The gaming problem: A latent class analysis of DSM-5 criteria for Internet Gaming Disorder in a non-clinical sample [version 1; peer review: 1 approved with reservations]

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**Abstract**

**Background:** In this study we aimed to test whether suggested DSM-5 criteria for Internet Gaming Disorder (IGD) share a similar latent structure to formally recognised addiction.

**Methods:** We used latent class analysis on a dichotomous measure of IGD. The data was collected from a convenient general population sample (500) and a targeted gaming forum sample (236).

**Results:** We found a four or six-class model to be most appropriate, ranging from ‘casual/non-gamer’ to ‘potentially disordered’ with increasing symptom severity. The majority of ‘potentially disordered’ gamers (5+ criteria) were found to be 18-30 years old, and no ‘potentially disordered’ gamers were over 42.

**Conclusions:** The results suggest that gaming may share a similar latent structure to established addictions, with adolescents and young adults being more at risk. Studies replicating these results would be beneficial, with further emphasis on a critical evaluation of the criteria and symptom cut-off point.

**Keywords**

Gaming, Internet Gaming Disorder, Pathological Gaming, Latent Class Analysis, Addiction, Behavioural Addiction

This article is included in the Gambling and Gaming Addiction collection.
Introduction
Gaming Disorder (GD) was recently recognised by the World Health Organization (2020) as a behavioural addiction in the eleventh edition of the International Classification of Diseases (ICD-11), while the apparently synonymous Internet Gaming Disorder (IGD) is not recognised diagnostically, but was included in the Diagnostic and Statistical Manual (DSM-5) to foster research in the area (American Psychiatric Association, 2013).

A comparison of both systems in Mexico found that prevalence estimates of the DSM were almost twice as high as the ICD (Borges et al., 2021). Similarly, Jo et al. (2019) found that while all ICD-11 cases were found by the DSM-5, not all DSM-5 cases were found by the ICD-11. This could suggest that the current DSM-5 criteria are too inclusive, or that the ICD-11 criteria are not sensitive enough. We have focused this study on the DSM-5 criteria, since evidence has shown the measure to have robust psychometric properties (Lemmens et al., 2015). In addition, Aarseth et al. (2017) highlighted a number of concerns with the inclusion of GD in the ICD-11.

Previous studies on gaming have been inconsistent in classification, and results on prevalence, course, treatment, and biomarkers have been inconclusive (Petry et al., 2014). Many researchers believe that gaming can become problematic (Charlton & Danforth, 2007; Gentile, 2009), while some are cautious (James & Tunney, 2017) and do not regard IGD as a genuine behavioural addiction. Some of the concerns highlighted by Aarseth et al. (2017) around gaming in the ICD-11 are relevant to the IGD, and these suggest that the introduction of gaming in any diagnostic manual is premature. In fact, Przybylski and Weinstein (2019) suggested that disordered gaming may actually be a symptom of a different underlying issue.

Latent class analyses help researchers to determine the number and type of classes a potential disorder may be split into, however the results are generally a function of the sample characteristics, and so may not be representative of ‘definite’ classes. Despite this, we can examine the classes found across several studies and see that research on problem gambling typically reports a three- (Chamberlain et al., 2017; James et al., 2016; McBride et al., 2010) or four-class pattern (Kong et al., 2014; Xian et al., 2008), with increasing severity between classes. Similarly, substance use has been found to fit a three-class (Cohn et al., 2017; Evans et al., 2020; Henry & Muthen, 2010; Safiri et al., 2016), or four-class model (Morean et al., 2016; Yu et al., 2018), categorised by severity. Interestingly, Deloez et al. (2015) investigated both behavioural and substance addiction and found three theoretical subgroups. These included addiction-prone individuals, at-risk users, and not-prone individuals. They noted that although only a small sample of participants reported gaming, it was associated with loss of control and negative outcomes over half of the time.

Previous research into IGD has found a similar three-class model (Lemmens et al., 2015; Peeters et al., 2019), with Peeters et al. (2019) suggesting that the DSM-5 criteria could be helpful in identifying what they called ‘problematic’ gamers. However, they note that a strict cut-off point could lead to false positives. In contrast, Myrseth and Notelaers (2018) found a five-class model using the Gaming Addiction Scale-Adolescents. Despite this, Deloez et al. (2017) determined in their study that a two-class system was more able to distinguish between ‘problematic’ and ‘regular’ gamers. This dichotomous outcome hints at gaming being different to established addiction disorders and suggests a need for more research into how gaming compares to formally recognised addictions.

The listed studies either used a small sample, did not include adults, or used non-DSM criteria. Although Clement (2021) reported that most gamers in the UK during 2019 were young adults (16-24), a significant number were older. In fact, 52% aged 25-34 were identified as gamers, 36% aged 35-44, and 40% aged 45-54. This would suggest that including a range of ages in gaming analysis could be beneficial.

Methods
Design
Using data collected from a cross-sectional online survey we conducted latent class analysis of DSM-5 criteria for IGD. Data was collected from a sample of adults (18+) to provide evidence towards whether IGD has a similar class structure to established addictions.
Participants
Five-hundred participants from the general population were recruited using convenience sampling through prolific.com in return for £7.50 (US$10.02). There were 244 females, 250 males, and six selected the option ‘other’. The average age was 29.67 years (sd = 10.04). A further 236 participants were recruited from online gaming forums (Discord and Reddit). Eighty-two were female, 139 were male, seven selected ‘other’, and five did not answer. The average sample age was 25.41 years (sd = 6.52).

Procedure
Potentially problematic symptoms associated with gaming were measured using nine dichotomous (Yes/No) items from the IGD scale (Lemmens et al., 2015), based on the diagnostic criteria of IGD described in the DSM-5 appendix. The survey was hosted at Qualtrics.com as part of a preregistered study (Raybould & Tunney, 2020) that gained ethical approval from the Aston University ethics committee. The targeted gamer sample also completed the IGD questions at Qualtrics.com in a study approved by Aston University.

Statistical analysis
We conducted latent class analysis on the samples separately using poLCA in RStudio (Linzer & Lewis, 2011), and then combined samples to examine IGD distribution across non-gamers, casual gamers, and dedicated gamers as a whole. Following this, we analysed the relationship between age and gaming using regression and descriptive statistics.

Ethical approval
Ethical approval [Ref: 1598] was granted by the Aston University ethics committee. All methods were carried out in accordance with relevant guidelines and regulations. Written informed consent was obtained from all participants.

Pre-printing
An earlier version of this article can be found on Research Square (doi: 10.21203/rs.3.rs-1003239/v1).

Results
Latent class analysis of the separate samples (Tables 1 & 2) suggested a two-, four-, or five-class model in the general population, and a two-, four- or six-class model in the gaming sample. The lowest Bayesian-Information Criteria (BIC),

Table 1. Model fit for latent class analysis of gaming data in a general population sample.

|         | 2 Classes | 3 Classes | 4 Classes | 5 Classes | 6 Classes |
|---------|-----------|-----------|-----------|-----------|-----------|
| AIC     | 3221.108  | 3147.275  | 3140.409  | 3146.423  | 3154.588  |
| BIC     | 3301.185  | 3269.498  | 3304.778  | 3352.938  | 3403.250  |
| G²      | 340.4032  | 246.5705  | 219.7043  | 205.7183  | 193.8838  |
| X²      | 977.2995  | 480.3543  | 523.5736  | 576.3231  | 401.1686  |
| Df      | 481       | 471       | 461       | 451       | 441       |
| p       | .000      | .373      | .023      | .000      | .913      |

Notes: Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), G² Likelihood-Ratio (G²), Pearson X² (X²), Degrees of Freedom (Df), and significance (p) are presented to analyse model fit for two to six latent classes. Analysis was conducted on Internet Gaming Disorder (DSM-5) data in a general population.

Table 2. Model fit for latent class analysis of gaming data in a gaming forum sample.

|         | 2 Classes | 3 Classes | 4 Classes | 5 Classes | 6 Classes |
|---------|-----------|-----------|-----------|-----------|-----------|
| AIC     | 1969.802  | 1963.023  | 1960.944  | 1966.664  | 1971.174  |
| BIC     | 2035.615  | 2063.474  | 2096.033  | 2136.391  | 2175.54   |
| G²      | 213.4089  | 186.6297  | 164.5502  | 150.2703  | 134.7806  |
| X²      | 478.2925  | 493.4909  | 467.759   | 436.2665  | 369.5004  |
| Df      | 217       | 207       | 197       | 187       | 177       |
| p       | .000      | .000      | .000      | .000      | .000      |

Notes: Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), G² Likelihood-Ratio (G²), Pearson X² (X²), Degrees of Freedom (Df), and significance (p) are presented to analyse model fit for two to six classes. Analysis was conducted on Internet Gaming Disorder (DSM-5) data in a targeted gaming forum population.
Akaike Information Criteria (AIC), and Likelihood ratio (LR) indicated different models, suggesting high model uncertainty.

We then compared the distribution of participant responses (Figure 1) and found left-skewed results for both samples, with a more normal distribution in the gamers. This suggests that a large number of the general population were casual/non-gamers, while most of the gaming sample scored 2-3 checklist items. Interestingly, participants scoring 5+ were similar in both samples, suggesting an equal share of potential candidates for diagnosis (Raybould et al., 2022).

We repeated class analysis in the combined sample, testing model fit up to six classes since the BIC was consistently larger (Table 3). The three- and five-class models failed to reach significance, whereas the two-, four-, and six-class models were significant. The lowest BIC indicated a four-class model, however the lowest AIC and LR suggested six-classes. We therefore analysed both in more detail (Table 4).

A ‘casual/non-gamer’ class (1) with low likelihood of symptoms, and ‘potentially disordered’ class with high likelihood of all symptoms (4/6) was present in both models. In the four-class model we found a group who are more likely than not to be preoccupied with gaming and use games to escape (2: ‘mild gamer’), and a group who are additionally likely to be unable to stop and have lost interest in other hobbies (3: ‘at-risk’). Similarly, the six-class model included class 2 ‘mild gamers’, and ‘at-risk’ gamers as class 4. In addition, we found class 3 ‘moderate gamers’ who are likely to be preoccupied, gaming to escape, and have withdrawal, and class 5 ‘borderline’ gamers who are likely to be preoccupied, increasing play, playing despite life impact, lying and gaming to escape. Averaged probability scores suggest a potential path of increasing severity in the four-class (1 – 0.036; 2 – 0.290; 3 – 0.434; 4 – 0.755), and six-class model (1 – 0.033; 2 – 0.268; 3 – 0.399; 4 – 0.476; 5 – 0.604; 6 – 0.850). To check the validity of this we asked R to predict participant class (Tables 5 and 6), and cross-tabulated predictions against IGD scores (Table 7).

### Figure 1. Distribution of IGD criteria in a General Population and Gaming forum sample.

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### Table 3. Model fit for latent class analysis of gaming data in a combined sample.

|      | 2 Classes | 3 Classes | 4 Classes | 5 Classes | 6 Classes |
|------|-----------|-----------|-----------|-----------|-----------|
| AIC  | 5441.266  | 5310.379  | 5290.404  | 5287.812  | 5289.223  |
| BIC  | 5528.689  | 5443.815  | 5469.852  | 5513.273  | 5560.695  |
| G²   | 472.8254  | 321.9388  | 281.9641  | 259.3721  | 240.7824  |
| X²   | 1730.994  | 478.5486  | 679.2437  | 469.0852  | 632.6213  |
| Df   | 492       | 482       | 472       | 462       | 452       |
| p    | .000      | .536      | .000      | .400      | .000      |

Notes: Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), G² Likelihood-Ratio (G²), Pearson X² (X²), Degrees of Freedom (Df), and significance (p) presented to analyse model fit for two to six classes. Analysis was conducted on Internet Gaming Disorder (DSM-5) data in a combined general and targeted gaming forum population.
Age related to IGD Score ($F_{1,735} = 68.373, R^2 = .085, p = .000$), and accounted for 9% of symptom variation. We found that 15.65% of participants aged 18-20 selected 5+ criteria, compared to 13.75% aged 21-30, 8.28% aged 31-40, 4.44% aged 41-50, and 0% over 50. Further analysis on average results by age found that participants 18-20 were more likely to have mild symptoms and a higher mean IGD score (Table 8).

Despite this, 71.43% (four-class) and 63.64% (six-class) of ‘potentially disordered’ gamers were over 21, while only 17.14% (four-class) and 14.63% (six-class) were over 30. There were none over the age of 42. This suggests that while some older adults display potentially disordered gaming, young adults appear more at risk.

**Discussion**

The criteria for IGD appears to have a four- or six-class structure ranging from ‘casual/non-gamers’ to ‘potentially disordered’ with increasing severity, suggesting that IGD may be presenting in a similar manner to established

**Table 4. Probability of positive response to IGD Questions based on a four- and six-class latent analysis model.**

| Item                  | 1   | 2    | 3    | 4    | 1   | 2   | 3    | 4   | 5      | 6    |
|-----------------------|-----|------|------|------|-----|-----|------|-----|--------|------|
| Preoccupation         | 0.051 | 0.595 | 0.626 | 1.000 | 0.052 | 0.536 | 1.000 | 0.628 | 0.826  | 1.000 |
| Withdrawal Symptoms   | 0.000 | 0.117 | 0.163 | 0.825 | 0.000 | 0.026 | 1.000 | 0.156 | 0.495  | 1.000 |
| Increased Gaming      | 0.005 | 0.278 | 0.184 | 0.817 | 0.004 | 0.252 | 0.312 | 0.164 | 1.000  | 0.748 |
| Unable to Stop        | 0.005 | 0.054 | 0.651 | 0.659 | 0.005 | 0.054 | 0.000 | 0.631 | 0.216  | 0.919 |
| Lost Interest in Hobbies | 0.119 | 0.299 | 0.526 | 0.528 | 0.116 | 0.308 | 0.129 | 0.543 | 0.149  | 0.724 |
| Play despite Life Impact | 0.029 | 0.431 | 0.428 | 0.784 | 0.026 | 0.423 | 0.396 | 0.825 | 0.816  | 1.000 |
| Lying                 | 0.019 | 0.057 | 0.428 | 0.784 | 0.021 | 0.022 | 0.066 | 0.427 | 1.000  | 0.694 |
| Escape                | 0.092 | 0.781 | 0.707 | 1.000 | 0.073 | 0.787 | 0.678 | 0.712 | 0.930  | 1.000 |
| Relationship Issues   | 0.000 | 0.000 | 0.193 | 0.401 | 0.000 | 0.000 | 0.000 | 0.202 | 0.000  | 0.567 |

Notes: Probability values above 0.5 are highlighted in bold for reference.

**Table 5. Participant class predictions for a four-class latent structure.**

|     | 1    | 2    | 3    | 4    | 1    | 2    | 3    | 4    | 5    | 6    |
|-----|------|------|------|------|-----|-----|------|-----|-----|------|
| [1] | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [51]| 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [101]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [151]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [201]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [251]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [301]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [351]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [401]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [451]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [501]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [551]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [601]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [651]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| [701]| 1   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |

Note: Analysis of participant classification in a four-class latent structure model using $M4$predclass in R.

Age related to IGD Score ($F_{1,735} = 68.373, R^2 = .085, p = .000$), and accounted for 9% of symptom variation. We found that 15.65% of participants aged 18-20 selected 5+ criteria, compared to 13.75% aged 21-30, 8.28% aged 31-40, 4.44% aged 41-50, and 0% over 50. Further analysis on average results by age found that participants 18-20 were more likely to have mild symptoms and a higher mean IGD score (Table 8).

Despite this, 71.43% (four-class) and 63.64% (six-class) of ‘potentially disordered’ gamers were over 21, while only 17.14% (four-class) and 14.63% (six-class) were over 30. There were none over the age of 42. This suggests that while some older adults display potentially disordered gaming, young adults appear more at risk.
addictions. A four-class model was identified in both the combined and separate sample analysis; however, a six-class model may offer more nuance.

We additionally found that most potentially disordered gamers were under 30 years old, and none were over 42. Additionally, mean IGD scores continued to decrease with age, reaching as low as 0.26 in those over 51. Lemmens et al. (2015) also found that 31-40 year olds scored significantly lower than young adults and adolescents, which may suggest that adolescents and young adults are more at risk. Despite this, gaming is a new activity, with the first home consoles introduced in the 1970s. Contemporary gaming is very different from these simple arcade-style games, and Olson et al. (2011) reported that younger adults were more likely to use new technology, specifically computer/video games than older adults. Since the apparent addictive nature of gaming has only emerged recently it is therefore possible that future studies will find more potentially disordered gamers among older participants who have had more exposure to ‘modern’ videogaming from a young age.

| Table 6. Participant class predictions for a six-class latent structure. |
|---------------------------------------------------------------|
|                | 1234567890 | 1234567890 | 1234567890 | 1234567890 | 1234567890 |
| [1]             | 1122162226  | 1111142411  | 4221521211  | 5111411544  | 1121221111 |
| [51]            | 1212115421  | 1114216142  | 1261211116  | 1121211122  | 1111121221 |
| [101]           | 1511121122  | 2122421214  | 1111124212  | 1121214421  | 1114211111 |
| [151]           | 1155111221  | 2111121252  | 1211261312  | 1314222121  | 1141222111 |
| [201]           | 11111221153 | 1411126411  | 4241213611  | 4141111111  | 5114121112 |
| [251]           | 1111111512  | 1141112242  | 1541122111  | 1122212221  | 1111111111 |
| [301]           | 2121112114  | 1111111111  | 1111411221  | 4122255614  | 2211211211 |
| [351]           | 6111641234  | 1112122141  | 1111111126  | 3212122112  | 2212121221 |
| [401]           | 2152311111  | 1511131256  | 2111115122  | 5211411212  | 1211142311 |
| [451]           | 1142111121  | 1112411111  | 6222122211  | 111142154  | 4122111244 |
| [501]           | 66666666444 | 56444444444 | 44444444424 | 2432422322  | 2422443432 |
| [551]           | 4442434432  | 3533222222  | 2332324222  | 3422222224  | 4232342222 |
| [601]           | 2222223222  | 2222222223  | 2222222222  | 2222222222  | 2222222222 |
| [651]           | 2232224222  | 2222222222  | 2212111121  | 2222212222  | 1111112111 |
| [701]           | 1121112112  | 2211111111  | 1111111111  | 1111111111  |

Note: Analysis of participant classification in a four-class latent structure model using $M4$predclass in R.

| Table 7. Number of identified criteria and most common igd score for each latent class. |
|---------------------------------------------------------------|
| Model | Class | Number of criteria | Most common IGD score(s) |
|-------|-------|---------------------|--------------------------|
| 4     | 1 - Casual/Non-Gamer | 0-2 | 0 |
|       | 2 - Mild            | 1-5 | 2-3 |
|       | 3 - At-Risk         | 2-7 | 4-5 |
|       | 4 - Potentially Disordered | 5-9 | 6-9 |
| 6     | 1 - Casual/Non-Gamer | 0-2 | 0 |
|       | 2 - Mild            | 1-5 | 2-3 |
|       | 3 - Moderate        | 2-5 | 4 |
|       | 4 - At-Risk         | 2-7 | 4-5 |
|       | 5 - Borderline      | 3-7 | 5-6 |
|       | 6 - Potentially Disordered | 6-9 | 7-8 |

Note: Where a range of IGD scores are provided the frequency of participants was the same for each value.

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We additionally found that most potentially disordered gamers were under 30 years old, and none were over 42. Additionally, mean IGD scores continued to decrease with age, reaching as low as 0.26 in those over 51. Lemmens et al. (2015) also found that 31-40 year olds scored significantly lower than young adults and adolescents, which may suggest that adolescents and young adults are more at risk. Despite this, gaming is a new activity, with the first home consoles introduced in the 1970s. Contemporary gaming is very different from these simple arcade-style games, and Olson et al. (2011) reported that younger adults were more likely to use new technology, specifically computer/video games than older adults. Since the apparent addictive nature of gaming has only emerged recently it is therefore possible that future studies will find more potentially disordered gamers among older participants who have had more exposure to ‘modern’ videogaming from a young age.
In exploring the current DSM-5 symptom criteria, relationship issues were less than 50% likely in all classes except model-six ‘potentially disordered’ gamers (57%), suggesting it may not be an appropriate criterion. However, without additional information on relationships we cannot test this result. Similarly, lying, and increased involvement were both less than 50% likely for low-moderate classes, but at least 70% likely in ‘borderline’ or ‘potentially disordered’ gamers. These may therefore be signs of maladaptive gaming. In contrast, preoccupation and gaming to escape were over 50% likely in all but the ‘casual/non-gamer’ class and therefore may be facets of gaming generally rather than an indication of potentially disordered use.

Withdrawal symptoms were found to be 100% likely in the ‘moderate gamer’ and ‘potentially disordered’ class (six-class), suggesting a group of non-clinical gamers who experience withdrawal. Despite this, Kaptsis et al. (2016) found the evidence on withdrawal in behavioural addiction was underdeveloped, and symptoms were reported in less than 50 participants across five studies. They noted that withdrawal in IGD can be mistaken for reactions to imposed deprivation, and many studies did not specify the expected withdrawal symptoms proposed by the DSM-5. Further to this, Orford et al. (1996) reported that emotional withdrawal in gambling did not significantly contribute to maintaining the addiction, while Rosenthal and Lesieur (1992) found that some abstaining gamblers experienced symptoms which did not correlate with substance abuse withdrawal. Studies relying on a participant’s understanding of withdrawal therefore may not accurately reflect potential symptoms.

In our sample we found a suggested prevalence of 2.98 – 4.74% of ‘potentially disordered’ gamers. There appears to be a lot of variation in estimated prevalence rates for IGD, (0.7-27.5% - Mihara and Higuchi (2017); 0.7%-15.6% - Feng et al. (2017); 1.6% - Müller et al. (2015); 3.1% - Ferguson et al. (2011); 3.7% - Kuss et al. (2013)) however our results were in the expected range. Despite this, the prevalence rates of participants endorsing 5+ criteria were 11.82%, suggesting that the current cut-off may be too low. In fact, when amending this to 7+ symptoms we found a prevalence of 3.26%.

Future research into IGD should continue to build evidence on whether gaming is addictive, with an emphasis on critically evaluating the suggested criteria. Additionally, research comparing online and offline play, and various game types, may help to explain the different findings between studies. Subtle differences may arise as the social benefits of online multiplayer are likely to be significantly different from local multiplayer. Similarly, while most online games involve multiplayer competitive elements, offline gaming is often single-player storylines.

Table 8. Average IGD score and predicted class for each age group.

| Age   | Mean score | Standard deviation | Most common predicted class | Four-Class | Six-Class |
|-------|------------|--------------------|-----------------------------|------------|-----------|
| 18-20 | 2.73       | 2.03               | Mild Gamers                 | 46.96%     | 43.48%    |
| 21-30 | 2.14       | 2.08               | Casual/Non-Gamer            | 46.75%     | 41.00%    |
| 31-40 | 1.40       | 1.84               | Casual/Non-Gamer            | 63.45%     | 56.55%    |
| 41-50 | 1.13       | 1.56               | Casual/Non-Gamer            | 71.11%     | 60.00%    |
| 51+   | 0.26       | 0.68               | Casual/Non-Gamer            | 93.55%     | 87.10%    |

Data availability

Underlying data
Open Science Framework: Impulsivity, Scarcity and Maladaptive Choice Behaviours Project, https://doi.org/10.17605/OSF.IO/WXJUM (Raybould et al., 2022).

This project contains the following underlying data:

- LCA Dataset.xlsx
- Full Survey Dataset.xlsx
Extended data
Open Science Framework: What are the Relationships between Impulsivity, Scarcity and Addiction?, https://doi.org/10.17605/OSF.IO/WXJUM (Raybould et al., 2022).

This project contains the following extended data:
- Grisk_SocialStatus_Questions.pdf
- 9. AUDIT.pdf
- 6,8. MacArthur Scale of Subjective Social Status.pdf
- 5,7. NSSEC.pdf
- 16. GMQ-F.pdf
- 15. Debt Questions.pdf
- 14. TFEQ-18.pdf
- 13. DSM-V Criteria for Gaming Disorder.pdf
- 12. PGSI.pdf
- 10. CDS5.pdf
- 11. DUDIT.pdf

Data are available under the terms of the Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication).

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The article explores the underlying class structure of the DSM criteria scale in samples of prolific and gaming forum users (discord and reddit). They find both 4 and 6 models provide good model fit in terms of BIC, AIC, Chi-square etc. Young adults had the highest gaming scores.

Introduction/Literature Review
Introduction could do with more clearly stating it's aims and hypotheses that it wishes to test. For example, in the design there is a suggestion that ICG has similar class structure to established addiction yet in the literature review addictions seemed to vary from 3-4 classes.

With the statistical analysis section I am guessing one sample was the prolific sample (N = 294) and Gaming forum sample (N = 236). Is this correct? Please do make this clearer.

Results
Clearer statement of what each of the classes is classed as in the text between tables 4 and table 5 for each type of model.

It would also be useful to know what percentage of your two different samples fell into each class. This would relate back to Introduction where prevalence of classes and differences between DSM and IGD were discussed. This could be added in as two extra columns in Table 7.

Are there any benefits of having 6 or 4 class model in terms of numbers classed as at risk gamers and potentially disordered gamers. i.e. comparison of percentages.

Do you have any items that might be able to link DSM scores to more behavioural measures like the amount of time spent playing games per week? Or amount spent on gaming?

Discussion
What extra nuance does a six model hold? You state this and only later suggest what this might be.
Good points made around withdrawal and the value or not in pre-occupation and escapism as potential facets of gaming or any enjoyable hobby for that matter.

**Data Availability**
Even better if the Rscript with the LCA analysis was also deposited in the OSF so other could check the code.

**Is the work clearly and accurately presented and does it cite the current literature?**
Yes

**Is the study design appropriate and is the work technically sound?**
Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**
Partly

**If applicable, is the statistical analysis and its interpretation appropriate?**
Yes

**Are all the source data underlying the results available to ensure full reproducibility?**
No

**Are the conclusions drawn adequately supported by the results?**
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Gambling research and statistical methods

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.
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