



Videogame Addiction Scale for Children: Psychometric Properties and Gamer Profiles in the Italian Context

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Abstract

Given the few studies examining the evaluation of screening tools for videogame addiction among children aged 12 years and under, the present study analyzed (i) the psychometric properties (factorial structure, reliability indices and criterion validity) of the Italian version of the Videogame Addiction Scale for Children (VASC) and (ii) its construct validity using a person-centered approach. Two studies were carried out. In study 1, 728 participants completed a survey including demographic information, questions concerning the amount of time spent in playing videogames, and the Italian version of the VASC. In study 2, 1008 participants completed a survey comprising demographic information, the Italian version of the VASC, the Big Five Questionnaire for Children, and the social dimension subscale of the Multidimensional Self-Concept Scale. Findings supported (i) the four-dimensional first-order factor structure, (ii) full scalar invariance across age groups and partial scalar equivalence across gender, and (iii) reliability and criterion validity of the VASC. The construct validity of the VASC was confirmed by the identification of two distinct profiles (high videogame players vs. low videogame players) and their specific patterns of associations with personality traits and social self-concept. Interaction effects of gender \times profiles on personality traits were evidenced. Overall, the findings provided validity for the use of the Italian version of the VASC and extending the body of literature on videogame addiction.

Keywords Videogame addiction · Psychometric properties · Validity · Children · Video-gamer profiles

A growing body of studies has contributed to the debate on whether playing videogames causes positive or negative effects on individuals (e.g., Calvert et al. 2017; Gentile 2011; Laffan et al. 2016). In relation to negative effects, researchers' interest has been focused on maladaptive behaviors among teenagers, from aggressive tendencies to behavioral addictions.

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In this context, a significant negative aspect concerns prolonged videogame playing and the tendency by a minority of gamers to consider the social aspects of the in-game world more attractive and satisfying than what happens in the real world and where individuals can (i) cope with feelings of boredom and loneliness (Lee and LaRose 2007), (ii) find social recognition from other players (King and Delfabbro 2009) and satisfaction from being part of a group (Yee 2006), and (iii) escape from daily life problems (Wan and Chiou 2006). For some individuals, the playing of videogames is much more attractive than being in the real world and can become an excessive activity. Such excessive use may lead to problematic and (in some cases) addictive gaming (Griffiths 2005). For teenagers, this can affect their everyday activities and interests including family life, friendships, and how well they do in school.

The excessive and compulsive use of videogames has been considered one of the core features of Internet Gaming Disorder (IGD). IGD is defined by the American Psychiatric Association (APA) in Section III of the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) as “a pattern of excessive and prolonged Internet gaming that results in a cluster of cognitive and behavioral symptoms analogous to those of substance use disorder” (APA 2013, p. 796). However, the concept has not yet obtained a general consensus given the various theoretical models of technology-based addictions (e.g., King et al. 2013; Kuss and Griffiths 2012a). In light of this, further empirical evidence to legitimize IGD as a separate mental disorder was recommended in the DSM-5. More recently, the World Health Organization (WHO 2019) included gaming disorder (GD) in the International Classification of Diseases (ICD-11), defining the phenomenon as a pattern of persistent or recurrent gaming behavior (digital gaming or video-gaming), which may be online (i.e., over the internet) or offline. It is characterized by three diagnostic criteria: (i) impaired control over gaming, (ii) increasing priority given to gaming over other interests and activities, and (iii) continuation or escalation of gaming despite of the occurrence of negative consequences.

Because addictions tend to have precursors during childhood and early adolescence (Hawkins and Fitzgibbon 1993; Kuss and Griffiths 2012b), the assessment of gaming addiction during this developmental period is important to prevent and reduce risk factors, as well as enhance protective factors (Gentile et al. 2017). To the best of the authors' knowledge, videogame addiction screens were initially developed for adults and adolescents aged over 12 years. Recently, a new instrument—the Videogame Addiction Scale for Children (VASC)—was developed and validated among a sample of young Turkish children sample who played videogames via many different methods both online and offline via smartphones, tablets, and dedicated gaming consoles (Yilmaz et al. 2017). To date, there is a paucity of international studies on risk and protective factors related to gaming addiction among children and young adolescents (Paulus et al. 2018). In addition, there is there is no empirical evidence for either psychometric property or measurement invariance of the VASC for children aged 12 years and under in the Italian context.

The VASC is a 21-item instrument and has a four-factor structure comprising impaired self-control (ISC), reward/reinforcement (RR), problems (PR), and involvement (INV), reflecting both the IGD framework defined by the APA and the GD criteria outlined by the WHO. ISC refers to impaired control of the time spent playing videogames; RR refers to the pleasure derived from this activity; PR refers to the negative consequences of excessive playing (e.g., limited time spent with family, not eating regular meals); and INV refers the persistent interest in playing videogames for both interpersonal relationships and intrapersonal experiences.

Based on the aforementioned literature and in line with previous investigations on the development and maintenance of IGD (Gentile et al. 2017; Paulus, Ohmann, Gontard and Popow 2018), the dimensions of the scale might be associated with specific personality traits and interpersonal relationships. Personality traits, based on the Five-Factor model that includes neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness (Costa and McCrae 1985), are important in light of the theoretical assumption that some of these traits are closely associated with addictive behaviors (Floros and Siomos 2014). Notably, Landers and Lounsbury (2006) reported that introverted individuals are more likely to be engaged in technological addictive behaviors, since they use them as a way of hiding or changing their identities, creating a new life style, and preventing the likelihood of being ridiculed and rejected. Individuals with low conscientiousness appear to display higher levels of Internet use due to the unstructured procedures and parameters of virtual environments. Mark and Ganzach (2014) reported that neurotic individuals tend to use the Internet to lower their feelings of loneliness. Similarly, less agreeable individuals may prefer virtual social contacts and avoid close social boundaries (Müller et al. 2014) and to exercise their fantasies of hurting others without any serious consequences (Kırcaburun et al. 2018) and consequently losing themselves in the game over time (Müller et al. 2014).

A recent systematic review reported significant (but also not always consistent) associations between IGD and personality traits (Şalvarlı and Griffiths 2019). For instance, there appear to be no significant relationships or negative associations between the traits of extraversion and openness to experience and IGD. However, there is more empirical evidence of a significant positive association between neuroticism and IGD (e.g., Braun et al. 2016; Lehenbauer-Baum and Fohringer 2015; Li et al. 2016; Wang et al. 2015). Mixed results have been reported in the relationships of conscientiousness and agreeableness with IGD (Müller et al. 2014; Ozer and Benet-Martinez 2006; Wang et al. 2015; Wittek et al. 2016). Despite this literature, further empirical evidence is required to clarify the associations between personality traits and IGD.

Another potential psychological risk factor in problematic gaming is low self-esteem which is generally conceived as a unidimensional construct (Beard et al. 2017; Sincek et al. 2017; Wartberg et al. 2017). In Bracken's (1992) multi-dimensionally oriented model of self-concept, self-esteem is considered as a learned response acquired by children in their relationships with the different life domains, receiving feedback about behaviors from two response modes (i.e., from their personal experiences of success and failure, and from other individuals). Among the six life contexts (academic, family, physical, competence, affect, and social), the social domain (i.e., social interactions and interpersonal relationships) may be considered as one of the most relevant in relation to addiction problems, because different behavioral addictions are often associated with poor or impaired peer relationships, consequently affecting individuals' health-risk behaviors. Similarly, past research (Kobus 2003; Simons-Morton and Farhat 2010) has explained the association between the onset of substance addiction and social relationships by utilizing primary socialization theory (Oetting et al. 1998). This theory is focused on the relational bonds of children and adolescents with their peers and families and postulates that social sources (parents and peers) integrated with individual factors transmit norms concerning the behavior and increase the likelihood of participating in behavior.

In the field of internet-related behavioral addictions, the social compensation hypothesis has been applied to explain the associations between addictions and interpersonal relationships (Liu and Kuo 2007). Indeed, because the unpleasant experiences with peers during childhood and adolescence may determine social anxiety, individuals may try to compensate for frustrated personal companionships or weaker social relationships by playing videogames as a means to find a sense of belonging, social connectedness, and well-being (Lo et al. 2005).

The Present Study

Following Yilmaz et al.'s (2017) suggestions for cross-cultural validation of the VASC as a screening instrument, the present study had three main goals. These were to (i) ascertain the factorial dimensionality, the reliability, and the criterion validity of the original VASC among Italian children and young adolescents, (ii) explore its measurement invariance across gender and age groups, and (iii) provide empirical evidence for its construct validity using a person-centered approach (Bergman et al. 2003). Contrary to the variable-centered approach, which implies that variables are key units and each individual within a same population is interchangeable with another individual according to a homogeneity principle, the person-centered strategy distinguishes subgroups within a specific population, each of them characterized by shared patterns of relationships among factors of interest. Consequently, person-oriented methods emphasize a more holistic and dynamic view and the potential uniqueness of individuals. Consequently, given that the VASC was intended as a screening tool, this instrument should be able to distinguish different subgroups of participants to be classified into distinct videogame playing profiles, based on high or low levels of impaired self-control, reward/reinforcement, problems, and involvement. Therefore, each profile group should be associated with different levels of theoretically-related dimensions, such as personality traits and the social domain of self-concept.

To achieve these three goals, two studies were performed using different samples. In Study 1, it was expected that (i) the four-factor structure of the original VASC would be found as the best solution among Italian children and young adolescents and (ii) each factor would demonstrate robust reliability and criterion-related validity. In Study 2, it was expected that (i) the VASC's four-factor structure would be replicated among a different sample and that there would be gender and age group measurement invariance, (ii) at least two gamer profiles (higher levels of videogame playing vs. low level of videogame playing) would be found, and (iii) the profiles with higher levels of addiction would show higher levels of emotional instability and lower levels of conscientiousness, agreeableness, and social self-concept, while the profiles with lower levels of addiction would show an opposite pattern of relationships. In relation to the final hypothesis, it was also expected that profiles would interact with gender in defining the different levels of emotional instability, conscientiousness, agreeableness, and social self-concept. Although previous studies have reported gender differences in IGD among adolescent and young adult samples generally showing that males are more likely to experience IGD than females (Braun et al. 2016; Dieris-Hirche et al. 2020; Su et al. 2019; Wang et al. 2015; Wittek et al. 2016), a recent neuroimaging study demonstrated that females appeared to be more vulnerable to IGD than males (Wang et al. 2019). Additionally, following Lopez-Fernandez et al.'s (2019) suggestions to conduct further empirical research on this gender-specific factor, the study intended to contribute to this ongoing discussion by investigating the interaction effects of gender and gaming profiles on personality constructs.

Method (Study 1)

Participants and Procedure

The sample comprised 728 participants ($M_{age} = 10.65$ years, $SD = 1.41$; 48.6% female) recruited from primary ($n = 435$, 48.5% female) and middle schools ($n = 293$, 48.8% female) located

in different urban areas of southern Italy and from a mixed socioeconomic background. Pupils from primary schools were fourth and fifth graders, while adolescent students were sixth, seventh, and eighth graders. Almost all were of Caucasian origin (96%), and all of them were Italian speakers.

The study was performed in accordance with the ethical principles for conducting research with human participants as suggested by the Italian Association of Psychology (2015) as well as in agreement with the European and Italian law of privacy. Written informed consent was obtained from parents and heads of the schools. Participants completed a self-report questionnaire anonymously which took approximately 20 min during the regular school day. In each school, the questionnaire was administered in collective sessions with the support of research assistants.

Measures

Demographics Participants were asked to report general information concerning their gender, age, and the amount of time spent in playing videogames (hours per day and days per week).

VASC Participants completed the VASC (Yilmaz et al. 2017) comprising 21 items scored on a five-point Likert scale from 1 (*never*) to 5 (*very often*). The instrument includes four factors: impaired self-control (seven items; e.g., “I cannot resist playing videogames even if it negatively affects my life” and “I am not interested in anything else while playing videogames”), reward/reinforcement (six items; e.g., “I think playing videogames is very enjoyable activity” and “I feel happy when I play videogames”), problems (four items; e.g., “I have sleeping problems due to playing videogames” and “The games I play prevent me from spending time with my family”), and involvement (four items; e.g., “I always talk about videogames with my friends” and “I act like videogame characters in my daily life activities”). Scores for each factor are obtained by averaging all the related items. A total score is also obtained by summing all 21 items (ranging 21 to 105), with higher scores indicating higher level of videogame addiction. The original version of the VASC showed adequate internal consistency of item scores, with Cronbach’s alphas $> .73$ for each subscale as well as the entire scale (Yilmaz et al. 2017). The measure was translated from English into Italian according to the guidelines of the International Test Commission (2005).

Data Analysis

Six steps were followed in carrying out the analyses. First, the univariate normality of all item scores were checked following the George and Mallery’s (2016) standard guidelines (skewness and kurtosis falling in the range of -2 to $+2$). To identify multivariate outliers, Mardia’s multivariate kurtosis test was used and compared with the recommended value $p(p+2)$, where p is the total number of variables. Second, a parallel analysis was performed to determine the number of factors to be retained. Third, exploratory structural equation modeling (ESEM) was performed extracting one to four factors and comparing the best solution with that obtained by the parallel analysis. Fourth, based on the solution suggested by the previous steps, a confirmatory factor analysis (CFA) was carried out and the model goodness of fit was evaluated. Fifth, the internal consistency reliabilities for each factor was assessed by calculating the Cronbach’s alpha (α), the composite reliability (CR), and the factor determinacies (FDs), considering coefficients $\geq .70$ as adequate and $\geq .80$ as good (Muthén and Muthén

2012; Tabachnick and Fidell 2013). Sixth, criterion validity was assessed by performing Pearson's correlations using a bootstrap sample of 1000 (with 95% bias-corrected and accelerated confidence intervals) between the VASC factors and time spent playing videogames (hours per day and days per week).

Results (Study 1)

Preliminary Analyses

Only three participants (0.4%) had missing information on one or two VASC items. These participants were excluded from the analyses. By checking for univariate and multivariate outliers, some problems with skewness (Items 15, 17, and 21 were slightly higher than 2) or kurtosis (Items 15, 17, 20, and 21 ranged from 2.11 to 3.09) were identified. Also, Mardia's coefficient was 646.66, more than the recommended value of 483, demonstrating multivariate non-normality. Consequently, robust estimators (e.g., robust maximum likelihood estimator) were used in the following analyses.

Factorial Structure

Parallel analysis procedures, which were based on permutations of raw data ($N = 1000$) with an eigenvalue criterion of the 95th percentile (O'Connor's 2000), showed that four factors emerged as exceeding the random ones. Following this, ESEM analysis was performed, using oblimin rotation in *Mplus 7* (Muthén and Muthén 2014). Model fit was evaluated by relying on multiple fit indices (Kline 2016). The used cutoffs were the following: comparative fit index (CFI) $\geq .90$ for acceptable and $\geq .95$ for good fit, root mean square error approximation (RMSEA) $\leq .06$, and standardized root mean square residual (SRMR) $\leq .08$. To establish significant improvement of fit between models, the following criteria had to be met: chi-square significantly decreased ($\Delta\chi^2$ with $p < .05$), supplemented by smaller values of Akaike information criterion (AIC), Bayesian Information Criterion (BIC), and sample-size adjusted BIC indices. The four-factor model fitted the data better than the other models (see Table 1). Table 2 shows the emerging factorial structure and the specific content of each item. All factor loadings were higher than .30 and significant at $p < .001$. However, Item 7 ("I forget my problems while playing videogames") was placed in the RR factor instead of the original ISC factor. This change was acceptable, given that it reflected the meaning that playing videogames may be a means to attain a form of hedonic pleasure by the relief from problems.

Starting from this four-factor solution, a CFA was carried out by permitting each item to load on the hypothesized factor and to be freely estimated while fixing to zero the cross-loadings. The variance of each factor was set at 1.0 to guarantee the measurement scale and factor co-variances were allowed. The model fit was adequate, $\chi^2(183) = 420.28$, $p < .001$, CFI = .948, RMSEA = .042 [90% CI = .037–.048], SRMR = .048. The standardized solution is shown in Table 2.

Reliability and Criterion-Related Validity

Following CFA, the internal consistency reliabilities were evaluated by calculating the Cronbach's α , CR, and FD coefficients for each factor. As shown in Table 2, all coefficients

Table 1 Exploratory structural equation modeling goodness-of-fit indices for the 21-item Videogame Addiction Scale for Children in the Study 1 sample (N = 725)

Model	χ^2 (df)	CFI	RMSEA [90% CI]	SRMR	$\Delta\chi^2$ (Δdf)	AIC	BIC	SSA-BIC
1. One-factor	1174.27*** (189)	.784	.085 [.080-.089]	.080	-	51,791.38	52,080.31	51,880.26
2. Two-factor	522.71*** (169)	.922	.054 [.049-.059]	.038	587.99*** (20)	50,927.95	51,308.61	51,045.06
3. Three-factor	324.15*** (150)	.962	.040 [.034-.046]	.027	171.00*** (19)	50,685.89	51,153.67	50,829.79
4. Four-factor	225.70*** (132)	.979	.031 [.024-.038]	.021	91.90*** (18)	50,588.11	51,138.45	50,757.41

CFI comparative fit index, RMSEA root mean square error approximation, CI confidence interval, SRMR standardized root mean square residual, AIC Akaike information criterion, BIC Bayesian Information Criterion, SSA-BIC Sample Size Adjusted Bayesian Information Criterion

*** $p < .001$

were $>.70$, suggesting adequate reliability of the VASC subscales. As expected, positive associations emerged between each dimension of the VASC and the time (hours per day and days per week) spent in playing videogames (see Table 3).

Method (Study 2)

Participants and Procedure

A different and non-dependent sample comprising 1008 participants ($M_{\text{age}} = 10.55$ years, $SD = 1.38$; 48.1% female) was recruited. They came from the same primary ($n = 632$, 46.0% female) and middle schools ($n = 376$, 51.6% female) as well as grades of those in study 1. Almost all were of Caucasian origin (95%) and all of them were Italian speakers. The same procedure as described in the Study 1 was followed. Participants completed the self-report survey in approximately 40 min.

Measures

Demographics Participants were asked to report the same information as described in Study 1.

VASC-IT Participants completed the Videogame Addiction Scale for Children—Italian version (VASC-IT) following the procedures described in Study 1 (see Table 7 of Appendix). However, in this study, Item 7 was part of the RR subscale (seven items in this version) instead of the ISC subscale (six items in this version). Cronbach's α 's were acceptable for all the subscales: .86 for ISC, .89 for RR, .73 for PR, and .74 for INV. Cronbach's α for the whole scale was excellent (.92).

BFQ-C To assess the Big Five personality factors, participants were administered the BFQ-C (Barbaranelli et al. 1998, 2003), a self-report scale specifically developed for children and adolescents (from 7 to 14 years old). Each of the five factors includes 13 items scored on a three-point Likert-type scale ranging from 1 (*almost never*) to 3 (*almost always*) in the version for children (7–10 years old) and on a five-point Likert-type scale ranging from 1 (*almost never*) to 5 (*almost always*) in the version for adolescents (11–14 years old). In the present

Table 3 Bootstrapped Pearson's correlations matrix with 95% bias-corrected and accelerated confidence intervals (bootstrap sample of 1000) between the Videogame Addiction Scale for Children (VASC) four dimensions and the amount of time spent in playing videogames (hours per day and days per week) for the Study 1 sample ($N = 725$)

VASC dimension	Amount of time spent in playing videogames	
	Hours per day [95% BCa CI]	Days per week [95% BCa CI]
Impaired self-control	.55*** [.49–.60]	.54*** [.49–.59]
Reward/reinforcement	.51*** [.45–.57]	.52*** [.46–.57]
Problems	.26*** [.18–.34]	.23*** [.15–.30]
Involvement	.47*** [.40–.54]	.41*** [.35–.47]

CI confidence interval

* $p < .05$; ** $p < .01$; *** $p < .001$

study, only three out of the five factors were assessed: agreeableness (sensitivity towards others and their needs), conscientiousness (dependability, orderliness, precision, and the fulfilling of commitments), and emotional instability (i.e., neuroticism; feelings of anxiety, depression, discontent, and anger). Cronbach's α coefficients were acceptable ranging from .76 to .82 in the child sample and from .81 to .83 in the adolescent sample.

MSCS One subscale of the Italian version of the Multidimensional Self-Concept Scale (MSCS) (Bergamini and Pedrabissi 2003; original version: Bracken 1992) was used to assess the social dimension of self-concept. The full Italian version of MSCS comprises 150 Likert-type items ranging from 1 (*not at all true*) to 4 (*extremely true*) assessing the construct of self-concept in the following six subdomains: social, competence, affect, academic, family, and physical. Each subscale comprises 25 items. As aforementioned, in the present study, only the social subscale was used (example items: "I am usually a lot of fun to be with" and "People do not seem to be interested in talking with me" [reversed scored]). The subscale reflects how children and adolescents feel about their ability to interact with others, how they participate socially, and how they are accepted within social settings. According to Bracken (2006), social interactions and interpersonal relationships are crucial to healthy mental development. Higher scores on the MSCS social subscale indicate feelings of social competence and better self-concept, while lower scores indicate worse self-concept. Cronbach's α coefficients for this subscale were good for the child, adolescent, and total samples ($> .85$).

Data Analysis

Analyses followed six main steps. First, normality as specified in Study 1 was checked for. Second, a CFA was performed according to the four-factor model of VASC as derived from Study 1 and using the same indices and criteria for the model fit (Kline 2016). Third, the assessment of both internal consistency reliabilities and the criterion validity as presented in the Study 1 were carried out. Fourth, VASC measurement invariance was examined across gender and age groups by different multi-sample CFAs, sequentially introducing appropriate constraints to test different levels of invariance: configural invariance (equal factor structure), metric invariance (equal factor loading), scalar invariance (equal item intercept), residual variance invariance (equal item error variance), and structural invariance (equal factor variances/covariances) (Van de Schoot et al. 2012; see also Musso et al. 2018, for a practical application). To ascertain significant differences between nested models, Chen's (2007, p. 501) recommendations for sample sizes of > 300 were used. Two models were considered to provide equivalent fits when the following criteria were satisfied: $\Delta CFI \geq -.010$, $\Delta RMSEA \leq .015$, and $\Delta SRMR \leq .010$. Fifth, to identify distinct profiles of videogame players, cluster analyses were conducted based on the scores obtained from VASC subscales, following Gore's (2000; see also Aldenderfer and Blashfield 1984) two-step approach. The number of clusters was initially determined utilizing hierarchical cluster analyses using Ward's method and based on squared Euclidian distances, among both child and adolescent samples. Cluster solutions were compared with two to six clusters by considering their theoretical meaningfulness, parsimony, and explanatory power (i.e., the cluster solution had to explain approximately 26% of the variance in each VASC dimension; see Cohen 1988). Then, distributions of children and young adolescents across the obtained profiles were compared using a chi-square test. If both groups were distributed in similar proportions across similar profiles, they were collapsed into a single

group and a new cluster analysis was performed using the same procedure. Ultimately, study participants were grouped by *K*-means cluster analysis procedures, and standardized mean values of the VASC grouping variables describing the characteristics of each identified profile were calculated. Validity of the final solution was checked using multivariate analysis of variance (MANOVA) on the four VASC dimensions by profile. The replicability of the final solution was also tested by splitting the sample into two random halves and conducting the cluster analyses for each subsample again. Levels of agreement were calculated using Cohen's (1960) kappa. Sixth, to examine how profiles of videogame players were related to personality traits and perceived social interaction, two distinct multivariate analyses of variance (MANOVAs) were performed for children and young adolescents with profiles and gender as independent variables, and conscientiousness, agreeableness, emotional instability, and social self-concept as dependent variables.

Results (Study 2)

Preliminary Analyses

No missing information was identified in the dataset. By checking for univariate and multivariate outliers, problems with skewness (slightly higher than 2 in some cases) or kurtosis (higher than 3 in some cases) were found. Also, Mardia's coefficient was 666.86, more than the recommended value of 483, demonstrating multivariate non-normality. Consequently, robust estimators (e.g., robust maximum likelihood estimator) were used in the following analyses.

Confirmatory Factor Analysis of the VASC-IT

The VASC-IT four-factor model had an adequate fit to the data, $\chi^2(183) = 578.33$, $p < .001$, CFI = .944, RMSEA = .046 [90% CI = .042–.051], SRMR = .045. Figure 1 shows the standardized solution. Factor loadings were all significant ($\geq .52$, $p < .001$), and all the factors were positively and largely associated.

Reliability and Criterion-Related Validity

Cronbach's α ($> .72$), CR ($> .73$), and FD ($> .87$) coefficients for each factor were adequate (see Table 4), suggesting adequate reliability of the VASC subscales. Also, as in Study 1, positive associations ($> .27$, $p < .001$; average of correlation was .48) emerged between each dimension of the VASC-IT and the time (hours per day and days per week) spent in playing videogames (see Table 4).

VASC-IT Gender and Age-Group Measurement Invariance

Results from VASC-IT invariance analysis (see Table 5) showed full measurement and structural invariance across age groups (children vs. young adolescents). Regarding gender-group invariance, scalar invariance was evidenced. However, partial residual variance and structural invariance were obtained. More specifically, modification indices were suggested to freely estimate error variance for Items 1–6 (related to ISC) and for items 16–21 (related to INV). When comparison analyses were carried out, Item 1 (1.170 vs. .711), Item 2 (.914 vs.

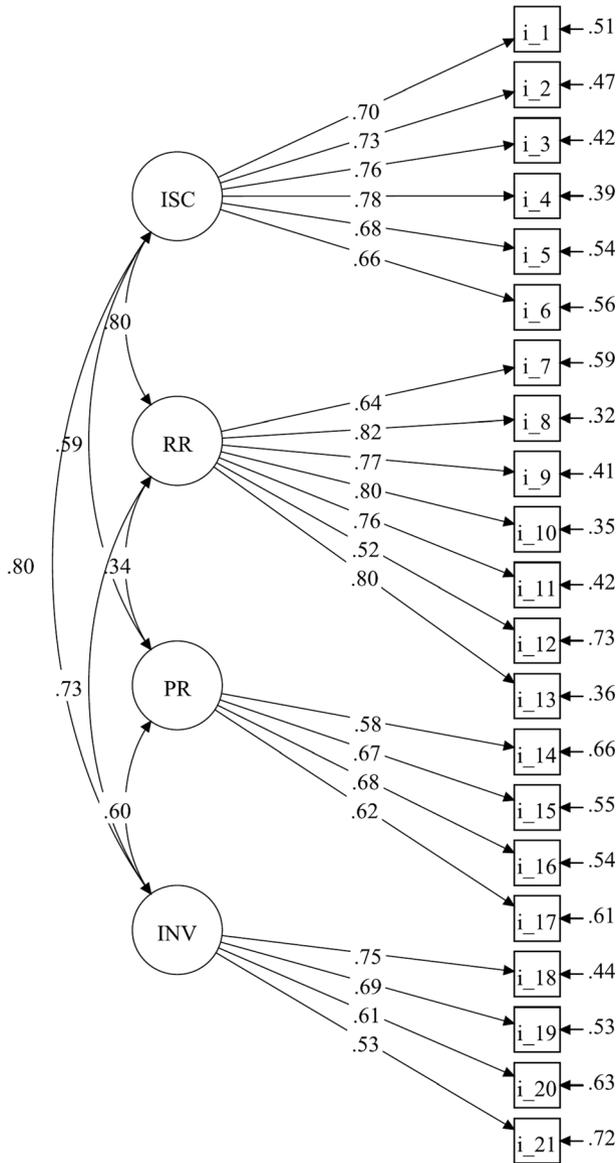


Fig. 1 Completely standardized parameter estimates of confirmatory factor analysis model of the Videogame Addiction Scale for Children among Italian children and young adolescents in study 2 ($n = 1008$). All values are significant at $p < .001$. ISC impaired self-control, RR reward/reinforcement, PR problems, INV involvement, i item

.541), Item 3 (.926 vs. .568), Item 4 (.8139 vs. .523), Item 5 (1.250 vs. .783), Item 6 (1.236 vs. .811), Item 16 (.978 vs. .539), Item 17 (.690 vs. .426), Item 18 (1.045 vs. .619), Item 19 (1.416 vs. .716), Item 20 (1.226 vs. .666), and Item 21 (1.149 vs. .526) had residual variances significantly higher for males than females, meaning that a greater number of random factors, external to the ISC and INV factors, determined the response to these items for males.

Table 4 Reliability coefficients and bootstrapped Pearson’s correlations matrix with 95% bias-corrected and accelerated confidence intervals (bootstrap sample of 1000) between the Videogame Addiction Scale for Children (VASC) four dimensions and the amount of time spent in playing videogames (hours per day and days per week) for the study 2 sample ($N=1008$)

VASC dimension	Reliability coefficients			Amount of time spent in playing video games	
	Cronbach’s α	CR	FD	Hours per Day [95% BCa CI]	Days per Week [95% BCa CI]
Impaired self-control	.86	.87	.95	.60*** [.55–.64]	.56*** [.52–.61]
Reward/reinforcement	.89	.89	.96	.58*** [.53–.62]	.56*** [.52–.61]
Problems	.73	.73	.88	.30*** [.22–.36]	.27*** [.20–.33]
Involvement	.74	.74	.91	.50*** [.45–.55]	.45*** [.40–.50]

CI confidence interval, CR composite reliability

* $p < .05$; ** $p < .01$; *** $p < .001$

Profiles of Videogame Players

Based on the a priori criteria, among both child and adolescent samples, a two-cluster solution was the most acceptable. Examining the distributions from the two samples across the two

Table 5 Multi-group confirmatory factor analysis goodness-of-fit indices for the 21-item Videogame Addiction Scale for Children—Italian version in the Study 2 sample ($N=1008$)

Model	χ^2 (df)	CFI	RMSEA	SRMR	$\Delta\chi^2$ (Δdf)	ΔCFI	$\Delta RMSEA$	$\Delta SRMR$
Across age groups (children vs. young adolescents)								
0.Equal factor structure	787.02*** (366)	.942	.048	.051	-			
1.Equal factor loadings	814.51*** (383)	.940	.047	.055	25.46ns (17)	-.002	-.001	.004
2.Equal item intercepts	875.97*** (400)	.934	.049	.056	70.76*** (17)	-.006	.002	.001
3.Equal item error variances	941.93*** (421)	.928	.050	.059	62.49*** (21)	-.006	.001	.003
4. Equal factor variances/co-variances	947.67*** (427)	.928	.049	.061	3.95ns (6)	.000	-.001	.002
Across gender								
0.Equal factor structure	710.83*** (366)	.945	.043	.050	-			
1.Equal factor loadings	741.75*** (383)	.943	.043	.055	30.56* (17)	-.002	.000	.005
2.Equal item intercepts	794.85*** (400)	.937	.044	.057	57.72*** (17)	-.006	.001	.002
3.Equal item error variances	1102.36*** (421)	.892	.057	.068	277.02*** (21)	-.045	.013	.011
3P. Partial equal item error variance	859.70*** (409)	.928	.047	.063	60.66*** (9)	-.009	.003	.006
4. Equal factor variances/co-variances	901.70*** (415)	.923	.048	.073	58.95*** (6)	-.005	.004	.010

CFI comparative fit index, RMSEA root mean square error approximation, SRMR standardized root mean square residual, ns not significant

* $p < .05$; *** $p < .001$

paired profiles, no significant differences emerged ($\chi^2(1) = 0.98, p = .32$), meaning children and young adolescents were distributed in similar proportions across the two profiles. Therefore, combined data across the two samples were combined.

In the combined sample, a similar two-cluster solution emerged as the most acceptable solution. Therefore, this solution was used to cluster participants into two groups by *K*-means cluster analysis. The obtained profiles are shown in Fig. 2. The first cluster ($n = 635; 63\%$) consisted of individuals showing mean *z*-scores below average on ISC, RR, PR, and INV. The second cluster ($n = 373; 37\%$) comprised of individuals showing mean *z*-scores above average on the same dimensions. Therefore, clusters representing a low videogame playing profile, and a high videogame playing profile were identified.

Results from validity check indicated that the two-cluster solution explained substantial percentages of variance (52% of variability in ISC, 34% in RR, 33% in PR, and 51% in INV). Replication analyses also indicated good reliability ($\kappa = .89$). Finally, the distributions of participants were again examined from both the child and young adolescent samples across the two profiles, and no significant differences were obtained ($\chi^2(2) = 0.93, p = .34$).

Association of Profiles of Videogame Players with Personality Traits and Social Self-concept

First, the data derived from the child sample were analyzed. The MANOVA on the personality traits and social self-concept resulted in a significant multivariate effect of gamer profile (Wilks' Lambda = .87, $F(4, 625) = 22.35, p < .001, \eta^2 = .13$). No gender and no interaction effects were statistically significant. As displayed in Table 6, univariate analyses of variance

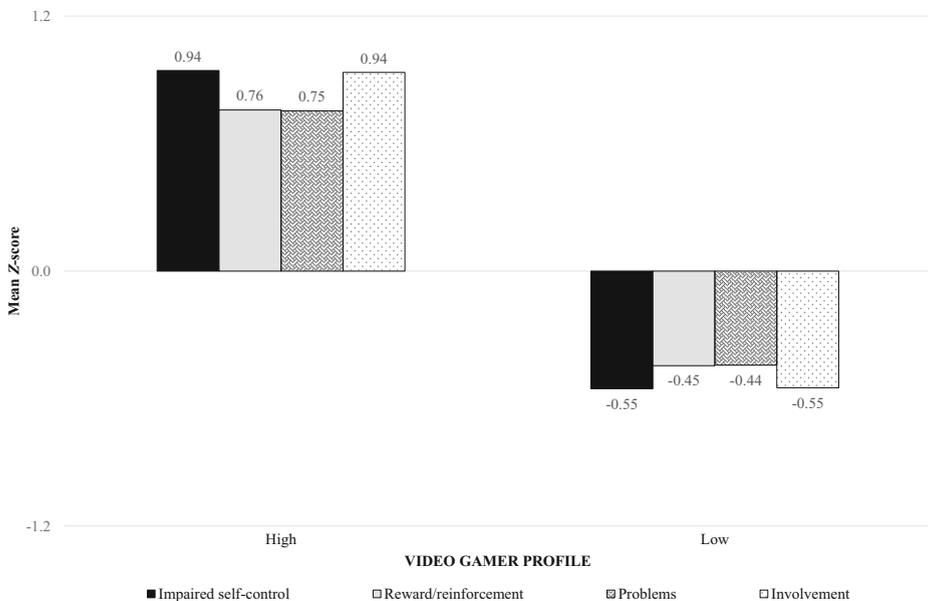


Fig. 2 Mean Z-scores for VASC-IT impaired self-control, reward/reinforcement, problems, and involvement dimensions by the obtained two (high and low) videogame playing profiles. VASC-IT Videogame Addiction Scale for Children—Italian version

Table 6 Univariate analyses of variance and pairwise comparisons for the two videogame player profile (low vs. high) on the personality traits and social self-concept in children ($N = 632$) and young adolescents ($N = 376$)

	Children's MANOVA-adjusted means by profile		$F(1, 628)$	η^2
	Low videogame playing profile ($n = 391$)	High videogame playing profile ($n = 241$)		
Personality traits				
Conscientiousness	31.70 ^a	28.71 ^b	60.96***	.09
Agreeableness	31.81 ^a	29.17 ^b	40.12***	.06
Emotional instability	23.07 ^a	25.64 ^b	34.91***	.05
Social self-concept	76.24 ^a	74.11 ^b	5.98*	.01
	Young adolescents' MANOVA-adjusted means by profile		$F(1, 372)$	η^2
	Low videogame playing profile ($n = 244$)	High videogame playing profile ($n = 132$)		
Personality traits				
Conscientiousness	45.87 ^a	40.80 ^b	21.23***	.05
Agreeableness	46.40 ^a	41.09 ^b	26.06***	.07
Emotional instability	35.22 ^a	37.63 ^b	4.82*	.01
Social self-concept	76.25 ^a	73.45 ^b	6.61*	.02

A profile mean is significantly different ($p < .05$) from another mean within the same raw if they have different superscripts

* $p < .05$; *** $p < .001$

(ANOVAs) indicated significant adjusted group mean differences among the gamer profiles for conscientiousness, agreeableness, emotional instability, and social relationships. Pairwise comparisons ($p < .02$) showed that the children in the high videogame playing profile (compared with those in the low videogame playing profile) scored (i) lower on conscientiousness, agreeableness, and social relationships and (ii) higher on emotional instability.

When analyzing the young adolescent dataset, the MANOVA resulted in a significant multivariate effect of both videogame playing profiles: Wilks' Lambda = .91, $F(4, 369) = 8.69$, $p < .001$, $\eta^2 = .09$, and videogame playing profile \times gender interaction, Wilks' Lambda = .96, $F(4, 369) = 3.66$, $p < .01$, $\eta^2 = .04$. No gender effects were statistically significant. As displayed in Table 6, follow-up analyses, including ANOVAs and pairwise comparisons of main effects ($p < .03$), showed that the videogame playing profiles had significant effects on conscientiousness, agreeableness, emotional instability, and interpersonal relationships, with the young adolescents in the high videogame playing profile scoring lower on conscientiousness, agreeableness, and social relationships as well as higher on emotional instability than those in the low videogame playing profile. Furthermore, the videogame playing profile \times gender interaction had significant effects on (i) conscientiousness, wherein young male adolescents scored higher in the high videogame playing profile (42.28 vs. 39.32) and lower in the low videogame playing profile (45.00 vs. 46.75) than young female adolescents, and (ii) on emotional instability, wherein young male adolescents scored higher in the high videogame playing profile (38.10 vs. 37.16) and lower in the low videogame playing profile (32.92 vs. 37.52) than young female adolescents.

Discussion

The present study tested the psychometric properties and validity characteristics of the VASC among Italian children aged 12 years and under (i.e., a segment of the population at risk of developing videogame addiction [Gentile et al. 2017]). Overall, the findings indicated that the

VASC is a valid and reliable tool. Both exploratory and confirmatory factor analyses fit indices provided evidence for the four-factor solution. When looking at factor loadings, all values were statistically significant and relatively high, therefore demonstrating that items were good construct indicators. This was in line with Yilmaz et al.'s (2017) study, although Item 7 of the Italian version loaded on the reward/reinforcement factor rather than the impaired self-control factor. In the present authors' opinion, this change is theoretically acceptable given that playing videogames is instrumental in achievement of hedonic pleasure.

Measurement invariance analyses, performed to verify whether the four VASC dimensions of the Italian version operated equivalently across age (children vs. young adolescents) and gender groups, confirmed that the factorial structure was invariant at a scalar level across both age groups and gender. Scalar invariance is usually considered sufficient ground to establish measurement invariance in practice and, therefore, to assume that the factor structure of the scale remained relatively unaltered across groups; namely, the VASC dimensions were assessed by children and young adolescents, as well as males and females, in a similar manner. However, the male responses on impaired self-control and involvement factors were more affected by a larger error variance than female responses. This means that other external random factors might influence the related item responses for males. Therefore, this would be interesting to explore in future research, with the aim of understanding, for example, what other factors could better explain gender differences and ensure full measurement invariance between all the dimensions involved in problematic videogame playing. Consequently, addiction concepts such as the salience of playing videogames and mood modification resulting from videogame play (Griffiths 2005) could be further integrated with the dimensions analyzed in the VASC.

The reliability and the validity of the instrument were also supported because these values were found to be high in both studies. This demonstrated that the scale was reliable and accurate in assessing videogame addiction. Criterion-related validity was warranted due to the expected positive pattern of correlations that were found between the VASC dimensions and the two related playing measures (i.e., days and hours spent videogame playing). This in line with recent studies showing that high levels of time spent playing videogames are positively associated with problematic video gaming behavior (for a systematic review of the literature, see Mihara and Higuchi 2017).

Using a person-centered approach, the study was also able to support the construct validity of the VASC by identifying two distinct videogame playing profiles. The first one represented children and young adolescents scoring higher on all the VASC dimensions (the high videogame playing profile), while the second represented children and young adolescents scoring lower on the same variables. This binary discrimination between the two groups suggests that the VASC may be considered an adequate screening tool (Yilmaz et al. 2017).

This aspect of validity was further established by the different associations of each of the videogame playing profiles with personality traits and social self-concept. As expected, and consistent with the previous findings, the high videogame playing profile showed higher levels of emotional instability (Li et al. 2016; Müller et al. 2014; Wittek et al. 2016) and the lower levels of conscientiousness (Müller et al. 2014; Wang et al. 2015; Wittek et al. 2016), agreeableness (Collins et al. 2012; Müller et al. 2014), and poorer social and interpersonal relationships (Beard et al. 2017; Müller et al. 2014; Sincek et al. 2017; Wartberg et al. 2017). This latter association empirically supported the compensatory hypothesis related to impaired

interpersonal relationships as suggested by Liu and Kuo (2007) and Lo et al. (2005). Also as expected, the low videogame playing profile showed an opposite pattern of relationships.

One puzzling finding was the effect of the interaction between videogame playing profile and gender on the personality traits of conscientiousness and emotional instability. More specifically, young male adolescents were more conscientious but emotionally unstable in the high videogame playing profile than young female adolescents. In terms of conscientiousness, the differences among males belonging to the two profiles were smaller than the differences among females, while, in terms of emotional stability, the differences among males were higher than those among females. On one hand, these findings suggest that, although females tend to be more emotionally unstable, this aspect becomes particularly relevant for males when playing videogames excessively. Such an interpretation parallels the studies reporting that male adolescents are more likely to be more emotionally vulnerable to IGD than females (Braun et al. 2016; Dieris-Hirche et al. 2020; Su, Han, Jin, Yan & Potenza 2019; Wang et al. 2015; Wittek et al. 2016).

On the other hand, the higher levels of conscientiousness emerging in high videogame profile for males than for females may be due to the fact that females appear to be more vulnerable than males in decreasing the levels of conscientiousness when playing videogames excessively. This could be related to the mixed findings found in the relationship between conscientiousness and IGD highlighted in a recent systematic review (Şalvarlı and Griffiths 2019). Future studies are required to clarify this relationship.

Some limitations should be noted. First, one of the main shortcomings concerned the cross-sectional nature of the study design. Consequently, potential causal associations could not be established. For example, although the MANOVA in Study 2 used the videogame player profile as the independent variable, and personality traits and social self-concept among both children and young adolescents as dependent variables, the direction of the associations among these variables cannot be determined. Therefore, future longitudinal studies, following the same participants from childhood to adolescence, are needed in order to (i) examine changes in children's and adolescents' addictive behaviors, personality traits, and social self-concept, (ii) explore which variables might be considered as antecedents or outcomes, and (iii) draw clearer conclusions about the developmental processes involved. Second, the instruments were self-report, and, consequently, they suffer from well-known biases, such as social desirability and memory recall biases. Future research should therefore integrate other methodologies to corroborate self-report accounts (e.g., online behavioral tracking data). Third, possible comorbidities and their possible influence on susceptibility for videogame activities were not taken into account. Future research needs to assess the VASC in relation to other variables that are known to be associated with problematic gambling (e.g., mood disorders such as depression and anxiety). Fourth, although the sample size was sufficiently large for research, findings could be considered non-representative of Italian child and young adolescent population. Future research should use more nationally representative samples.

Overall, the findings concerning the psychometric proprieties of the VASC were confirmed. More specifically, (i) the original four dimensional first-order factor structure identified by Yılmaz and colleagues (Yılmaz et al. 2017) as the best model among children and young adolescents; (ii) its multidimensional structure

tapping into different, yet related, domains of videogame addiction; (iii) its measurement invariance across age groups and gender; and (iv) its construct validity by using a person-centered approach, which provided evidence of two distinct profiles (high videogame playing vs. low videogame playing profile), along with specific patterns of associations with personality traits and social self-concept, as well as an effect of gender \times profile interaction on some personality traits, such as conscientiousness and emotional instability, suggesting gender differences need to be further explored. However, additional refinements and adjustments are needed, for example, considering a reevaluation of Item 7 and the improvement of the measurement invariance characteristics with reference to gender.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the University's Research Ethics Board and with the 1975 Helsinki declaration.

Appendix

Table 7 The Italian version of the Video Game Addiction Scale for Children

Subscale	Items
Deficit autocontrollo	1. Non posso resistere a non giocare ai videogiochi anche se questi giochi mi possono far male
	2. Anche se controllo la quantità di tempo che passo giocando ai videogiochi, dopo un po' riprendo a giocare in maniera incontrollabile
	3. Credo che qualunque cosa faccia, non riesco a controllare il tempo che passo a giocare ai videogiochi
	4. Non posso smettere di giocare ai videogiochi, anche se penso di aver passato tanto tempo a giocare con loro
	5. Non sono interessato a nient'altro mentre gioco ai videogiochi
	6. Sebbene voglia ridurre la quantità di tempo passato a giocare ai videogiochi, fallisco ogni volta
Premio/rinforzo	7. Dimentico i miei problemi mentre gioco ai videogiochi
	8. Nei videogiochi sono contento quando sconfiggo i miei nemici o supero un livello
	9. Nei videogiochi mi sento più forte dei miei nemici quando li sconfiggo o supero un livello
	10. Penso che giocare ai videogiochi sia un'attività molto divertente
	11. Nei videogiochi la mia autostima aumenta quando sconfiggo i miei nemici o supero un livello
Problemi	12. Non mi annoio quando gioco ai videogiochi
	13. Sono felice quando gioco ai videogiochi
	14. Giocare ai videogiochi non mi permette di portare a termine i miei compiti
	15. Giocare ai videogiochi mi impedisce di mangiare pasti regolari
Coinvolgimento	16. Giocare ai videogiochi mi impedisce di passare del tempo con la mia famiglia
	17. Ho problemi di sonno a causa dei videogiochi
	18. Parlo sempre di videogiochi con i miei amici
	19. Faccio amicizia attraverso i videogiochi online
	20. Vedo i personaggi dei miei videogiochi nei sogni.
	21. Mi comporto come i personaggi dei videogiochi nelle mie attività giornaliere.

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