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FULL-LENGTH REPORT

How expected and experienced reward and relief contribute to gaming-related mental imagery and gaming frequency in daily life: Testing a dual pathway hypothesis

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ABSTRACT

Background and aims: Research on the development of gaming disorder assumes that the quality of reinforcement learning as well as the content of use expectancies are initially rewarding in the early stages of the addictive behavior and becomes steadily more compensatory in the later stages. This assumed transition could be reflected in gaming-related mental imagery as well as the decision to play videogames in daily life. *Methods:* We recruited 127 individuals who play videogames. Following a strict diagnostic procedure, individuals were either classified as showing casual or at-risk gaming patterns. The experience and expectancy of reward and relief were assessed in the laboratory, followed by a 14-day ambulatory assessment asking for gaming-related mental imagery intensity and playing frequency. Besides group differences, we tested a gratification and a compensation pathway in a structural equation model among groups separately. *Results:* Results indicate that mental imagery and playing frequency as well as reinforcement processes and use expectancies are heightened among individuals showing at-risk gaming patterns as compared to casual gaming patterns. Gaming-related mental imagery was only predicted by compensation among individuals showing casual gaming patterns, and we found no significant predictions for daily gaming frequency in any of the models. *Discussion and conclusions:* The results implicate that individuals with at-risk gaming patterns might hold stronger learned reinforcement contingencies. Daily usage seems unaffected by these contingencies, possibly indicative of habitualized behaviors. Additionally, the results provide some support for the consideration of imaginal desire thoughts as a specific coping mechanism in the context of gaming behaviors.

KEYWORDS

desire thinking, gaming disorder, gaming frequency, gratification/compensation, sensory imagery, use expectancies

INTRODUCTION

The reasons for which gaming disorder was acknowledged as an addictive disorder by diagnostic and classification systems such as the ICD-11 (World Health Organization, 2019) and Section III of the DSM-5 (American Psychiatric Association, 2013) include, among others, the empirically and theoretically arguable similarity of underlying psychological mechanisms to those identified in substance-use disorders (e.g., Rumpf et al., 2018). The Interaction of Person-Affect-Cognition-Execution (I-PACE) model (Brand et al., 2019) is a theoretical framework that organizes the core mechanisms of prevailing theories on the development and maintenance of addictive behaviors (e.g., Bechara, 2005; Berridge & Robinson, 2016; Blum, Cull, Braverman, & Comings, 1996; Everitt & Robbins, 2005, 2016;

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Koob & Volkow, 2010; Robinson & Berridge, 1993) in a cyclic dynamic. It emphasizes the role of reinforcement-learning and the formation of use expectancies in the development and maintenance of addictive behaviors. Considering gaming disorder, these mechanisms might induce a heightened sensitivity for gaming-related cues which could in turn result in stronger desire/craving experiences and diminished response inhibition for gaming behaviors (Brand et al., 2019). Specifically, the I-PACE model suggests a shift in reinforcement-learning and expectancy-building where, throughout the addiction development, compensatory experiences and expectancies (e.g., "I feel less stressed when gaming") become stronger and might outweigh gratifying ones (e.g., "I feel good when gaming") (Wegmann, Antons, & Brand, 2022). Individuals in progressed stages of problematic gaming might have passed through a greater number of reward cycles where they experienced reinforcement through their gaming behavior more often. Consequently, these individuals may have formed stronger reward expectancies where avoidance coping expectancies in the context of gaming might become increasingly stronger and may increasingly be the reason for which decisions to game are made (Melodia, Canale, & Griffiths, 2022). This shift is further theorized to be reflected in a relief-oriented and a pleasure-oriented pathway to the occurrence of desire and craving (Brandtner, Antons, Cornil, & Brand, 2021) where it might explain whether desires arise on the grounds of gratifying (i.e., imagining how exciting gaming could feel) and/or compensating aspects of gaming (i.e., imagining how relieving gaming could feel) (Brand et al., 2019; Wegmann et al., 2022).

According to the Elaborated Intrusion Theory of Desire (EIT; Kavanagh, Andrade, & May, 2005), mental imagery (i.e., a simulation of an activity with all its visual, auditory, olfactory, gustatory, and haptic constituents and emotional accompaniments) lies at the heart of a desire experience and is directly associated with simulated pleasure and relief. Mental images are prevalent in a range of addictive disorders such as alcohol-use disorder, tobacco-use disorder, and gambling disorder (e.g., Cornil et al., 2018; Cornil, Rothen, De Timary, & Billieux, 2021; Dale, Rock, & Clark, 2020; Littel, van den Hout, & Engelhard, 2016; Månsson, Andrade, Jayaram-Lindström, & Berman, 2022; Rooijmans, Rosenkamp, Verholt, & Visser, 2012); and also seem to play a role in the desire to play videogames (Brandtner, Pekal, & Brand, 2020; Kim et al., 2022). As for the context of gaming, a range of correlational studies support the relevance of mental imagery for gaming disorder when investigated as a facet of desire thinking (Caselli & Spada, 2015). As such, desire thinking is associated with gaming disorder symptoms (Aydın et al., 2022; Byrne, Allen, Stavropouios, & Kannis-Dymand, 2022), craving for gaming (Bonner, Allen, Katsikitis, Love, & Kannis-Dymand, 2022; Brandtner & Brand, 2021), and decisions for gaming despite conflicting activities (Brandtner, Wegmann, & Brand, 2020). Although accumulating research on the relief-oriented pathway suggests that desire thinking might be initiated as a coping mechanism in response to psychological discomfort such as stress, anxiety, or depressive mood and the context of addictive behaviors (Fernie et al., 2014; Khosravani, Spada, Sharifi Bastan, & Samimi Ardestani, 2022; Sharifi Bastan, Spada, Khosravani, & Samimi Ardestani, 2022; Solem et al., 2020; Thomas, Katsikitis, Allen, & Kannis-Dymand, 2020) and gaming (Aydın et al., 2022; Brandtner & Brand, 2021; Dragan & Grajewski, 2021), no study has investigated whether imaginal desire thoughts might function as coping mechanisms in the first place, or whether this functionality develops with the progression of problematic gaming.

Therefore, we aimed to investigate whether and how gaming-specific reinforcement-learning processes (i.e., experience of gratification and compensation), gaming-specific use expectancies (i.e., expectancy of gratification and compensation), and the intensity of mental imagery differ between individuals who show casual gaming behaviors and individuals who are at-risk to develop gaming disorder (hereafter: casual and at-risk gaming patterns). Further, we aimed to explore the contribution of a pleasure-oriented pathway (i.e., experience and expectancy of gratification) and a relief-oriented pathway (i.e., experience and expectancy of compensation) to the intensity of mental imagery and gaming frequency in daily life (see Fig. 1) applying a structural equation model (SEM).

METHODS

Procedure

The procedure applied and test battery assessed here is part of a multi-center DFG-funded addiction research unit (FOR2974) on affective and cognitive mechanisms of specific Internet-use disorders (ACSID; Brand et al., 2021). Data collection of the first funding period has not been completed yet, wherefore this study depicts an interim analysis. ACSID focuses on the most prominent online addictive behaviors (i.e., gaming, pornography use, buying-shopping, and social-networks use) of which gaming is the focus of this study.

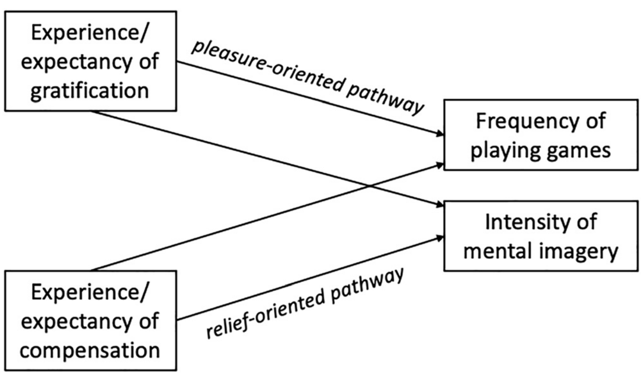

Fig. 1. Hypothesized model of the dual-pathways of reinforcement-learning and use expectancies predicting gaming-related mental imagery and gaming frequency
Note. Operationalizations of variables are described in the methods section.

The ACSID procedure was pre-registered in the open science framework (OSF; https://osf.io/6x93n/). During the first contact with participants, a telephone screening assessed the tendency for at-risk or casual gaming behavior as well as medication use and further potential exclusion criteria (e.g., additional mental disorders). Participants were excluded if they regularly consumed psychoactive medication or substances (except for tobacco). After this initial screening, participants were invited to our laboratories for an extensive diagnostic procedure and a comprehensive neurocognitive testing. The laboratory study started with the comprehensive clinical interview. After that, the participants filled out an extensive test battery, including the here used self-report questionnaires measuring ICD-11 symptoms of gaming disorder, the experience of gratification and compensation, and use expectancies. One day after the laboratory study, participants received an automatic e-mail with a link inviting them to participate in the end-of-day ambulatory assessment. This e-mail was sent daily at 6.00PM for 14 consecutive days. Participants were able to fill out the survey retrospectively until 9.00AM of the following day. After that, the survey for the respective day was no longer accessible. Only participants who had completed at least 50% of the ambulatory assessment were included in the analyses. Accordingly, all those who completed seven days or less were not included. Data was collected between 10th November 2021 and 15th October 2022.

Participants

Individuals who play videogames were recruited via local print advertisements, postings on social networking sites, and via local radio announcements. The initial sample was screened for complete data sets and ensures that participants had filled in at least 50% (i.e., 7 days) of the ambulatory assessment. This makes for a final sample of N = 127 individuals (11 women, 0 non-binary, 1 missing; $M_{age} = 24.32$, $SD = 4.51$, range = 18–40) with either casual ($n = 63$, 8 female) or at-risk gaming behavior ($n = 64$, 3 female). Individuals were classified according to the result of a clinical diagnostic interview (see below). Individuals indicated to play videogames averagely 113.91 min ($SD = 83.20$) on a typical weekday and 216.34 min ($SD = 157.14$) on a typical day on weekends (see Table 2 for group comparisons). 80.3% of participants were students, 96.1% were born in Germany, 62.2% were having a permanent relationship, and 5.5% were married.

Measures

Structured clinical interview. Upon invitation, a comprehensive structured clinical interview was conducted at the beginning of the study. The diagnostic interview was based on the Assessment of Internet and Computer Game Addiction – Structured Clinical Interview (AICA-SKI:IBS; Müller & Wölfling, 2017). It was performed by trained psychologists (master's degree) and supervised by experienced clinicians. The DSM-5-approximated criteria include preoccupation or obsession, withdrawal, tolerance, loss of control, loss of interest, continued overuse, deceiving, escape of negative feelings and functional impairment in the period of the past 12 months as well as the past 30 days. The fulfillment of the criteria was evaluated by the interviewer on a six-point Likert scale ranging from 0 = *not applicable* to 5 = *very applicable*. With a minimum of four on the rating scale, the criterion was considered fulfilled. Based on the criteria met, participants were classified as casual, at-risk, or pathological users. As for the classification, we followed the cut-off scores provided in the DSM-5 (i.e., five or more criteria met indicate pathological use) with one exception that was decided amongst clinical researchers within the addiction research unit that this study was embedded in Brand et al. (2021): Instead of classifying one to four criteria as being at-risk behaviors, we reduced the range to being two to four criteria since cut-offs that recycle substance use criteria are being criticized to over-pathologize gaming behaviors (Nogueira-López, Rial-Boubeta, Guadix-García, Villanueva-Blasco, & Billieux, 2023). Therefore, if none or one criterion was met, participants were considered casual users. If two to four criteria were met, they were considered users at risk to develop gaming disorder, and if five or more criteria were met, they were considered users showing pathological behaviors. Only individuals scoring casually or risky according to the diagnostic interview were included into analyses.

Assessment of criteria for specific internet-use disorders. In addition to the clinical interview, we assessed self-reported symptoms as measured with the Assessment of Criteria for Specific Internet-use Disorders (ACSID-11; Müller et al., 2022). The ACSID-11 is an 11-item screening instrument that captures ICD-11 criteria for gaming disorder and other potential Internet-use disorders. The three main criteria impaired control (IC), increased priority (IP), and continuation/escalation (CE) are each represented by three items. Two additional items capture functional impairment and marked distress through the usage. Each item was answered using a two-fold response format asking for the frequency of occurrence (0 = *never*, 1 = *rarely*, 2 = *sometimes*, 3 = *often*) and if at least 'rarely', also for the intensity of the symptom experience (0 = *not at all intense*, 1 = *rather not intense*, 2 = *rather intense*, 3 = *intense*) in the last 12 months. To validate the results of the clinical interview, we calculated a mean score across all items to assess whether self-reported symptoms differed between the groups derived from the diagnostic interview (see Table 2).

Experience of gratification scale and experience of compensation scale. To assess the experience of gratification and compensation, we used the Experience of Gratification Scale (EGS) and Experience of Compensation Scale (ECS; Wegmann et al., 2022). Both scales consist of two factors which are represented by three items each. The EGS consists of "gratification of needs" (e.g., "feel successful") and "experience of pleasure" (e.g., "feel good"), while the ECS reflects "compensation of needs" (e.g., "feel less unsuccessful") and "experience of relief from negative feelings" (e.g., "feel less constricted"). The answers were given on a five-point Likert scale ranging from 0 = *never* to 4 = *very often*. Mean scores were calculated for each of the subscales. Both the EGS and the ECS had a good reliability with Cronbach's α being 0.742 for the EGS, and Cronbach's α being 0.834 for the ECS.

Internet use expectancies scale. The Internet Use Expectancies Scale (IUES; Brand, Laier, & Young, 2014) specified for gaming was used to measure gaming-related use expectations. The scale comprises two factors, with four items each. The first subscale reflects "positive reinforcement" (e.g., "To have fun") and the second subscale "avoidance/negative reinforcement" (e.g., "To distract from problems"). All items were answered on a six-point Likert scale ranging from 1 = *completely disagree* to 6 = *completely agree*. Mean scores were calculated for both subscales. Both subscales had a good reliability with Cronbach's α for positive expectancies being .823, and Cronbach's α for avoidance expectancies being .767.

End-of-day gaming-related mental imagery. To measure gaming-related mental imagery, the participants answered one item (i.e., "How intensely did you figuratively imagine yourself gaming today."), as part of the 14-days end of day assessment in the ambulatory survey. Participants answered on a 10-point Likert scale from 1 = *not intense at all* to 10 = *very intense* how intensely they actively imagined the activity. Ratings were averaged across days of participation with higher mean scores indicating more intense imagery.

End-of-day playing frequency. As part of the end-of-day assessment in the ambulatory survey, participants were asked to indicate whether they had played video games or not (binary answering option: yes or no). We put into relation the days on which the ambulatory assessment was filled in with the days on which video games were played. Thus, we formed a percentage indicative of the proportion of survey days that the participants had played videogames (e.g., participants played on 60% of the completed days).

Statistical analyses

Descriptive statistics, correlational analyses, and independent *t*-tests were conducted with SPSS version 27, with error probabilities set to .05. SEM was conducted with MPlus version 8 on a MacBook Pro running Monterey version 12.4. We modelled the gratification and compensation pathways as latent factors with respective reinforcement experiences and use expectancies as manifest variables, and used end-of-day assessment items for desire thinking and gaming frequency as manifest dependent variables in the model. We did not regress the gaming frequency on desire thinking since both variables were end-of-day assessments wherefore analyzing a causal relationship between them is not possible (i.e., did more intense desire thoughts contribute to more frequent playing, or was it that participants had more intense desire thoughts because they could not play on that day?). However, we allowed correlations of residuals to treat measurement errors more as day-specific variations that may have similarly influenced both ratings. Since compensation and gratification are both constituted by reinforcement-learning and expectancies, we allowed their residual covariance in the model. Significant results from the Shapiro-Wilk and Kolmogorov-Smirnov Tests ($p < .01$) indicated that none of the variables exhibited a normal distribution except for the EGS. The proposed model was analyzed at a multigroup level based on different levels of symptom severity, specifically casual and at-risk manifestations. We utilized mean structure analysis as is often done to compare group means on the proposed constructs (Dimitrov, 2006). In this analysis, the sub-sample displaying casual gaming behaviors served as the reference group. In the constrained model, path estimates were fixed, meaning the model was forced to be equal across both groups. In the unconstrained model, path estimates were estimated freely. The assumption of invariance between the constrained and unconstrained models was tested using $\chi 2$ difference testing provided in MPlus via the DIFFTEST-command. Due to a small sample size, non-normally distributed observed variables, and mean structure analysis, we followed the recommendation of Maydeu-Olivares (2017) and employed a robust maximum likelihood estimator known as MLMV, which is resilient to non-normality. Goodness-of-fit was considered satisfactory with a standard root mean square residual (SRMR) below 0.08, root mean square error of approximation (RMSEA) below 0.08, comparative fit indices (CFI/TLI) above 0.90 for a good, above 0.95 for an excellent fit, and if the degrees of freedom ratio (χ^2/df) was below 3 (Hu & Bentler, 1995, 1999). With 91.3% of the sample being male, which makes for a significantly unequal gender distribution (χ^2 (1) = 86.81, $p < .001$), and due to research suggesting gender differences for reward learning (e.g., Becker & Chartoff, 2019; Hoeft, Watson, Kesler, Bettinger, & Reiss, 2008; Li et al., 2019) we controlled for gender effects on the latent factors gratification and compensation (1 = *male*, 2 = *female*).

Ethics

The study procedures were carried out in accordance with the Declaration of Helsinki. The local ethics committee of University of Duisburg-Essen approved the study protocol (ID: 1911APBM0457) that was similarly conducted at the respective sites of this multi-centered research unit. All participants were informed about the study protocol and provided informed consent for the different parts of the study separately (i.e., laboratory study, end-of-day assessment).

RESULTS

Descriptive statistics

Table 1 shows means, standard deviations, and ranges for relevant study variables. It further displays correlations among study variables.

Table 1. Descriptive statistics of study variables

	Descriptive statistics		Correlations					
	M (*SD*)	Range	2)	3)	4)	5)	6)	7)
1) Experience of gratification	2.49 (0.61)	0.67–4.00	0.660**	0.372**	0.291*	0.201*	0.240**	0.104
2) Expectancy of gratification	4.70 (0.79)	2.25–6.00	–	0.319**	0.274**	0.253**	0.278**	0.194*
3) Experience of compensation	1.47 (0.82)	0.00–3.50		–	0.589**	0.214*	0.326**	0.430**
4) Expectancy of compensation	3.07 (1.16)	1.00–5.75			–	0.291**	0.245**	0.467**
5) Playing frequency[1] in %	52.36 (28.68)	0.00–100.00				–	0.307**	0.353**
6) Intensity of mental imagery	2.76 (1.52)	1.00–8.68					–	0.366**
7) Symptom severity[2]	0.71 (0.53)	0.00–2.73						–

Note. $N = 127$; $^{**}p < .01$; [1]Playing frequency was calculated as the percentage of all ambulatory assessment days on which subjects reported having played; [2]as measured with the ACSID-11, see description in methods.

Group comparisons

Table 2 shows means and standard deviations for relevant study variables separately for the groups of individuals with casual and at-risk gaming patterns. It further displays the results for *t*-tests for independent samples that were conducted between both groups. Comparisons show that all study variables were heightened among individuals with at-risk gaming patterns.

Structural equation model

Figures 2 and 3 show the results of the mean structured SEM including significant, standardized, and direct pathways. No indirect pathways were modeled. The model fits the observed data well with $\chi^2/df = 1.32$ (χ^2 contribution of casual = 20.04 and at-risk = 9.05), CFI = .934, TLI = .874, RMSEA = .071, and SRMR = .069. The model explained 3.5% of the daily gaming frequency and 11.3% of daily mental imagery in the casual group, and 2.2% of the daily gaming frequency and 13.6% of daily mental imagery in the at-risk group. The only significant direct effects were observed from compensation to mental imagery in the casual group (see Fig. 2) and from gender (1 = *male*, 2 = *female*) on compensation in the at-risk group (see Fig. 3). The chi-square difference testing revealed that this model was not significantly different from a model where path-coefficients among casual and at-risk sub-groups were forced to be equal (χ^2 (4) = 2.95, p = .566) suggesting that estimates do not deviate significantly between groups.

DISCUSSION

The aim of this study was to investigate several core assumptions of the I-PACE model on the development of desire and behavior execution (Brand et al., 2019; Brandtner et al., 2021) in the context of casual and at-risk gaming patterns. Besides direct comparisons, we used structural equation modelling to analyze effects of early and later stages (i.e., casual and at-risk gaming patterns) via gratifying and compensatory pathways on gaming-related mental imagery and gaming frequency as measured in an ambulatory end-of-day assessment.

Our results indicate that gaming-specific reinforcement mechanisms (i.e., experience of gratification and compensation) and use expectancies (i.e., expecting gratification and compensation) are heightened among individuals who show at-risk gaming patterns as compared to those with casual gaming patterns. These findings empirically confirm the theoretical assumptions on a transition from earlier to later stages in the addiction development as stated in the I-PACE

Table 2. Descriptive statistics and independent *t*-tests for groups of individuals according to gaming patterns

	Casual gaming pattern (n = 63) *M*(*SD*)	At-risk gaming pattern (n = 64) *M*(*SD*)	Independent *t*-tests *t* (*df*)
Demographic information			
Age	24.03 (3.69)	24.61 (5.20)	t (113.81)[2] = −0.723, p = .472
Playtime on weekdays (minutes/day)	72.22 (69.70)	154.93 (74.93)	t (125) = −6.44, p < .001
Playtime on weekends (minutes/day)	141.90 (111.45)	289.61 (161.76)	t (125) = −5.98, p < .001
Study variables			
Experience of gratification	2.31 (0.54)	2.65 (0.62)	t (125) = −3.35, p < .001
Expectancy of gratification	4.50 (0.85)	4.90 (0.67)	t (125) = −2.98, p < .010
Experience of compensation	1.13 (0.70)	1.80 (0.80)	t (125) = −5.08, p < .001
Expectancy of compensation	2.61 (1.06)	3.53 (1.07)	t (125) = −4.87, p < .001
Playing frequency[1] in %	40.90 (29.32)	63.65 (23.22)	t (125) = −4.85, p < .001
Intensity of mental imagery	2.38 (1.47)	3.15 (1.47)	t (125) = −2.95, p < .001
Symptom severity[3]	0.42 (0.36)	0.99 (0.52)	t (112.85)[2] = −7.10, p < .001

Note. N = 127; [1]Playing frequency was calculated as the percentage of all ambulatory assessment days on which subjects reported having played; [2]equal variances were not assumed according to Levene's test; [3]as measured with the ACSID-11, see description in methods.

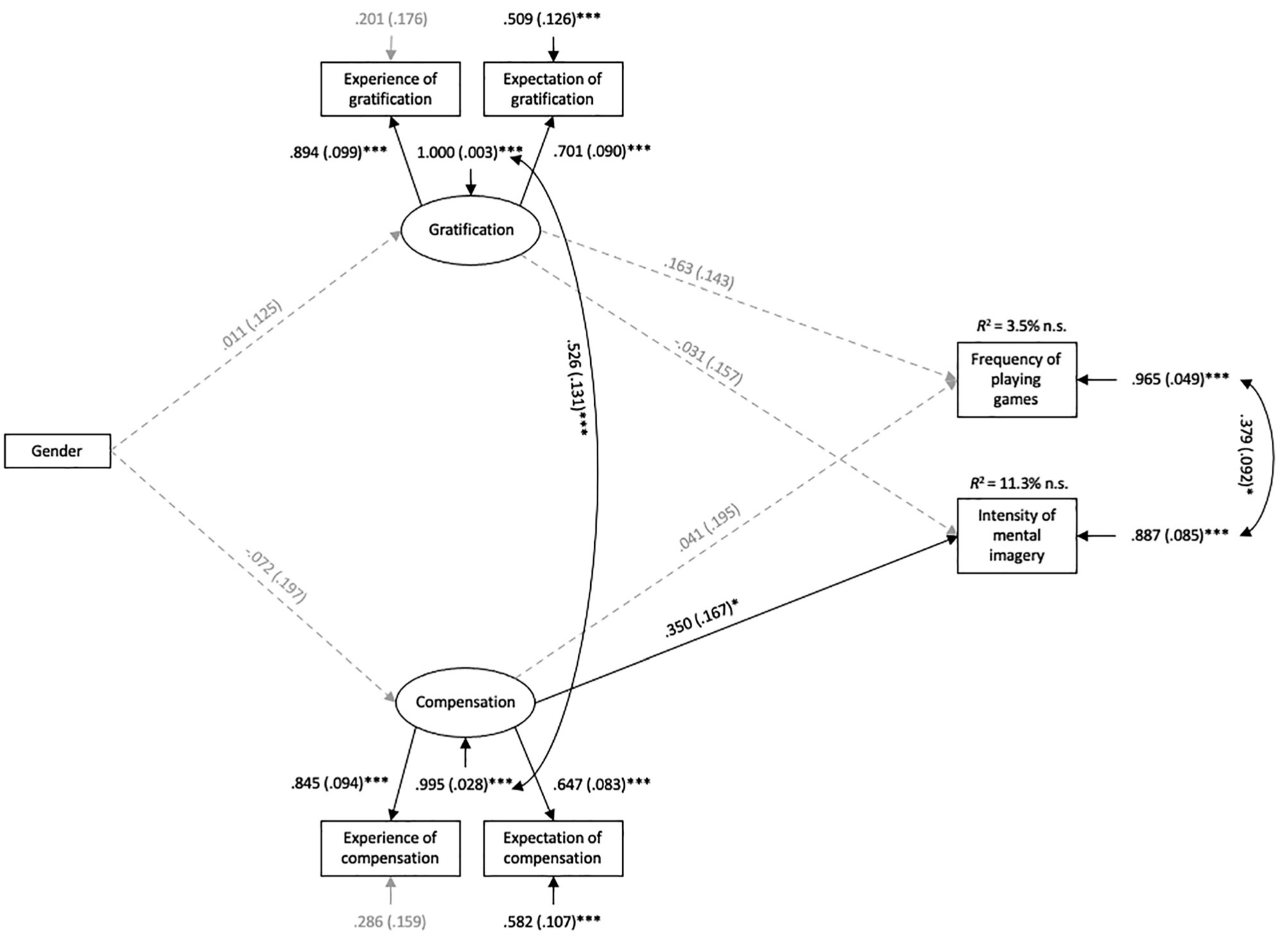

Fig. 2. Tested structural equation model for the casual gaming group

Note. $n = 63$. Figure shows direct effects with their respective β-weights with standard errors, levels of significance, and residual variances. $^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$.

model (Brand et al., 2019): Seemingly, individuals who are at risk for problematic gaming not only experience more gratification, but also more compensation, and have higher expectancies of the same towards gaming. An increase of both might therefore be an indicator for a vulnerable, but sub-clinical group with a general heightened reward-sensitivity, be it reward seeking or harm avoidance. More broadly speaking, these individuals could have learned that playing videogames might be an ideal activity for fun-seeking and emotional relief – which is an equivalent to other risky, but not necessarily addictive behaviors such as hazardous drinking (Hamilton, Sinha, & Potenza., 2012; Spada, Moneta, & Wells, 2007) or risky internet use (Brand et al., 2014). This finding is in line with the theoretical assumption that choices underlying addictive behaviors might be initially goal-driven (i.e., expecting reward or relief) (Brand, 2022; Ersche et al., 2016; Everitt & Robbins, 2005, 2016). More specifically, individuals in the goal-directed mindset might use their learned contingency knowledge on the specific outcomes of gaming on purpose (Hogarth, 2020; Holton & Berridge, 2013), while only in the later stages this same behavior might be more strongly driven by compulsion (Everitt & Robbins, 2005, 2016; Lüscher, Robbins, & Everitt, 2020; Perales et al., 2020). Thus, we would expect the compensatory pathway to be even more pronounced in individuals with the full picture of gaming disorder.

Besides reinforcement experiences and expectancies, also the intensity of gaming-related mental imagery and the playing frequency in daily life are heightened in individuals at risk for problematic gaming as assessed by a 14-day end-of-day survey. Our results indicate that the active elaboration of mental imagery might be more prevalent among individuals who show at-risk gaming behaviors. This result aligns with previous work suggesting that individuals with at-risk gaming behaviors mentally elaborate their gaming behaviors more frequently (e.g., when studied as a sub-facet of desire thinking; Dragan & Grajewski, 2021). However, previous studies investigating gaming-related desire thinking have explored the trait-like tendency of desire thinking (Bonner et al., 2022; Brandtner & Brand, 2021; Dragan & Grajewski, 2021). Thus, this is the first study showing that imaginal desire thinking, which in this case can be understood as a state measure assessing the intensity of elaboration in everyday life, might be more prevalent among individuals with at-risk gaming behavior compared to casual gamers. Additionally, also the playing frequency was heightened among individuals with at-risk gaming behaviors. Our demographic information (see Table 2) extends

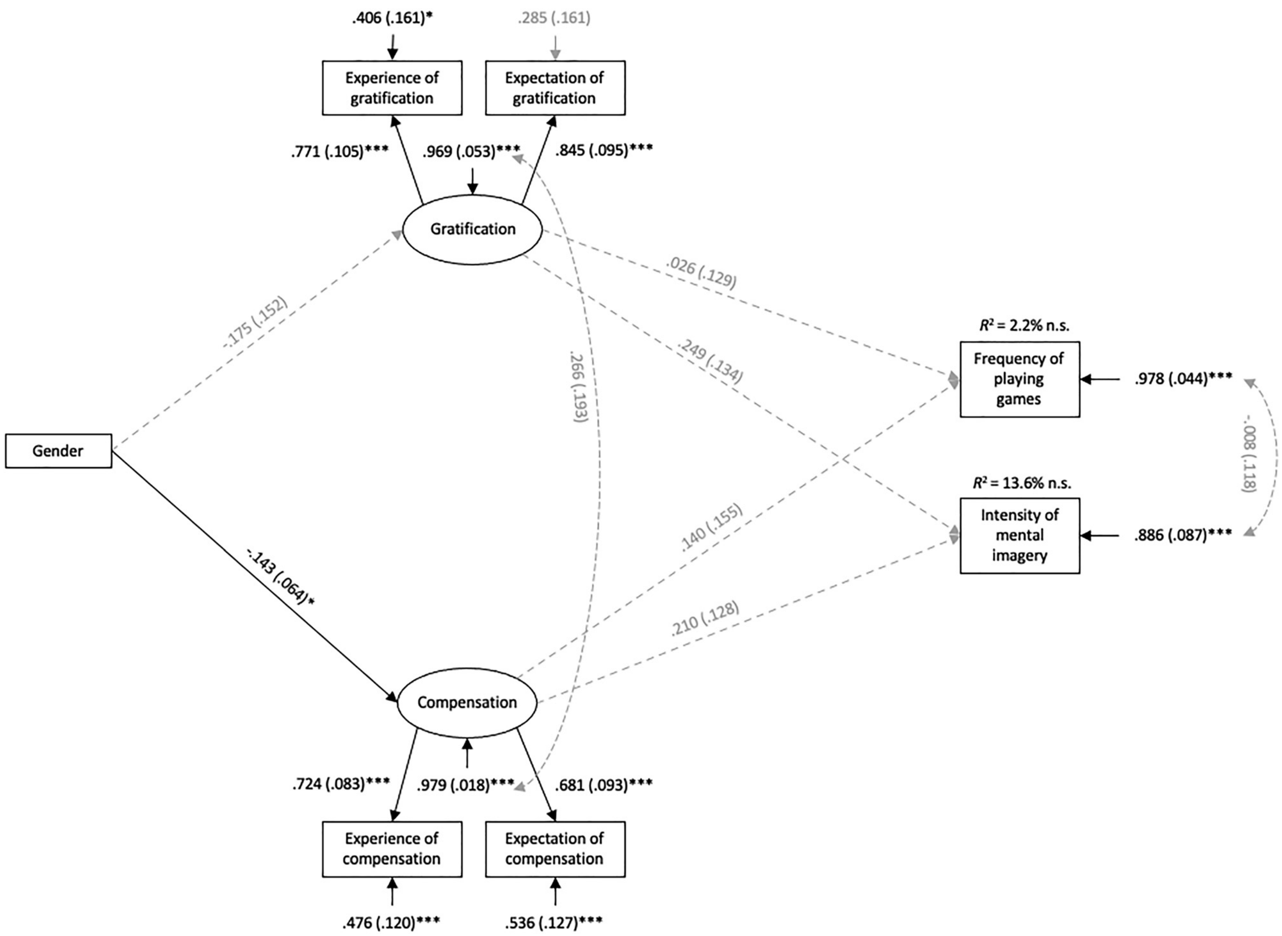

Fig. 3. Tested structural equation model for the at-risk gaming group

Note. $n = 64$. Figure shows direct effects with their respective β-weights with standard errors, levels of significance, and residual variances. $^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$.

this finding in that also the playtimes are heightened in the group showing at-risk gaming behaviors. Of note, a high gaming engagement is distinguishable from addictive gaming behaviors (Charlton & Danforth, 2007; Deleuze et al., 2017, 2018), but it might be worth considering that learning mechanisms underlying gaming behavior and resulting use expectancies could provide explanations for more frequent gaming-sessions (Bickel et al., 2018; Lewis, 2017; Perales et al., 2020).

We analyzed in a SEM, if and how the differences we found in gaming-related mental imagery and the playing frequency could be explained by the experiences and expectancies of gratification (i.e., pleasure-oriented pathway) and compensation (i.e., relief-oriented pathway). Interestingly, playing frequency in daily life was neither predicted by gratification nor compensation across models. In contrast, mental imagery was only explained by compensation, and only in the casual group. Although there are several studies that have indeed established relationships between use expectancies and time spent playing or symptom severity (e.g., Chamarro, Oberst, Cladellas, & Fuster, 2020; Lee, Ko, & Chou, 2015; Müller, Werthmann, Beutel, Wölfling, & Egloff, 2021), our results suggest that the playing frequency might not be predicted by expectancies or foregone experiences. Possibly, the experience and expectancy of reward might not determine how often a person decides to game but rather, how intensively and problematically that person might be engaged with gaming. Moreover, research suggests that daily decisions might be predicted by more proximal, situational variables (e.g., Zhou, Zhou, Zhou, Shen, & Zhang, 2022). Similarly, gratification and compensation could be more closely associated with immersive experiences while gaming, causing increased playtimes (Chamarro et al., 2020), a greater loss of control (Lee et al., 2015; Müller et al., 2021; Wang et al., 2021; Wu, Ko, Wong, Wu, & Oei, 2016), or craving (Wegmann et al., 2022).

Daily gaming-related mental imagery was only predicted by compensation in the casual group model, but we found no significant pathways in the at-risk group model. While the group comparisons indicate that mental imagery increases with the transition from causal to at-risk gaming patterns, the SEM might not be able to explain this shift with the available variables (due to missing effects in the at-risk group). Instead, the SEM reveals that in earlier stages, mental imagery might be primarily compensation-driven whereas in the at-risk group, we observed a moderate increase in effect size for the effect of gratification on mental imagery. However, this path was not significant in the model (see Fig. 3) and both models for the casual and at-risk group did not significantly differ as indicated by chi-square difference testing. Daringly suspecting that these results are approaching true effects, this would be against our theoretical reasoning within the I-PACE model, which would assume this shift to be the other way around. However, our data does not allow a reliable interpretation for the reasons mentioned above. Yet, these results provide some support for the relief-oriented pathway of imaginal desire thinking (Brandtner et al., 2021), assuming that conscious mental imagery might be initiated to free the individual from uncomfortable feelings, already in casual stages of gaming. Thus, imaginal desire thinking (i.e., imagining something that makes the individual 'feel better'; Brand, 2022) might be understood as an indefinite, inherent coping mechanism, that could develop with addictive behavior, and might similarly become stronger with it. However, there is a great amount of unexplained variance within daily gaming-related mental imagery that neither gratification nor compensation could explain. This might be due to mental imagery being an inherent human faculty (Caselli & Spada, 2015) that does not necessarily develop with addictive tendencies, but might be availabe from the outset.

Limitations of our study count in the comparatively small sample size and the strong gender imbalance in this non-clinical sample. In the SEM, we controlled for gender effects on the latent variables, however, the small sample size and strong imbalance make it difficult to interpret the observed effect of gender on compensation. More gender-balanced samples are needed to draw valid conclusions. Of note, we assessed mental imagery with only one item which neglects its rich sensory qualities that go beyond imagery (i.e., tactile, auditory, gustatory, olfactory impressions) and might be psychometrically suspect. Furthermore, the current samples included individuals with casual and at-risk gaming patterns only. One strength of the study, however, is that we have clearly defined these groups based on an extensive diagnostic procedure. When adding an adequately sized group of individuals diagnosed with gaming disorder, the presumed effects could potentially be modeled more clearly. This is one goal of the ongoing research unit ACSID (Brand et al., 2021).

CONCLUSION

Although gaming-specific reinforcement-learning processes (i.e., experience of gratification and compensation) and gaming-specific use expectancies (i.e., expectancy of gratification and compensation) are both heightened in individuals with at-risk gaming behaviors, our results suggest that especially the compensating aspects about gaming might be relevant to the development of gaming-related mental imagery. In contrast, the playing frequency seems to endure independently of reinforcement learning and expectancies. Considering the coping hypothesis of desire thinking in addictive behaviors, our results implicate that an early work and intervention with imaginal desire thoughts might be beneficial in preventing that coping thoughts translate into actual coping behaviors.

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