

Situating problematic gaming and psychotic-like experiences in the adolescent landscape of affordances: A cohort study







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FULL-LENGTH REPORT



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ABSTRACT

Background and aims: Problematic gaming has been linked to increased levels of psychotic-like experiences (PLEs) in youth, but the role of environmental factors remains unclear. We aimed to examine the association of problematic gaming with PLEs and, using affordance theory, to evaluate whether environmental factors could help enhance the identification of this risk. *Methods:* Participants were 6,467 youth (39.2% female) who reported playing digital games, from the Adolescent Brain Cognitive Development Study in the U.S. Measures included problematic gaming, peer environment (number of close friends), school environment (teachers, activities, etc.), family environment (parental monitoring), and PLEs. We examined whether the peer, school, and family environments at age 12 were associated with problematic gaming and moderated its association with PLEs at age 13. *Results:* Higher levels of problematic gaming at age 12 were associated with higher levels of PLEs at age 13, independently of sociodemographic variables and previous PLEs. The strength of the association between problematic gaming and PLEs did not significantly vary as a function of the peer, school, or family environment variables (i.e., there was no significant interaction effect). However, more protective school and family environments at age 12 were associated with lower levels of problematic gaming at age 13, independently of previous levels of problematic gaming. *Discussion and conclusions:* Positive school and family environments may be protective against problematic gaming in adolescence but do not appear to attenuate the putative effect of problematic gaming on PLEs. The results provide partial support to an affordance-based conceptualization of problematic gaming.

KEYWORDS

adolescence, affordances, gaming disorder, problematic video gaming, psychotic-like experiences

INTRODUCTION

Psychotic-like experiences (PLEs) are unusual thoughts and perceptions similar to the symptoms of psychotic disorders, such as paranoia and hallucinations, but of lesser intensity.

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PLEs are found in 9–14% of adolescents (Healy et al., 2019; Lindgren & Therman, 2024) and are associated with a greater risk of psychotic, mood, and anxiety disorders (McGrath et al., 2016; Sullivan et al., 2020). Risk factors for PLEs in adolescence include genetics, lower socioeconomic status, ethnoracial minority status, and adversity in the school and family environment, with no consistent evidence for sex or gender differences (McMahon et al., 2021; Staines et al., 2022; D. Wang et al., 2022).

A potential risk factor for PLEs is problematic gaming. In the 11th revision of the International Classification of Diseases, the World Health Organization (WHO, 2024) defines gaming disorder as a persistent pattern of impaired control over the gaming behavior, prioritization of gaming at the detriment of other activities, and continuation of gaming despite negative consequences. Problematic gaming should therefore be distinguished from merely playing games, which is not in itself a risk factor for PLEs (Paquin, Ferrari, et al., 2024; Paquin, Philippe, et al., 2024) and which can provide experiences that are beneficial for mental health, such as social connections, identity development, and stress relief (Ballou, Hakman, Vuorre, Magnusson, & Przybylski, 2024). There is interest in improving the management of problematic gaming in youth, including to mitigate its potential impact on psychotic disorders (Huot-Lavoie et al., 2024). Problematic gaming was positively correlated to PLEs in a cross-sectional study (Zhang et al., 2022) and was suggested to contribute to psychotic symptoms in clinical case reports (Huot-Lavoie et al., 2023). One explanation for the potential effect of problematic gaming on PLEs is its association with increased social withdrawal, a risk factor for PLEs (Narita et al., 2024).

There is a need, however, to accurately differentiate problematic from non-problematic gaming. Some of the typical items used to measure problematic gaming in research, such as “frequently thinking about games”, are thought to lack specificity by tapping into a harmless proclivity for games (Billieux, Flayelle, Rumpf, & Stein, 2019; Charlton & Danforth, 2007; Wichstrøm, Stenseng, Belsky, von Soest, & Hygen, 2019). This is why, in contrast to survey-based assessments of problematic gaming, the clinical diagnosis of gaming disorder requires the presence of functional impairment or psychological distress (King, Billieux, Behm, & Delfabbro, 2025). Given that clinical assessments are typically lacking from population-based cohort studies, other information can be used to complement survey measures of problematic gaming. We propose that the integration of environmental factors using affordance theory may help distinguish problematic from non-problematic gaming and ultimately better identify the associated risk for PLEs.

Affordance theory of problematic gaming

Environmental factors in problematic gaming can be understood using affordance theory (Glackin, Roberts, & Krueger, 2021; Lavalley & Osler, 2024), which posits addictive behaviour as not merely the result of individual

psychological features but as arising from and being sustained by features of the person’s environment (Lavalley & Osler, 2024, p. 380). Affordances are possibilities of action or experience that are enabled by the environment: a pen affords writing, close friendships afford intimacy, and games afford enjoyment (Gibson, 1979; Rietveld & Kiverstein, 2014). Affordances are not purely external features of the world or internal mental states: they are constituted by both the features of the environment and the embodied needs and capabilities of the person (Kiverstein, 2020). For instance, a game might afford the possibility of being played to two people, but if the former person is a passionate gamer and the latter dislikes games, then its affordance of play will only be alluring for the former person.

For Lavalley and Osler (2024), addiction is characterized by the narrowing of affordances to those related to the addictive behavior. Accordingly, in its problematic form, gaming starts as a central means for someone to fulfill their psychological needs and becomes pathological as the person reorganizes their life to pursue gaming, to the detriment of nurturing other spheres of their social environment that could enable alternative affordances. This notion is consistent with previous evidence that certain motivations for gaming, notably escaping interpersonal difficulties or perceived failure in the external environment, are associated with problematic gaming (Giardina, Fournier, et al., 2024; Király et al., 2022; H.-Y. Wang & Cheng, 2022). In contrast, a person’s maintenance of diverse affordances across their social environment might be a sign that their gaming behavior has not evolved into an addiction. Further, environments that provide a wider range of possibilities for the fulfillment of psychological needs (i.e., “protective” affordances) might help prevent the monopolizing effect of gaming-related affordances (Allen & Anderson, 2018; Snodgrass et al., 2014). Altogether, this affordance-based understanding reiterates the clinical recognition of functional impairment as an essential feature of gaming disorder and expands on it by formalizing the relationship between addiction and the person’s environment.

The implication of affordance theory is that we can better evaluate problematic gaming and its association with PLEs by integrating information about a person’s perceived affordances in their environment. During adolescence, the peer, school and family environments are important determinants of mental health (McGorry et al., 2024). Experiences of hostility or exclusion in these spheres are associated with greater engagement in digital games and higher levels of PLEs (Paquin, Ferrari, et al., 2024). The presence of protective affordances enabled by peer, school, and family environments might be a sign that an adolescent’s gaming is not problematic, and it could attenuate the impact of problematic gaming on PLEs by mitigating the exposure to hostility, exclusion, or other risk factors for PLEs. In sum, higher survey scores for problematic gaming may be less reliable markers of PLE risk among adolescents who report better protective features in their peer, school, or family environment.

This study aimed to examine, through the lens of affordance theory, the prospective association of problematic gaming during adolescence with PLEs. To this end, we used a population-based cohort to evaluate the role of protective affordances in the peer, school, and family environments in this association. We hypothesized that the protective affordances indexed by environmental variables would be associated with lower levels of problematic gaming and that they would attenuate the association of problematic gaming with subsequent PLEs.

METHODS

Participants

Data was drawn from the Version 5.1 of the Adolescent Brain and Cognitive Development (ABCD) Study (Garavan et al., 2018), which includes visits between September 1st, 2016 and January 15, 2022. The ABCD Study is a population-based cohort of 11,868 children aged 9–10 years at baseline and followed annually. Participants were recruited from randomly selected schools within a 50-mile radius of 22 research sites across the United States. The present analyses focused on follow-up data at years 2 and 3 (ages 12–13). We chose year 2 because it is the first time point where problematic gaming was measured, and we examined PLEs in the next year to estimate a prospective association. Analyses were restricted to participants with complete data on analytic variables ($n = 8,855$). Because the problematic gaming questionnaire was not administered to non-gaming participants, the analyses were further restricted to participants who reported playing digital games at year 2, leading to a final sample of $n = 6,467$. To index affordances in the peer, school and family environments, we used self-reported rather than informant-reported measures, following the notion that affordances reflect not only the features of the environment but also the person's relation to it, including their perception (Lavalley & Osler, 2024).

Measures

PLEs were measured at years 2 and 3 using the Prodromal Questionnaire–Brief Child Version (PQBC). It includes 21 items on the occurrence of unusual beliefs, perceptual experiences, and disorganization (e.g., feeling persecuted, hearing strange sounds, and communication difficulties; corresponding to the “positive symptoms” of the psychosis spectrum) in the past month over a 7-point scale: 0 = no distress, 1 = yes but low distress, and 2–6 = yes with increasing distress. The questionnaire was read to participants by research assistants. There are two typical approaches to analyzing the PQBC: the number of PLEs with a score ≥ 1 can be summed to calculate the “Total” score (total range 0–21), or the score for each item (item range 0–6) can be summed to calculate the “Distress” score (total range 0–126). Both approaches in the ABCD conform to a 1-factor solution with good evidence of construct validity as a measure of the psychosis spectrum (Karcher et al., 2018).

Here, we used the Distress score because of its broader range and common use in the literature, and we applied a log-transformation to attenuate the skewed distribution as done previously (Karcher et al., 2022; Petti, Schiffman, Oh, & Karcher, 2025), followed by a multiplication by 10 to reduce scaling differences relative to other variables. A higher score indicates more severe PLEs.

Problematic gaming was measured at years 2 and 3 with the Video Game Addiction Questionnaire (Bagot et al., 2022), adapted from the Bergen Facebook Addiction Scale (Andreassen, Torbjørn, Brunborg, & Pallesen, 2012). It includes 6 items based on the components model of addiction (Griffiths, 2005): spending a lot of time thinking about games, feeling the need to play games more and more, playing games to forget about problems, trying to play games less but not being able to, becoming stressed or upset when not allowed to play games, and bad effects on schoolwork or job from playing too much. Items are rated on a scale of 1 = “Never” to 6 = “Very often” and summed (range: 6–36). A higher score indicates more severe problematic gaming.

Peer environment was measured at year 2 as the number of close friends, calculated from the sum of 3 items about close friends of female, male, or other gender. These 3 ad-hoc items were included in the ABCD as part of the youth-reported mental health questionnaires. We chose this measure as the proxy for peer environment based on a previous study that found that the number of close friends attenuated the association of neighborhood fragmentation with PLEs in the same cohort at age 9–10 (Ku, Ren, et al., 2024). We preferred this measure over other peer-related variables from the ABCD Study, which assessed risk rather than protective factors (e.g., bullying) or targeted specific behaviors not related to our research question (e.g., peer encouragement for not using drugs). Given the wide distribution of the variable (median: 5; range: 0–200), we applied winsorizing to limit the influence of outlier values, setting values above the 95th percentile to the 95th percentile value, which was 17.

School environment was measured at year 2 with the School Environment subscale of the School Risk and Protective Factor Survey (Arthur et al., 2007; Hamilton et al., 2011). This subscale includes 6 items addressing protective aspects of the school environment, such as “In my school, students have lots of chances to help decide things like class activities and rules” and “I get along with my teachers”. The subscale score (range: 6–24) is the sum of each item rated on scale of 1 = “NO!” to 4 = “YES!”. A higher score indicates a more protective school environment. This measure was previously found to moderate the cross-sectional association between neighborhood-level deprivation and hippocampal volumes in the ABCD at ages 9–10 years (Ku, Aberizk, et al., 2024).

Family environment was measured at year 2 using the Parental Monitoring Survey, adapted for the ABCD Study from homonymous questionnaires from Karoly, Callahan, Schmiege, and Ewing (2016), 3 items, and Stattin and Kerr (2000), 9 items. The present version includes 5 items

assessing a parent's active care efforts regarding the whereabouts of the child, such as "How often do your parents/guardians know where you are?" and "If you are at home when your parents or guardians are not, how often do you know how to get in touch with them?". Items are rated on a scale of 1 = "Never" to 5 = "Always or almost always" and were averaged to obtain a mean score (range: 1–5). A higher score indicates a higher level of parental active care efforts.

Other covariates were reported by caregivers: age, sex assigned at birth, higher parental education (defined as at least one of the parents or caregivers having a bachelor's degree), income-to-needs ratio, ethnoracial group (Asian, Black, Hispanic, White, and other), family history of psychosis, and parental separation (yes or no). Income-to-needs ratio was calculated as the midpoint of the income category divided by the federal poverty line for the respective household size (Rakesh, Zalesky, & Whittle, 2022). Family history of psychosis was assessed as any vs. none across first- and second-degree relatives using the Family History Assessment Module Screener (van Dijk, Murphy, Posner, Talati, & Weissman, 2021). In sensitivity analyses, we additionally included problematic social media use, self-reported using the 6-item Social Media Addiction Questionnaire (Bagot et al., 2022), given its potential overlap with problematic gaming. All covariates were assessed at baseline, except parental separation and problematic social media use which were measured at year 2. Finally, we included number of hours played at year 2 (separately measured for single-player games on weekends and multi-player games on weekdays) in descriptive analyses.

Statistical analyses

We conducted the analyses in R version 4.5.0 between February and July 2025 following our preregistered study protocol (<https://osf.io/f53ah/>) and published the analytic codes online (<https://osf.io/4zfxd/>). Deviations from the protocol were the inclusion of ethnoracial group and parental separation as covariates; also, non-preregistered sensitivity analyses were conducted to confirm the robustness of the findings (Supplementary Table 1). From the total ABCD sample, characteristics of participants with and without missing data on analytic variables were compared to identify meaningful differences, using effect sizes ≥ 0.100 rather than p -values (Yang & Dalton, 2012). Participants who did not report playing games at year 2 were removed after to arrive at the final sample.

For subsequent analyses, nominal statistical significance was set at p -value $< .05$. First, we used a linear mixed model to examine the associations of the peer, school, and family environments at year 2 with levels of problematic gaming at year 2. The model had random intercepts for sites and families to account for clustered observations. Covariates were age, sex, parental education, income-to-needs ratio, ethnoracial group, family history of psychosis at baseline, parental separation, and PLEs at 2 years. Second, we used another linear mixed model to examine the association

between problematic gaming at year 2 and PLEs at year 3. Covariates were the same as above, including the peer, school, and family environment variables. Third, we examined whether the peer, school, and family environment variables at year 2 moderated the association between problematic gaming at year 2 and PLEs at year 3. We modeled 2-way interactions for each pair of environmental variable and problematic gaming in three separate models. p -values of interaction terms were adjusted for false discovery rate using the Benjamini-Hochberg method (Benjamini & Hochberg, 1995).

As sensitivity analyses, we tested a 2-factor model of problematic gaming using confirmatory factor analysis. We drew from recent evidence of two latent factors ("engagement", items 1–2; and "addiction", items 3–6) in a similar 6-item scale of problematic social media use (Fournier et al., 2023). Following the analytic code provided by Fournier et al. (2023), we applied the weighted least squares means and variance adjusted robust estimation method, and we assessed the quality of the model using conventional fit indices. Furthermore, we examined whether the peer, school, and family environment variables at year 2 were prospectively associated with problematic gaming at year 3. Data on problematic gaming at year 3 were available for 5,866 (2052 [35.0%] female) participants. Finally, we examined associations adjusted only for pre-registered covariates (i.e., without ethnoracial group and parental separation), as well as associations adjusted for problematic social media use in the subsample of 3,129 (1,242 [44.3%] female) participants who reported using social media.

Ethics

The study procedures were carried out in accordance with the Declaration of Helsinki. Children provided verbal assent and caregivers provided written informed consent to the ABCD research protocol, which was approved by the Institutional Review Board at each participating site: https://abcdstudy.org/consortium_members/.

RESULTS

Relative to participants excluded from analyses because of missing data, the sample of included participants featured slightly younger age at year 2, greater proportions of higher parental education and White participants, smaller proportions of Asian, Black, and Hispanic participants, a higher income-to-needs ratio, lower levels of gaming, problematic gaming, and PLEs, and higher scores for parental monitoring (effect sizes ≥ 0.100 ; Table 1). Bivariate correlations between analytic variables are in Fig. 1.

Main analyses

Higher scores for protective school and family environments were concurrently associated with lower levels of problematic gaming at year 2, whereas the peer environment variable

Table 1. Characteristics of participants included in and excluded from the analyses

	Exclusion of participants because of missing data			Final sample ^b N = 6,467
	Included N = 8,855	Excluded N = 3,011	Effect size ^a	
Age at year 2 in years, Mean (SD)	12.0 (0.66)	12.1 (0.68)	0.137	12.0 (0.67)
Age at year 3 in years, Mean (SD)	12.9 (0.65)	12.9 (0.65)	0.060	12.9 (0.65)
Sex, N (%):			0.018	
Male	4,638 (52.4%)	1,550 (51.5%)		3,933 (60.8%)
Female	4,217 (47.6%)	1,460 (48.5%)		2,534 (39.2%)
Parental education, N (%):			0.477	
College associate degree or lower	2,584 (29.2%)	1,559 (52.0%)		2,006 (31.0%)
Bachelor's degree or higher	6,271 (70.8%)	1,440 (48.0%)		4,461 (69.0%)
Income-to-needs ratio, Mean (SD)	3.88 (2.46)	3.20 (2.57)	0.271	3.78 (2.45)
Ethnoracial group, N (%):			0.502	
Asian	153 (1.73%)	99 (3.29%)		111 (1.72%)
Black	1,024 (11.6%)	760 (25.2%)		813 (12.6%)
Hispanic	1,648 (18.6%)	762 (25.3%)		1,236 (19.1%)
Other	926 (10.5%)	321 (10.7%)		698 (10.8%)
White	5,104 (57.6%)	1,069 (35.5%)		3,609 (55.7%)
Family history of psychosis, N (%):			0.003	
No	7,911 (89.3%)	2,259 (89.4%)		5,770 (89.2%)
Yes	944 (10.7%)	270 (10.6%)		697 (10.8%)
Parental separation			0.016	
No	7,538 (85.1%)	1,728 (84.5%)		5,484 (84.8%)
Yes	1,317 (14.9%)	316 (15.5%)		983 (15.2%)
Gaming time, single-player, hours/weekend day	1.19 (2.06)	1.53 (2.52)	0.147	1.53 (2.22)
Gaming time, multiplayer, hours/weekday	0.90 (1.63)	1.17 (1.96)	0.149	1.15 (1.77)
Problematic gaming score at year 2, Mean (SD)	12.3 (6.22)	13.1 (6.78)	0.121	12.3 (6.22)
Close friends at year 2, Mean (SD)	5.69 (4.14)	5.87 (4.39)	0.043	5.67 (4.16)
School environment at year 2, Mean (SD)	19.6 (2.77)	19.6 (2.83)	0.004	19.6 (2.77)
Parental monitoring at year 2, Mean (SD)	4.50 (0.45)	4.41 (0.53)	0.190	4.48 (0.46)
Psychotic-like experiences at year 3, Mean (SD)	2.74 (6.40)	3.93 (7.82)	0.167	2.88 (6.56)

^aStandardized mean differences in absolute values (for continuous variables) and Mahalanobis distance between group-specific proportion vectors (for categorical variables) following Yang and Dalton's (2012) approach; range: 0.000–1.000. Bold indicates effect sizes ≥ 0.100 .

^bAfter exclusion of non-gaming participants.

was not significantly associated with problematic gaming in the same year (Fig. 2A). Higher levels of problematic gaming at year 2 were significantly associated with higher levels of PLEs at year 3 (Fig. 2C). There was a significant interaction effect between school environment and problematic gaming at year 2 which however did not survive adjustment for false discovery rate (Fig. 2D). Probing the interaction with school environment indicated that at higher levels of protective school environment, there was a *larger* association between higher levels of problematic gaming at year 2 and higher levels of PLEs at year 3. However, the estimated trends did not significantly differ over the lowest and upper quartiles of the school environment scores (Supplementary Figure 1). This means that any significant interactive effect would be confined to very low or very high values of school environment scores. Other interactions of problematic gaming with the peer and family environment variables were not significant.

Sensitivity analyses

A 2-factor model of problematic gaming at year 2 provided a good fit to the data, but the two factors were almost perfectly

correlated, preventing their evaluation as separate predictors of PLEs (Fig. 3). Higher scores for protective school and family environments at year 2 were significantly associated with lower levels of problematic gaming at year 3 (Fig. 2B). Associations were consistent in models adjusted only for preregistered covariates (Supplementary Figure 2) and adjusted for problematic social media use (Supplementary Figure 3; with the exception that the school environment was no longer associated with problematic gaming at year 3). Of note, problematic social media use was also associated with PLEs at year 3, independently of problematic gaming and the other covariates.

DISCUSSION

Problematic gaming was prospectively associated with higher levels of PLEs, independently of prior PLEs and other sociodemographic and environmental factors. The association is consistent with a previous cross-sectional study on problematic gaming and PLEs in adolescents (Zhang et al., 2022) and longitudinal studies that examined problematic internet use, a concept similar to problematic gaming, in

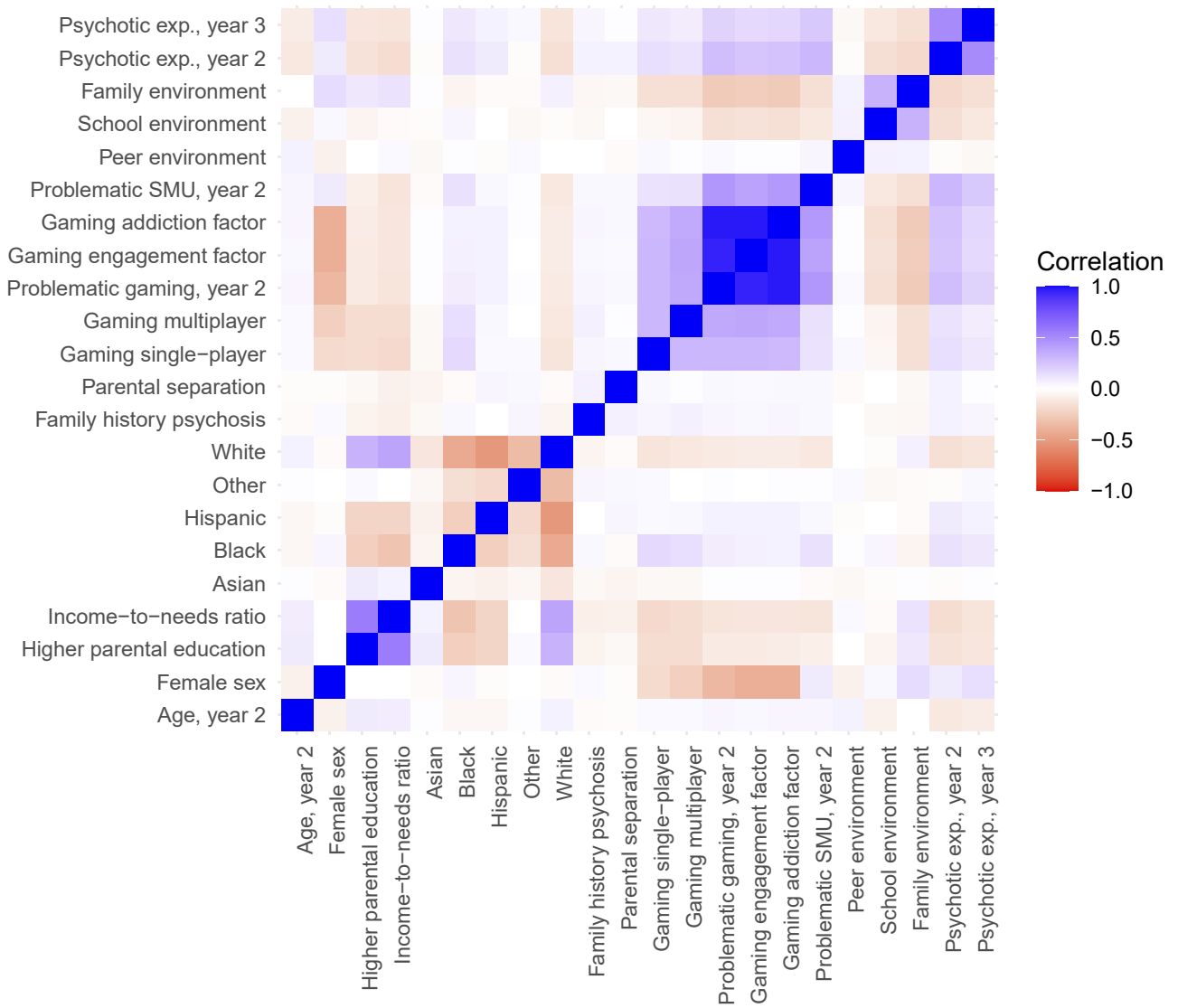


Fig. 1. Bivariate correlations between variables of the main analyses

Note: Correlations are Pearson’s *r*. For ethnoracial groups, variables were dichotomized and the comparator for each group was all other ethnoracial groups combined. Scores for psychotic-like experiences were log-transformed. SMU: social media use.

	A) Association with problematic gaming, year 2 Estimate (95% CI)	B) Association with problematic gaming, year 3 Estimate (95% CI)
Peer environment	0.01 (-0.02, 0.04)	-0.01 (-0.04, 0.03)
School environment	-0.15 (-0.21, -0.10)	-0.05 (-0.10, -0.00)
Family environment	-2.37 (-2.69, -2.05)	-0.81 (-1.13, -0.49)
Problematic gaming, year 2-		0.50 (0.48, 0.52)

	C) Association with PLEs, year 3 Estimate (95% CI)	D) Interaction with problematic gaming Estimate (95% CI)
Peer environment	0.01 (-0.04, 0.06)	0.00 (-0.01, 0.01)
School environment	-0.11 (-0.19, -0.03)	0.01 (0.00, 0.02)
Family environment	-1.18 (-1.68, -0.69)	0.06 (-0.01, 0.12)
Problematic gaming, year 2-	0.13 (0.09, 0.17)	

-log₁₀(p) 0 5 >10

Fig. 2. Associations between problematic gaming, environmental factors and psychotic-like experiences

Note: Bold indicates *p* < .05. All models were adjusted for age, sex, parental education, income-to-needs ratio, ethnoracial groups, family history of psychosis, and parental separation. Psychotic-like experiences (PLEs) at year 3 was further adjusted for PLEs at year 2 (both log-transformed and rescaled), and problematic gaming at year 3 was adjusted for problematic gaming at year 2. For interactions with problematic gaming (bottom right), the outcome is PLEs at year 3.

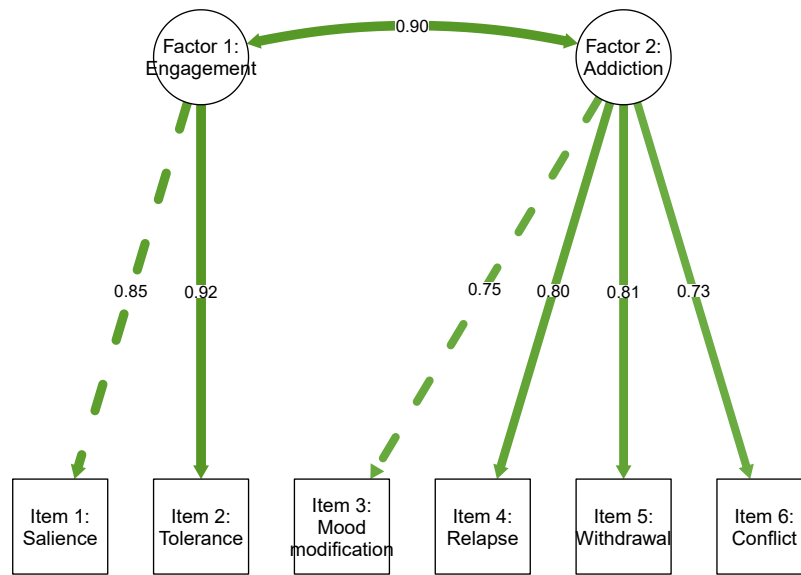


Fig. 3. Confirmatory factor analysis of a 2-factor model of problematic gaming at year 2

Note: Model based on Fournier et al. (2023). Fit indices: $\chi^2(8) = 136.989$, $p < .001$; root mean square error of approximation (RMSEA) = 0.05; comparative fit index (CFI) = 0.997, Tucker-Lewis index (TLI) = 0.995.

association with PLEs in adolescents (Narita et al., 2024) and college students (Peng & Zou, 2025). Although this finding is observational and subject to unmeasured confounding influences, it could reflect a causal effect of problematic gaming on the emergence of PLEs as a result of increased social isolation, interpersonal conflicts, or other socio-environmental disruptions (Narita et al., 2024; Paquin, Ferrari, Sekhon, & Rej, 2023). These putative consequences of problematic gaming are consistent with an affordance-based view of addiction, wherein gaming monopolizes the person's pursuits to the detriment of nurturing other affordances in their environment. In the same vein, we also found that problematic social media use was associated with higher levels of PLEs, independently of problematic gaming; however, since the present study was not aimed to investigate this association, we invite further research dedicated to it.

The results mostly supported our first hypothesis, which was that protective affordances indexed by the peer, school, and family environment variables would be associated with lower levels of problematic gaming. We found such protective associations for the school and family environment variables across problematic gaming at years 2 and 3. These associations are consistent with the affordance theory of addiction: a greater diversity and availability of affordances in the social environment may more successfully compete with the allure of gaming, reducing the likelihood that gaming comes to monopolize the person's pursuits. The role of school and parental factors in the risk of problematic gaming during adolescence is supported by previous research (Coşa, Dobrea, Georgescu, & Păsărelu, 2023; Gao, Wang, & Dong, 2022). For example, in a cohort of 833 youth aged 11–14 years in China, greater parent-adolescent closeness and school connectedness were prospectively associated with lower levels of problematic gaming (Zhu, Zhang, Yu, & Bao,

2015). However, we found no association of the peer environment variable (close friends) with problematic gaming, contrary to previous studies in which having fewer closer friends was cross-sectionally associated with higher levels of problematic gaming in young adults in Turkey (Ünal, Gökler, & Turan, 2022) and the U.S. (Ohayon & Roberts, 2021), as well as in children in Japan (Yamada, Sekine, & Tatsuse, 2023). We chose this indicator as the “best” indicator available in the ABCD dataset, in our opinion, to assess the protective peer environment, but admittedly it has at least two limitations: it focuses on the quantity rather than the quality of friendships, and it does not capture whether the friends encourage or discourage problematic gaming behaviors. These two limitations may explain the null association with problematic gaming.

The results did not support our second hypothesis that higher scores for protective peer, school, and family environments would attenuate the association between problematic gaming and PLEs. The only significant interaction was with the school environment, but its direction was opposite to what we hypothesized (i.e., a better school environment seemingly amplified the association between problematic gaming and PLEs). However, it did not survive p -value correction and was too weak to produce significant differences within the lower and upper quartiles of school environment scores. Overall, the prospective risk of PLEs that is putatively conferred by problematic gaming appeared stable across a range of peer, school, and family environmental characteristics. This finding is contrary to our hypothesis, which was that information about protective affordances would help better identify the risk for PLEs given the role of these affordances in differentiating problematic and non-problematic gaming from the perspective of affordance theory.

In addition, the measure of problematic gaming did not lend itself to a 2-factor model, despite previous evidence that sum scores on this type of scale conflate indicators of engagement (e.g., frequently thinking about games) with indicators of addiction (e.g., functional impairment) (Fournier et al., 2023). The 2-factor model is another proposal to better differentiate problematic from non-problematic gaming, following the notion that addiction to games is characterized by functional impairment or psychological distress (WHO, 2024). The present study provides initial evidence that the two approaches – interaction and factor analyses – do not help discriminate the contribution of gaming to the emergence of PLEs, beyond what the sum score of problematic gaming already indicates, and within the limits of the environmental measures examined here.

Limitations of the study include the reliance on empirical proxies that incompletely index the concepts that we sought to investigate, such as affordances in the peer, school, and family environments. Extended assessments using more detailed measures of the environment, ambulatory data, or qualitative inquiries could address this gap. We examined the two timepoints (years 2 and 3) of the ABCD where data on problematic gaming was available, but shorter timeframes would elucidate more immediate interdependencies between gaming and the environment, whereas longer timeframes would be necessary to discriminate between transient and persistent PLEs. Problematic gaming was assessed through self-report in a community-based sample, limiting the transferability of the results to clinical populations where functional impairment and distress are subject to a personalized evaluation by the clinician. Participants generally had low scores for problematic gaming and PLEs, limiting the capacity to detect associations and interaction effects. Importantly, the 6-item measure of problematic gaming does not fully capture the diagnostic criteria of gaming disorder, and data on other key aspects of gaming, such as motivations, game genres, and platforms, were not available. External validity may also be limited by the effect of attrition related to parental education, household income, or ethnoracial groups, in keeping with previous data on attrition in the ABCD (Ewing et al., 2022), as well as participant age, parental monitoring, problematic gaming, and PLEs, which were associated with missingness in the present analyses.

Implications for an affordance theory of problematic gaming

To our knowledge, this is the first conceptualization of problematic gaming that is explicitly grounded in an affordance theory of addiction (Lavallee & Osler, 2024). We defined problematic gaming as the concentrated pursuit of affordances related to games to the detriment of pursuing other affordances in the person's environment. Affordance theory emphasizes that problematic gaming depends not only on the player's psychological features and behaviors, or the features of the game, but also on the broader environment in which the player and game are situated.

This framework is compatible with more specific theories of problematic gaming, such as the notion that escapism, coping, or fantasy motivations for gaming may increase the risk for problematic gaming (Király et al., 2022), particularly when the skills acquired in games are not transferred into the external environment (Giardina, Schimmenti, et al., 2024). Other accounts of problematic gaming have similarly acknowledged the role of the environment in the emergence or maintenance of problematic gaming, with some divergences on the relative importance of individual vs. social dimensions, as well as whether “addiction” is an appropriate term (e.g., Kardefelt-Winther, 2017; Király, Koncz, Griffiths, & Demetrovics, 2023; Snodgrass et al., 2014).

Of relevance for the study of PLEs, it has been noted elsewhere that many gamers experience “game transfer phenomena” (Ortiz de Gortari & Griffiths, 2015). This term refers to game-related perceptions and involuntary thoughts that manifest outside of gaming sessions. There is a conceptual proximity between game transfer phenomena and the general, unusual perceptual experiences associated with PLEs. Indeed, the two constructs appear to be correlated (Ortiz de Gortari & Diseth, 2022), and game transfer phenomena are cross-sectionally associated with problematic gaming (Ortiz de Gortari & Panagiotidi, 2023). Although game transfer phenomena are generally benign, their presence may signal a greater propensity for unusual perceptual experiences (Ortiz De Gortari, Cudo, Llamas-Alonso, & Lerner, 2024). Game transfer phenomena may also be sensory manifestations of the person's emotional and cognitive preoccupation for games (Ortiz De Gortari et al., 2024). Following affordance theory, it is possible that the narrowing of affordances in problematic gaming fosters game transfer phenomena via two complementary mechanisms: greater isolation and adversity in the social environment (a general risk factor for PLEs; Paquin, Ferrari, et al., 2024) and increased preoccupation for gaming. A direction for future research is to consider differential associations of problematic gaming with categories of PLEs, including positive symptoms such as those measured here, game transfer phenomena, and negative symptoms of the psychosis spectrum (e.g., asociality; Schimmenti, Infanti, Badoud, Laloyaux, & Billieux, 2017).

Finally, our contention is not that affordance theory is superior to other explanations of problematic gaming, but rather that it has some utility in understanding the process of addiction and its mental health ramifications. An affordance-based conception calls for a close examination of what affordances, in the person's environment, protect against or suffer from the emergence of problematic gaming. The present results suggest that protective affordances in the school and family environments may protect against problematic gaming or at least may be indirect markers of non-problematic gaming. Of interest for future research, an affordance-based conception of problematic gaming can integrate more granular theories of the psychological motivations for gaming, such as self-determination theory and escapism (Allen & Anderson, 2018; Giardina, Schimmenti, et al., 2024), as well as the role of game characteristics in

promoting addiction (Flayelle et al., 2023). By rethinking problematic gaming in terms of affordances in and out of games, researchers and clinicians may find affordance theory a helpful device for holding together the psychological, environmental, and game-related factors that shape problematic gaming.

CONCLUSION

We found that problematic gaming was prospectively associated with higher levels of PLEs in a cohort of adolescents, and that positive aspects of the school and family environment (“protective affordances”) were associated with lower levels of problematic gaming. These results support an affordance-based view of addiction, which posits that a greater diversity and availability of affordances prevent addictive processes by competing with the allure of gaming. However, the socio-environmental factors measured in this study did not attenuate the association between problematic gaming and PLEs, indicating that such information about protective affordances does not improve the identification of risk for PLEs. The results of the study illustrate the applicability of affordance theory for examining and interpreting the relationship between problematic gaming, mental health, and environmental factors.

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Authors’ contribution: VP designed the present study (a secondary analysis of the ABCD), conducted the analyses and drafted the manuscript. SG provided supervision. VP, SG, ZL, MHL, BSK, and CDC contributed to revising the study protocol, interpreting the results and revising the manuscript. VP had full access to all data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. ABCD consortium investigators designed and implemented the ABCD study or provided data but did not participate in the analysis or writing of this report.

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SUPPLEMENTARY DATA

Supplementary data to this article can be found online at <https://doi.org/10.1556/2006.2025.00094>.

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