make for diagnosis:

1. Impaired control over gaming;
2. Precedence of gaming over other interests and activities;
3. Continuation or escalation of gaming despite negative consequences.

The Interaction of Person-Affect-Cognition-Execution (I-PACE) model (Brand et al., 2016; Brand et al., 2019) was constructed to explain disorders related to internet use, which is frequently applied to explain GD. I-PACE describes the development of GD over time and attempts to define the roles of related factors in the process. The model differentiates between an early phase, when the behavior is gratifying by itself and a later phase mainly driven by compensatory need. The components of the model are assigned to three different roles:

1. Risk factors include several neurobiological and psychological features, such as social cognitions, personality, biopsychological constitution, comorbid psychopathology and motives.

2. Mediators of risk factors include subjective situation perception (e.g. salience, stress reactivity), affective and cognitive responses (e.g. craving, attentional bias) and executive functioning/inhibitory control.
3. Moderators of risk factors include coping style and internet related cognitive biases (e.g. expectancies).

In line with the I-PACE model, a great proportion of research is aimed at exploring the motivational drivers of GD, frequently built upon two, popular motivational models: the "motivations for play in online games" (MPOGQ; Yee, 2006) including three main motivational factors (achievement, social, immersion), which consists of an additional 10 subcomponents; and the model of the motives for online gaming questionnaire (MOGQ) (Demetrovics et al., 2011) including the following seven motivations: escape, coping, fantasy, skill development, recreation, competition, social. These motivations show considerable association with GD (Bäcklund et al., 2022) and were found to be useful in the explaining the association between poor mental health and GD (Király et al., 2015; Ballabio et al., 2017).

2. Research aims

I. Execute a qualitative synthesis of the previous gaming motivation theories and construct a comprehensive measurement tool that can broadly explore the drivers of video game use while taking their overlap into consideration (Study 1).
II. Write a narrative review of available empirical research on the aetiological factors of GD to support and/or refute previous models. Additionally, provide a summary of areas not covered in earlier models: the role of external (e.g. culture, peers, family etc.) and game-related (e.g. game genres, structural characteristics etc.) factors (Study 2).
III. Provide a quantitative synthesis of studies focusing on the ADHD-GD association and supplement earlier research with qualitative summary of the potential mediators explaining the underlying process of this association (Study 3).
IV. Test the potential mediator role of video game motivations in the association between ADHD, GD and average time spent playing (Study 4).

3. A comprehensive model to understand and assess the motivational background of video game use: the Gaming Motivation Inventory (GMI) (Study 1)[1]

3.1. Methods

All analyses were performed with SPSS version 25 (IBM Corp., 2017) and Mplus 8 (Muthén & Muthén, 1998–2017). Several goodness-of-fit indices were estimated to determine model fit (Brown, 2015).

Stage 1 (procedure and analyses): PubMed, ScienceDirect, Web of Science, and Scopus were screened to identify studies including measurement of video game motives. Most frequently used instruments measuring gaming motives were used to identify underlying motives and generate a comprehensive item pool for their assessment.

Stage 2-4 (procedure): an online, self-report survey was designed and administered in Qualtrics distributed in collaboration with a popular Hungarian gamer magazine (GameStar) to recruit a large sample of Hungarian-speaking video game players (N=14,740, 89.3% male, mean age 24.1 years). The survey consisted of sociodemographic measures, questions related to video game use habits, the survey constructed at Stage 1 for gaming motivation measurement, and the following, previously validated scales:

- sociability was assessed with five items proposed by Asendorpf and Wilpers (1998);
- competitiveness was assessed with three items from the nine-item Enjoyment of Competition subscale of the Revised Competitiveness Index (Harris & Houston, 2010; Houston, Harris, McIntire, & Francis, 2002);
- sensation seeking was assessed with the four-item subscale of the short version of the UPPS-P Impulsive Behavior Scale (Billieux et al., 2012; Zsila, Bőthe, Demetrovics, Billieux, & Orosz, 2020);
- general self-esteem, self-esteem when playing video games were measured with the five positive items of the Rosenberg Self-Esteem Scale (Rosenberg, 1965) (original and modified version);

[1] The published version of this study is the following: „Király, O., Billieux, J., King, D. L., Urbán, R., Koncz, P., Polgár, E., & Demetrovics, Z. (2022). A comprehensive model to understand and assess the motivational background of video game use: The Gaming Motivation Inventory (GMI). *Journal of Behavioral Addictions*, 11(3), 796-819. https://doi.org/10.1556/2006.2022.00048"

- positive and negative affect traits were measured with the 20-item Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988);
- perceived stress was measured for the previous 3 months with the short four-item version of the Perceived Stress Scale (Cohen, 1986; Cohen & Williamson, 1988);
- GD symptoms were assessed with the Ten-Item Internet Gaming Disorder Test (IGDT-10; Király et al., 2019; Király, Sleczka, et al., 2017);
- depression symptoms were measured by the six-item version of the Center of Epidemiological Studies-Depression Scale (CES-D; Radloff, 1977).

Stage 2 (analysis): at the *first step*, a confirmatory factor analysis (CFA) was used to validate 27 theoretically proposed motivational factors. Then the total sample was divided into three non-overlapping random samples. At the *second step*, exploratory factor analysis (EFA) was used to test how the motivational factors found at step one cluster into higher-order factors. At the *third step*, an independent sub-sample was used to cross-validate the model found at the second step. At the *fourth step*, exploratory structural equation modeling (ESEM) was used to cross-validate the hierarchical structure found at the second and third step. To evaluate model fit, chi-square ($\chi 2$) test of exact model fit was performed and Comparative Fit Index (CFI), Tucker-Lewis index (TLI), root-mean square error of approximation (RMSEA) and standardized root-mean-square residual (SRMR) were estimated.

Stage 3 (analysis): multiple indicators, multiple causes (MIMIC) analysis was used to cross-validate the six higher-order motivational factors with the measured psychological and personality variables.

Stage 4 (analysis): a parallel mediation model was constructed within structural equation modeling (SEM) to test the mediation role of the six higher-order motivations. This analysis was expected to further validate the model by showing similar patterns of association as in earlier, similar research (Király et al., 2015; Ballabio et al., 2017).

3.2. Main results

Stage 1: 100 items were generated based on previous instruments which covered 27 theoretical motivational factors.

Stage 2: 26 first-order factors were identified using CFA (*first step*), which were clustered into six higher order factors during two independent EFA (*second and third step*). The factors were named as Mastery, Immersion/Escapism, Competition, Stimulation, Social and Habit/Boredom (Table 1). The ESEM model had confirmed the model resulted from the earlier EFAs (*fourth step*). The ESEM model had shown adequate fit to the data ($\chi 2$ (184) = 3,264.4, $p < 0.001$; CFI = 0.944; TLI = 0.901; RMSEA = 0.059, 90% confidence interval 0.057–0.060; SRMR = 0.021).

Table 1

Exploratory Structural Equation Modeling of the 26 Motivational Factors from the Results of the Exploratory Factor Analysis (n_3 = 4,872)

	Factor loadings					
	Mastery	Immersion/Escapism	Competition	Stimulation	Social	Habit/Boredom
Advancement	**0.730**	0.018	0.196	0.059	−0.080	−0.011
Amotivation	0.057	−0.032	0.012	−0.049	0.033	**0.677**
Autonomy	**0.533**	**0.458**	−0.040	0.021	0.000	0.030
Boredom	−0.024	0.093	0.066	0.167	−0.013	**0.464**
Competence	0.145	**0.332**	**0.606**	0.021	0.005	−0.014
Competition	0.101	−0.183	**0.660**	0.243	0.053	0.043
Completion	**0.778**	−0.087	0.193	0.018	−0.102	0.037
Coping	−0.070	**0.631**	0.115	0.158	0.046	−0.051
Escape	−0.113	**0.783**	0.050	0.020	−0.011	0.099
Exploration + Mechanics	**0.878**	0.030	−0.014	−0.147	0.085	0.071
Fantasy	0.217	**0.735**	−0.109	0.073	−0.053	0.035
Financial	0.024	0.028	0.293	−0.111	0.140	0.127
Game skills	**0.622**	−0.093	**0.503**	0.019	0.019	−0.058
Identity	0.159	**0.620**	0.273	−0.133	0.061	−0.111
Introjected regulation	−0.075	**0.499**	**0.335**	0.002	−0.033	0.173
Recreation	0.159	0.271	−0.129	0.191	0.035	−0.237
Skill development	**0.384**	0.136	**0.306**	−0.008	0.132	−0.144
Social	0.018	0.163	0.178	−0.102	**0.694**	−0.010
Status	0.005	0.125	**0.692**	0.035	0.144	0.054
Arousal-action	0.079	−0.009	0.222	**0.644**	0.111	−0.052
Cooperation	0.009	−0.124	−0.020	0.102	**0.875**	0.005
Customization	**0.324**	0.127	−0.143	0.286	0.106	0.075
Destruction	−0.007	0.156	0.086	**0.534**	0.025	0.165
Graphics	0.090	0.015	0.004	**0.503**	−0.042	−0.165
Story	0.344	0.237	**−0.341**	0.180	0.010	−0.038
Strategy	**0.390**	−0.104	−0.113	0.093	**0.359**	0.042

Correlation between the factors

	Mastery	Immersion/Escapism	Competition	Stimulation	Social
Immersion/Escapism	0.447***				
Competition	0.329***	0.269***			
Stimulation	0.436***	0.350***	0.124***		
Social	0.337***	0.191***	0.480***	0.276***	
Habit/Boredom	−0.223***	0.111***	0.172***	−0.013	0.047*

Note. Salient factor loadings (>0.30) are boldfaced.
*$P < 0.05$. ***$P < 0.001$.

Stage 3: several significant, positive path coefficients were found between main motives and theoretically related psychological and personality variables, including (in ascending order) negative affect and Immersion/Escapism motivation (β = 0.242, p < 0.001), sociability and Social motivation (β=0.261, p<0.001), positive affect and Mastery motivation (β=0.344, p<0.001), competitiveness and Competition motivation (β=0.604, p<0.001) (Table 2). Additionally, video game genre preference had shown distinguishable motivational profiles.

Table 2

*How Relevant Psychological Variables Predict the Six Main Motivations: Path Coefficients of Multiple Indicator Multiple Cause Model (*N*=14,740)*

Predictor	Gaming motive					
	Mastery	Immersion/Escapism	Competition	Stimulation	Social	Habit/Boredom
Self-esteem	−0.096***	−0.063***	−0.023*	0.052***	−0.087***	−0.036
Positive affect	0.344***	0.123***	0.033**	0.092***	0.097***	−0.220***
Negative affect	0.024	0.242***	0.154***	0.128***	0.010	0.250***
Sociability	−0.087***	−0.103***	−0.016	−0.020	0.261***	0.067**
Competitiveness	0.012	−0.148***	0.604***	0.187***	0.133***	−0.120*
Perceived stress	0.077***	0.188***	0.044***	0.053**	0.030*	0.148***
Sensation seeking	0.123***	0.080***	−0.008	0.174***	0.083***	0.050**
Age	−0.067***	−0.080***	−0.155***	−0.045	−0.250***	−0.266***
Gender	0.056***	0.062***	−0.034***	−0.060*	−0.041***	−0.103***

Note. Effect sizes are provided as standardized betas. Gender: males were coded as 0, females as 1.
*$P < 0.05$. **$P < 0.01$. ***$P < 0.001$.

Stage 4: results had verified a similar pattern of association compared to earlier, similar models: the effect of depression symptoms and GD symptoms (total effect: β=0.375, p<0.001) was partially mediated via Immersion/escapism (indirect effect: β=0.089, p<0.001) and via Competition (indirect effect: β=0.016, p<0.001). Additionally, the model had shown a relatively strong indirect association via Habit/Boredom (indirect effect: β=0.089, p<0.001) not covered in earlier path models (Figure 1).

Figure 1

*Mediation Model Between Depression Symptoms and Gaming Disorder Symptom Severity and Gaming Time (*N*=14,740)*

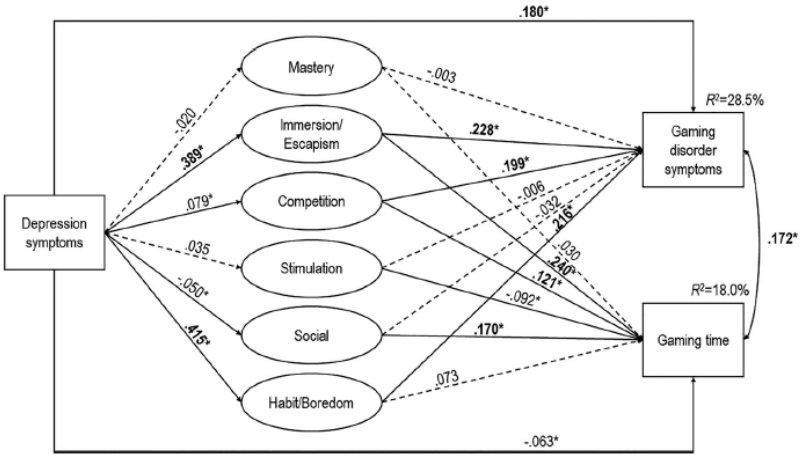


Fig. 2. Mediation model between depression symptoms and gaming disorder symptom severity and gaming time (N = 14,740)
Note. Values on single-headed arrows are standardized regression coefficients (β). The value on the double-headed arrow represents a correlation coefficient. Due to the large sample size, only $^*P < 0.001$ was considered as a significant effect. Solid lines represent significant standardized regression coefficients. Dashed lines represent non-significant standardized regression coefficients. Bold letters represent considerable standardized regression coefficients ($\beta > 0.1$). Gaming disorder symptoms were calculated by summarizing the dichotomized Ten-Item Internet Gaming Disorder Test items, except for Item 8 (i.e., escaping or relieving a negative mood). We removed Item 8 because its content conceptually overlapped with the higher-order motive Immersion/Escapism, which could have biased the results. The model was controlled for age and gender. However, to ease the interpretation of the figure, correlation coefficients between the latent variables and the covariate effects of gender and age are not shown.

3.3. Discussion

This study has successfully created a valid comprehensive tool with good psychometric properties suitable to measure 26 motives that can be clustered into 6 higher-order motivational dimensions. GMI includes the dimensions of the previously popular tools including the MPOGQ (Yee, 2006) and the MOGQ (Demetrovics et al., 2011). GMI also follows similar hierarchical structure as the MPOGQ: Achievement component is measured Mastery and Competition in GMI, there is a Social component in both motivational system with similar content and the Immersion higher-order component of MPOGQ is also mostly covered by Immersion/Escapism.

The criterion validity of the higher-order has been verified by showing considerable significant correlation between these dimensions and psychological scales: Competition higher-order motive was strongly associated with competitiveness; Social higher-order motive was moderately associated with sociability; Mastery higher-order motive had the positive association with positive affect in line with the studies of Ryan and colleagues

(2006) which have shown that game enjoyment is related to the fulfillment of basic psychological needs through tackling challenges; Immersion/Escapism was moderately associated with negative affect in line with previous studies showing reporting moderate association between mental health issues and escapism, fantasy, coping (Ballabio et al., 2017; Bányai et al., 2019; Király et al., 2015); Habit/Boredom was positively associated with negative affect and negatively with positive affect with moderate effect sizes, which is in line with studies showing that amotivation (main motive of Habit/Boredom) shows positive association with need frustration during daily life (Mills et al., 2018) and negative association with need fulfillment in-game (Lafrenière et al. 2012).

Finally, a similar parallel mediation model was tested as in previous studies (Ballabio et al., 2017; Bányai et al., 2019; Király et al., 2015) where the effect of depressive symptoms on GD was mediated by Immersion/Escapism, Habit/Boredom and Competition. This model is in line with the theoretical conceptualization of GD, showing the importance of inflexible, avoidance oriented maladaptive coping (Kross et al., 2008) and consistent with previous research regarding the correlations of amotivation (Mills et al., 2018; Zsila et al., 2017).

This research holds some limitations, such as the usage of self-report assessment (vulnerable to memory recall and social desirability bias), the cross-sectional design (not suitable to explore causal or temporal associations), extensive length of the questionnaire (resulting in fatigue and attrition among respondents). Despite these limitations, GMI can be used in research to widely explore the motivational basis of problematic video game users, most importantly Immersion/Escapism and Habit/Boredom higher order motives. Furthermore, clinical practice can benefit from using GMI to track the motivational background of GD patients signifying the state of latent psychological need fulfillment and frustration.

4. Gaming disorder: A summary of its characteristics and aetiology (Study 2)[2]

4.1. Methods

The authors collected, processed and narratively described the most recent and relevant research findings explaining the characteristics and aetiological factors of GD based on their scientific knowledge. An initial goal was to include studies covering the following three main areas of interest: individual, environmental and gaming-related factors.

4.2. Main results

A large set of research (N = 177) was identified covering a wide range of variables found to play a role in the emergence, development and maintenance of GD.

4.2.1. Gaming-related factors

Online video game players were consistently found to be more affected by GD (Lemmens & Hendriks, 2016; Montag et al., 2021; Mößle & Rehbein, 2013; Smyth, 2007) which may be related to the capacity of online games to provide safe environments of social interactions as the identity of players can remain anonymous and there is no necessity of participating in face-to-face social activities to have social interactions (Heng et al., 2021; Bodi et al., 2021; Lee & Leeson, 2015). Several game genres were consistently associated with problematic gaming, such as massively multiplayer online role-playing games (MMORPGs), first-person/third person shooter (FPS/TPS) games, real-time strategy (RTS) games, and multiplayer online battle arena (MOBA) games (Müller et al., 2015; Rehbein et al., 2021). The contribution of specific genres to the addictive nature of games for vulnerable individuals is supposedly due to their structural characteristics (Billieux et al., 2015; King et al., 2010; Rehbein et al., 2021) such as the permanent nature of game worlds (in case of MMOs), advancement and complex reinforcement systems (in case of RPGs), virtual social organizations in the form of guilds and clans (in case of MMORPGs and online shooters). Additionally, options for detailed character customization (in case of MMORGPs and simulation games) provide an opportunity to create personalized avatars

[2] The published version of this study is the following: „ Király, O., Koncz, P., Griffiths, M. D., & Demetrovics, Z. (2023). Gaming disorder: A summary of its characteristics and aetiology. *Comprehensive Psychiatry*, 122, 152376. https://doi.org/10.1016/j.comppsych.2023.152376”

which through identification can reduce discrepancy among real and idealized self, thus possibly contributing to the addictive nature of video games (Szolin et al., 2022).

Video game monetization is frequently built upon microtransactions (i.e., the purchase of additional game content in the form of virtual items such as textures/skins, weapons, currency, or levels), especially in case of free-to-play games (Dreier et al., 2017). Several monetization techniques are seen as predatory (King, Delfabbro, 2018), as they are built upon player behavior tracking used to personalize offers and pricing, which are further supported by different pressuring tactics such as "limited time offers" (King et al., 2019). Some members of the video game industry deliberately aims to profit from a small proportion of high spending players (known as "whales) (Dreier et al., 2017), who are not necessarily wealthy, but rather problematic users (Close et al., 2021). Another emerging field is the growing presence of gambling like elements in the world of video games, including loot boxes (virtual containers which include random virtual items of different value)(Raneri et al., 2022) and skin gambling (using video game cosmetics for betting) (Hing et al., 2021). Loot boxes show visual similarities with slot machines and have been consistently associated with problematic use (Raneri et al., 2022).

4.2.2. Individual factors

Adolescent and young adult males are the most vulnerable population for the development of GD (Stevens et al., 2020; Su et al., 2020). Several studies have examined the relationship of GD with personality traits, finding several associations with the Big Five personality traits: neuroticism was positively associated, while extraversion, conscientiousness and agreeableness were negatively associated with problematic video game use (Akbari et al., 2021; Chew, 2022). Furthermore, impulsivity was also consistently found to be also associated with GD (Lee et al., 2019). The mental health of GD affected is worse compared to healthy individuals in several areas including more frequent symptoms of depression, anxiety, substance and polysubstance misuse, ADHD and autism (Ji et al., 2022; Ostinelli et al., 2021; Wang et al., 2017; Koncz et al., 2023; Murray et al., 2021). Additionally, GD affected individuals are more socially isolated and have lower self-esteem (Pápay et al., 2013; Van Rooij et al., 2014) and social competence (Van Rooij et al., 2014; Wichstrøm et al., 2019). While these issues are supposed to be the results of problematic use, they are

also expected to be risk factors for the development and maintenance of problematic involvement.

Understanding motivation to play in relation to GD is crucial in explaining problematic use. Escapism (a tendency to avoid real life problems by playing) is most closely related motivation to GD followed by achievement, immersion and social motivations (Wang & Cheng, 2022; Bäcklund et al., 2022). Specific motivations are not only risk factors of GD but are also shown to be intervening between other individual risk factors (e.g. comorbidities) and GD (Ballabio et al., 2017; Bányai et al., 2019; Király et al., 2015), indicating that the presence of issues in other areas of life drive players to use video games to avoid their problems or compensate for their lacking need fulfillment (Şalvarlı & Griffiths, 2021; Szolin et al., 2022).

Based on the similarities of the neurobiological basis of substance use disorders and GD, genetic vulnerability is assumed to be responsible for GD development, but only a few studies were published in this topic yet. Brain imaging studies have shown unique neurobiological patterns of GD affected individuals including different functioning in prefrontal areas and the temporoparietal, frontolimbic and subcortical regions (Schettler et al., 2022) and reduced gray-matter volume and altered white matter density in areas responsible for decision-making, emotion regulation and behavioral control (Weinstein, 2017; Yao et al., 2017).

4.2.3. Environmental factors

Families play an important role in prevention as the quality of parent-child relationships are evidently negative related to the severity of GD (Schneider et al., 2017). 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 (Nielsen et al., 2020). Several studies have noted that the importance of father-child relationships as a protective factor (Schneider et al., 2017; Su et al., 2018; Throuvala et al., 2019) and growing up in single-parent families is a risk factor for GD (Batthyany et al., 2009; Schneider et al., 2017). Furthermore, childhood maltreatment (emotional, sexual, or physical abuse and physical or emotional neglect of a

child) is also considered as a risk factor for GD (Nielsen et al., 2020; Torres-Rodríguez et al., 2018; Vadlin et al., 2016). Besides family relations, peers and school related factors were also found to be related to GD. Being bullied and bullying others, having friends whose gaming is also problematic, having low educational and career achievements (skipping school classes, truancy, and having low school grades), and a low level of integration are all found to be associated with GD (Mihara & Higuchi, 2017). Cultural differences were found in the prevalence of GD, higher pooled prevalence rate was found for the prevalence of gaming disorder in Asian countries (5.08%) compared to Europe (2.72%) (Stevens et al., 2021). Despite low amount of studies were made among esports players, it is argued that the further promotion of videogame playing under the umbrella of esports would likely increase the prevalence of hazardous gaming and GD (Chung et al., 2019).

4.3. Discussion

Based on the gaps identified in the present review, future studies should focus on specific aspects of aetiology. Videogames are continually changing and advancing using newer behavioural mechanics that appear to manipulate gamers to play more and spend more, thus this area should be an important area of continuous research. The research on comorbid psychopathology holds utmost importance as mental health can significantly hinder recovery if no treated in parallel. 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 and colleagues (2023) 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. 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.

5. The emerging evidence on the association between symptoms of ADHD and gaming disorder: A systematic review and meta-analysis (Study 3)[3]

5.1. Methods (procedure and analyses)

Articles search was done systematically on Scopus, Science Direct, Web of Science, and PubMed to identify studies relating to the association between ADHD and GD. Studies were included, if at least one of the following was reported: a correlation coefficient regarding ADHD-GD association; group means and SDs of ADHD symptom severity (between GD and non-GD individuals); group means and SDs of GD symptom severity (between ADHD and non-ADHD individuals). Data extraction was performed with the inclusion of BA, MA and PhD students.

Data was analyzed using the Comprehensive Meta-Analysis Software Version 3.0 (Borenstein, Hedges, Higgins, & Rothstein, 2009). Data synthesis was executed using random-effects model and confirmed in structural equation meta-analysis, heterogeneity estimates were calculated (Q and I^2 statistics) and figures (forest plots), were created for illustration. All analyses were performed on either the combined ADHD symptom severity, and/or on ADHD subdomain (inattention and hyperactivity/impulsivity) severity scores. Findings not suitable for data synthesis were reported qualitatively.

Publication bias tests were implemented (funnel plot, trim-and-fill method, Rosenthal's fail-safe N method) (Egger, Smith, Schneider, & Minder, 1997; Duval, Tweedie, 2000; Rosenthal, 1979) to test the robustness of findings to systematic missingness due to selective publication practice. Moderator analyses were performed using several potential moderators (age, gender ratio, year of data collection, study quality, sample type, country of origin, GD measure and source, ADHD measure and source, type of addiction examined). Quality assessment was provided for the included research articles based on the protocol of Murray and colleagues (2021). Theoretical summary was provided to explain the role of all intervening factors of the association.

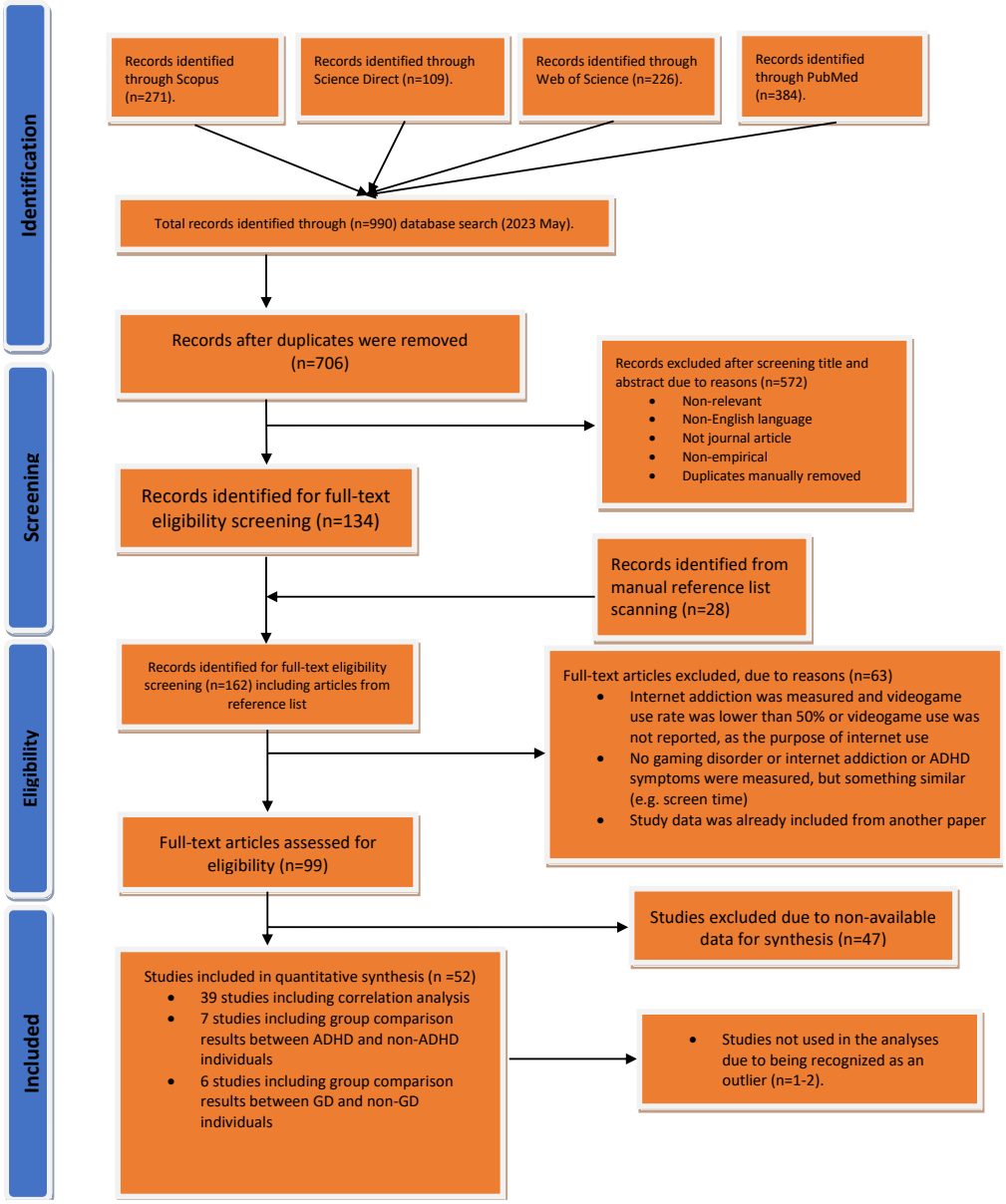
[3] The published version of this study is the following: „Koncz, P., Demetrovics, Z., Takacs, Z. K., Griffiths, M. D., Nagy, T., & Király, O. (2023). The emerging evidence on the association between symptoms of ADHD and gaming disorder: A systematic review and meta-analysis. *Clinical Psychology Review*, 106, 102343. https://doi.org/10.1016/j.cpr.2023.102343"

5.2. Main results

As the results of articles search and data extraction 52 studies were found suitable for data synthesis (39 studies with correlation estimates, 7 studies comparing GD severity of ADHD and non-ADHD affected individuals, 6 studies comparing ADHD severity of GD and non-GD individuals) (Figure 2).

Figure 2

Flowchart of the Systematic Database Search and Screening Process



After data synthesis pooled estimates of correlation between GD and ADHD were all significant, indicating a positive, moderate association with combined ADHD scores (r = 0.296, $p < 0.001$), inattention scores (r = 0.306, $p < 0.001$), and hyperactivity/impulsivity scores (r = 0.266, $p < 0.001$) (Figure 3). These results were confirmed by structural equation meta-analysis. A large average difference was found in GD severity between ADHD affected and non-ADHD affected individuals (g = 0.693, $p < 0.001$) (Figure 4). A large average difference was found in ADHD severity between GD affected and non-GD affected individuals (g = 0.854, $p < 0.001$) (Figure 5).

Figure 3

Forest Plot for Studies With Correlation Data of the Association Between Gaming Disorder Symptom Severity and Combined ADHD Scores

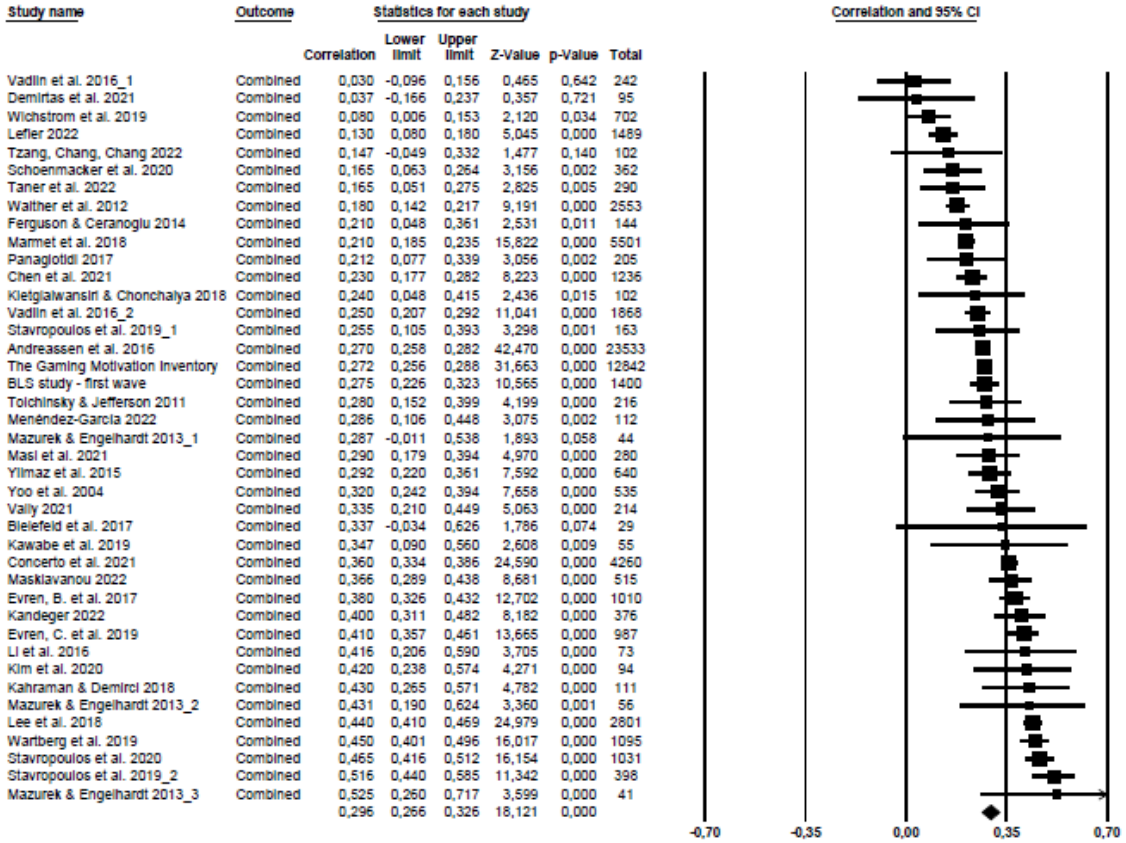
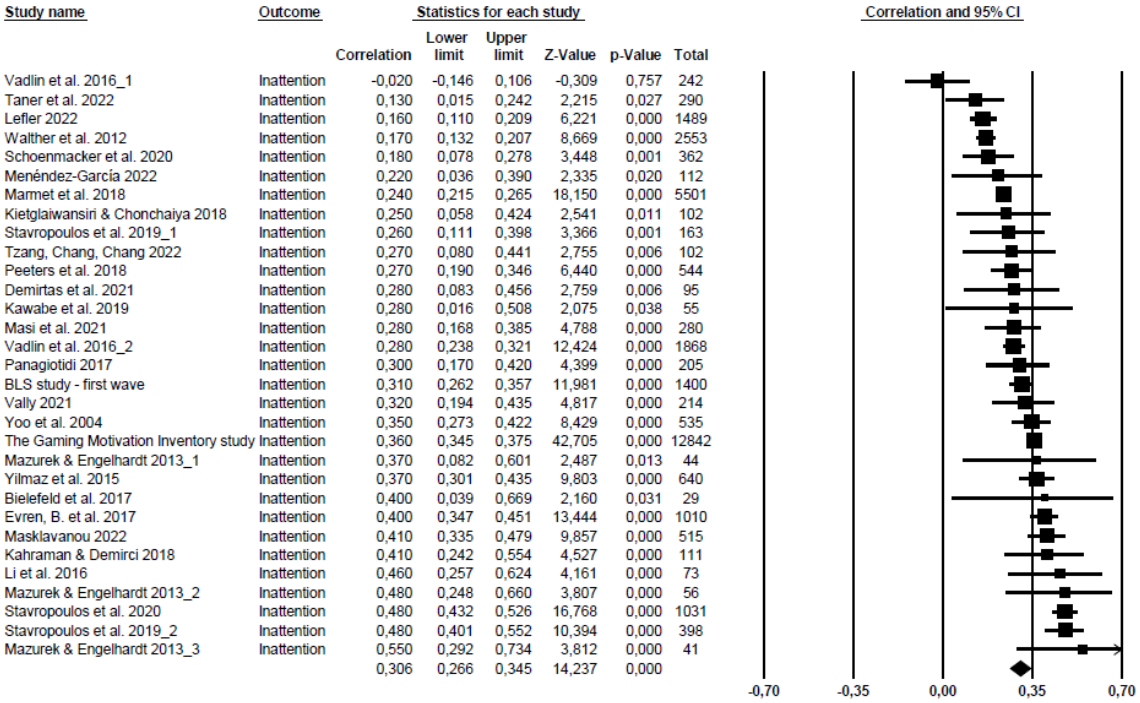


Figure 4

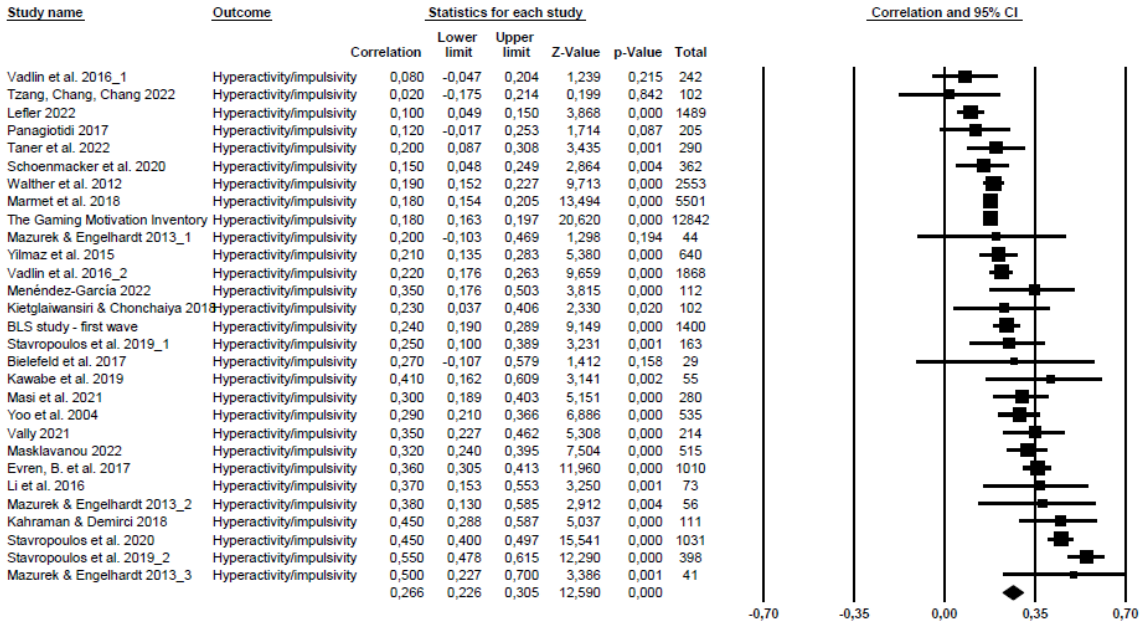
Forest Plot for Studies With Correlation Data of The Association Between Gaming Disorder Symptom Severity and ADHD Inattention Scores



Study name	Outcome	Correlation	Lower limit	Upper limit	Z-Value	p-Value	Total
Vadlin et al. 2016_1	Inattention	-0,020	-0,146	0,106	-0,309	0,757	242
Taner et al. 2022	Inattention	0,130	0,015	0,242	2,215	0,027	290
Lefler 2022	Inattention	0,160	0,110	0,209	6,221	0,000	1489
Walther et al. 2012	Inattention	0,170	0,132	0,207	8,669	0,000	2553
Schoenmacker et al. 2020	Inattention	0,180	0,078	0,278	3,448	0,001	362
Menéndez-García 2022	Inattention	0,220	0,036	0,390	2,335	0,020	112
Marmet et al. 2018	Inattention	0,240	0,215	0,265	18,150	0,000	5501
Kietglaiwansiri & Chonchaiya 2018	Inattention	0,250	0,058	0,424	2,541	0,011	102
Stavropoulos et al. 2019_1	Inattention	0,260	0,111	0,398	3,366	0,001	163
Tzang, Chang, Chang 2022	Inattention	0,270	0,080	0,441	2,755	0,006	102
Peeters et al. 2018	Inattention	0,270	0,190	0,346	6,440	0,000	544
Demirtas et al. 2021	Inattention	0,280	0,083	0,456	2,759	0,006	95
Kawabe et al. 2019	Inattention	0,280	0,016	0,508	2,075	0,038	55
Masi et al. 2021	Inattention	0,280	0,168	0,385	4,788	0,000	280
Vadlin et al. 2016_2	Inattention	0,280	0,238	0,321	12,424	0,000	1868
Panagiotidi 2017	Inattention	0,300	0,170	0,420	4,399	0,000	205
BLS study - first wave	Inattention	0,310	0,262	0,357	11,981	0,000	1400
Vally 2021	Inattention	0,320	0,194	0,435	4,817	0,000	214
Yoo et al. 2004	Inattention	0,350	0,273	0,422	8,429	0,000	535
The Gaming Motivation Inventory study	Inattention	0,360	0,345	0,375	42,705	0,000	12842
Mazurek & Engelhardt 2013_1	Inattention	0,370	0,082	0,601	2,487	0,013	44
Yilmaz et al. 2015	Inattention	0,370	0,301	0,435	9,803	0,000	640
Bielefeld et al. 2017	Inattention	0,400	0,039	0,669	2,160	0,031	29
Evren, B. et al. 2017	Inattention	0,400	0,347	0,451	13,444	0,000	1010
Masklavanou 2022	Inattention	0,410	0,335	0,479	9,857	0,000	515
Kahraman & Demirci 2018	Inattention	0,410	0,242	0,554	4,527	0,000	111
Li et al. 2016	Inattention	0,460	0,257	0,624	4,161	0,000	73
Mazurek & Engelhardt 2013_2	Inattention	0,480	0,248	0,660	3,807	0,000	56
Stavropoulos et al. 2020	Inattention	0,480	0,432	0,526	16,768	0,000	1031
Stavropoulos et al. 2019_2	Inattention	0,480	0,401	0,552	10,394	0,000	398
Mazurek & Engelhardt 2013_3	Inattention	0,550	0,292	0,734	3,812	0,000	41
		0,306	0,266	0,345	14,237	0,000	

Figure 5

Forest Plot for Studies with Correlation Data of the Association Between Gaming Disorder Symptom Severity and ADHD Hyperactivity/Impulsivity Scores



Publication bias tests had shown no evidence for considerable publication bias for any data type, as funnel plots indicated only slight asymmetry in case of correlation coefficients between all three types (combined, inattention, hyperactivity/impulsivity) ADHD symptoms severity scores and GD and no asymmetry in case of groups comparison results. According to the results of the fail-safe N method, the average effects were robust, large amount of non-significant studies would be necessary to turn the average effect non-significant: 31,960 in case of correlation coefficients between combined ADHD and GD; 13,912 in case of correlation coefficients between combined inattention and GD; 8016 in case of correlation coefficients between combined hyperactivity/impulsivity and GD; 321 in case of GD symptom severity differences between ADHD and non-ADHD groups and 261 in case of ADHD symptom severity differences between GD and non-GD groups.

The moderator analyses indicated significant effects in case of three moderators: stronger positive correlation was found between combined ADHD and GD scores in studies with higher percentage of males (coefficient = 0.0018, $p < 0.05$) (Figure 6); stronger positive correlation was found between combined ADHD and GD scores in studies where not only

GD, but a mixture of GD and internet addiction (IA) was measured ($r = 0.288$, $p < 0.001$ for only GD; $r = 0.374$, $p < 0.001$ for mixed measurement Q (1) = 8.636, $p < 0.003$) (Figure 7); larger difference was found in GD symptom severity between ADHD affected and non-ADHD affected individuals in more recent studies (coefficient = 0.0528, $p < 0.001$) (Figure 8).

Figure 6

Meta-Regression Analysis of Gender Distribution on Correlation Estimates Between Combined ADHD Scores and Gaming Disorder Symptom Severity

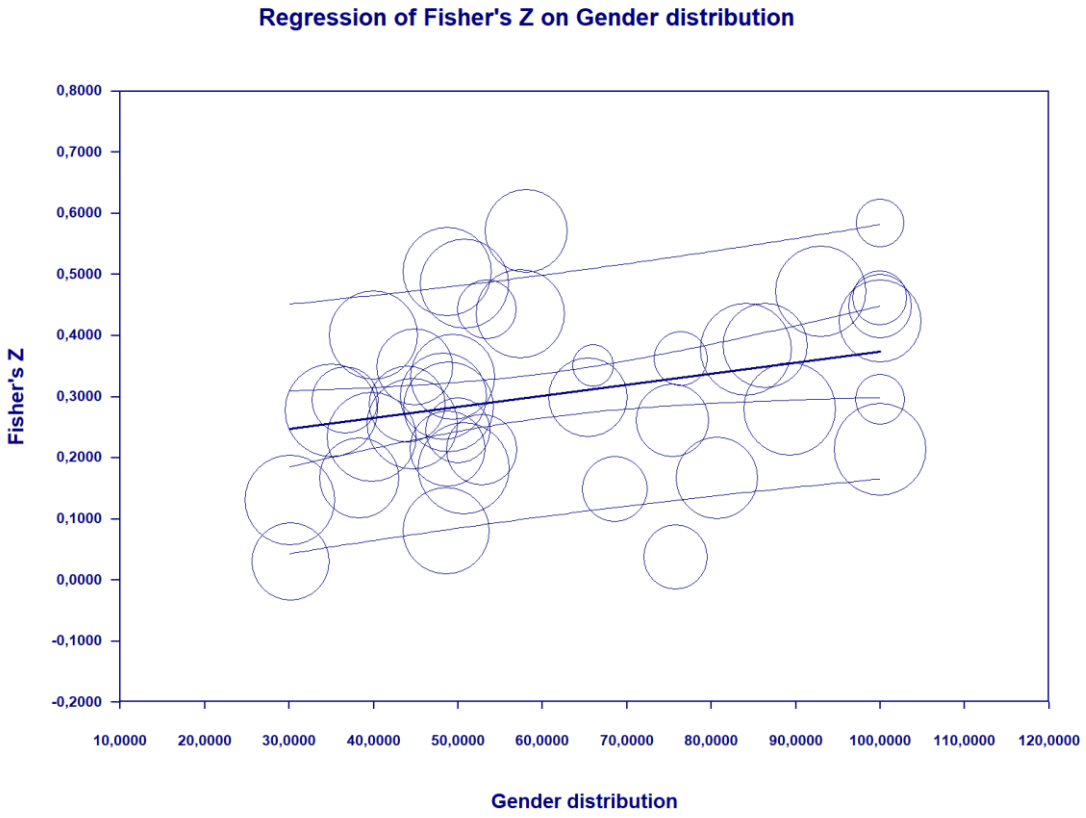
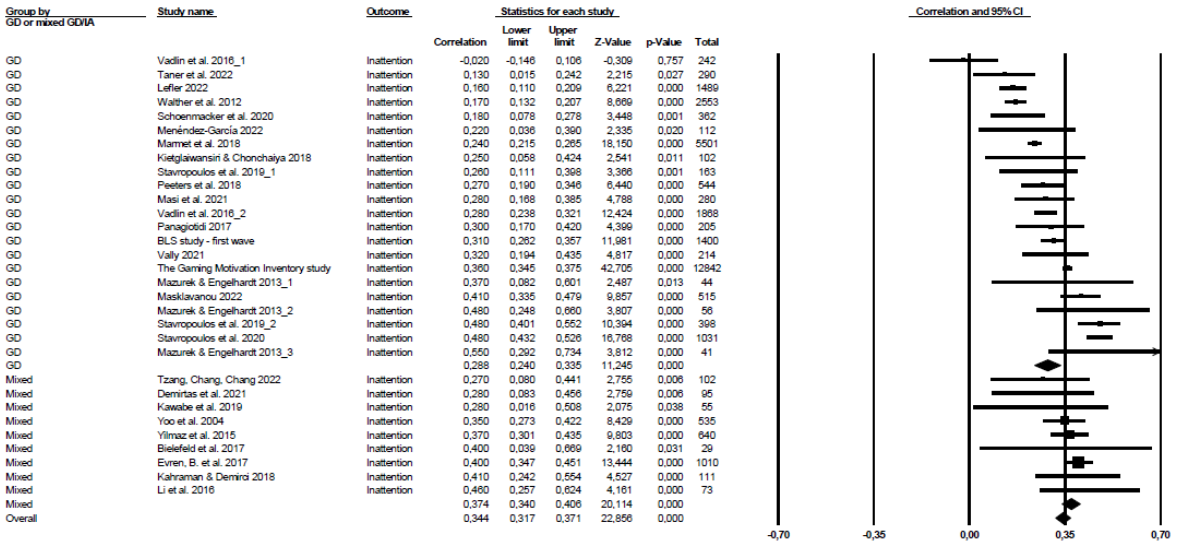


Figure 7

Forest Plot for the Comparison of Correlation Estimates of the Association Between Gaming Disorder and ADHD Inattention Scores Between Studies Measuring Gaming Disorder and Internet Addiction Mixed with Gaming Disorder



Group by GD or mixed GD/IA	Study name	Outcome	Correlation	Lower limit	Upper limit	Z-Value	p-Value	Total
GD	Vadlin et al. 2016_1	Inattention	-0,020	-0,146	0,106	-0,309	0,757	242
GD	Taner et al. 2022	Inattention	0,130	0,015	0,242	2,215	0,027	290
GD	Lefler 2022	Inattention	0,160	0,110	0,209	6,221	0,000	1489
GD	Walther et al. 2012	Inattention	0,170	0,132	0,207	8,669	0,000	2553
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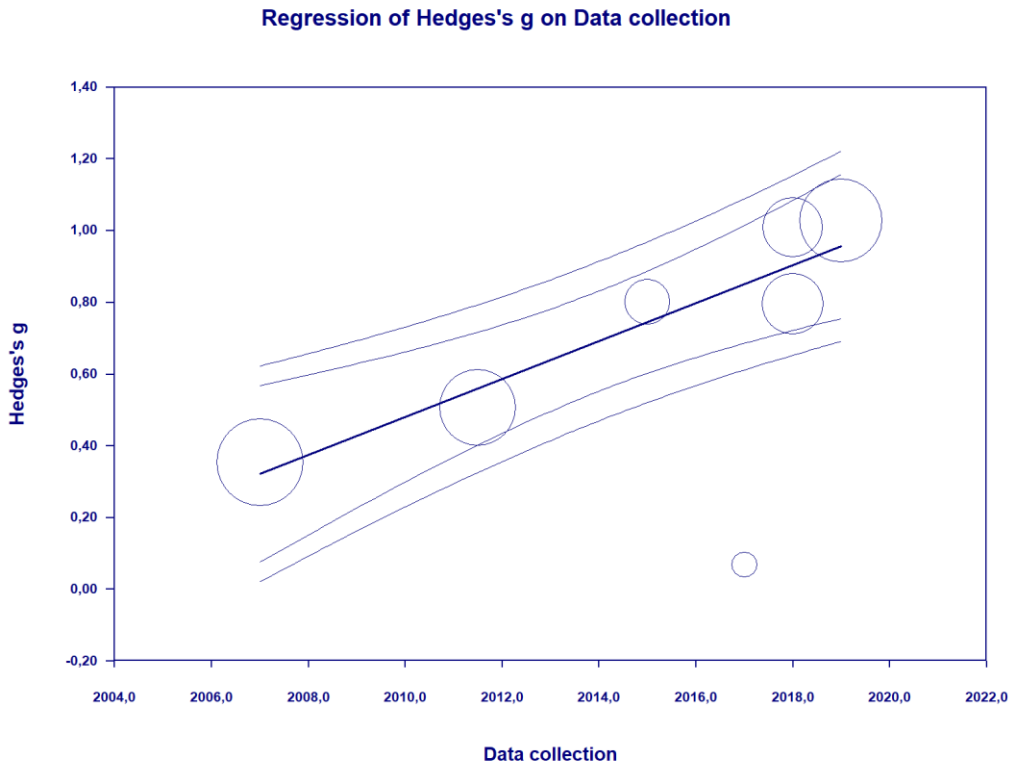
GD	Menéndez-García 2022	Inattention	0,220	0,036	0,390	2,335	0,020	112
GD	Marmet et al. 2018	Inattention	0,240	0,215	0,265	18,150	0,000	5501
GD	Kietglaiwansiri & Chonchaiya 2018	Inattention	0,250	0,058	0,424	2,541	0,011	102
GD	Stavropoulos et al. 2019_1	Inattention	0,260	0,111	0,398	3,366	0,001	163
GD	Peeters et al. 2018	Inattention	0,270	0,190	0,346	6,440	0,000	544
GD	Masi et al. 2021	Inattention	0,280	0,168	0,385	4,788	0,000	280
GD	Vadlin et al. 2016_2	Inattention	0,280	0,238	0,321	12,424	0,000	1868
GD	Panagiotidi 2017	Inattention	0,300	0,170	0,420	4,399	0,000	205
GD	BLS study - first wave	Inattention	0,310	0,262	0,357	11,981	0,000	1400
GD	Vally 2021	Inattention	0,320	0,194	0,435	4,817	0,000	214
GD	The Gaming Motivation Inventory study	Inattention	0,360	0,345	0,375	42,705	0,000	12842
GD	Mazurek & Engelhardt 2013_1	Inattention	0,370	0,082	0,601	2,487	0,013	44
GD	Masklavanou 2022	Inattention	0,410	0,335	0,479	9,857	0,000	515
GD	Mazurek & Engelhardt 2013_2	Inattention	0,480	0,248	0,660	3,807	0,000	56
GD	Stavropoulos et al. 2019_2	Inattention	0,480	0,401	0,552	10,394	0,000	398
GD	Stavropoulos et al. 2020	Inattention	0,480	0,432	0,526	16,768	0,000	1031
GD	Mazurek & Engelhardt 2013_3	Inattention	0,550	0,292	0,734	3,812	0,000	41
GD			0,288	0,240	0,335	11,245	0,000	
Mixed	Tzang, Chang, Chang 2022	Inattention	0,270	0,080	0,441	2,755	0,006	102
Mixed	Demirtas et al. 2021	Inattention	0,280	0,083	0,456	2,759	0,006	95
Mixed	Kawabe et al. 2019	Inattention	0,280	0,016	0,508	2,075	0,038	55
Mixed	Yoo et al. 2004	Inattention	0,350	0,273	0,422	8,429	0,000	535
Mixed	Yilmaz et al. 2015	Inattention	0,370	0,301	0,435	9,803	0,000	640
Mixed	Bielefeld et al. 2017	Inattention	0,400	0,039	0,669	2,160	0,031	29
Mixed	Evren, B. et al. 2017	Inattention	0,400	0,347	0,451	13,444	0,000	1010
Mixed	Kahraman & Demirci 2018	Inattention	0,410	0,242	0,554	4,527	0,000	111
Mixed	Li et al. 2016	Inattention	0,460	0,257	0,624	4,161	0,000	73
Mixed			0,374	0,340	0,406	20,114	0,000	
Overall			0,344	0,317	0,371	22,856	0,000	

Figure 8

Meta-Regression Analysis of Data Collection Date on Gaming Disorder Symptom Severity Differences Between ADHD and Non-ADHD Groups



As the result of quality assessment no low-quality studies were found and most of the studies (38 out of 52) were found to be of high quality. Among studies reporting correlation analysis, only the possibility of sampling/selection bias was identified as a common problem. In studies including group comparisons between ADHD and non-ADHD individuals, sampling/selection bias and the use of less reliable GD/IA assessment tools were identified, affecting general study quality. Ratings of studies including a comparison between GD and non-GD samples were all rated high in all aspects, with no systematic quality issue.

5.3. Discussion

The present study extends the knowledge regarding common GD comorbidities, as previously the co-occurrence of depression and sub-clinical depressive symptoms (Ostinelli et al., 2021) and autism spectrum disorder (Murray et al., 2020) were confirmed using meta-analysis methodology. Based on cross-sectional correlational results, a medium-sized significant positive correlation was found between the two disorders, which was true for the association with both inattention and hyperactivity/impulsivity subdomain scores. Moderate-to-large differences were found in both studies where the GD and non-GD individuals were compared using ADHD symptom severity scores and in studies where ADHD and non-ADHD individuals were compared using GD symptom severity scores. The present meta-analysis provides an overview of the field in regard to research methods. We found that the majority of the studies reported cross-sectional results based on self-report. Interestingly, the single study, which reported a correlation coefficient based on professional rating (clinicians' rating) for both ADHD and GD found only a weak relationship, which warrants for further studies using professional assessment as opposed to self-report.

GD is more prevalent among the male population (Stevens et al., 2020), and ADHD-affected males show higher symptom severity on both subdomains compared to ADHD-affected females (Gershon, 2002), and this factor did moderate the association between the two disorders, indicating stronger association for samples where most of the participants are males. A significantly stronger association was found between GD symptoms and inattentive symptoms in studies assessing problematic internet use in predominantly video game user samples compared to studies where purely gaming disorder severity was assessed. These results might indicate that the presence of inattentive symptoms of ADHD is a risk factor for the problematic use of numerous other online activities rather than online gaming only. These findings are in line with a meta-analysis, where the association between ADHD and PUI was explored (Werling et al., 2022). Conflicting results were found for the year of data collection. While correlation estimates and ADHD symptom severity differences in group comparison between GD and non-GD individuals were not associated with the year of data collection, newer studies reported larger differences in GD

symptom severity between ADHD and non-ADHD individuals. However, as this association was only found in one analysis, it is unclear whether the association may be strengthening over time. The result might simply be the consequence of a confounding variable such as a change in methodology, a trend in different assessment instruments for instance. Also, it should be considered that the moderator analyses might have been underpowered with the relatively small number of studies that we could include in this meta-analysis.

Although the present results cannot establish causality or even the temporal direction of the association, several underlying mechanisms could be involved. A major factor to explain the association between the two disorders is impulsivity (Yen et al., 2017, Li et al., 2016). One important characteristic of children with ADHD is the preference of immediate over delayed rewards (delay aversion) (Sonuga-Barke, 2002). Regarding excessive gaming, there are a wide range of experimental neurocognitive studies showing on average a moderate difference in response inhibition between GD individuals compared to healthy controls (Argyriou et al., 2017). Affective functioning may be another important area of consideration. A study of Chen and colleagues (2021) demonstrated that depression severity and hopelessness mediate the relationship between the symptoms of the two disorders and problematic gaming can lead to progression of disruptive mood dysregulation among ADHD patients (Tzang, Chang, Chang, 2022). Social functioning in ADHD affected individuals, presenting in the form of intrusiveness and aggressivity have several consequences, such as unpopularity, peer rejection or lack of reciprocal relationships (Nijmeijer et al., 2008). Social difficulties are a risk factor for GD, as online video games can be used to compensate for needs that are hard or impossible to satisfy in everyday life (Király et al., 2023). Purely ADHD sample-based studies of Chou and colleagues (Chou et al., 2015; 2016) also support this hypothesis. Another idea is that ADHD individuals may have a greater need for highly stimulating activities, such as video games (Chou, Chang, Yen 2018) to reach an optimal level of arousal (Paulus et al., 2018 in Dullur, Krishnan, Diaz et al., 2020). The higher tendency of ADHD individuals for immersion into video games may be one factor contributing to greater vulnerability for problematic use (Jung et al., 2020), which may be a manifestation of ADHD-related hyperfocus (Hupfeld, Abagis, Shah 2018).

Regarding future studies the results show that there is a great need for longitudinal studies to establish temporal precedence and the direction of the effect in addition to assessment based on clinicians' ratings or diagnosis. The use of robust psychometric instruments suitable for cross-culturally comparison is highly recommended, such as the IGDT-10 (Király et al., 2017, 2019) or the IGDS-9SF (Pontes & Griffiths, 2015). Moderator analyses should be run again in the future, when more data are available in the different categories (sample type, country, assessment tool, informant, type of disorder examined). On a practical note, screening of both disorders is recommended in the presence of either.

6. Gender-specific motivational pathways in ADHD-related inattention and gaming disorder symptoms (Study 4)[4]

6.1. Methods (procedure and analyses)

All analyses were based on the data collected during Study 1 (for further information, see methods section of Study 1, Stage 2-4). 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. Participants reported the average hours spent gaming during weekdays and weekend days (to one decimal place) and the average weekly gaming time was calculated from these data. Analyses were performed with SPSS version 28 (IBM Corp., 2021) and Mplus 8 (Muthén & Muthén, 1998–2017). To determine the adequacy of model fit the guidelines of Browne (1993) and Kline (2015) were used. A parallel mediation model was tested in SEM using robust maximum likelihood estimation (MLR). ADHD subdomain (inattention and hyperactivity/impulsivity) severity scores and higher-order motivations (for further information, see Study 1, Stage 2, *second step*) were used as predictors, and GD symptom severity (without escapism symptom) and time spent gaming were the outcomes. Both models were controlled for age and models were tested separately for males and females. For model fit evaluation chi-square ($\chi 2$) test of exact model fit was performed and RMSEA, SRMR, CFI were calculated.

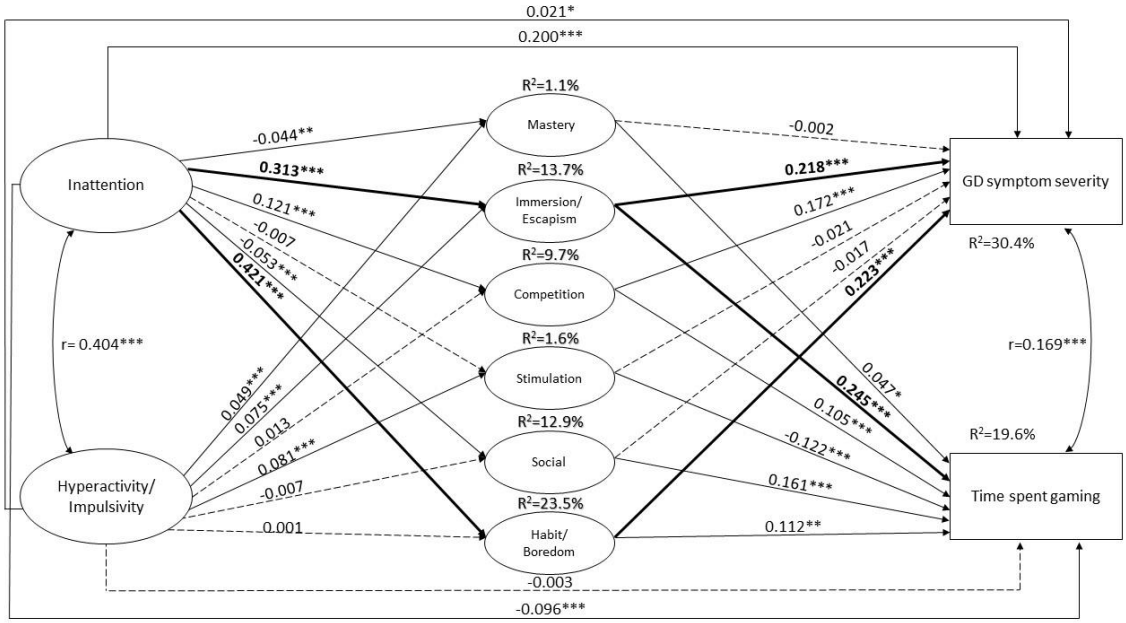
6.2. Main results

Male model: the male model had shown adequate fit to the data ($\chi 2$ (df = 407) = 11881.4, $p < 0.001$; CFI = 0.934; RMSEA = 0.046; SRMR = 0.027). The effect of inattention to GD (total effect: $\beta=0.385$, $p<0.001$) was partially mediated via Immersion/escapism (indirect effect: $\beta=0.068$, $p<0.001$), via Competition (indirect effect: $\beta=0.021$, $p<0.001$) and Habit/Boredom (indirect effect: $\beta=0.094$, $p<0.001$). The effect of hyperactivity/impulsivity to GD (total effect: $\beta=0.038$, $p<0.01$) was partially mediated via Immersion/escapism (indirect effect: $\beta=0.016$, $p<0.001$) (Figure 9).

[4] The published version of this study is the following: „ Koncz, P., Demetrovics, Z., Urbán, R., Griffiths, M. D., & Király, O. (2024). Gender-specific motivational pathways in ADHD-related inattention and gaming disorder symptoms. *Addictive Behaviors*, 158, 108120. https://doi.org/10.1016/j.addbeh.2024.108120"

Figure 9

The mediation model for males

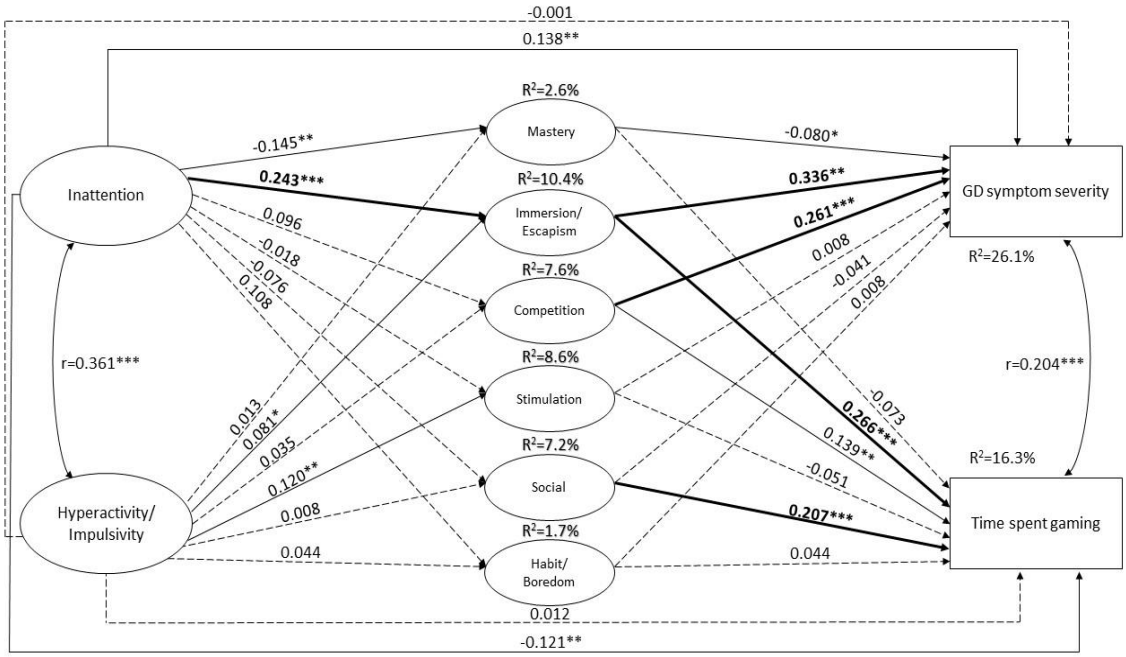


Note: N=13,157; Both subdomains of attention-deficit/hyperactivity disorder (inattention and hyperactivity/impulsivity) were entered into the model as latent variables, assessed using their related Adult ADHD Self-Report Scale items (not represented in the figure). Gaming motives were also introduced 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.

Female model: the female model had shown adequate fit to the data ($\chi2(df = 407) = 2195.9$, $p < 0.001$; CFI = 0.918; RMSEA = 0.053; SRMR = 0.033). The effect of inattention to GD (total effect: $\beta=0.260$, $p<0.001$) was partially mediated via Immersion/escapism (indirect effect: $\beta=0.081$, $p<0.05$) (Figure 10).

Figure 10

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 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.

6.3. Discussion

The association between inattention symptoms and GD symptom severity mostly mediated through immersion/escapism motivation among both genders, and through competition motivation among males. 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. This aligns with the observations that poor emotional regulation is a central characteristic of children with ADHD (Graziano & Garcia, 2016) and coping difficulties are also frequently observed (Al-Yagon et al., 2020; Barra et al., 2021; Hampel

et al., 2008; Young, 2005), meanwhile GD 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).

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. 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) 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).

Furthermore, the gender-specificity of this effect requires additional explanation. 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. Among female video gamers, the presence of harassment directed specifically towards them in videogames may provoke resistance toward and disengagement from daily habitual play (Kaye & Pennington, 2016; McLean & Griffiths, 2019).

Overall, the results of the present study provide a foundation for personalized GD interventions. 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 the need of ADHD affected male players to find subjectively meaningful alternatives for gaming (Wong, 2016), while also beneficially affecting the symptoms of other comorbid disorders (Vos et al., 2015). But, despite motivations account for a significant proportion of the association between the two disorders, ADHD symptoms seem to have independent effect of motivational drivers therefore it is not enough to only identify and address the underlying causes of motivations without applying appropriate treatment for the symptoms of ADHD.

Finally, 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 recruitment and data collection method applied may have been affected by self-selection, social desirability and recall biases, while Hyperactivity/Impulsivity was only defined by two items in the models. The seemingly differing model parameter estimates were not comparable statistically due to the lack of measurement invariance of the motivational scale and the different sample sizes of males and females resulted in a significantly stronger statistical power to detect mediation effects in the male subsample. 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.

7. Summary of findings

The result of Study 1 is the construction of a comprehensive tool measuring 27 theoretical motivational factors originating from earlier research, which shows good psychometrical properties. Further analysis has successfully identified six higher-order motivational dimensions in which the 27 motivational factors clusters into: Mastery, Immersion/Escapism, Competition, Stimulation, Social and Habit/Boredom. This instrument was cross-validated using several different psychological scales including positive/negative affect, sociability, competitiveness. The validity of this tool was further verified by the results of a similar parallel mediation model tested in earlier empirical research (Király et al., 2015; Ballabio et al., 2017) showing that the association between symptoms of depression of was mediated through Immersion/Escapism and Competition. An additional mediational path was identified through Habit/Boredom which has shown similarly strong indirect path as Immersion/Escapism. In Study 2, a wide range of articles were identified and summarized regarding the main characteristics and aetiological factors of GD, covering gaming-related, individual and environmental aspects.

Study 3 includes a qualitative review and quantitative synthesis of research focusing on the association between ADHD and GD. As a result of this study, a moderate positive correlation was found between the symptom severity of ADHD and GD, and a large average difference was found both during ADHD symptom severity comparison between GD affected and non-GD affected groups and GD symptom severity comparison between ADHD and non-ADHD affected groups. No low-quality studies were identified, and the results were not affected considerably by publication bias. Most of the moderator analyses had shown no significant difference in estimates, except three cases: (1) stronger positive correlation was found between combined ADHD and GD scores in studies with higher percentage of males; (2) stronger positive correlation was found between combined ADHD and GD scores in studies where not only GD, but a mixture of GD and internet addiction (IA) was measured; (3) larger difference was found in GD symptom severity between ADHD affected and non-ADHD affected individuals in more recent studies. The co-occurrence of ADHD and GD symptoms was

explained by impulsivity, difficulties in affective and social functioning, and motivational deficits. In study 4, two separate parallel mediation models were testes (one for males, one for females) attempting to explain the association between the symptoms of ADHD and GD. In the male model the effect of inattention to GD was partially mediated through Immersion/escapism, Competition and Habit/Boredom and the effect of hyperactivity/impulsivity to GD was partially mediated through Immersion/Escapism. In the female model the effect of inattention to GD was partially mediated through Immersion/escapism.

8. Limitations

The research presented in this dissertation has a few limitations. Firstly, two articles (Study 2 and partially Study 3) present a qualitative synthesis of previous findings rather than presenting results from the collection and analysis of new and original data. The simple narrative description of these findings does not (or only partially) make it possible to assess the methodological shortcomings or the strength of the effects of the research mentioned. Secondly, most of the studies are observational studies using a cross-sectional design (or built upon such studies), which hold a drawback that they do not allow to clarify cause and the effect relations. Thirdly, all empirical studies and a large proportion of qualitative summaries are based on responses to psychological questionnaires using self-reports. This data collection procedure can lead to several biases, such as reference, recall, misinterpretation, social-desirability and introspection bias. And finally, the presented comprehensive motivational model (Study 1) and the parallel mediation analysis which was built upon the previous motivational model describing the relationship between ADHD and GD (Study 4) was constructed from data of a Hungarian-speaking sample. Replication of findings using non-Hungarian samples would be necessary to support the international generalizability of the findings.

9. Conclusions

GD is a complex issue, determined by the combination of internal, external and gaming-related causes, thus multidisciplinary intervention may be more effective in addressing this problem. The exploration of the gender-specific motivational drivers of problematic use can

be beneficial during daily clinical practice and upcoming research, especially Immersion/Escapism, Habit/Boredom and Competition higher-order motives. ADHD symptoms have shown a robust, moderate positive association with GD, thus screening for one in the presence of the other is recommended during diagnostic process. Similar motivational patterns appear to be responsible for the co-occurrence of depression and ADHD with GD symptoms, demonstrating that Immersion/Escapism is a common, while for ADHD symptoms Habit/Boredom is a male-specific pathway for GD development.

10. References

Akbari, M., Seydavi, M., Spada, M. M., Mohammadkhani, S., Jamshidi, S., Jamaloo, A., & Ayatmehr, F. (2021). The Big Five personality traits and online gaming: A systematic review and meta-analysis. *Journal of Behavioral Addictions*, 10(3), 611-625. https://doi.org/10.1556/2006.2021.00050

Al-Yagon, M., Forte, D., & Avrahami, L. (2020). Executive functions and attachment relationships in children with ADHD: Links to externalizing/internalizing problems, social skills, and negative mood regulation. *Journal of attention disorders*, 24(13), 1876-1890. https://doi.org/10.1177/1087054717730608

Argyriou, E., Davison, C. B., & Lee, T. T. (2017). Response inhibition and internet gaming disorder: a meta-analysis. *Addictive behaviors*, 71, 54-60. https://doi.org/10.1016/j.addbeh.2017.02.026

Asendorpf, J. B., & Wilpers, S. (1998). Personality effects on social relationships. *Journal of Personality and Social Psychology*, 74(6), 1531. https://doi.org/10.1037/0022-3514.74.6.1531

Bäcklund, C., Elbe, P., Gavelin, H. M., Sörman, D. E., & Ljungberg, J. K. (2022). Gaming motivations and gaming disorder symptoms: A systematic review and meta-analysis. *Journal of behavioral addictions*, 11(3), 667-688. https://doi.org/10.1007/978-1-0716-1975-9_18

Ballabio, M., Griffiths, M. D., Urbán, R., Quartiroli, A., Demetrovics, Z., & Király, O. (2017). Do gaming motives mediate between psychiatric symptoms and problematic

gaming? An empirical survey study. *Addiction Research & Theory*, 25(5), 397-408. https://doi.org/10.1080/16066359.2017.1305360

Bányai, F., Griffith, M. D., Demetrovics, Z., & Király, O. (2019). The mediating effect of motivations between psychiatric distress and gaming disorder among esport gamers and recreational gamers. *Comprehensive Psychiatry*, 94, 152117. https://doi.org/10.1016/j.comppsych.2019.152117

Bányai, F., Zsila, Á., Kökönyei, G., Griffiths, M. D., Demetrovics, Z., & Király, O. (2021). The moderating role of coping mechanisms and being an e-sport player between psychiatric symptoms and gaming disorder: Online survey. *JMIR Mental Health*, 8(3), e21115. https://doi.org/10.2196/21115

Barra, S., Grub, A., Roesler, M., Retz-Junginger, P., Philipp, F., & Retz, W. (2021). The role of stress coping strategies for life impairments in ADHD. *Journal of Neural Transmission*, 128(7), 981-992. https://doi.org/10.1007/s00702-021-02311-5

Batthyany, D., Müller, K. W., Benker, F., & Woelfling, K. (2009). Computer game playing: Clinical characteristics of dependence and abuse among adolescents. *Wiener Klinische Wochenschrift*, 121(15-16), 502-509. https://doi.org/10.1007/s00508-009-1198-3

Billieux, J., Deleuze, J., Griffiths, M. D., & Kuss, D. J. (2015). Internet gaming addiction: The case of massively multiplayer online roleplaying games. In N. el-Guebaly, G. Carrà, & M. Galanter (Eds.), *Textbook of addiction treatment: International perspectives* (pp. 1515-1525). Springer. https://doi.org/https://doi.org/10.1007/978-88-470-5322-9_105

Billieux, J., Rochat, L., Ceschi, G., Carré, A., Offerlin-Meyer, I., Defeldre, A.-C., Khazaal., Y, Besche-Richard, C., & Van der Linden, M. (2012). Validation of a short French version of the UPPS-P Impulsive Behavior Scale. *Comprehensive Psychiatry*, 53(5), 609-615. https://doi.org/10.1016/j.comppsych.2011.09.001

Bodi, G., Maintenant, C., & Pennequin, V. (2021). The role of maladaptive cognitions in gaming disorder: Differences between online and offline gaming types. *Addictive behaviors*, 112, 106595. https://doi.org/https://doi.org/10.1016/j.addbeh.2020.106595

Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2009). *Introduction to meta-analysis.* John Wiley.

Brand, M., Wegmann, E., Stark, R., Müller, A., Wölfling, K., Robbins, T. W., & Potenza, M. N. (2019). The Interaction of Person-Affect-Cognition-Execution (I-PACE) model for addictive behaviors: Update, generalization to addictive behaviors beyond internet-use disorders, and specification of the process character of addictive behaviors. *Neuroscience & Biobehavioral Reviews*, 104, 1-10. https://doi.org/10.1016/j.neubiorev.2019.06.032

Brand, M., Young, K. S., Laier, C., Wölfling, K., & Potenza, M. N. (2016). Integrating psychological and neurobiological considerations regarding the development and maintenance of specific Internet-use disorders: An Interaction of Person-Affect-Cognition-Execution (I-PACE) model. *Neuroscience & Biobehavioral Reviews*, 71, 252-266. https://doi.org/10.1016/j.neubiorev.2016.08.033

Brown, T. A. (2015). *Confirmatory factor analysis for applied research (2nd ed.).* Guilford Press.

Browne, M. W. (1993). Alternative ways of assessing model fit. In *K. Bollen, & J. Long (Eds.), Testing structural equation models* (pp. 136–162). Sage.

Chambers, R., Gullone, E., & Allen, N. B. (2009). Mindful emotion regulation: An integrative review. *Clinical Psychology Review*, 29(6), 560-572. https://doi.org/10.1016/j.cpr.2009.06.005

Chen, C., Dai, S., Shi, L., Shen, Y., & Ou, J. (2021). Associations between attention deficit/hyperactivity disorder and internet gaming disorder symptoms mediated by depressive symptoms and hopelessness among college students. *Neuropsychiatric Disease and Treatment*, *17,* 2775. https://doi.org/10.2147/NDT.S325323

Chew, P. K. (2022). A meta-analytic review of internet gaming disorder and the Big Five personality factors. *Addictive behaviors*, 126, 107193. https://doi.org/https://doi.org/10.1016/j.addbeh.2021.107193

Chou, W. J., Chang, Y. P., & Yen, C. F. (2018). Boredom proneness and its correlation with Internet addiction and Internet activities in adolescents with attention-deficit/hyperactivity disorder. *The Kaohsiung Journal of Medical Sciences*, 34(8), 467-474. https://doi.org/10.1016/j.kjms.2018.01.016

Chou, W. J., Huang, M. F., Chang, Y. P., Chen, Y. M., Hu, H. F., & Yen, C. F. (2016). Social skills deficits and their association with Internet addiction and activities in adolescents with attention-deficit/hyperactivity disorder. *Journal of Behavioral Addictions*, *6*(1), 42-50. https://doi.org/10.1556/2006.6.2017.005

Chou, W. J., Liu, T. L., Yang, P., Yen, C. F., & Hu, H. F. (2015). Multi-dimensional correlates of Internet addiction symptoms in adolescents with attention-deficit/hyperactivity disorder. *Psychiatry research*, 225(1-2), 122-128. https://doi.org/10.1016/j.psychres.2014.11.003

Chung, T., Sum, S., Chan, M., Lai, E., & Cheng, N. (2019). Will esports result in a higher prevalence of problematic gaming? A review of the global situation. *Journal of Behavioral Addictions*, 8(3), 384-394. https://doi.org/10.1556/2006.8.2019.46

Close, J., Spicer, S. G., Nicklin, L. L., Uther, M., Lloyd, J., & Lloyd, H. (2021). Secondary analysis of loot box data: Are high-spending "whales" wealthy gamers or problem gamblers? *Addictive behaviors,* 117, 106851. https://doi.org/https://doi.org/10.1016/j.addbeh.2021.106851

Cohen, S. (1986). Contrasting the Hassles Scale and the Perceived Stress Scale: Who's really measuring appraised stress? *American Psychologist*, 41(6), 716–718. https://doi.org/10.1037/0003-066X.41.6.716

Cohen, S., & Williamson, G. M. (1988). Perceived stress in a probability sample of the United States. In S. Spacapan & S. Oskamp (Eds.), *The Social Psychology of Health* (pp. 31-67). Newbury Park, CA: Sage.

Demetrovics, Z., Urbán, R., Nagygyörgy, K., Farkas, J., Zilahy, D., Mervó, B., ... & Harmath, E. (2011). Why do you play? The development of the motives for online gaming

questionnaire (MOGQ). *Behavior research methods*, 43, 814-825. https://doi.org/10.3758/s13428-011-0091-y

Dreier, M., Wölfling, K., Duven, E., Giralt, S., Beutel, M. E., & Müller, K. W. (2017). Free-to-play: about addicted Whales, at risk Dolphins and healthy Minnows. Monetarization design and internet gaming disorder. *Addictive Behaviors*, 64, 328-333. https://doi.org/10.1016/j.addbeh.2016.03.008

Dullur, P., Krishnan, V., & Diaz, A. M. (2021). A systematic review on the intersection of attention-deficit hyperactivity disorder and gaming disorder. *Journal of Psychiatric Research*, 133, 212-222. https://doi.org/10.1016/j.jpsychires.2020.12.026

Duval, S., & Tweedie, R. (2000). Trim and fill: A simple funnel-plot–based method of testing and adjusting for publication bias in meta-analysis. *Biometrics*, 56, 455–463. https://doi.org/10.1111/j.0006-341x.2000.00455.x

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ*, 315, 629–634. https://doi.org/10.1136/bmj.315.7109.629

Fabio, D. (2024). *How many gamers are there? (New 2025 statistics)*. Exploding Topics. https://explodingtopics.com/blog/number-of-gamers

Faheem, M., Akram, W., Akram, H., Khan, M. A., Siddiqui, F. A., & Majeed, I. (2022). Gender-based differences in prevalence and effects of ADHD in adults; A systematic review. *Asian Journal of Psychiatry*, 75, 103205. https://doi.org/10.1016/j.ajp.2022.103205

Gershon, J., & Gershon, J. (2002). A meta-analytic review of gender differences in ADHD. *Journal of Attention Disorders*, 5(3), 143-154. https://doi.org/10.1177/108705470200500302

Gordon, C. T., & Fabiano, G. A. (2019). The transition of youth with ADHD into the workforce: Review and future directions. *Clinical Child and Family Psychology Review*, 22, 316-347. https://doi.org/10.1007/s10567-019-00274-4

Graziano, P. A., & Garcia, A. (2016). Attention-deficit hyperactivity disorder and children's emotion dysregulation: A meta-analysis. *Clinical Psychology Review*, 46, 106-123. https://doi.org/10.1016/j.cpr.2016.04.011

Green, C. S., & Bavelier, D. (2015). Action video game training for cognitive enhancement. *Current Opinion in Behavioral Sciences*, 4, 103-108. https://doi.org/10.1016/j.cobeha.2015.04.012

Hampel, P., Manhal, S., Roos, T., & Desman, C. (2008). Interpersonal coping among boys with ADHD. *Journal of attention disorders*, 11(4), 427-436. https://doi.org/10.1177/108705470729933

Harris, P. B., & Houston, J. M. (2010). A reliability analysis of the revised competitiveness index. *Psychological Reports*, 106(3), 870-874. https://doi.org/10.2466/PR0.106.3.870-874

Heng, S., Zhao, H., & Wang, M. (2021). In-game social interaction and gaming disorder: a perspective from online social capital. *Frontiers in psychiatry*, 11(468115). https://doi.org/https://doi.org/10.3389/fpsyt.2020.468115

Hing, N., Russell, A. M., Bryden, G. M., Newall, P., King, D. L., Rockloff, M., Browne, M., & Greer, N. (2021). Skin gambling predicts problematic gambling amongst adolescents when controlling for monetary gambling. *Journal of Behavioral Addictions,* 10(4), 920-931. https://doi.org/10.1556/2006.2021.00078

Houston, J., Harris, P., McIntire, S., & Francis, D. (2002). Revising the competitiveness index using factor analysis. *Psychological Reports*, 90(1), 31-34. https://doi.org/10.2466/pr0.2002.90.1.31

Hupfeld, K. E., Abagis, T. R., & Shah, P. (2019). Living “in the zone”: hyperfocus in adult ADHD. *ADHD Attention Deficit and Hyperactivity Disorders*, 11, 191-208. https://doi.org/10.1007/s12402-018-0272-y

IBM Corp. (2017). *IBM SPSS statistics for windows, Version 25.0.* IBM Corp.

IBM Corp. (2021). *IBM SPSS Statistics for Windows, Version 28.0.* Armonk, NY: IBM Corp.

Ji, Y., Yin, M. X. C., Zhang, A. Y., & Wong, D. F. K. (2022). Risk and protective factors of Internet gaming disorder among Chinese people: A meta-analysis. *Australian and New Zealand Journal of Psychiatry*, 56(4), 332-346. https://doi.org/10.1177/00048674211025703

Jung, D., Shim, E. J., Park, H., Lee, K., Lee, S., Kim, E. Y., ... & Hahm, B. J. (2020). The association between excessive internet gaming behavior and immersive tendency, mediated by attention deficit/hyperactivity disorder symptoms, in Korean Male University students. *Psychiatry Investigation*, *17*(5), 403-411. https://doi.org/10.30773/pi.2019.0173

Kaye, L. K., & Pennington, C. R. (2016). "Girls can't play": The effects of stereotype threat on females' gaming performance. *Computers in Human Behavior*, 59, 202-209. https://doi.org/10.1016/j.chb.2016.02.020

Kessler, R. C., Adler, L., Ames, M., Demler, O., Faraone, S., Hiripi, E. V. A., … Walters, E. E. (2005). The World Health Organization Adult ADHD Self-Report Scale (ASRS): A short screening scale for use in the general population. *Psychological Medicine*, 35(2), 245–256. https://doi.org/10.1017/S0033291704002892

King, D. L., & Delfabbro, P. H. (2018). Predatory monetization schemes in video games (eg 'loot boxes') and internet gaming disorder. *Addiction*, 113(11), 1967-1969. https://doi.org/10.1111/add.14286

King, D. L., Delfabbro, P. H., & Griffiths, M. D. (2010). The role of structural characteristics in problem video game playing: A review. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, 4(1), article 6. https://doi.org/10.1007/s11469-010-9289-y

King, D. L., Delfabbro, P. H., Gainsbury, S. M., Dreier, M., Greer, N., & Billieux, J. (2019). Unfair play? Video games as exploitative monetized services: An examination of game patents from a consumer protection perspective. *Computers in Human Behavior*, 101, 131-143. https://doi.org/10.1016/j.chb.2019.07.017

Király, O., Bőthe, B., Diaz, J. R., Rahimi-Movaghar, A., Lukavska, K., Hrabec, O., Miovsky, M., Billieux, J., Deleuze, J., Nuyens, F., Karila, L., Griffiths, M.D., Nagygyörgy,

K., Urbán, R., Potenza, M.N., King, D.L., Rumpf, H-J., Carragher, N., & Demetrovics, Z. (2019). Ten-Item Internet Gaming Disorder Test (IGDT-10): Measurement invariance and cross-cultural validation across seven language-based samples. *Psychology of Addictive Behaviors*, 33, 91-103. https://doi.org/10.1037/adb0000433

Király, O., Demetrovics, Z. (2020). Viselkedési addikciók. In Elekes, Z., Arnold, P., & Bencsik, N. (szerk.), *Iskolások egészségkárosító magatartása 25 év távlatában: A 2019. évi ESPAD kutatás magyarországi eredményei* (pp. 113-131). Budapest: Budapesti Corvinus Egyetem.

Király, O., Demetrovics, Z., Paksi, B. (2021). Videojáték-használat. In Paksi, B., & Demetrovics, Z. (szerk.), *Addiktológiai problémák Magyarországon: Helyzetkép a lakossági kutatások tükrében. II. Viselkedési addikciók* (pp. 37-49). ELTE PPK – L'Harmattan Kiadó.

Király, O., Koncz, P., Griffiths, M. D., & Demetrovics, Z. (2023). Gaming disorder: A summary of its characteristics and aetiology. *Comprehensive Psychiatry*, 122, 152376. https://doi.org/10.1016/j.comppsych.2023.152376

Király, O., Sleczka, P., Pontes, H. M., Urbán, R., Griffiths, M. D., & Demetrovics, Z. (2017). Validation of the Ten-Item Internet Gaming Disorder Test (IGDT-10) and evaluation of the nine DSM-5 Internet Gaming Disorder criteria. *Addictive Behaviors*, 64, 253-260. https://doi.org/10.1016/j.addbeh.2015.11.005

Király, O., Urbán, R., Griffiths, M., Ágoston, C., Nagygyörgy, K., Kökönyei, G., & Demetrovics, Z. (2015). Psychiatric symptoms and problematic online gaming: The mediating effect of gaming motivation. *Journal of medical Internet research*, 17(4), Article e88. https://doi.org/10.2196/jmir.3515

Kline, R. B. (2015). *Principles and practice of structural equation modeling (2nd ed.).* New York: Guilford press.

Ko, C. H., Király, O., Demetrovics, Z., Griffiths, M. D., Kato, T. A., Tateno, M., & Yen, J. Y. (2023). Heterogeneity of gaming disorder: A clinically-based typology for developing

personalized interventions. *Journal of Behavioral Addictions*, 12(4), 855-861. https://doi.org/10.1556/2006.2023.00059

Kollins, S. H., DeLoss, D. J., Cañadas, E., Lutz, J., Findling, R. L., Keefe, R. S., ... & Faraone, S. V. (2020). A novel digital intervention for actively reducing severity of paediatric ADHD (STARS-ADHD): A randomised controlled trial. *The Lancet Digital Health*, 2(4), e168-e178. https://doi.org/10.1016/S2589-7500(20)30017-0

Koncz, P., Demetrovics, Z., Takacs, Z. K., Griffiths, M. D., Nagy, T., & Király, O. (2023). The emerging evidence on the association between symptoms of ADHD and gaming disorder: A systematic review and meta-analysis. *Clinical Psychology Review*, 106, 102343. https://doi.org/10.1016/j.cpr.2023.102343

Kross, E., & Ayduk, O. (2008). Facilitating adaptive emotional analysis: Distinguishing distanced-analysis of depressive experiences from immersed-analysis and distraction. *Personality and Social Psychology Bulletin*, 34(7), 924-938. https://doi.org/10.1177/0146167208315938

Lafrenière, M.-A. K., Verner-Filion, J., & Vallerand, R. J. (2012). Development and validation of the Gaming Motivation Scale (GAMS). *Personality and Individual Differences*, 53(7), 827-831. https://doi.org/10.1016/j.paid.2012.06.013

Lee, B. W., & Leeson, P. R. (2015). Online gaming in the context of social anxiety. *Psychology of Addictive Behaviors*, 29(2), 473. https://doi.org/10.1037/adb0000070

Lee, R. S. C., Hoppenbrouwers, S., & Franken, I. (2019). A systematic meta-review of impulsivity and compulsivity in addictive behaviors. *Neuropsychology review,* 29(1), 14-26. https://doi.org/10.1007/s11065-019-09402-x

Lemmens, J. S., & Hendriks, S. J. (2016). Addictive online games: Examining the relationship between game genres and Internet gaming disorder. *Cyberpsychology, Behavior, and Social Networking*, 19(4), 270-276. https://doi.org/10.1089/cyber.2015.0415

Li, W., Zhang, W., Xiao, L., & Nie, J. (2016). The association of Internet addiction symptoms with impulsiveness, loneliness, novelty seeking and behavioral inhibition system

among adults with attention-deficit/hyperactivity disorder (ADHD). *Psychiatry Research*, *243*, 357-364. https://doi.org/10.1016/j.psychres.2016.02.020

Loe, I. M., & Feldman, H. M. (2007). Academic and educational outcomes of children with ADHD. *Journal of Pediatric Psychology*, 32(6), 643-654. https://doi.org/10.1093/jpepsy/jsl054

Luman, M., Oosterlaan, J., & Sergeant, J. A. (2005). The impact of reinforcement contingencies on AD/HD: a review and theoretical appraisal. *Clinical Psychology Review,* 25(2), 183-213. https://doi.org/10.1016/j.cpr.2004.11.001

Mazeas, A., Duclos, M., Pereira, B., & Chalabaev, A. (2022). Evaluating the effectiveness of gamification on physical activity: Systematic review and meta-analysis of randomized controlled trials. *Journal of Medical Internet Research*, 24(1), e26779. https://doi.org/10.2196/26779

McLean, L., & Griffiths, M. D. (2019). Female gamers' experience of online harassment and social support in online gaming: A qualitative study. *International Journal of Mental Health and Addiction*, 17, 970-994. https://doi.org/10.1007/s11469-018-9962-0

Mihara, S., & Higuchi, S. (2017). Cross-sectional and longitudinal epidemiological studies of internet gaming disorder: A systematic review of the literature. *Psychiatry and clinical neurosciences*, 71(7), 425-444. https://doi.org/10.1111/pcn.12532

Mills, D. J., Milyavskaya, M., Heath, N. L., & Derevensky, J. L. (2018). Gaming motivation and problematic video gaming: The role of needs frustration. *European Journal of Social Psychology*, 48(4), 551-559. https://doi.org/10.1002/ejsp.2343

Montag, C., Schivinski, B., & Pontes, H. M. (2021). Is the proposed distinction of gaming disorder into a predominantly online vs. offline form meaningful? Empirical evidence from a large German speaking gamer sample. *Addictive behaviors reports*, 14, Article 100391. https://doi.org/https://doi.org/10.1016/j.abrep.2021.100391

Mößle, T., & Rehbein, F. (2013). Predictors of problematic video game usage in childhood and adolescence. *SUCHT*, 59(3), 153-164. https://doi.org/10.1024/0939-5911.a000247

Murray, A., Koronczai, B., Király, O., Griffiths, M. D., Mannion, A., Leader, G., & Demetrovics, Z. (2021). Autism, problematic internet use and gaming disorder: A systematic review. *Review Journal of Autism and Developmental Disorders*, 1-21. https://doi.org/10.1007/s40489-021-00243-0

Muthén, L. K., & Muthén, B. O. (1998–2017). *Mplus user's guide (8th ed.)*. Muthén & Muthén.

Müller, K. W., Janikian, M., Dreier, M., Wölfling, K., Beutel, M., Tzavara, C., Richardson, C., & Tsitsika, A. (2015). Regular gaming behavior and internet gaming disorder in European adolescents: results from a cross-national representative survey of prevalence, predictors, and psychopathological correlates. *European child & adolescent psychiatry*, 24(5), 565-574. https://doi.org/10.1007/s00787-014-0611-2

Nielsen, P., Favez, N., & Rigter, H. (2020). Parental and family factors associated with problematic gaming and problematic internet use in adolescents: A systematic literature review. *Current Addiction Reports*, 7(3), 365-386. https://doi.org/10.1007/s40429-020-00320-0

Nijmeijer, J. S., Minderaa, R. B., Buitelaar, J. K., Mulligan, A., Hartman, C. A., & Hoekstra, P. J. (2008). Attention-deficit/hyperactivity disorder and social dysfunctioning. *Clinical psychology review*, 28(4), 692-708. https://doi.org/10.1016/j.cpr.2007.10.003

Ostinelli, E. G., Zangani, C., Giordano, B., Maestri, D., Gambini, O., D'Agostino, A., Furukawa, T. A., & Purgato, M. (2021). Depressive symptoms and depression in individuals with internet gaming disorder: A systematic review and meta-analysis. *Journal of Affective Disorders*, 284, 136-142. https://doi.org/10.1016/j.jad.2021.02.014

Pápay, O., Urbán, R., Griffiths, M. D., Nagygyörgy, K., Farkas, J., Kökönyei, G., Felvinczi, K., Oláh, A., Elekes, Z., & Demetrovics, Z. (2013). Psychometric properties of the Problematic Online Gaming Questionnaire Short-Form and prevalence of problematic online gaming in a national sample of adolescents. *Cyberpsychology, Behavior, and Social Networking*, 16(5), 340-348. https://doi.org/10.1089/cyber.2012.0484

Paulus, F. W., Sinzig, J., Mayer, H., Weber, M., & von Gontard, A. (2018). Computer gaming disorder and ADHD in young children — A population-based study. *International Journal of Mental Health and Addiction*, *16*(5), 1193-1207. https://doi.org/10.1007/s11469-017-9841-0

Pontes, H. M., & Griffiths, M. D. (2015). Measuring DSM-5 internet gaming disorder: Development and validation of a short psychometric scale. *Computers in Human Behavior, 45,* 137-143. https://doi.org/10.1016/j.chb.2014.12.006

Radloff, L. S. (1977). The CES-D scale: a self-report depression scale for research in the general population. *Applied Psychological Measurement*, 1, 385–401. https://doi.org/10.1177/014662167700100306

Raneri, P. C., Montag, C., Rozgonjuk, D., Satel, J., & Pontes, H. M. (2022). The role of microtransactions in internet gaming disorder and gambling disorder: A preregistered systematic review. *Addictive behaviors reports*, 15(100415). https://doi.org/https://doi.org/10.1016/j.abrep.2022.100415

Rehbein, F., King, D. L., Staudt, A., Hayer, T., & Rumpf, H.-J. (2021). Contribution of game genre and structural game characteristics to the Risk of problem gaming and gaming disorder: A systematic review. *Current Addiction Reports*, 8(2), 263-281. https://doi.org/0.1007/s40429-021-00367-7

Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton University Press.

Rosenthal, R. (1979). The file drawer problem and tolerance for null results. *Psychological Bulletin*, *86*, 638-6141. https://doi.org/10.1037//0033-2909.86.3.638

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and emotion*, 30(4), 344-360. https://doi.org/10.1007/s11031-006-9051-8

Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review*, 32(1), 77-112. https://doi.org/10.1007/s10648-019-09498-w

Şalvarlı, Ş. İ., & Griffiths, M. D. (2021). Internet gaming disorder and its associated personality traits: A systematic review using PRISMA guidelines. *International Journal of Mental Health and Addiction,* 19(5), 1420-1442. https://doi.org/https://doi.org/10.1007/s11469-019-00081-6

Schettler, L., Thomasius, R., & Paschke, K. (2022). Neural correlates of problematic gaming in adolescents: A systematic review of structural and functional magnetic resonance imaging studies. *Addiction Biology*, 27(1), e13093. https://doi.org/10.1111/adb.13093

Schneider, L. A., King, D. L., & Delfabbro, P. H. (2017). Family factors in adolescent problematic Internet gaming: A systematic review. *Journal of Behavioral Addictions*, 6(3), 321-333. https://doi.org/10.1556/2006.6.2017.035

Schneider, L. A., King, D. L., & Delfabbro, P. H. (2018). Maladaptive coping styles in adolescents with internet gaming disorder symptoms. *International Journal of Mental Health and Addiction,* 16, 905-916. https://doi.org/10.1007/s11469-017-9756-9

Skogli, E. W., Teicher, M. H., Andersen, P. N., Hovik, K. T., & Øie, M. (2013). ADHD in girls and boys–gender differences in co-existing symptoms and executive function measures. *BMC Psychiatry*, 13(1), 298. https://doi.org/10.1186/1471-244X-13-298

Smyth, J. M. (2007). Beyond self-selection in video game play: An experimental examination of the consequences of massively multiplayer online role-playing game play. *CyberPsychology & Behavior*, 10(5), 717-721. https://doi.org/10.1089/cpb.2007.9963

Soares, L., Thorell, L. B., Barbi, M., Crisci, G., Nutley, S. B., & Burén, J. (2023). The role of executive function deficits, delay aversion and emotion dysregulation in internet gaming disorder and social media disorder: Links to psychosocial outcomes. *Journal of Behavioral Addictions*, 12(1), 94-104. https://doi.org/10.1556/2006.2023.00007

Sonuga-Barke, E. J. (2002). Psychological heterogeneity in AD/HD—a dual pathway model of behaviour and cognition. *Behavioural brain research*, 130(1-2), 29-36. https://doi.org/10.1016/S0166-4328(01)00432-6

Stevens, M. W., Dorstyn, D., Delfabbro, P. H., & King, D. L. (2021). Global prevalence of gaming disorder: A systematic review and meta-analysis. *Australian & New Zealand Journal of Psychiatry*, 55(6), 553-568. https://doi.org/10.1177/0004867420962851

Su, W., Han, X., Yu, H., Wu, Y., & Potenza, M. N. (2020). Do men become addicted to internet gaming and women to social media? A meta-analysis examining gender-related differences in specific internet addiction. *Computers in Human Behavior*, 113, 106480. https://doi.org/10.1016/j.chb.2020.106480

Szolin, K., Kuss, D., Nuyens, F., & Griffiths, M. (2022). Gaming Disorder: A systematic review exploring the user-avatar relationship in videogames. *Computers in Human Behavior*, 128, 107124. https://doi.org/10.1016/j.chb.2021.107124

Throuvala, M. A., Janikian, M., Griffiths, M. D., Rennoldson, M., & Kuss, D. J. (2019). The role of family and personality traits in Internet gaming disorder: A mediation model combining cognitive and attachment perspectives. *Journal of Behavioral Addictions*, 8(1), 48-62. https://doi.org/10.1556/2006.8.2019.05

Torres-Rodríguez, A., Griffiths, M. D., Carbonell, X., & Oberst, U. (2018). Treatment efficacy of a specialized psychotherapy program for Internet Gaming Disorder. *Journal of Behavioral Addictions*, 7(4), 939-952. https://doi.org/10.1556/2006.7.2018.111

Tzang, R. F., Chang, C. H., & Chang, Y. C. (2022). Structural equation modeling (SEM): Gaming disorder leading untreated attention-deficit/hyperactivity disorder to disruptive mood dysregulation. *International Journal of Environmental Research and Public Health*, *19*(11), 6648. https://doi.org/10.3390/ijerph19116648

Vadlin, S., Åslund, C., Hellström, C., & Nilsson, K. W. (2016). Associations between problematic gaming and psychiatric symptoms among adolescents in two samples. *Addictive Behaviors*, 61, 8-15. https://doi.org/10.1016/j.addbeh.2016.05.001

Van Rooij, A. J., Kuss, D. J., Griffiths, M. D., Shorter, G. W., Schoenmakers, T. M., & Van De Mheen, D. (2014). The (co-) occurrence of problematic video gaming, substance use, and psychosocial problems in adolescents. *Journal of Behavioral Addictions*, 3(3), 157-165. https://doi.org/10.1556/jba.3.2014.013

Volkow, N. D., Wang, G. J., Newcorn, J. H., Kollins, S. H., Wigal, T. L., Telang, F., Fowler, J. S., Goldstein, R. Z., Klein, N., Logan, J., Wong, C., Swanson, J. M. (2011). Motivation deficit in ADHD is associated with dysfunction of the dopamine reward pathway. *Molecular Psychiatry*, 16(11), 1147-1154. https://doi.org/10.1038/mp.2010.97

Vos, J., Craig, M., & Cooper, M. (2015). Existential therapies: A meta-analysis of their effects on psychological outcomes. *Journal of Consulting and Clinical Psychology*, 83(1), 115. http://dx.doi.org/10.1037/a0037167

Wang, C.-Y., Wu, Y.-C., Su, C.-H., Lin, P.-C., Ko, C.-H., & Yen, J.-Y. (2017). Association between Internet gaming disorder and generalized anxiety disorder. *Journal of Behavioral Addictions*, 6(4), 564-571. https://doi.org/10.1556/2006.6.2017.088

Wang, H.-Y., & Cheng, C. (2022). The associations between gaming motivation and internet gaming disorder: Systematic review and meta-analysis. *JMIR Mental Health*, 9(2), e23700. https://doi.org/10.2196/23700

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology*, 54(6), 1063. https://doi.org/10.1037//0022-3514.54.6.1063

Weinstein, A. M. (2017). An update overview on brain imaging studies of internet gaming disorder. *Frontiers in Psychiatry*, 8, 185. https://doi.org/10.3389/fpsyt.2017.00185

Werling, A. M., Kuzhippallil, S., Emery, S., Walitza, S., & Drechsler, R. (2022). Problematic use of digital media in children and adolescents with a diagnosis of attention-deficit/hyperactivity disorder compared to controls. A meta-analysis. *Journal of Behavioral Addictions*, 11(2), 305-325. https://doi.org/10.1556/2006.2022.00007

Wichstrøm, L., Stenseng, F., Belsky, J., von Soest, T., & Hygen, B. W. (2019). Symptoms of internet gaming disorder in youth: predictors and comorbidity. *Journal of Abnormal Child Psychology*, 47(1), 71-83. https://doi.org/10.1007/s10802-018-0422-x

Wong, P.T.P. (2016). Integrative meaning therapy: From logotherapy to existential positive interventions. In: Russo-Netzer, P., Schulenberg, S., & Batthyany, A. (Eds.) *Clinical perspectives on meaning.* Springer. https://doi.org/10.1007/978-3-319-41397-6_16

World Health Organization. (2019). ICD-11 for Mortality and Morbidity Statistics. https://icd.who.int/browse11/l-m/en

Yao, Y.-W., Liu, L., Ma, S.-S., Shi, X.-H., Zhou, N., Zhang, J.-T., & Potenza, M. N. (2017). Functional and structural neural alterations in Internet gaming disorder: A systematic review and meta-analysis. *Neuroscience and Biobehavioral Reviews*, 83, 313-324. https://doi.org/10.1016/j.neubiorev.2017.10.029

Yee, N. (2006). Motivations for play in online games. *CyberPsychology & behavior*, 9(6), 772-775. https://doi.org/10.1089/cpb.2006.9.772

Yen, J. Y., Liu, T. L., Wang, P. W., Chen, C. S., Yen, C. F., & Ko, C. H. (2017). Association between Internet gaming disorder and adult attention deficit and hyperactivity disorder and their correlates: Impulsivity and hostility. *Addictive Behaviors*, *64,* 308-313. https://doi.org/10.1016/j.addbeh.2016.04.024

Young, S. (2005). Coping strategies used by adults with ADHD. *Personality and individual differences*, 38(4), 809-816. https://doi.org/10.1016/j.paid.2004.06.005

Zsila, Á., Bőthe, B., Demetrovics, Z., Billieux, J., & Orosz, G. (2020). Further exploration of the SUPPS-P impulsive behavior scale's factor structure: Evidence from a large Hungarian sample. *Current Psychology*, 39(1), 378-388. https://doi.org/10.1007/s12144-017-9773-7

Zsila, Á., Orosz, G., Bőthe, B., Tóth-Király, I., Király, O., Griffiths, M., & Demetrovics, Z. (2017). An empirical study on the motivations underlying augmented reality games: The case of Pokémon Go during and after Pokémon fever. *Personality and Individual Differences*, 133, 56-66. https://doi.org/10.1016/j.paid.2017.06.024

11. List of publications directly used in the dissertation

Study 1: Király, O., Billieux, J., King, D. L., Urbán, R., Koncz, P., Polgár, E., & Demetrovics, Z. (2022). A comprehensive model to understand and assess the motivational background of video game use: The Gaming Motivation Inventory (GMI). *Journal of Behavioral Addictions*, 11(3), 796-819. https://doi.org/10.1556/2006.2022.00048

Study 2: Király, O., Koncz, P., Griffiths, M. D., & Demetrovics, Z. (2023). Gaming disorder: A summary of its characteristics and aetiology. *Comprehensive Psychiatry*, 122, 152376. https://doi.org/10.1016/j.comppsych.2023.152376

Study 3: Koncz, P., Demetrovics, Z., Takacs, Z. K., Griffiths, M. D., Nagy, T., & Király, O. (2023). The emerging evidence on the association between symptoms of ADHD and gaming disorder: A systematic review and meta-analysis. *Clinical Psychology Review*, 106, 102343. https://doi.org/10.1016/j.cpr.2023.102343

Study 4: Koncz, P., Demetrovics, Z., Urbán, R., Griffiths, M. D., & Király, O. (2024). Gender-specific motivational pathways in ADHD-related inattention and gaming disorder symptoms. *Addictive Behaviors*, 158, 108120. https://doi.org/10.1016/j.addbeh.2024.108120

12. List of publications directly not used in the dissertation

Journal Articles

Czakó, A., Király, O., Koncz, P., Yu, S. M., Mangat, H. S., Glynn, J. A., Romero, P., Griffiths, M. D., Rumpf, H. J., Demetrovics, Z. (2023). Safer esports for players, spectators, and bettors: Issues, challenges, and policy recommendations. *Journal of Behavioral Addictions*, 12(1), 1-8. https://doi.org/10.1556/2006.2023.00012

Katz, D., Horváth, Z., Pontes, H. M., Koncz, P., Demetrovics, Z., & Király, O. (2024). How much gaming is too much? An analysis based on psychological distress. *Journal of Behavioral Addictions*, 13(3), 716-728. https://doi.org/10.1556/2006.2024.00036

Koncz, P., Demetrovics, Z., Griffiths, M. D., & Király, O. (2023). The potential harm of gambling streams to minors. *Journal of the American Academy of Child and Adolescent Psychiatry*, 62(7), 713-715. https://doi.org/10.1016/j.jaac.2023.01.020

Mangat, H. S., Urbán, R., Koncz, P., Demetrovics, Z., Czakó, A., Griffiths, M. D., & Király, O. (2025). Personality, motivations, and gaming disorder symptoms: A large-scale comparative study of esports players, highly engaged gamers, and recreational players. *Comprehensive Psychiatry*, 152623. https://doi.org/10.1016/j.comppsych.2025.152623

Szabó, B., Koncz, P., Király, O., Koronczai, B., Paksi, B., & Demetrovics, Z. (2022). A problémás közösségimédia-használat és a mentális egészség kapcsolata magyar kamaszok körében. *Impulzus – Szegedi Pszichológiai Tanulmányok*, 9(1).

Conference presentations

Demetrovics, Z., Bányai, F., Koncz, P., & Király, O. (2021). Esportolók és rekreációs videójáték használók: hasonlóságok és különbségek. In *VI. Fogyasztás Interdiszciplináris Szimpózium. Sport és játék – Fogyasztás a virtuális térben* (pp. 3).

Katz, D., Koncz, P., Demetrovics, Z., & Kiraly, O. (2023). Comparing general self-esteem and self-esteem related to video game use in the development of problematic gaming. In *Journal of Behavioral Addictions* (vol. 12, pp. 11), Budapest, Hungary: Akademiai Kiado.

Király, O., Koncz, P., & Demetrovics, Z. (2024). Manipulatív technikák a közösségi médiában és videójátékokban (előadás). In *A Magyar Addiktológiai Társaság XIV. Országos kongresszusa - előadáskivonatok* (pp. 20).

Király, O., Koncz, P., Demetrovics, Z., Comparing the Gaming Motives of Esports Players, Recreational and Highly Engaged Gamers. In *Book of Abstracts* (pp. 105-107). Esport Research Network Conference.

Király, O., Koncz, P., Paksi, B., Magi, A., & Demetrovics, Z. (2021). Gaming disorder symptoms and attention deficit and hyperactivity disorder risk in a representative sample of adolescents from Budapest. In *24th conference of the European Association of Substance Abuse Research (EASAR) - Book of Abstracts* (pp. 13).

Kiraly, O., Urban, R., King, D. L., Billieux, J., Koncz, P., & Demetrovics, Z. (2022, July). A systematic overview of gaming motivation scales and the development of a comprehensive and up-to-date measure. In *Journal of Behavioral* Addiction (vol. 11, pp. 32), Budapest, Hungary: Akademiai Kiado.

Koncz, P. (2024). A problémás digitáliseszköz-használat és a figyelem kapcsolata. In *Mobiltelefon az iskolában: áldás vagy átok? Konferencia – Rövidletek.*

Koncz, P., Bányai, F., Demetrovics, Z., & Király, O. Are Esports Players at More Risk for Mental Health Concerns?. In *Book of Abstracts* (pp. 28-30). Esport Research Network Conference.

Koncz, P., Demetrovics, Z., & Király, O. (2021). The association of attention deficit and hyperactivity disorder risk with gaming motives and gaming disorder symptoms in a large sample of highly engaged gamers. In *24th conference of the European Association of Substance Abuse Research (EASAR) - Book of Abstracts* (pp. 14).

Koncz, P., Demetrovics, Z., & Király, O. (2024). Szerencsejátékos elemek a videójátékok világában (előadás). In A *Magyar Addiktológiai Társaság XIV. Országos kongresszusa - előadáskivonatok* (pp. 20).

Koncz, P., Demetrovics, Z., Paksi, B., Magi, A., & Király, O. (2023). A játékkal töltött idő és a játékhasználati zavar tüneteinek kapcsolata serdülők körében: A mentális egészség, mint moderáló tényező. In *ONK2023 Absztraktkötet: Elkötelezettség és rugalmasság: a neveléstudomány útjai az átalakuló világban* (pp. 165).

Koncz, P., Demetrovics, Z., Paksi, B., Magi, A., Eisinger, A., & Király, O. (2022). The moderating role of mental health on the association between gaming time and gaming disorder symtoms. *European Psychiatry*, 65(S1), (pp. S81). Cambridge, United Kingdom: Cambridge University Press.

Koncz, P., Kiraly, O., Takacs, Z., Demetrovics, Z., The correlation between ADHD and Gaming Disorder symptom severity is universal: Preliminary results of a meta-analysis. In *Journal of Behavioral Addictions* (vol. 11, pp. 9), Budapest, Hungary: Akademiai Kiado.

Koncz, P., Kiss, T., Demetrovics, Z., & Király, O. (2019). A videojáték-használati zavar és a figyelemhiányos hiperaktivitás-zavar (ADHD) összefüggése felnőtt populációban. In *A Magyar Addiktológiai Társaság XII. Országos Kongresszusa - előadáskivonatok* (pp. 26).

Koncz, P., Paksi, B., Magi, A., Eisinger, A., Demetrovics, Z., & Király, O. (2022). A játékhasználati zavar tüneteinek előfordulási gyakorisága és korrelátumai budapesti serdülők reprezentatív mintáján. In *A Magyar Addiktológiai Társaság XIII. Országos Kongresszusa - Előadáskivonatok* (pp. 14).

Mangat, H. S., Urban, R., Kiraly, O., Koncz, P., Czako, A., & Demetrovics, Z. (2024, December). Esports players, highly engaged gamers, and recreational videogamers: A comparative analysis of their psychological and behavioral predictors. In *Journal of Behavioral Addictions* (vol. 13, pp. 206), Budapest, Hungary: Akademiai Kiado.

Mangat, H. S., Urbán, R., Király, O., Koncz, P., Czakó, A., & Demetrovics, Z. (2024). Comparative Analysis of Psychological and Behavioral Predictors in Esports Players, Highly Engaged Gamers, and Recreational Videogamers. In *27th EASAR Conference - Book of Abstracts* (pp. 31).