Measurement Invariance of the Internet Gaming Disorder Scale–Short-Form (IGDS9-SF) between the United States of America, India and the United Kingdom

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Abstract

The Internet Gaming Disorder Scale–Short-Form (IGDS9-SF) has been extensively used worldwide to assess Internet Gaming Disorder (IGD) behaviors. Therefore, investigating cultural limitations and implications in its applicability is necessary. The cross-cultural feasibility of a test can be psychometrically evaluated with measurement invariance analyses. Thus, the present study used Multigroup Confirmatory Factor Analysis (MGCFA) to examine the IGDS9-SF measurement invariance across gamers from the United States of America (USA), India, and the United Kingdom (UK). A total of 1,013 gamers from the USA (n = 405), India (n = 336), and the UK (n = 272) were recruited. Although the one-factor structure of the IGD construct was supported, cross-country variations were demonstrated considering the way that this was reflected on items assessing preoccupation/salience, tolerance, deception, gaming escapism/mood modification, as well as daily activities' impairment related to gaming. Furthermore, the same scores on items assessing withdrawal symptoms, tolerance, lack of control over gaming engagement, escapism/mood modification and daily activities impairment associated to gaming, have been found to reflect various levels of IGD severity across the three groups. The implications of these results are further discussed in the context of existing evidence regarding the assessment of IGD.

Keywords: Internet Gaming Disorder, IGD, IGDS9-SF, Gaming Addiction, Measurement invariance, Gamers

1. Introduction

Internet Gaming Disorder (IGD) is broadly described as a form of persistent and recurrent involvement with videogames, often leading to the impairment of daily, work and/or educational activities and has been suggested as a mental condition requiring further study (*Diagnostic and Statistical Manual of Mental Disorders* [DSM-5]; American Psychiatric Association (2013). In that context, standardized IGD measurement has been identified as a pivotal research area (Kardefelt-Winther, 2014; Petry et al., 2014). To address this need, the Internet Gaming Disorder Scale–Short-Form (IGDS9-SF; Pontes and Griffiths, 2015) was introduced based upon the nine DSM-5 criteria (American Psychiatric Association, 2013). A recent mini-review on the psychometric assessment of IGD identified a total of seven clinical and psychometric instruments assessing IGD according to the diagnostic criteria developed by the APA in the DSM-5 (Pontes, 2016). Although a relatively high number of standardized assessment tools to assess IGD has been recently developed, the IGDS9-SF has been extensively utilized in several countries and employed in a number of research studies given its excellent psychometric properties and conciseness to assess IGD. More specifically, the IGDS9-SF has been developed adapted and translated to different languages, such as: English (Pontes and Griffiths, 2015), Slovenian (Pontes et al., 2016), Portuguese (Pontes and Griffiths, 2016), Italian (Monacis et al., 2016), and Persian (Wu et al., 2017). Additionally, researchers are currently developing the Turkish, Greek, Spanish, and Polish versions of the IGDS9-SF (studies under development see http://www.halleypontes.com/assessment/igds9-sf/ for more information). The constantly increasing number of IGD studies worldwide that utilize the IGDS9-SF, precipitates the need to advance research on the assessment of IGD by providing further psychometric information on the cross-cultural feasibility of the instrument.

In particular, the significant amount of IGD research across different disciplines (i.e., clinical psychology, cognitive psychology, sociology, and human-computer interaction), along

with the global use of IGDS9-SF for clinical purposes, make the evaluation of its cross-cultural psychometric properties imperative (Petry et al., 2014; Pontes and Griffiths, 2015). A worldwide-used measure should demonstrate equivalence of underlying psychometric and scaling properties to be efficiently used across cultures (Gomez, 2013; Gomez and Rohner, 2011). Measurement invariance (MI) refers to groups (i.e., cultures, countries) reporting the same observed scores when they exhibit the same level of the underlying trait (Gomez, 2013; Gomez and Rohner, 2011). If there is no support for the MI of an instrument across the groups being studied, then the results of such comparisons are confounded by differences in measurement and scaling properties. Subsequently, support for IGDS9-SF MI is a prerequisite for the meaningful use of the instrument across gamers from different countries (Kuss et al., 2017).

Multigroup Confirmatory Factor Analysis (MGCFA) has been recommended to assess MI (Gomez, 2013; Gomez and Rohner, 2011). This analysis evaluates the invariance of the items of a psychometric scale between different groups considering the number of factors (i.e., configural invariance), item factor loadings (i.e., metric invariance), item intercepts and thresholds for continuous and categorical responses, respectively (i.e., scalar invariance), and error variances (Gomez, 2013; Gomez and Rohner, 2011). Support for *configural invariance* indicates that the same number of factors and the same patterns of free factor loadings apply between the groups. Support for *metric invariance* indicates that the strength of the relationships between the items and their respective factors are equivalent between groups, and that across the groups, the items are assessing their relevant latent factors using the same metric scale. Finally, *scalar invariance* reveals that individuals belonging to different groups will select the same observed level (i.e., when observed scores are treated as continuous) or response category (i.e., when observed scores are treated as ordered categorical), when they are experiencing the same level of the latent trait (e.g. IGD). Confirmation of *error variances*

invariance suggests that the unique variances are equivalent across groups (however, methodologists consider it as unnecessary and it is usually avoided; Brown, 2015; Cheung and Lau, 2012).

Despite strong relevant recommendations posed in the international literature, to date, no published studies have assessed IGDS9-SF MI between groups of gamers coming from different countries (Pontes and Griffiths, 2015). Although, the unidimensional factor solution (e.g. the single factor structure of the IGD construct) for the instrument has been separately established in British, Portuguese, Italian, Slovenian, and Persian samples (Monacis et al., 2016; Pontes and Griffiths, 2015, 2016; Pontes et al., 2016; Wu et al., 2017), the IGDS9-SF MI across gamers from different cultural groups has not been investigated.

The present study aspires to address this, based on self-reported ratings of gamers from the USA, India, and the UK, for the one-factor model. Given that cultural differences have been described as a factor that may influence the way behaviors are perceived and reported (e.g., e.g. the level the construct coincides in different cultures, response patterns, social desirability/compliance effects, social deprivation factors/lack of exposure to specific behaviors to be able to appropriately identify them; Chen et al., 2008; Cheung and Rensvold, 2002), further validation of measurement scales is needed to address diverse cultural conceptualizations and response styles (Gjersing et al., 2010; Landrine and Klonoff, 1992). In that line, differences between the USA, India, and the UK considering "vertical" vs. "horizontal" individualism and collectivism could affect the way psychopathology (and thus IGD) is experienced and reported (Singelis et al., 1995; Stavropoulos et al., 2013), as well as findings indicating that mental disorders (such as IGD) are perceived (and therefore could be reported) in a more stigmatized (extreme/not normalized) way, the more collectivistic a culture tends to be (Papadopoulos et al., 2013). More specifically, Singelis et al. (1995) suggested that the USA is characterized by a more vertically individualistic pattern compared to the UK,

which is conceived as less individualistic than the USA (Hofstede, 1983), while India has long been envisaged as a vertically collectivistic cultural context (Liu et al., 2015; Shavitt and Cho, 2016) based on relevant research (Verma and Triandis, 1999).

Individualism refers to a bond between the person and the society, where individual goals, and self-reliance are prioritized (Oyserman et al., 2002). Collectivism on the other hand, emphasizes more on group interests and values that in turn define individual decisions and behaviors (Lee and Wohn, 2012). In this context, "vertical" individualism refers to a sub-type of individualism where the highlight on individual interests and values is interwoven with inequality among group members (i.e., inequality in opportunities and social welfare). On the contrary, "horizontal" individualism describes a situation where the value of independency is intertwined with equality between group members (Lee and Wohn, 2012; Singelis et al., 1995). More specifically, vertical collectivism involves a perception of the self as a part of a group, where inequalities between members are accepted and acknowledged, while in horizontal collectivism the self-perception is still defined by group membership, but members are viewed as equal. Counterintuitively, vertical individualism refers to the conception of an autonomous/independent individual, who might be unequal to others. Finally, horizontal individualism involves the conception of an autonomous individual with a focus on equality. Interestingly, it has been reported that the notion of "verticality" introduces inequalities between individuals as necessary to service hierarchy and functionality in group members (Singelis et al., 1995).

On that basis, the UK is considered a more horizontally individualistic country, as individual autonomy and independence assume equality between the individual and others. Conversely, the USA, in social policy and cultural practice, assume independence with a more distinct sense of inequality between individuals, with competition being a key cultural component (Lee and Wohn, 2012; Singelis et al., 1995). Finally, India is considered a paradigm

of a vertically collectivistic country, where the power of the belonging group (e.g., the family) is intertwined with inequality between individuals due to a hierarchic social structure (Singelis et al., 1995).

Interestingly, collectivistic intolerance to differences may result to responses closer to the mean (Smith et al., 2016), potentially minimizing the range of IGDS9-SF item responses. Similarly, acceptance of inequality (vertical individualism and/or vertical collectivism) has been associated with a higher tendency to social compliance to the perceived social hierarchy and a higher tendency to self-blame and guilt (Singelis et al., 1995). Furthermore, with regards to gaming, the distinction in horizontal and vertical individualism has been linked to differences in expected rewards, with vertically-oriented gamers focusing more on ranking and achievement, that may exacerbate IGD risk (Lee and Wohn, 2012). Finally, under a broader country-level social context, differences in the experiences of health concerns and behaviors based on equal access to community and healthcare services could influence IGD's awareness (Clemens et al., 2014). Overall, these are envisaged to potentially differentiate gamers' responses to the IGDS9-SF, and therefore the instrument's psychometric and scaling properties between the three countries (i.e., more pathologized scores less close to the mean - responses in the USA). This is reinforced by studies suggesting lack of measurement invariance considering the assessment of various psychological constructs between the USA, India and the UK, such as parental acceptance rejection (Gomez and Rohner, 2011), perceived stress reactivity (Schlotz et al., 2011), and emotion regulation (Snow et al., 2013).

1.2. The present study

To contribute to the extant knowledge, the present study used three nonprobability normative online samples of American, Indian, and British gamers in order to provide novel cross-cultural insights onto IGD by means of: (i) assessing the unidimensionality of the IGDS9-

SF and; (ii) investigating its MI across the three samples, after controlling for potential gender and age effects. In particular, considering the variables being controlled in the present study (i.e., age and gender), the rationale for this procedure was due to their widely reported associations to IGD score fluctuations (Anderson et al., 2016; Coffey et al., 2003; Pontes et al., 2014).

2. Method

2.1. Participants and procedures

The American (N = 405, minimum age = 16 years, maximum age = 70 years, mean age = 32.57 years; SD = 11.33; 62% males), the Indian (N = 336, minimum age = 16 years, maximum age = 69 years, mean age = 30.37 years; SD = 8.90; 67.6% males), and the British (N = 272, minimum age = 16 years, maximum age = 70 years, mean age = 41.61 years; SD = 14.03; 50.7% males) samples comprised a total of 1,004 gamers with a relatively even gender split (minimum age = 16 years, maximum age = 70 years, mean age = 34.24 years; SD = 12.27; 60.8% males). Data collection was identical between gamers from three countries. More specifically, English-speaking gamers from the USA, India, and UK were recruited online by advertising the link of the study in a total of 52 English-speaking online gaming forums[1] popular among gamers in March 2014.

Authorization from the all forum moderators was sought prior the creation of a thread containing the link to the study. Every thread was individually checked for a period of one month on a daily basis. The research team gave personalized feedback to any important queries raised by the gamers. The study was approved by the ethics committees of the research team's institutions and participants were recruited online. Eligible individuals (adult gamers,

[1] Example of gaming forums utilized for the data collection included: https://us.battle.net/forums/en/wow/; https://eu.battle.net/forums/en/wow/; https://www.ea.com/forums; http://www.indianvideogamer.com; and http://www.gamesforum.com

permanent residents or citizens of the countries involved), interested in participating were invited to declare their nationality and register with the study via a *SurveyMonkey* link that was advertised across numerous online gaming websites and forums. The link of the study directed potential participants to the plain language information statement (PLIS). The PLIS explicitly indicated that participation was voluntary and that participants were free to withdraw from the study at any time prior to its completion. Any discontinuation of participation, at any point, required no explanation and was without any penalties. Completion and submission of the questionnaire was only possible after participants had provided their consent to partake in the study, and indicated that participants understood the nature of the research being conducted.

2.2. Measure

2.2.1. Measurement of Internet Gaming Disorder

The Internet Gaming Disorder Scale–Short-Form (IGDS9-SF) was utilized to assess IGD. The nine-item IGDS9-SF (Pontes and Griffiths, 2015 – see Appendix 1) is a brief psychometric tool based on the nine core criteria defining IGD as suggested by the DSM-5 (American Psychiatric Association, 2013). More specifically, the IGDS9-SF assesses the severity of IGD and its detrimental effects by examining both online and/or offline gaming activities occurring over a 12-month period. The nine questions comprising the IGDS9-SF are answered using a 5-point scale: 1 ('*Never*'), 2 ('*Rarely*'), 3 ('*Sometimes*'), 4 ('*Often*'), and 5 ('*Very often*'). The final score can be calculated by accumulating participants' responses to the nine items ranging from 9 to 45, with higher scores being indicative of a higher degree of disordered gaming. Internal reliability in the present study was high and highly comparable across the three countries (see Table 1).

2.3. Statistical analysis

All analyses were conducted with *Mplus* 7 (Muthén and Muthén, 2012). First, descriptive analyses for each scale and each sample were conducted. Then, a series of Confirmatory Factor Analyses (CFAs) were computed in order to assess the factor structure of the IGDS9-SF across the three samples and its MI accounting for gender and age effects. In brief, this procedure involves comparing progressively more constrained models that test for configural invariance, metric invariance, and scalar invariance (Millsap and Yun-Tein, 2004). To ascertain which factor loadings and intercepts should be unconstrained, three statistical processes were combined. First, the Satorra-Bentler (S-B) X^2 difference test, which is appropriate for the evaluation of model fit differences in nested models (progressively more restricted models), was used to calculate and compare the fit of the different models being tested (Satorra and Bentler, 2010). Second, modification indices (MIs) were calculated through *Mplus* and applied (i.e., unconstraining items) for both the loadings and the intercepts based on descending MI values. Third, the Benjamini-Hochberg multiple testing procedure (Raykov et al., 2013) was implemented in order to locate (i.e., double check) the parameters that violated the MI restrictions. To control for the effects of gender and age the approach used by (Mastrotheodoros et al., 2015) was applied.

3. Results

3.1. Data screening and preparation

The American, the Indian and British samples did not have any item-level missing values. Additionally, screening for multivariate outliers was performed at the item-level through plotting the outlier log-likelihood provided by *Mplus* with the latent variable. This resulted to a visual representation of the multivariate outliers that did not confirm any serious multivariate outliers. Additionally, country-level descriptive statistics and reliability coefficients per item if item is delete were estimated for all the nine items comprising the

IGDS9-SF (see Table 2).

Please insert Table 2 about here

3.2. Confirmatory Factor Analysis and MI Outcomes

Table 1 presents descriptive statistics [means, standard deviations (SDs), mean inter-item correlations, and reliability coefficients] for the IGDS9-SF across the three countries. Successive CFAs were computed separately for each country to test the one-factor structure of the IGDS9-SF. Overall, the model demonstrated acceptable fit for the American (χ^2 =140.62, df = 43, p = 0.0001, CFI = 0.94, RMSEA = 0.08, SRMR = 0.04), Indian (χ^2 = 72.64, df = 43, p = 0.0001, CFI = 0.97 RMSEA = 0.05, SRMR = 0.03), and British (χ2 = 98.19, df = 43, p = 0.0001, CFI = 0.92, RMSEA = 0.07, SRMR = 0.05) samples. All unstandardized factor loadings were statistically significant (i.e., $p < 0.01$) and above .599 (standardized above .537) for the American sample, above .597 (standardized above .612) for the Indian sample, and above .357 (standardized above .571) for the British sample.

Please insert Table 1 and Figures 1-3 about here

Following the CFA tests of model fit, the configural invariance (i.e., the unconstrained multi group) model was computed. Under this process both *factor loadings* and *intercepts* were unconstrained, thus allowed to differ between groups. The resulting model had an acceptable fit (χ^2 = 439.30, df = 129, $p < 0.001$, CFI = .91, RMSEA = 0.08, SRMR = 0.05). Given the CFI's sensitivity to sample size, the RMSEA will be considered as the main index of fit (see Hooper et al., 2008). Metric invariance (i.e., factor loadings fixed, intercepts free) resulted in a drop in fit indices (S-B Scaled Difference = 97.9179, df = 18, $p < 0.001$). Holding the intercepts only (i.e., Model 3, intercepts fixed and loadings free), and then both factor loadings and intercepts fixed resulted in worsening of fit (S-B Scaled Difference = 220.2674, df = 18, $p <$ 0.001; Table 3). Those parameters that were non-invariant were located by combining the

modification indices and the Benjamini-Hochberg procedure. More specifically, factor loadings of Items 1 (‘*Do you feel preoccupied with your gaming behavior?*’ *[Some examples: Do you think about previous gaming activity or anticipate the next gaming session? Do you think gaming has become the dominant activity in your daily life?]*’), 3 (‘*Do you feel the need to spend increasing amount of time engaged gaming in order to achieve satisfaction or pleasure?*’), 7 (‘*Have you deceived any of your family members, therapists or others because the amount of your gaming activity?*’), 8 (‘*Do you play in order to temporarily escape or relieve a negative mood [e.g., helplessness, guilt, anxiety]?*’), 9 (‘*Have you jeopardized or lost an important relationship, job or an educational or career opportunity because of your gaming activity?*’) and intercepts for Items 2 (‘*Do you feel more irritability, anxiety or even sadness when you try to either reduce or stop your gaming activity?’*), 3 (‘*Do you feel the need to spend increasing amount of time engaged gaming in order to achieve satisfaction or pleasure?*’), 4 (‘*Do you systematically fail when trying to control or cease your gaming activity?’*), 8 (‘*Do you play in order to temporarily escape or relieve a negative mood [e.g., helplessness, guilt, anxiety])?’*, 9 (‘*Have you jeopardized or lost an important relationship, job or an educational or career opportunity because of your gaming activity?’*) appeared to be non-invariant (see Table 4, for the exact differences). Therefore, a final partial invariance model with the above parameters unconstrained was calculated. Partial invariance has lower BIC index than scalar thus, has a better trade-off between model fit and model complexity (S-B Scaled Difference = 29.0518, df = 14, $p > 0.01$; Table 3). Furthermore, the rest fit indices remained adequate, approaching closer those of the configural model.

Please insert Table 3 and 4 about here

4. Discussion

The aim of the present study was to evaluate MI of the IGDS9-SF across groups of gamers from the USA, India and the UK accounting for potential confounding effects of gender

and age, using the single-factor model previously established (Monacis et al., 2016; Pontes and Griffiths, 2015, 2016; Pontes et al., 2016; Wu et al., 2017). Configural invariance and partial metric and scalar invariance were supported similarly to other psychological constructs (Gomez and Rohner, 2011; Schlotz et al., 2011; Snow et al., 2013). The supported configural invariance indicates that the single-factor structure of the IGDS9-SF holds across the different countries compared. More specifically, this finding highlights a common unidimensional factor structure of the IGDS9-SF in all three samples, which means that the IGD construct can be assessed by the same underlying factor across the three distinct cultural contexts. The support for partial metric invariance revealed that the magnitudes of the relationships between the IGDS9-SF Items related to preoccupation/salience, tolerance, deception, gaming escapism/mood modification, as well as daily activities' impairment due to gaming and the latent construct differ across gamers from the three countries. Finally, the support for partial scalar invariance revealed that for the same level of the latent IGD trait, gamers across the three countries compared, would give different response ratings in Items measuring withdrawal symptoms, tolerance, lack of control over gaming engagement, escapism/mood modification and daily activities impairment associated to gaming. These finding can be understood and interpreted at both the cultural and theoretical level.

At the cultural level, this finding may be interpreted on the basis of differences considering the cultural dimensions of "vertical" individualism and collectivism across the USA, India, and the UK (Shavitt and Cho, 2016; Singelis et al., 1995; Stavropoulos et al., 2017; Verma and Triandis, 1999). Since the USA is considered higher on vertical individualism, the interpersonal and relationships difficulties associated with IGD may be reported differently (Anderson et al., 2016). Following this line of argument, American gamers might be more IGD-vulnerable due to focusing more on game performance, and concurrently experience lower levels of awareness to addictive behavior due to decreased access to mental health and

community services, thus presenting with different response patterns in IGDS9-SF (Clemens et al., 2014; Lee and Wohn, 2012; Stetina et al., 2011). Similarly, more collectivistic Indian gamers might present with a different range of IGDS9-SF responses.

At the theoretical level, the reported loadings and intercepts inequalities regarding the IGD criteria suggest that direct comparisons between American, Indian, and British English-speaking gamers may not be made lightly because specific aspects of IGD, as assessed by the non-invariant criteria involving preoccupation/salience, tolerance, deception, gaming escapism/mood modification, daily activities' impairment, withdrawal symptoms and lack of control over gaming engagement, may be culturally specified. At this point it should be noted, that the current study adopted a carefully conservative psychometric approach to detect lack of invariance, based on the combined use of statistical processes recommended by Satorra and Bentler (2010) and Raykov et al. (2013). However, based on more 'lenient' literature recommendations considering differences in approximate fit indices between successively nested models (an increase of the RMSEA>. 015 is necessary to indicate lack of invariance; Chen, 2007; Chen and West, 2008), full invariance could be inferred here for the factor loadings and marginally for the intercepts (according to the findings). Subsequently, although IGD can be assessed by one underlying factor across the three cultures, its specific meaning is not identical. Interestingly, Items 5 and 6 appeared to be invariant across the three cultural groups investigated. Item 5 (i.e., *'loss of interests in previous hobbies and entertainment as a result of, and with the exception of, Internet games'*) and Item 6 (i.e., *'Continued excessive use of Internet games, despite knowledge of psychosocial problems'*) suggest that the experience of conflict in IGD may be a key factor towards diagnosing this potential disorder across different cultures. This finding is corroborated by previous studies reporting the key role of Item 5 in predicting a positive IGD diagnosis because it has the highest association with IGD and the fact that Item 6 is predictive of IGD (Rehbein et al., 2015).

Overall, these findings appear to reinforce and complement studies that have investigated the role of the nine IGD criteria in terms of their diagnostic weight and accuracy. For example, Király et al. (2017) concluded that although the IGD construct may be effectively measured by a single factor, unique stages and IGD severity levels could be involved with the way that each proposed criterion associates to IGD. More specifically, IGD criteria related to "continuation" (IGDS9-SF, Item 6), "preoccupation/salience" (IGDS9-SF, Item 1), "negative consequences" (IGDS9-SF, Item 9), and "escapism/mood modification" (IGDS9-SF, Item 8) were found to be associated with lower severity of IGD, while "tolerance" (IGDS9-SF, Item 3), "loss of control" (IGDS9-SF, Item 4), "giving up other activities" (IGDS9-SF, Item 5), "withdrawal symptoms" (IGDS9-SF, Item 2), and "deception" (IGDS9-SF, Item 7) were all found to be associated with more severe levels of IGD. In the same vein, Rehbein et al. (2015) found that the criteria "giving up other activities" (IGDS9-SF, Item 5), "tolerance" (IGDS9-SF, Item 3), and "withdrawal symptoms" (IGDS9-SF, Item 2) were of key importance for identifying IGD effectively, while Lemmens et al. (2015) reported that "escapism/mood modification" (IGDS9-SF, Item 8) did not add further diagnostic accuracy due to its lack of diagnostic specificity. The differences regarding the significance of the IGD criteria reported above may be partly explained on the basis of lack of MI of the IGD measurements used across the different populations studied.

As the use of the Internet and videogames continues to integrate into the daily lives of a global community, human-computer interactions will continue to be a domain of scientific study and inquiry in cross-cultural research. Notwithstanding this, the lack of information regarding the MI of one of the most widely used psychometric tests to assess IGD (i.e., IGDS9-SF) constitutes as a gap in the literature since such studies are of key importance to overcome methodological issues related establishing a framework for valid and reliable international cross-cultural comparisons among studies on IGD using the IGDS9-SF (e.g., Monacis et al.,

2016; Pontes and Griffiths, 2015, 2016; Pontes et al., 2016; Wu et al., 2017).

In that line, potential cultural variations in the understanding, the conceptualization, and the assessment of the IGD construct, could be further clarified by the implementation of a more emic approach (creation instead of adaptation/translation of questionnaires based on the specific cultural perspectives of the subjects assessed) considering the psychological measures applied (compared to the etic approach [from the perspective of the observer, who may not belong in the cultural group measured] which appears to currently dominate the field; Gadelrab and Alkhadher, 2017; Rogers et al., 2013). Such an approach would enable the construct of IGD and its associated measure to be differentially adjusted within the cultural contexts, where it is (or will be) applied. In light of these, the present study contributes valuably in this direction, although not without potential limitations. First, confounding factors others than age and gender were not controlled. One such factor could be related to the unique structural characteristics of the videogames played by gamers. Second, all gamers recruited to the study were from the general online community, in the USA, India, and the UK. Thus, it is possible that the present findings may not be fully applicable to clinical samples and/or to different cultural and national groups as further investigation in specific cohorts would be required. Third, participants were collected online through English-speaking websites. This could be a limitation of the study considering the Indian sample. However, it the present authors believe that this did not significantly impact the findings, given that English is an official language in India and that the population of interest (e.g. Internet gamers) tends to be linguistically skilled in English (Rankin et al., 2008; Thorne et al., 2009; Zhang et al., 2017). Finally, the dimensions of vertical/horizontal individualism-collectivism have not been assessed here, and therefore, the interpretation of the lack of metric and scalar invariance findings as involving their effects is (to some extent) theoretical. Ideally, future studies should assess these constructs and the IGD factor should be regressed on their scores across the different ethnic groups to demonstrate

the exact magnitude of their effects. Despite these potential limitations, it is hoped the results and information discussed in this study will contribute meaningfully towards facilitating further research on IGD and to a better understanding of the MI of the IGDS9-SF, clinical practice, and research involving the assessment of IGD across different nations where the use of videogames has become prevalent and potentially concerning due to excessive and unhealthy use.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest: none.

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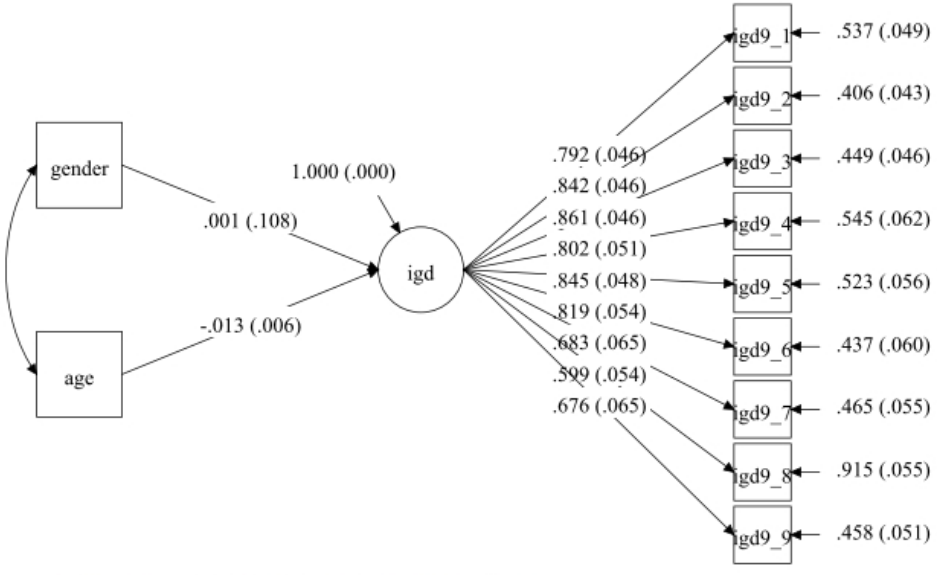

Figure 1. CFA USA, Unstandardized loadings

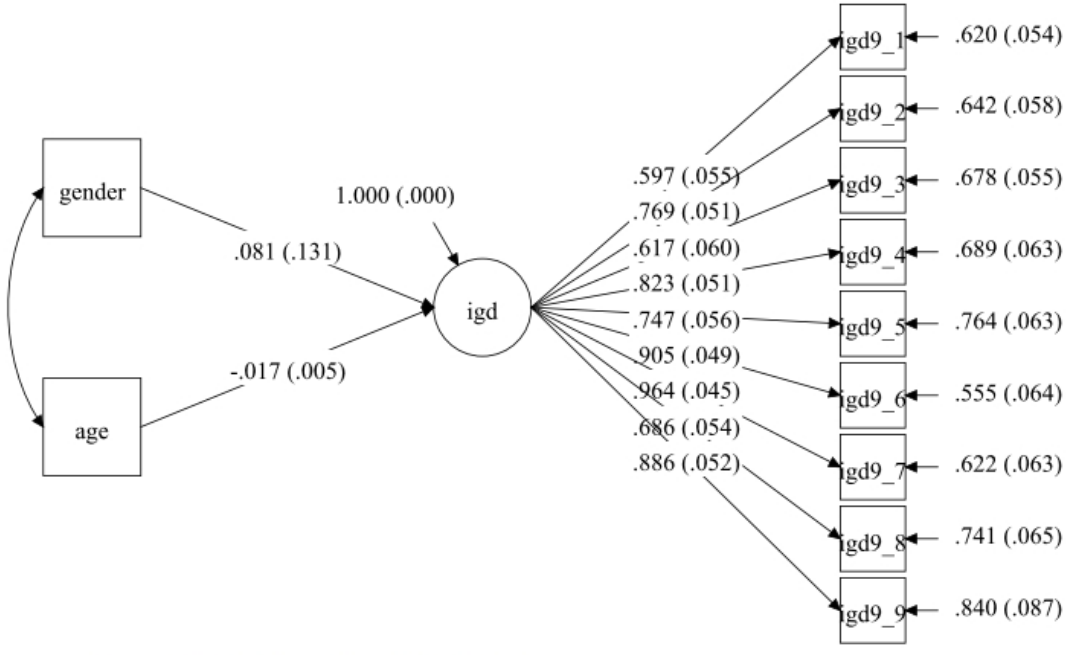

Figure 2. CFA India, Unstandardized loadings

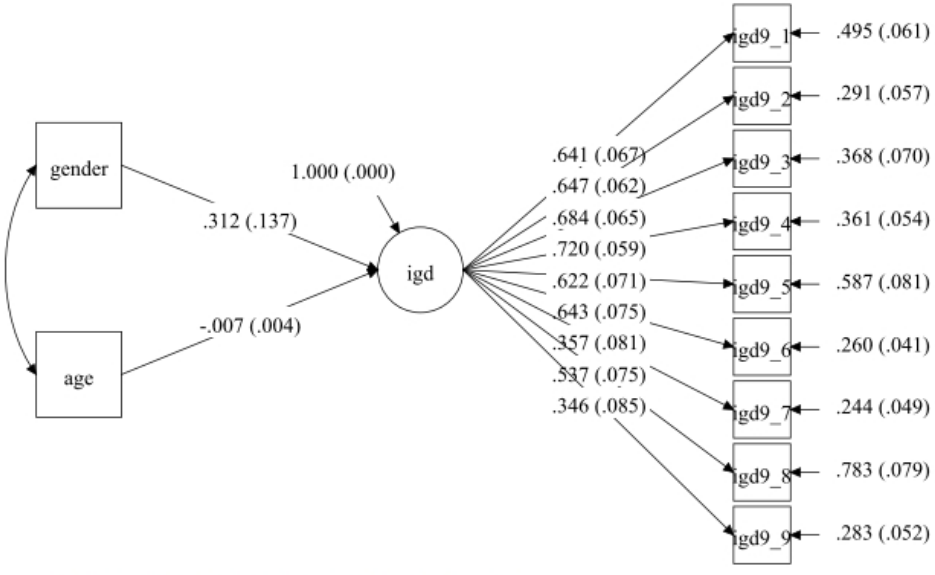

Figure 3. CFA UK, Unstandardized loadings

Table 1. Descriptive statistics and reliability coefficients for the Internet Gaming Disorder Scale–Short-Form (IGDS9-SF).

Measure	USA Sample (*n = 405*)				Indian Sample (*n = 336*)				UK Sample (*n* = 272)			
IGDS9-SF	M	SD	MIC	α	M	SD	MIC	α	M	SD	MIC	α
	18.06	7.36	.53	.91	26.57	7.64	.48	.89	14.04	5.67	.46	.88

Notes: MIC: mean inter-item correlation; α: Cronbach's α reliability coefficient.

Table 2. Internet Gaming Disorder Scale–Short-Form (IGDS9-SF) country-level d*escriptive statistics and reliability coefficients per item-if item is deleted*

Country	Data collection type		Minimum	Maximum	Mean	SD	*Cronbach's α if Item Removed*
USA	Online	Item 1	1.00	5.00	2.42	1.09	.90
		Item 2	1.00	5.00	2.11	1.07	.90
		Item 3	1.00	5.00	2.04	1.10	.90
		Item 4	1.00	5.00	2.11	1.10	.90
		Item 5	1.00	5.00	1.98	1.12	.90
		Item 6	1.00	5.00	1.78	1.06	.90
		Item 7	1.00	5.00	1.53	0.97	.90
		Item 8	1.00	5.00	2.54	1.14	.91
		Item 9	1.00	5.00	1.54	0.97	.90
	USA N = 405; USA Cronbach's α =.911; USA Cronbach's α Based on Standardized Items = .912						
India	Online	Item 1	1.00	5.00	3.23	1.01	.89
		Item 2	1.00	5.00	2.86	1.13	.88
		Item 3	1.00	5.00	3.27	1.04	.88
		Item 4	1.00	5.00	2.87	1.19	.88
		Item 5	1.00	5.00	3.05	1.17	.83
		Item 6	1.00	5.00	2.84	1.20	.87

		Item 7	1.00	5.00	2.62	1.27	.87
		Item 8	1.00	5.00	3.19	1.12	.88
		Item 9	1.00	5.00	2.65	1.30	.88
	India *N* =336; India Cronbach's α= .892; India Cronbach's α Based on Standardized items = .892						
UK	Online	Item 1	1.00	5.00	1.88	0.96	.87
		Item 2	1.00	5.00	1.57	0.86	.86
		Item 3	1.00	5.00	1.59	0.93	.86
		Item 4	1.00	5.00	1.71	0.95	.86
		Item 5	1.00	5.00	1.62	0.99	.87
		Item 6	1.00	5.00	1.43	0.84	.86
		Item 7	1.00	5.00	1.22	0.62	.87
		Item 8	1.00	5.00	1.81	1.04	.88
		Item 9	1.00	5.00	1.21	0.64	.88
	UK *N* = 272; UK Cronbach's α = .880; UK Cronbach's α Based on Standardized items = .884						

Table 3. *Tests of invariance of the IGDS-SF9 questionnaire between USA, India and UK gamers with gender and age as covariates-*

	X^2	df	P	CFI	RMSEA	BIC	AIC
Configural: Loadings + Intercepts free	439.30	129	.000	.91	.08	22845.990	22417.892
Metric: Loadings fixed+ Intercepts free	545.25	147	.000	.88	.09	22887.629	22548.102
Model 3: Loadings Free+ Intercepts fixed	600.35	147	.000	.86	.10	22936.210	22596.683
Scalar: Loadings + Intercepts fixed	737.26	165	.000	.82	.10	23007.683	22756.729
Partial Invariance	466.82	143	.000	.90	.08	22791.900	22432.691

Note: For the partial invariance model, the loadings of items 1, 3, 7, 8, 9 and the thresholds of items 2, 3, 4, 8, 9 were set free (released) across the three countries.

Table 3. Non-Invariant Loadings and Intercepts across USA, Indian and UK gamers.

Loadings	**USA**	**Indian**	**UK**	**Intercepts**	**USA**	**Indian**	**UK**
Item 1	0.71	0.70	0.74	Item 2	2.31	2.46	2.32
Item 3	0.79	0.74	0.83	Item 3	2.26	2.05	2.21
Item 7	0.73	0.63	0.84	Item 4	2.24	1.65	2.29
Item 8	0.58	0.64	0.64	Item 8	2.25	2.43	2.29
Item 9	0.72	0.59	0.82	Item 9	1.97	1.55	2.06