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Research paper

How can we measure gambling craving among adolescent gamblers? Psychometric properties of the *Gambling Craving Scale*

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ABSTRACT

Background: Craving plays an important role in behavioural addictions such as Gambling Disorder (GD). However, it has only been included as a diagnostic criterion for substance addiction. Moreover, research on craving has focused mainly on adults, leaving out adolescents who can also be heavily involved in gambling behaviour. The purpose of this study was to investigate the psychometric properties of the most widely used craving assessment scale, the *Gambling Craving Scale* (GACS), in adolescent gamblers.
Method: For the current study, 1246 adolescent gamblers attending secondary school were recruited to complete a self-report questionnaire online. The psychometric properties of the GACS were examined: Confirmatory factor analysis was conducted; reliability was examined using the internal consistency method; in terms of validity, the relationship between the GACS total and subscale scores with some risk factors for problem gambling, gambling frequency and gambling problem severity was analyzed.
Results: The factor analysis supported the three-factor structure, and good internal consistency was found for the GACS total scale and its three subscales. As regards validity, the GACS subscales resulted to be significantly and positively associated with economic perception of gambling and outcome expectancy, gambling-related cognitive distortions, gambling frequency, and problem gambling.
Limitations: The findings of this study were based on self-report data and only criterion validity was analyzed.
Conclusions: The GACS is a valid and rapid self-report measure of gambling craving in adolescent gamblers. In terms of prevention, the multidimensionality of the GACS is important for interventions. Clinical samples of adolescents are needed to confirm the validity of the scale.

1. Introduction

Gambling Disorder (GD) is defined as a persistent and recurrent problematic gambling behaviour leading to clinically significant impairment or distress in the latest version of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013) and in the recently published eleventh *International Classification of Diseases* (World Health Organization, 2018). In both the classification systems, GD has been included as a non-substance addictive disorder, as a large body of evidence highlighted important similarities between substance-related disorders and non-substance related disorders (e.g., Clark, 2010; Goudriaan et al., 2006; Potenza, 2006). One of the aspects that the two different forms of addictions share is *craving*, a multidimensional construct which includes, in addition to the dimension of the impulsive desire to use the substance/act the behaviour, the dimension of relief from negative feelings as a consequence of the use of the substance/action of the behaviour, and the dimension of anticipation, that is, the intention to use the substance/to do a certain behaviour with the expectation that it will elicit positive affect states such as gratification and pleasure (Brand and Potenza, 2021; Cornil et al., 2018; Young and Wohl, 2009). In recent decades, it has become widely accepted that craving plays a fundamental role also in behavioural addictions (Hasin et al., 2013; Tiffany and Wray, 2012). Nevertheless, craving has been included as a diagnostic criterion only for substance use addictions and not for the diagnosis of GD (DSM-5; APA, 2013).

This is very surprising as craving plays a fundamental role in the relationship with gambling behaviour. It has been demonstrated that the intensity of the desire to gamble is closely related with frequency and intensity of gambling behaviour (de Castro et al., 2007; Ladouceur et al., 2007). According to some scholars, craving plays a predictive role in

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relation to the severity of gambling (Ciccarelli et al., 2019; Hawker et al., 2021; Quintero et al., 2020). Furthermore, craving appears to be correlated to the cognitive aspects underlying gambling. Specifically, the strong and urgent desire to gamble is associated with greater gambling-related cognitive distortions as well as positive perceptions of gambling (Ashrafioun and Rosenberg, 2012; Cornil et al., 2018). This relationship is particularly important as cognitive distortions play a central role in the mechanism that explains gambling behaviour and problem gambling (Cornil et al., 2018). Research concerning craving has focused mainly on adults, while it is widely attested that problem gambling in adulthood frequently originates from early involvement in gambling (e.g., Blaszczynski and Nower, 2002; Calado et al., 2017a; Volberg et al., 2010). Moreover, nowadays, legalized gambling opportunities have arisen and new forms of gambling have been developed, especially in regard to Internet-based activities and new media contexts (Macey and Hamari, 2018). For this reason, there has been a rapid increase of the prevalence of adolescent gambling (see, for a review, Calado et al., 2017a). International studies report that gambling is exceedingly common among adolescents. This trend has been reported in various parts of the word, such as Canada, the United States, the United Kingdom, Australia and Nordic countries, where it is reported that an average of 60–80%of young people aged 13–17 years gambled at least once per year, with 3–5 % of adolescents displaying signs of problem gambling (Håkansson, 2020; Jenkinson et al., 2020; Kang et al., 2019; Lawn et al., 2020). Problem gambling is now one of the most frequently reported addictions among young people (Riley et al., 2021). Indeed, if practiced excessively, gambling behaviour can become problematic, even in adolescents. Calado et al.' (2017a) review attests that a proportion of youth comprised between 0.2 % and 12.3 % develop negative psychosocial consequences due to their gambling behaviour, i.e., symptoms of GD. Among adolescents, gambling craving discriminates across different and progressively severe categories of adolescents (Ciccarelli et al., 2019), and the components of anticipation and desire are significant predictors of gambling severity (Ciccarelli et al., 2020).

These studies have been conducted by using the *Gambling Craving Scale* (GACS; Young and Wohl, 2009), a self-report instrument developed for adults. Over the years, several scales have been developed for the assessment of gambling-related craving in adults. However, the GACS is the most widely used instrument with adult gamblers. It consists in nine items with a seven-point Likert scale, and it has a multidimensional structure. Specifically, the authors theorized craving as a construct that refers not only to desire as a means of experiencing positive affect, but also to the desire to be relieved of negative affects together with an anticipatory component, for which an expectation of experiencing pleasure is created. The GACS was developed starting from a pool of eighteen items selected from Tiffany and Drobes' (1991) questionnaire on craving for cigarette smoke, adapting them to the gambling context. In detail, items were rephrased in order to measure craving to gamble consisting of the desire to gamble, anticipation of immediate positive subjective experiences from gambling, intention to gamble, immediate relief from negative subjective experiences believed to result from gambling. Moreover, content validity was assessed by consulting academicians expert in gambling (Young and Wohl, 2009). Starting from these items, through an Exploratory Factor Analysis (EFA), they extracted a structure with three correlated factors, from which they selected the nine items with the highest factor loadings. The result of the analysis was the GACS, that consists in three correlated dimensions: *Anticipation*, i.e., the expectation of pleasure resulting from the bet, *Desire*, i.e., the strong and impulsive desire to gamble in order to experience positive affect, and *Relief*, intended as the relief of negative affect after gambling. Young and Wohl (2009) found good psychometric properties of the GACS in terms of reliability and validity in a sample of university students who claimed to be gamblers. The instrument showed good internal consistency, with Cronbach's Alpha values between 0.81 and 0.85. Regarding validity, positive and significant correlations between the three GACS dimensions and gambling-related cognitive biases, depression, and positive and negative affect related to gambling, were found. Moreover, *Desire* and *Relief* were found to be significant and positive predictors of gambling problem severity.

Given the current lack of psychometric evidence of a measurement instrument for gambling craving in adolescents, the general goal of the present study was to give a contribution to the focus on the construct of craving in the field of adolescent gambling starting from its measurement, given that currently there is a lack of psychometric evidence. This goal is motivated by several reasons: i) the high rate of gamblers among teenagers (Riley et al., 2021), ii) the role of craving in gambling, as a predictor of gambling behaviour in youth (Ciccarelli et al., 2020), iii) the role of craving as a factor of maintaining the disorder in gamblers (Duvarci and Varan, 2000), that makes conceivable that it may be a maintaining factor even for adolescents. Due to its wide use with different clinical and non-clinical populations (e.g. university students, non-gamblers, gamblers, individuals with GD), we chose the GACS as the targeted instrument. This choice is also explained by the fact that it is a brief scale grasping the multidimensionality of the construct, that represents a great advantage, as previous studies have shown that various declines of craving are differently related to various aspects of gambling. For instance, high scores in *Desire* are associated with higher gambling problem severity (Young and Wohl, 2009), and *Anticipation* and *Desire* are strong predictors of the gambling behaviour itself, in particular in teenagers (Ciccarelli et al., 2020). A psychometric analysis of the scale should also enrich a deeper knowledge about the adequacy of the scale. In fact, despite the wide use of the scale, to the best of our knowledge, there are few studies investigating its psychometric properties (Mallorquí-Bagué et al., 2023), and no psychometric study exists with adolescent gamblers.

More specifically referring to adolescents, the availability of a psychometrically sound measure for gambling craving in adolescence is also important if we think to its employment in prevention. As reported in Keen and colleagues' systematic review about adolescent gambling prevention (Keen et al., 2017), one of the difficulties of preventive interventions with adolescents are behavioural modifications, i.e., only in some cases the improvement in reasoning about gambling produced a reduction of gambling frequency and problem gambling symptoms in the long term (with some exceptions, e.g., Donati et al., 2014; Williams et al., 2010). Having a brief and sound instrument able to measure gambling craving would give important advantages for prevention. Since gambling craving is related to the momentary state of the respondent, it can be easily measured at the pre-test and a post-test of a prevention program without having to wait for a long-term follow-up. At the same time, given that gambling craving resulted to be predictive of problem gambling severity and behaviour in adolescents (Ciccarelli et al., 2020), if a significant reduction is found in craving from pre-test to post-test, this could be considered a valuable indicator of the efficacy of the intervention.

In detail, in the current study, we aimed at confirming the three-factor correlated structure of the scale (Young and Wohl, 2009) by conducting a Confirmatory Factor Analysis (CFA) after a preliminary evaluation of items distribution. We also aimed at evaluating the reliability in terms of internal consistency by computing the Omega Coefficient (McDonald, 1999) for each subscale and the total score. Indeed, based on a factor analytic model, coefficient omega uses the item factor loading and uniqueness to estimate reliability, thus allowing us to have a more precise estimate of reliability with respect to Alpha Coefficient (Cronbach, 1951). We were also interested in examining the validity of the GACS by examining the relationships between the three dimensions of the GACS and some well-known risk factors for problem gambling in adolescence, such as economic optimistic perceptions of gambling (e.g., Delfabbro and Thrupp, 2003; Delfabbro et al., 2006; Donati et al., 2013; Moore and Ohtsuka, 1999), positive expectations towards the economic advantages related to gambling (Gillespie et al., 2007), gambling-related cognitive distortions (e.g., Calado et al., 2017b; Donati et al., 2018; Huic et al., 2017) and gambling frequency (Donati et al., 2018; Vachon et al.,

2004). We expected to find positive and moderate in size correlations between the GACS subscale scores and all the variables taken into account, being them risk factors for adolescent problem gambling. In doing this validity analysis, we used a more update and psychometrically sound measure of adolescent problem gambling with respect to previous studies (Ciccarelli et al., 2019; Ciccarelli et al., 2020). Indeed, we employed the *Gambling Behaviour Scale – For Adolescents* (GBS-A; Primi et al., 2015), that has been developed by referring to the conceptualization of GD in the DSM-5 (APA, 2013) and that provides an Item Response Theory (IRT) - based scoring system that has been derived from the different severity of the symptoms and that resulted in being gender invariant among adolescents (Donati et al., 2017).

We conducted the study using a wide sample of Italian adolescents. The Italian Institute of Physiology of the National Research Council (IFC-CNR, ESPAD report, 2019) showed that 44 % of Italian adolescents aged 15–19 years declare that they have gambled at least once in the last 12 months, of which 40 % are adolescents under 18 years of age. Moreover, 13.5 % of them are high-risk gamblers, while 7 % have already developed problem gambling behaviour. These data were confirmed by the results of a gambling prevention project in Tuscany (PRIZE project; Donati et al., 2022a, 2022b), which showed that 75 % of adolescents reported having gambled at least once in the last 12 months and that 49 % of them do so regularly. Also from this study, it appears that the first experience with gambling is, on average, at the age of 12, although it is prohibited in Italy for children under 18, and that approximately 12 % of those who report gambling exhibit risky gambling behaviour, and approximately 6 % already exhibit problem gambling behaviour.

2. Materials and methods

2.1. Participants

The whole sample was composed of 1246 adolescent gamblers (67 % males) aged from 13 to 22 years (mean age = 16.40, *SD* = 1.22) attending high schools in Tuscany (Italy). Participants attended different types of high schools: Vocational schools (16 %), technical schools (41 %), and lyceum (43 %). All the secondary schools in Tuscany were invited to take part to a regional gambling prevention program (PRIZE 2 [Prevention of gambling risks among adolescents], Resolution of the Tuscany Region n. 1489, 30 November 2020). Thirty-four schools participated to the project (about 10 %). The characteristics of these schools in terms of typology (lyceum, technical, vocational schools) were consistent with the regional features of the school population and they covered all the three macro-areas of Tuscany (North-West, Centre, South-East). The project was approved by the institutional review boards at each school through a detailed study protocol which explained the project's goal and methodology. The students received an information sheet, which assured them that the data obtained would be handled anonymously. Parents were informed with a short study description and asked to provide their informant consent. Parents of adolescents aged <18 years were required to provide consent on behalf of their children. Adolescents aged 18 years or older were asked to give their personal consent together with the parental consent.

2.2. Measures and procedure

A research protocol was administered to all participants during school hours by educators and psychologists that, being recruited for the PRIZE 2 program, they were trained at conducting in the classrooms sessions dedicated to assessment as well as educational activities. The administration of the research protocol occurred between January and February 2022. The healthcare operators went to the classrooms and students filled in the protocol via mobile phone through an access link.

Preliminarily, we requested socio-demographic information such as sex, age, type of school and the school level. Then, the Italian version of the GACS (Young and Wohl, 2009) was administered. It was obtained performing a forward and backward translation procedure. In the first phase, two translators independently translated the scale into Italian. The two versions were compared and an accordance to a final version was obtained. Through this process, we achieved the final Italian version of the GACS. The GACS is a 9-item measure that assesses gambling-related craving: *Anticipation*, defined as intention to bet with the expectation that the bet will be fun and enjoyable; *Desire*, explained as strong and urgent desire to play; and *Relief*, i.e., Relief from a negative feeling by gambling (Young and Wohl, 2009). Example of items for each dimension are respectively "*Gambling would be fun right now*", "*I have an urge to gamble*", and "*Gambling would make me less depressed*". The scale has a 7-point Likert-type response format that requires respondents to indicate the extent of their agreement to the items (from 1, *total disagreement*, to 7, *total agreement*). Higher scores indicate higher levels of craving for gambling.

Gambling behaviour and relative severity were investigated through the GBS-A (Primi et al., 2015). The scale consists of two sections. Section A consists of questions aimed at detecting the type of gambling activity involved in and relative frequency in the last month. Nine gambling activities are taken into consideration: Cards games, bets on games of personal skills, bets on sports games, bets on horse races, bingo, slot machines, scratch cards, lotteries, and private bets with peers. For each activity, it is required to report the frequency of engagement in the previous month: *never* (0), *once a month* (1), *sometimes a month* (2), *sometimes a week* (4), *everyday* (4). An overall frequency of gambling engagement is then computed by summing each activity's frequency (range: 0–36). Moreover, based on their responses to this section, participants were identified as non-gamblers (no gambling behaviour) or gamblers (gambling on at least one activity; Welte et al., 2009). From this section, it is also possible to derive the number of gambling games done, the betting mode (online or offline), the social partners of gambling and the age of the first betting experience.

Section B is made up of nine items (e.g., "*Does gambling led you to lose interest in studying or working?*") with a 3-point Likert response format (*never*, *sometimes*, *often*) that reflect the symptoms of GD proposed in the DSM-5 (APA, 2013). Based on the responses to this section, it is possible to derive an IRT - based score for each respondent. Following the IRT-based scoring procedure, respondents can be classified into non-problem gamblers, at-risk gamblers, and disordered gamblers. The internal consistency was adequate in this sample with McDonald's ω of 0.78 (95 % CI [0.73, 0.82]).

To measure the economic perception of gambling, the *Gambling Attitude Scale* (GAS; Delfabbro and Thrupp, 2003; Italian version: Primi et al., 2013) was used. It contains nine Likert-type items, using a 5-point scale ranging from *strongly disagree* to *strongly agree*, yielding a maximum score of 45. An example of an item is "*You can make a living from gambling*". Total scores on the scale were calculated so that high scores corresponded to an optimistic perception of gambling (Delfabbro et al., 2009). In this study the scale had good reliability with a McDonald's ω of 0.82 (95 % CI [0.80, 0.83]).

Positive expectations towards the economic advantages related to gambling were assessed through the *Money* subscale of the *Gambling Expectancies Questionnaire* (GEQ; Gillespie et al., 2007), revised in a modified form and adapted for Italian adolescents (GEQ – MOD; Donati et al., 2022a, 2022b). The scale is composed of three Likert-type items with a 5-point scale (rather than a seven-point Likert scale). An example of item of the *Money* subscale is "*If you were gambling, gambling would make you… Getting rich*". McDonald's ω for the current sample was very good (McDonald's ω of 0.85 (95 % CI [0.83, 0.86])).

The *Gambling Related Cognition Scale – Revised for Adolescents* (GRCS – RA; Raylu and Oei, 2004; Italian version for adolescents: Donati et al., 2015; Donati et al., 2022a, 2022b) is a tool for the self-report evaluation of cognitive distortions on gambling. The scale consists of 14 items that reflect specific erroneous thoughts about gambling: *Illusion of Control* ("*Specific numbers and colours can help you increase your chances of* winning"), *Predictive Control* ("*Losses when gambling, are bound to be followed*

by a series of wins"), and *Interpretation Bias* ("*Relating my winnings to my skill and ability makes me continue gambling*"). In addition to calculating the specific scores for each cognitive bias, it is possible to compute a total score indicative of erroneous beliefs about gambling. The reliability of the total scale, tested with McDonald's ω was 0.91 (95 % CI [0.90–0.91]), it was 0.82 (95 % CI [0.80, 0.83]) for *Illusion of Control*, 0.80 (95 % CI [0.79, 0.81]) for *Predictive Control*, and 0.76 (95 % CI [0.74, 0.78]) for *Interpretation Bias*.

2.3. Statistical analyses

Preliminarily, we described gambling behaviour in the sample. The psychometric analyses on the GACS were conducted only on those adolescents who reported having gambled in the previous month. To assess the normality of the responses distribution at the GACS, an item analysis was performed with the Statistical Package for the Social Sciences (SPSS 21.0, IBM Corp., 2012) by looking at mean, skewness and kurtosis indices (Joanes and Gill, 1998). To check symmetry, skewness and kurtosis were measured; to be acceptable, these indices must fall between −1 and +1. Furthermore, a Shapiro-Wilk test was performed to verify if the distribution of the GACS items departed significantly from normality.

To assess the dimensionality of the scale, a CFA was conducted by employing the Mean-adjusted Maximum Likelihood (MLM) estimator (Mplus software; Muthén and Muthén, 2004), which provides measures of fit for non-normal sample data. In detail, it appears to be a good general approach to dealing with non-normality (Curran et al., 1996; Hu et al., 1992). To verify the model's fit, the Comparative Fit Index (CFI; Bentler, 1990), the Tucker-Lewis Index (TLI; Tucker and Lewis, 1973), and the Root Mean Square Error of Approximation (RMSEA; Steiger and Lind, 1980) were taken into account. For the TLI and CFI indices, values above 0.90 are indicative of acceptable fit, while values above 0.95 indicate excellent fit (Hu and Bentler, 1999). The RMSEA value is considered acceptable when it is below 0.08 and good when it is below 0.05 (Kline, 2010).

McDonald's ω coefficient was calculated for the internal consistency analysis. We employed the criteria proposed by the European Federation of Psychological Assessment (EFPA; Evers et al., 2013) to assess the size of the internal consistency coefficients.

As regards validity, we investigated the bivariate correlations between the three GACS dimensions and economic perception of gambling, positive expectations towards the economic advantages related to gambling, gambling-related cognitive distortions, gambling frequency and gambling problem severity.

3. Results

First, a missing analysis was conducted in order to identify cases with >10 % of missing values. No such case was found. For cases with <10 % of missing values, missing was replaced with the mean value, following the validation study (Young and Wohl, 2009). This replacement was conducted only for 1 % of the participants ($n = 13$). Descriptives for each item have also been computed separately for non-problem, at-risk, and disordered gamblers (Supplementary Materials I).

3.1. Gambling behaviour description

The most popular gambling activities, both in online and offline mode, were Instant scratch-cards (38 % of the sample gambles online and 51 % offline) and private bets with peers (26 % of the sample reported to betonline, and 32 % declared they bet offline). Another popular offline gambling activity was betting on sporting events (34 %). With regard to problem gambling, 9 % of adolescent gamblers resulted to be at-risk for GD, while 3 % showed GD symptoms. Consistent with the goal of the present study, the subsequent analyses on the GACS were conducted on adolescent gamblers.

3.2. Item analysis

Univariate distributions of the GACS items were examined to assess normality. The indices did not demonstrated a good assimilation to normality. Skewness and kurtosis indices were between −1 and +1 only for items 1, 2 and 3. For all other items, the indices were outside the range of normality (Table 1). Furthermore, the Shapiro-Wilk test showed that the distribution of the GACS items departed significantly from normality (all $ps < 0.001$). Item descriptives separately for non-problem, at-risk and disordered gamblers are reported in Supplementary Materials I.

3.3. Dimensionality

The confirmatory factor analyses employing the mean-adjusted maximum likelihood (MLM) estimator were employed. The tree-factor structure was tested and the results showed a good fit (TLI = 0.919, CFI = 0.946, RMSEA = 0.074, (90 % CI [0.064, 0.085])). Each item loaded strongly and significantly on its hypothesized factor with factor loadings ranging from 0.42 to 0.94. The correlations between the three factors ranged from 0.37 to 0.70 (Fig. 1).

After finding support for the three-dimensional structure, we computed the total and subscale scores separately for non-problem, at-risk, and disordered gamblers (Supplementary Materials I).

3.4. Reliability

Omega value for the overall scale was 0.81 (95 % CI [0.79, 0.82]) and all the corrected item-total correlations were above 0.30, ranging from 0.30 to 0.70. The value of omega did not increase if any item was deleted. Omega was 0.70 (95 % CI [0.67, 0.72]) for the *Anticipation* subscale, 0.89 (95 % CI [0.88, 0.90]) for the *Desire* subscale, and 0.82 (95 % CI [0.81, 0.84]) for the *Relief* subscale. Following the cut-offs proposed by the EFPA (Evers et al., 2013), the values of internal consistency were good for the scale and the subscales.

3.5. Validity

The bivariate correlations between the three GACS dimensions and economic perception of gambling, positive expectations towards the economic advantages related to gambling, gambling-related cognitive distortions, gambling frequency and gambling problem severity were computed.

We found that the GACS total score was significantly and positively related to all the variables taken into account, with correlation coefficients ranging from 0.30 to 0.44. The correlations were moderate in size especially with the economic perception of gambling and gambling problem severity. The GACS subscale scores were also significantly and positively related to all the criterion variables, with some specific patterns that could be recognized. For instance, *Anticipation* displayed the

Table 1
Means, standard deviations, skewness, and kurtosis of the items of the Gambling Craving Scale (GACS).

Item	*M*	*SD*	Skewness	Kurtosis
1	3.56	1.53	−0.02	−0.59***
2	3.21	1.66	0.30	−0.82
3	3.42	1.96	0.22	−1.15
4	1.73	1.29	2.05	4.06
5	1.52	1.14	2.78	8.14
6	1.40	1.04	3.29	11.70
7	1.66	1.26	2.32	4.86
8	1.55	1.18	2.55	6.56
9	1.66	1.23	2.14	4.39

Note. 7-point Likert Scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).
*** $p < .001$, $n = 1246$.

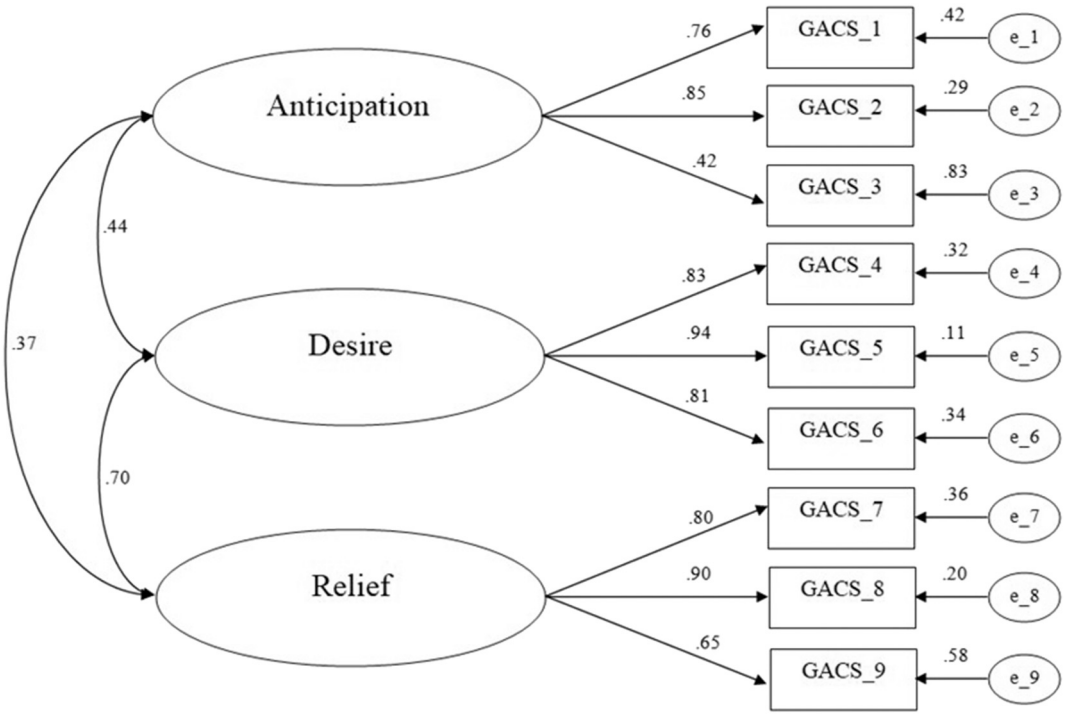

Fig. 1. The tree-factor model of the *Gambling Craving Scale* (GACS) in adoscelent-gamblers sample (n = 1246).

highest coefficient with the variables related to the economic perception and outcome expectancy towards gambling, while *Relief* was the GACS subscale that had the highest correlations with gambling-relate cognitive distortions. Concerning the relationship with gambling frequency and gambling problem severity, *Anticipation* and *Desire* had equivalent and higher correlations – with respect to *Relief* (Table 2).

To provide evidence of further validity and replicability of our results, we conducted the correlation analyses in another independent sample of adolescents. We found additional support of criterion validity (see Supplementary Materials II).

4. Discussion

Among adolescents, craving discriminates across different and progressively severe categories of gamblers (Ciccarelli et al., 2019), and it is associated with gambling severity (Ciccarelli et al., 2020; Ciccarelli et al., 2022). The general goal of this study was to analyze the psychometric properties of the instrument most widely employed to measure gambling craving both in adults and adolescents, i.e., the GACS (Young and Wohl, 2009). Despite its wide use, relatively scan evidence exists about its psychometric adequacy (Young and Wohl, 2009), with no psychometric study with adolescents.

Results indicated that, when administered to adolescents, the GACS displays characteristics comparable with those reported for adults (Young and Wohl, 2009). Specifically, the factor analysis supported the three-factor structure of the scale, and good internal consistency was found for the GACS total scale and its three subscales. Extending the research about its validity, we showed that the GACS total and subscale scores were significantly and positively related to GD symptoms based on the DSM-5 (APA, 2013). This result makes evidence that gambling craving is related to GD symptomatology, especially the dimension of *Anticipation* and *Desire*, confirming what previously found among adult and adolescent gamblers (Ciccarelli et al., 2020; Young and Wohl, 2009).

Table 2
Pearson correlations between the Gambling Craving Scale (GACS) subscale and total scores, optimistic perception of gambling, economic expectation of gambling, cognitive distortions on gambling, gambling frequency, and gambling problem severity.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. GACS - total score	–											
2. GACS - anticipation	0.76***	–										
3. GACS - desire	0.83***	0.38***	–									
4. GACS - relief	0.78***	0.30***	0.65***	–								
5. Economic perception of gambling	0.43***	0.40***	0.28***	0.30***	–							
6. Economic outcome expectation towards gambling	0.31***	0.28***	0.23***	0.21***	0.42***	–						
7. Gambling-related cognitive distortions	0.37***	0.24***	0.31***	0.34***	0.50***	0.42***	–					
8. Illusion of control	0.30***	0.17***	0.28***	0.29***	0.45***	0.34***	0.88***	–				
9. Predictive control	0.35***	0.23***	0.29***	0.32***	0.47***	0.42***	0.94***	0.75***	–			
10. Interpretation bias	0.33***	0.23***	0.27***	0.30***	0.42***	0.39***	0.89***	0.68***	0.75***	–		
11. Gambling frequency	0.38***	0.33***	0.32***	0.24***	0.23***	0.21***	0.19***	0.16***	0.18***	0.18***	–	
12. Gambling problem severity	0.44***	0.36***	0.38***	0.32***	0.20***	0.22***	0.22***	0.18***	0.20***	0.22***	0.41***	–
M	19.70	10.19	4.64	4.86	17.96	8.77	28.15	7.26	12.50	8.39	2.97	1.14
SD	8.14	4.06	3.15	3.14	6.08	3.06	10.40	3.39	4.64	3.44	3.15	2.18

Note. GACS = *Gambling Craving Scale*.
*** $p < .001$, n = 1246.

Moreover, we confirmed and extended results about the validity of the scale. In fact, we further support the positive relationships with gambling-related cognitive distortions (Young and Wohl, 2009), and we also provided results attesting that gambling craving is positively associated with economic attitude and outcome expectancies towards gambling, especially the *Anticipation* dimension. As *Anticipation* relies with the expectation of the pleasure following gambling, and *Desire* corresponds to the strong and impulsive desire to gamble in order to experience positive affect, these dimensions seem to be more linked to anticipatory aspects of gambling rather on gambling's outcomes, as for *Relief*, which is particularly related to gambling-related cognitive distortions that rely with erroneous cognitions with respect to gambling outcomes and interpretation of consequences after betting. Overall, our findings attested that the GACS is a brief, multidimensional, valid and reliable instrument useful to measure gambling craving in adolescent gamblers.

5. Conclusion

Craving plays a fundamental role in behavioural addictions, especially in GD (e.g., Ciccarelli et al., 2019; Hawker et al., 2021; Quintero et al., 2020), and not only in substance-use disorders (Hasin et al., 2013; Tiffany and Wray, 2012). Nevertheless, craving has been included as a diagnostic criterion only for substance use addictions and not for the diagnosis of GD (DSM-5; APA, 2013). Moreover, research concerning craving has focused mainly on adults, consistently leaving out the adolescents, who instead turn out to be highly involved in gambling behaviors (Calado et al., 2017b).

Indeed, this study highlights and confirms the relationships between gambling craving and GD symptoms in adolescent gamblers. According to the Elaborated Intrusion Theory of Desire (EIT) (Kavanagh et al., 2005; May et al., 2015), mental imagery is a core feature for craving, that is conceptualized as a higher order cognitive process that involves mental imagery – more than verbal thoughts (Månsson et al., 2023) – of the desired object or behaviour. External cues associated with the behaviour set off anticipatory autonomous responses, e.g., increased arousal. Such craving imagery has the potential to activate sensory processing without actual sensory input, allowing for an elaboration of the emotional responses of pleasure. In laboratory studies, cue-induced craving is a well-established paradigm where images of addiction stimuli are presented in a controlled setting, and experimental studies have shown that mental imagery tasks can be used to promote satiation and habituation to the desired stimulus (see Månsson et al., 2023). Much more experimental research is needed with addicted and non-addicted adolescent gamblers to understand the phenomenology of craving more deeply in relation to gambling. The employment of the GACS may allow researchers to have a rapid self-reported measure of gambling craving, that may hopefully accompanied by physiological measures and behavioural tasks.

Given that desire thinking is a voluntary cognitive process that involves the perseverative focus on memories, images and information related to a desired target (Caselli and Spada, 2011), an avenue that could be taken in treatment may be the employment of technological instruments that could give the possibility to experience gambling cues in safe and controlled settings. Experimental studies have shown that mental imagery tasks can be used to promote satiation and habituation to the desired stimulus (Morewedge et al., 2010). In this regards, based on the relapse prevention (RP) model proposed by Marlatt and Gordon (1985), an innovative psychological treatment for GD by using Virtual Reality has been proposed (Giordano et al., 2022). The protocol is based on a virtual serious game, i.e., a game designed for purposes other than entertainment, to prevent relapse in gambling behaviour by increasing self-efficacy in managing craving and emotional states and by reducing perceived gambling craving. Indeed, virtual environments are made ad hoc for the exposure of gamblers to specific gambling cues, directed at the detection and management of craving. Such protocols should be conducted with adolescents suffering from GD, by verifying its efficacy with the GACS, among other assessment measures.

With regards to prevention, it is important to consider that different emotional states appear to be related to the desire to gamble, based on the severity status. Particularly, among non-clinical gamblers, the most commonly reported trigger is positive affect (Cornil et al., 2018), in contrast to players with clinical disorders in which negative moods are more common (Månsson et al., 2023). For this, the primary and secondary prevention intervention levels should be differentiated. Inside universal preventive programs, it seems that acting on cognitive protective factors (e.g., probabilistic reasoning, understanding of randomness) as well as affective risk factors (optimistic perception of gambling, risk-taking) is effective in reducing gambling craving (Donati, 2023). Thus, being craving a cognitive process, and not only an affective desire (Månsson et al., 2023), such kinds of interventions should be conducted taking in mind that craving is recognized as a motivating experience in dependence (May et al., 2010); thus, a reduction of craving should hopefully lead to a reduction of gambling behaviour. Instead, for adolescents characterized by high levels of gambling frequency and severity, a targeted preventive intervention aimed at more clearly understand the positive affective states obtainable through gambling and the negative affective states that are trying to decrease through gambling should be conducted.

This study offers several notable strengths, including the large sample size and the investigation of the psychometric properties of the GACS in a sample of adolescent gamblers. However, the findings of this study were based on self-report data and this was a cross-sectional study involving a sample of public school students. Future research should focus on adolescents who do not attend high school. Moreover, clinical samples of adolescents are needed to confirm the validity of the scale. For instance, convergent validity of the GACS should be evaluated by using nonverbal and proxy measures of craving (Ashrafioun and Rosenberg, 2012), such as psychophysiological arousal in response to gambling-related stimuli (e.g., heart rate, skin conductance, electromyography).

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CRediT authorship contribution statement

Maria Anna Donati: Conceptualization, Methodology, Investigation, Writing. **Costanza Gori:** Software, Collaboration in writing - Original draft preparation. **Caterina Primi:** Supervision, Writing - Reviewing and Editing.

Declaration of competing interest

All authors declare that they have no conflict of interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2023.10.133.

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