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GamCog: Adapting the Gambling Related Cognitions Scale (GRCS) for video game-related gambling

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Abstract

"Gamblification" is a rapidly emerging form of media convergence between the more chance-based activity of gambling and the more skill-based activity of (video) gaming, for example in the competitive video gaming known as esports. The marriage of video gaming and gambling has been theorised as bringing about new forms of gambling-related cognitive processes in individuals and affecting the ways in which they approach and evaluate gambling situations. As such, a pertinent research problem is whether existing measurement instruments designed to identify gambling related cognitions can be employed in this new context and population, and if not, how they can be adapted. Therefore, in this study, we investigate the psychometric properties of Gambling Related Cognitions Scale (GRCS) and a series of items developed following a review of existing literature. We employ three separate datasets gathered from video game players who also gamble (N = 442; 391; and, 335). The results indicate that the GRCS is not a robust measure to use for video game players who gamble; the new GamCog measure was, therefore, developed to address this gap. The study implies that the most significant cognitive differences between video game players and the wider population are the ways in which concepts of skill and luck are perceived, potentially due to the sense of personal agency engendered by video games.

Keywords: Gamblification, Gambling, Virtual goods, Video games, Cognitive bias

1 Introduction.

Gambling has become increasingly normalised as part of contemporary western culture, with increased regulatory liberalisation a characteristic of recent years (Kingma, 2006; Markham & Young, 2015). This trend is evident in the "gamblification" of media spaces, an example being the convergence of video gaming and gambling which has become a prominent online phenomenon (D. King, Delfabbro, & Griffiths, 2010a; Lopez-Gonzalez & Griffiths, 2016; Macey & Hamari, 2018). The convergence of video gaming and gambling is usually associated with esports (Gainsbury, Abarbanel, & Blaszczynski, 2017), virtual items and currencies (Lehdonvirta, 2009; Hamari and Keronen, 2017) and the free-to-play business model (Gainsbury, Russell, King, Delfabbro, & Hing, 2016). Concerns about the potential effects of gamblified media have resulted in a debate about the moral, ethical, and legal status of gamblified products and services (Griffiths, 2018; King & Delfabbro, 2018; Martinelli, 2017).

Researchers in the field have theorised that the combination of skill-based video gaming and chance-based gambling may result in cognitions which differ from those endorsed by non-gaming gamblers. Examples of such potential cognitions can be found in respect to: the effect of gaming on perceptions of control over chance-based events (King, Ejova, & Delfabbro, 2012); the role of Locus of Control (Toprak, 2013); the desirability of gambling (Gainsbury *et al.*, 2015; Gainsbury, King, *et al.*, 2016); and manner of video game consumption (Gainsbury, et al., 2016).

Cognitions related to gambling have been shown to be heavily influenced by an individual's cultural background, and further reinforced through social connections such as family (Okuda, Balan, Petry, Oquendo, & Blanco, 2009). With this in mind, it appears that treating, measuring and understanding newly emergent forms of game-related gambling by simply utilising existing cognitive frameworks may prevent us from fully understanding these new phenomena. For example, the role of skill development in video game play may serve to reduce superstitious beliefs, such as the influence of a “lucky” colour, or routine. Therefore, ways to measure cognitive processes related specifically to video game-related gambling are needed.

Several measurement instruments exist for identifying gambling-related cognitions, developed for use in clinical and non-clinical environments, and for specific gambling activities. However, the newly emergent activities of video game-related gambling have created a new context for participation, resulting in a gap in this space.

The primary aim of this research is, therefore, to investigate the psychometric properties of an existing instrument (Gambling Related Cognitions Scale) in order to investigate the validity and fit of the instrument in the context of video game-based gambling. Additionally, this work will investigate cognitions theorised to promote problematic gambling behaviour in video game players. An example of which would be that proficiency in playing video games engenders a false perception of mastery of electronic systems, including those where the outcome is defined by chance not skill, as in digital gambling (King et al., 2012).

By integrating these two aims, this work will refine GRCS, both in context of video game players who gamble and in relation to the newly-emergent activities associated with video game-related gambling. The study employs three distinct sets of survey data gathered from regular video game players who also gambled within the preceding 12 months (N = 442; 391; and, 335).

2 Background

2.1 Heuristics as part of the cognitive process

The human cognitive process utilises heuristics as a means to optimise decision-making in a range of situations, especially those in which information is unknown or other constraints are present (Tversky & Kahneman, 1974). However, this tendency to employ heuristics, essentially cognitive short cuts, can lead to erroneous beliefs, or cognitive biases. These cognitive biases have been identified as contributing to a range of behavioural problems and addictive behaviour, such as that of problematic gambling (Kouimtsidis *et al.*, 2007). Both Cognitive and Cognitive Behavioural interventions have been found to reduce gambling behaviours (Petry et al., 2006; Champine & Petry, 2010). Indeed, gambling is an area in which cognitive biases influence many interactions, whether they are part of problematic behaviour or not, for example research has found that temporal and psychological distance affects perceptions of probability (Kirby, Petry, & Bickel, 1999; Sagristano, Trope, & Liberman, 2002) and that reminders of previous wins shape attitudes to risk (Ludvig, Madan and Spetch, 2015). Despite the efficacy of CBT in particular, there have been calls for continued investigation of treatments and tools used to address problematic gambling (Rash & Petry, 2014).

Cognitive approaches to addiction highlight the role of maladapted beliefs, or cognitive biases, in the development and continuation of problematic behaviour (Kouimtsidis *et al.*, 2007). Cognitive biases are a natural product of the human reasoning process, occurring as a result of the tendency to employ heuristic models, or “rules-of-thumb”, when making decisions, particularly in risky or uncertain situations (Kahneman, Slovic, & Tversky, 1982). While these heuristics are often beneficial to us in day-to-day situations, economising cognitive effort, they may also work against our well-being, such as in the case of procrastination, or in over-valuing low-value options (Nicolle, Symmonds and Dolan, 2011). A case in point, and that which is the particular focus of the present study, is gambling.

The biases born out of heuristic thinking affect all aspects of the cognitive process, from reasoning and judgement to memory and recall and have been shown to play an important role in the development of problematic behaviour and addiction, whether it be in relation to substance abuse (Verdejo-Garcia *et al.*, 2018), Internet use (Davis, 2001), or video games (Forrest, King and Delfabbro, 2016b). Gambling is no exception, indeed, the study of cognitive biases associated with gambling is well established with work in the 1970s laying the groundwork for the later development of cognitive-behavioural approaches to addiction (Oldman, 1974; Langer and Roth, 1975).

Maladapted beliefs related to gambling are manifold, but predominantly concern the nature of chance and probability (Tversky and Kahneman, 1974), misattributing the outcome of events (Gilovich, 1983), mistaken recollections and superstitious beliefs (Toneatto, 1999). A large body of work has shown that problem gamblers endorse higher rates of cognitive biases than do non-problem gamblers (Goodie & Fortune, 2013), with those activities thought to contain elements of skill, such as betting or card games, potentially being more prone to the influence of maladapted beliefs (Cantinotti, Ladouceur and Jacques, 2004).

2.2 Measuring Cognitions Related to Gambling

A number of gambling-related cognitions have been identified by researchers, with several measures having been designed to screen for cognitive biases in gamblers (Delfabbro & King, 2015; Toneatto, 1999). However, there are a number of problems with these scales, ranging from methodological issues to potential suitability for use outside of clinical settings. The Video Gaming Device Inventory (VGDI; Pike, 2002) was one of the first to be developed which specifically addressed cognitions related to gambling. Two sub-scales, Interest and Effects, constitute the 45-item scale, with the latter sub-scale reflecting the fact that the primary aim of the author was to identify problem gamblers, rather than gambling-related cognitions. An issue which further limits the wider use of this scale is that it was developed specifically to assess gamblers who use Electronic Gaming Machines (EGMs), such as video poker, blackjack, and so on.

The Gambler's Beliefs Questionnaire (GBQ; Steenbergh, Meyers, May, & Whelan, 2002) is a 21-item scale comprised of two sub-scales: Illusion of Control, and Luck/Perseverance. The first of these sub-scales addressed beliefs about skill and knowledge related to gambling, whilst the second assessed a range of behavioural patterns associated with gambling. The GBQ has been found to perform well in a number of studies, however, the two constructs overlap and no reliability indices were reported by the authors.

A further measure divided into constructs addressing perceptions of skill and luck is the Gambling Cognitions Inventory (GCI; McInnes, Hodgins and Holub, 2014), once again the sub-scales contain theoretically diverse items. Furthermore, the GCI is said to focus solely on the cognitive distortions around gambling and does not include gambling-related cognitions which are more general in scope. As such, it may be that the measure is more suited for clinical assessment than for use in more general populations or in research.

The Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004) is a 23-item measure which was specifically designed to be used in non-clinical settings. It consists of five sub-scales: Illusion of Control (IC); Gambling Expectancies (GE); Inability to Stop Gambling (IS); Predictive Control (PC); and Interpretive Bias (IB). Three of which (IC, PC, and IB) address categories proposed by Toneatto et al. (Toneatto *et al.*, 1997) and which are specifically related to gambling, whilst the final two (GE and IS) are wider in scope, addressing aspects of personal control and motivations to gamble. The authors acknowledge high levels of inter-factor correlation, as with GCI, but found sufficient unique variance to justify retaining the conceptually-discrete factors (Raylu and Oei, 2004).

As can be seen above, a number of measures exist which have been designed to investigate cognitions related to gambling (see table 1, below, for a summary of measures), however there are some common issues which serve to limit their potential use. First, many of the extant measures utilise a one- or two-factor model, often grouped around perceptions of skill and luck. Indeed, the role of luck, or more specifically the ideas surrounding the concept of luck, was a major focus of the Gambler's Beliefs Questionnaire (Steenbergh et al., 2002), one of the first attempts to create a measure by which cognitions related to gambling could be assessed. In addition, the authors of the Gambling Related Cognitions Scale (Raylu & Oei, 2004) noted a high correlation between constructs they labelled "predictive control" (PC) and "Illusion of Control" (IC). A higher order construct was theorised as potentially accounting for this relationship, however, it can be considered to be yet another example of the fundamental division between skill and luck. The common theme of "control" in the two constructs PC and IC refers to the attempts of gamblers to influence the outcomes of gambling events. Examination of the individual items constituting these constructs reveal that two distinct ways in which attempts are made to influence outcomes: the rational, via the development of skill and knowledge; and the irrational, through superstition and the acquisition of luck. The fact that these factors contain theoretically diverse items, meaning that they fail to meet face validity, a problem shared by other extant measures. The second issue limiting potential use is that several of the scales attempt to address a specific type of gambling activity, or are designed for use only in clinical settings, and therefore, their applicability in a range of gambling-like contexts may be limited.

Table 1: Structure of Existing Measures Assessing Cognitions Related to Gambling

Name of Measure	*# of Items*	*# of Factors*	*Name of Factors*	*Source*
The Video Gaming Device Inventory (VGDI)	45	2	Interests Effects	Pike, 2002
The Gambler's Beliefs Questionnaire (GBQ)	21	2	Illusion of Control Luck/Perseverance	Steenbergh, Meyers, May, & Whelan, 2002
Gambling Cognitions Inventory (GCI)	33	2	Skill and Attitude Luck and Chance	McInnes, Hodgins and Holub, 2014
The Gambling Related Cognitions Scale (GRCS)	23	5	Illusion of Control Predictive Control Interpretive Bias Gambling Expectancies Inability to Stop Gambling	Raylu and Oei, 2004

The primary aims of this research are: to investigate the suitability of existing measures for identifying gambling-related cognitions in respect to a population of video gamers who gamble, and to supplement the existing measure with new items in order to create a robust measure for use in this specific population. In accordance to the review above; the wider scope of the GRCS (Raylu and Oei, 2004), means that it is the preferred instrument for use in this study. Furthermore, the GRCS has been validated cross-culturally and in respect to pathological measures. Finally, the authors explicitly called for it to be validated in the context of specific gambling activities and distinct populations (Raylu and Oei, 2004).

2.3 Video Game-Related Gambling.

Gambling connected to video games is often associated with esports (Gainsbury, Abarbanel, & Blaszczynski, 2017; Macey & Hamari, 2018), where it takes the form of sportsbook-style betting on the outcome of matches and tournaments, or of fantasy esports.

The range of gambling activities associated with video games is, however, more substantial than simple betting, it is an area which continues to grow and develop[1]. In addition to

[1] An example of the constantly changing context is provided by the increasing regulation of loot boxes, see Macey and Hamari (2019), and Griffiths (2018) for detailed summaries.

established forms, such as sportsbook betting and fantasy sports mentioned above, there are emergent activities which have land-based analogues, one example being skins lotteries which are a form of sweepstake/jackpot-style lottery. The use of particular mechanics in contemporary digital games has also led to concerns about the promotion of gambling and gambling-like behaviours. The most contentious example of which are loot boxes, which have been likened to scratch cards and slot machines, and have been associated with problematic gambling behaviours (Macey & Hamari, 2019; Zendle & Cairns, 2018). Truly novel forms of gambling have also emerged from the video game community, ones such as crash betting which have no analogues in established forms. See Macey & Hamari (2019) for a full summary of these activities. Within video games we can find simulated gambling, i.e. where a gambling game, such as poker or roulette, forms part of the main game, usually in the form of a mission or a mini-game (King et al., 2010a). Also present within games is player-led emergent gambling, as has been seen in the game *Runescape* (Pips, 2013), among others. Finally, there are Social Network Casino games (SNCs) which offer simulated gambling to players using the Free-to-Play (F2P) business model (Gainsbury, Russell, *et al.*, 2016). Whether or not all these activities constitute gambling according to legal definitions, they highlight the fact that video game-related gambling is considerably more nuanced than simply transferring existing gambling activities to a new context.

The question of whether existing measures, used to identify cognitions in established gambling activities, are valid for the newly-emergent practices associated with gambling related to video games has significant implications. The first of which is screening for cognitions in at risk populations (Petry & Blanco, 2013) and, second, for the potential efficacy of treatments such as CBT (Rash & Petry, 2014). It especially pertinent when considering the fact that for video game players, participation in gambling is lower than in the wider population, but rates of problematic gambling are higher (Macey & Hamari, 2019).

3 Method

The aim of this research is twofold: first, to examine whether the GRCS constitutes a robust measure in regard to a newly emergent phenomenon, that of video game-related gambling, in a population of video gamers (stage 1); second, to explore the potential to supplement the GRCS with additional items related to cognitions concerning skill and luck (stage 2); and finally, additional items related to cognitions derived from the consumption of video games (stage 3). This research will then bring together the finalised constructs together, and will conduct a final assessment of the overall validity and reliability of the consolidated scale (stage 3). All analysis was conducted using SPSS and AMOS versions 25. This research was conducted in accordance with all relevant ethical guidelines of the University and conforms to the ethical standards of the APA.

3.1 Participants and Procedure

The target population is video game players who also gamble, while there is little existing research in this area, recent works allow us to outline certain characteristics which can be used to identify this population. Video gamers who gamble tend to be young males who often gamble using multiple channels, primarily online (King, Delfabbro and Griffiths, 2010; Forrest, King and Delfabbro, 2016a; Sally M. Gainsbury, Abarbanel and Blaszczynski, 2017; Macey and Hamari, 2018). Furthermore, they are not limited to any particular region or country, irrespective of local laws which may restrict access to traditional gambling products (Macey and Hamari, 2019).

Three separate datasets were collected, with each being randomly assigned for use in a single stage (as described above), they were each named according to the stage in which they were used (e.g. “dataset 1”, “dataset 2”, and “dataset 3”). For all datasets, a link was posted with text which detailed the aims of the study, funding, and eligibility criteria. No geographical restrictions were applied, although the survey was only available in English. Responses were received from across the globe, all three datasets included responses from every continent, with over 90 different nationalities being represented in total: dataset 1 (70); dataset 2 (49); and dataset 3 (68). The top three nationalities represented in the data were USA (14.96%), the UK (7.91%), and India (5.13%).

In order to participate respondents had to have both played video games and gambled at least once within the previous 12 months. Furthermore, respondents had to be at least 18 years of age, or to have permission from their legal guardians to participate in the research. The surveys included a filter question which asked participants to select a specific answer, those who failed to respond appropriately were removed from the sample

Datasets 1 and 3 were collected at different points in August 2019, via an online survey, with participants being recruited through the online service Pollfish, with ineligible respondents being disqualified in real-time. Those who failed the filter question were also disqualified before completing the survey. In total the datasets comprised 442 and 335 responses, sets 1 and 3, respectively.

Respondents in dataset 1 were predominantly male, 63.6%, with 33.5% being under 30 years of age. They reported being regular game players, 78.1% played once a week or more, while 50%, 47.5%, and 35.1% reported participating in offline gambling, online gambling, and video game-related gambling once a week or more, respectively.

In regard to dataset 3, 57.8% reported being male, and 36.7% were aged 30 or under. Once again, the respondents can be categorised as regular gamers, with 80.9% reporting playing once a week or more, while 43.3%, 48.1%, and 19.6% reported participating in offline gambling, online gambling, and video game-related gambling once a week or more, respectively.

For dataset 2, participants were recruited using an online survey, published on various social media sites and discussion forums dedicated to video games and esports. In order to encourage participation, valid respondents were offered the option of taking part in a prize draw to win one of five $50 gift vouchers.

In total, 2,397 responses were received, incomplete responses and those that failed to answer the question correctly were removed from the final data set, along with those respondents who reported that they had not gambled in the preceding 12 months. After filtering, the final dataset consisted of 391 records.

The finalised dataset 2was skewed towards young, male respondents, with 85.7% of respondents aged under 30, 93.4% were male. In regard to consumption habits, 98.2% reported playing video games at least once a week, 13.1% gambled offline at least once a week, 18.7% gambled online, and 21% participated in video game-related gambling at least once a week.

3.2 Criteria for Psychometric Validity

Hu and Bentler (1998) proposed the use of two indices: SRMR and one of either NNFI (TLI), CFI, GFI, or RMSEA. Kline recommends a more robust approach which advocates reporting χ^2, p-value, degrees of freedom, RMSEA, SRMR, and CFI (Kline, 2011). Given that Kline's recommendation incorporates that of Hu and Bentler, this work will adopt this approach. PCLOSE is the p-value associated with RMSEA and will also be reported. Additionally, the parsimony-adjusted CFI value (PCFI) will also be reported. Finally, as χ^2 is sensitive to sample size, especially when the sample exceeds 200, the normed χ^2 (χ^2/df; Wheaton, Muthén, Alwin, & Summers, 1977) will also be reported. The following cut-off values (table 2) are commonly accepted, however, as they are sensitive to both sample size and the number of variables, they are to be used as a guideline only.

Table 2: Goodness-of-fit Indices

Index	*Cut-off values/Thresholds*	*Source*
χ^2/df	< 3 good < 5 good	(Kline, 2011) (Wheaton et al., 1977)
CFI	> .95 very good > .9 acceptable	(Hu & Bentler, 1998); (Schreiber et al., 2006)
PCFI	No commonly agreed cut-off, but > 0.5 = acceptable	(Mulaik et al., 1989) (Hooper, Coughlan, & Mullen, 2008)
SRMR	< .08	(Hu & Bentler, 1998)
RMSEA	< 0.01 excellent < .05 good < .08 fair > 0.1 unacceptable	(MacCallum, Browne, & Sugawara, 1996)
PCLOSE	> 0.05	(Kenny, 2012)

Legend: χ2/df = chi-squared divided by degrees of freedom; CFI = Bentler Comparative Fit Index; PCFI = CFI adjusted for parsimony; SRMR = Standardized Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; PCLOSE = probability that the model is a close fit.

After goodness-of-fit has been established the next stage is to ensure that the proposed model structure meets the accepted criteria for reliability and validity. Convergent validity is established if the Average Variance Explained (AVE) of a factor is greater than .5, Discriminant Validity is established if both the Maximum Shared Variance (MSV) is less than the AVE and the square root of the AVE is greater than the absolute value of inter-factor correlations. Reliability is established when the Composite Reliability (CR) value is greater than .7 (Hair *et al.*, 2006). Finally, Cronbach's alpha is calculated for the overall scale and each of the sub-scales in order to assess internal consistency, commonly accepted cut-off values are as follows: $\alpha < .5$ = unacceptable; $.5 \leq \alpha < .6$ = poor; $.6 \leq \alpha < .7$ = questionable; $.7 \leq \alpha < .8$ =acceptable; $.8 \leq \alpha < .9$ = good; $.9 \leq \alpha$ = excellent (DeVellis, 2012).

3.3 Instrumentation

The GRCS (Raylu and Oei, 2004) is an established measure consisting of 23 items, rated on a Likert-scale, ranging from 1 = "strongly disagree", to 7 = "strongly agree". The GRCS comprises of five sub-scales: Gambling Expectancies (GE); Illusion of Control (IC); Predictive Control (PC); Inability to Stop Gambling (IS); and, Interpretive Bias (IB). Following a literature review, a number of supplementary items were included in addition to the GRCS. These items were selected as they were found to address issues not covered by the GRCS, most notably in relation to the perception of skill and beliefs about luck.

A full list of supplementary items, and their sources, can be found in appendix A.

4 Stage 1. Testing the GRCS in a Sample of Video Gamers.

4.1 CFA of Gambling Related Cognitions Scale

A Confirmatory Factor Analysis (CFA) for the original, five-factor, GRCS was conducted using a sample of video gamers who reported gambling in the preceding 12 months (dataset 1). The model used the "Maximum Likelihood" estimator.

4.1.1 Model Fit.

The results of the model fit indices were: χ^2 = 681.362, DF = 199; χ^2/DF = 3.424, p = < .001, CFI = 0.92, PCFI = 0.792, SRMR = .0508, RMSEA = .074, and PCLOSE = < .001. As with the χ^2 and p values of the model, PCLOSE is likely to be affected by the sample size as it is considered "large" and, therefore, will always return statistically significant values, as such it should be disregarded in favour of other indicators (Marsh, Balla and McDonald, 1988; Kenny, 2012). χ^2/DF, RMSEA, and CFI are within the range of values showing an acceptable model fit, while the PCFI and SRMR can be considered good. However, it must be noted that reasonably large sample sizes often result in inflated χ^2 value, and making it unlikely to produce non-significant results (Marsh, Balla and McDonald, 1988; Kenny, 2012).

4.1.2 Reliability and Validity

Cronbach's α (0.95) suggests a good level of internal consistency for the overall scale. Of the five sub-scales, 4 had moderate to high reliability (GE α = .882; IS α = .899; PC α = .822; and IC α = .833), while one (IB) was very low, with an α of .638. This final issue is further emphasised by the fact that the composite reliability value for IB is less than .7 (.641).

There were a number of significant concerns relating to discriminant validity as the square root of the Average Variance Extracted (AVE) values was less than the absolute value of (at least) one correlation with another factor all five factors. In addition, the AVE for two factors, PC and IB, was less than the Maximum Shared Variance (MSV).

Finally, there are also concerns about convergent validity as the AVEs for 2 factors, (PC, and IB) were less than .5: .446 and .378 respectively. Full validity and reliability information is provided below in table 3, factor loadings and factor correlations are provided in tables 4 and 5, respectively.

Table 3: Validity and Reliability Matrix for CFA of GRCS

						Factors				
		CR	*AVE*	*MSV*	*MaxR(H)*	*GEx*[1]	*IoC*[1]	*PC*[1,2,3]	*ItSG*[1]	*IB*[1,2,3,4]
Factors	*GEx*[1]	0.885	**0.65811**	0.875	0.892	**0.811**				
	IoC[1]	0.836	**0.561**	0.861	0.838	0.803***	**0.749**			
	PC[1,2,3]	0.827	**0.446**	1.118	0.838	0.864***	0.928***	**0.668**		
	ItSG[1]	0.9	**0.643**	0.693	0.908	0.774***	0.832***	0.741***	0.802	
	IB[1,2,3,4]	**0.641**	**0.378**	1.118	0.661	0.936***	0.867***	1.057***	0.742***	**0.615**

Legend. [1]Discriminant Validity (DV) concern: square root of the AVE for factor is less than its correlation with other factor(s); [2]DV concern: AVE for factor is less than MSV; [3]Convergent Validity concern: AVE is less than .5; [4]Reliability concern: CR is less than .7; *** $p < 0.001$

Table 4: Factor Loadings for GRCS CFA

Factor	Item	Std Loading	p value
GEx	GEX4	0.732	< .001
GEx	GEX3	0.829	< .001
GEx	GEX2	0.865	< .001
GEx	GEX1	0.812	< .001
IoC	IOC4	0.757	< .001
IoC	IOC3	0.78	< .001
IoC	IOC2	0.749	< .001
IoC	IOC1	0.707	< .001
PC	PBC3	0.607	< .001
PC	ICL1	0.552	< .001
PC	PDC3	0.661	< .001
PC	PDC2	0.664	< .001
PC	PDC1	0.742	< .001
PC	PBC4	0.757	< .001
ItSG	ISG5	0.856	< .001

ItSG	ISG4	0.785	< .001
ItSG	ISG3	0.806	< .001
ItSG	ISG2	0.698	< .001
ItSG	ISG1	0.854	< .001
IB	INB3	0.483	< .001
IB	INB2	0.654	< .001
IB	INB1	0.689	< .001

Table 5: Factor Correlations for GRCS CFA

Correlation			Estimate	P value
GEx	<-->	IoC	0.803	< .001
GEx	<-->	PC	0.864	< .001
GEx	<-->	ItSG	0.774	< .001
GEx	<-->	IB	0.936	< .001
IoC	<-->	PC	0.928	< .001
IoC	<-->	ItSG	0.832	< .001
IoC	<-->	IB	0.867	< .001
PC	<-->	ItSG	0.741	< .001
PC	<-->	IB	1.057	< .001
ItSG	<-->	IB	0.742	< .001

4.2 Analysis and Discussion

The GRCS does not appear to be an optimally fitting measurement model in the context of video game players who gamble, despite the model fit indices being considered acceptable. This is due to the significant number of problems with: convergent validity (two of five factors), discriminant validity (five of five factors), and composite reliability (one of five factors). A final issue is the high level of inter-factor correlation present in the model: notable examples are correlations between PC and IB (1.057), GE and IB (.936), and between IC and PC (.928), while the correlations between PC and GE, and between IC and IB also exceed the threshold of .85 (Kenny, 2012), please see table X. Of the five factors none proved to be robust, as all failed tests of discriminant validity and high levels of inter-factor correlation were observed. The large degree of inter-factor correlation suggests that reorganising and consolidating the constructs is likely to prove beneficial, while the addition of further items relating to skill and chance may also offer more clarity.

5 Stage 2: Revising the GRCS scale with additional items – Developing GamCog (Part 1).

In stage 1 the Confirmatory Factor Analysis of the GRCS revealed a number of significant problems with the measure for a sample of video gamers who gamble, as such, analysis could not continue according to the planned structure. Accordingly, it was decided to pool the 23 GRCS items with eight additional items addressing cognitions related to luck and skill in gambling. Viable constructs could then be extracted by subjecting dataset 2 to exploratory factor analysis (EFA). CFA would then be performed on dataset 3 in order to explore the validity and reliability of the newly extracted constructs.

5.1 Exploratory factor analysis

Extracting factors based on Eigen values of more than 1 (K1 test; Kaiser, 1960) is a common approach when conducting EFA, examination of the data showed six factors with Eigen values over 1. However, extracting factors based on Eigen values has been shown to over-estimate the total number of factors (Fabrigar, Wegener, MacCallum, & Strahan, 1999). As such, the scree-test (Cattell, 1966) and Parallel Analysis (PA; Horn, 1965) have been proposed as alternative methods for determining the total number of factors to retain in EFA (Costello & Osborne, 2005).

An initial examination of the scree-plot showed two points of inflection, after the fourth and seventh factors (figure 1), thereby justifying the use of PA. Parallel analysis was setup using the following criteria: 5,000 parallel datasets; 99th percentile confidence; principal axis/common factor analysis method; and that data was not assumed to be normally-distributed. PA indicated the presence of six factors which were extracted from the data using the principal axis factoring method with promax rotation. However, examination of the extracted pattern matrix showed there were several cross-loading and low-loading items.

A finalised scale should balance parsimony with representativeness, i.e. the total number of factors should be reduced while remaining representative of the underlying themes (Fabrigar *et al.*, 1999; Hayton, Allen and Scarpello, 2004). Given that the scree-test suggested a break point after four factors it was decided to examine the potential for a four-factor solution: once again a principal axis factoring with promax rotation was performed on section 1 of the split sample, with a Kaiser-Meyer-Olkin (KMO) value of .908 suggesting that factor analysis will yield both distinct and reliable factors (Hutcheson and Sofroniou, 1999). Relationships between variables were demonstrated by a p value of < 0.001 for Bartlett's test of Sphericity. After removing cross-loading and low-loading items, those under .32 (Vignoles *et al.*, 2016), four factors with at least five items each were revealed. The full pattern matrix is provided in appendix B.

6 CFA of Four Factor Model

A confirmatory factor analysis was performed on the four extracted factors, using dataset 3, the model had a $\chi 2$ value of 705.642 with DF = 269.

6.1 Model Fit

The model fit indices were as follows: χ^2/DF = 2.623, p = < .001, CFI = .911, PCFI = .817, SRMR = .0544, RMSEA = .07, and PCLOSE = < .001. The model, therefore, shows good fit values for all indices.

6.2 Validity and Reliability

Cronbach's α = .949 suggests a good level of internal consistency for the four-factor model. All four of the sub-scales also showed good internal consistency (IC α = .877; PGS[2] α = .881; IS α = .889; and BOG[3] α = .846). However, there several issues relating to both discriminant and convergent validity: the AVE of Factor IC was under .5 (.451); the AVE for factor IC was less than the MSV; the square root of the AVE for three factors, IC PGS, and IB, was less than correlations with other factors. See appendix C validity table.

In order to improve reliability two items with loadings of 6.5 or less were removed from Factor IC, ICL3= .363 and ICL1 = .64 (DeVellis, 2003). Consequently, the AVE of IC improved to .513.

An additional four items with loadings of .65 or less were removed iteratively, with validity and reliability being examined at each step: PBC3 (.57) was deleted from factor IC; PDC3 (.61) was removed from factor PGS; and GEX4 (.62) and INB1 (.65) were removed from factor BOG. After these deletions, all issues relating to discriminant validity were solved with the exception of factor IC, where the square root of the AVE was less than correlations with factors PGS and BOG. Of the six remaining items in factor IC, there were two which shared loadings of .67, IOC1 and IOC2. Examining these items, it was felt that IOC1 was very similar to IOC4, and as such was deleted, thereby removing the outstanding issues in regard to discriminant validity. Full validity and reliability information is provided in table 6, below, with factor loadings and factor correlations presented in tables 7 and 8, respectively.

With these changes made the revised χ^2 value was 344.827 with 129 degrees of freedom, the model fit indices were as follows: χ^2/DF = 2.673, p = < .001, CFI = .943, PCFI = .795, SRMR = .0496, RMSEA = .071, and PCLOSE = < .001. With the exception of the overall p

[2] The factor originally named "predictive control" (PC) in the GRCS has been re-named "perceived gambling skill" (PGS). Please see discussion section.

[3] The factor originally named "gambling expectancies" (GE) in the GRCS has been re-named "benefits of gambling" (BOG). Please see discussion section.

value and PCLOSE, as discussed previously, all indices showed either good or acceptable model fit. That α = .943 continues to suggests a high level of internal consistency, as do the four the sub-scales (IC α = .866; PGS α = .882; IS α = .889; and BOG α = .852).

Table 6: Validity and Reliability Table for CFA of GamCog

						Factors			
		CR	AVE	MSV	MaxR(H)	IOC	PGS	ISG	BoG
Factors	IOC	0.868	0.569	0.566	0.874	0.754			
	PGS	0.885	0.609	0.609	0.898	0.750***	0.781		
	ISG	0.889	0.617	0.539	0.893	0.731***	0.635***	0.785	
	BoG	0.855	0.663	0.609	0.862	0.752***	0.780***	0.734***	0.814

Legend: *** $p < .001$

Table 7: Factor Loadings for CFA of GamCog

Factor	Item	Std Loading	p value
IOC	IOC3	0.778	< .001
IOC	ICL2	0.807	< .001
IOC	IOC2	0.654	< .001
IOC	IOC4	0.783	< .001
IOC	ICL4	0.741	< .001
PGS	INB2	0.809	< .001
PGS	IOC6_PS	0.856	< .001
PGS	IOC5_PS	0.826	< .001
PGS	PBC2	0.638	< .001
PGS	PDC1	0.755	< .001
ISG	ISG3	0.8	< .001
ISG	ISG2	0.73	< .001
ISG	ISG4	0.8	< .001
ISG	ISG5	0.832	< .001
ISG	ISG1	0.762	< .001
BoG	GEX2	0.858	< .001
BoG	GEX3	0.818	< .001
BoG	GEX1	0.764	< .001

Table 8: Factor Correlations for CFA of GamCog

Correlation			Estimate	P Values
IOC	<-->	PGS	0.75	< .001
IOC	<-->	ISG	0.731	< .001
IOC	<-->	BoG	0.752	< .001

PGS	<-->	ISG	0.635	< .001
PGS	<-->	BoG	0.78	< .001
ISG	<-->	BoG	0.734	< .001

6.3 Analysis and Discussion

The four factors that were extracted were found to be conceptually coherent and, as such, were preferred over the anticipated 7-dimensional model. It is also preferable to reduce the number of discrete factors in a measurement scale whilst retaining sufficient variation (Fabrigar & Wegener, 2011), the final structure, therefore, reflected this principle.

The GRCS comprises of 23 items, of these 13 were retained in the new factor structure, with only one construct (IS) remaining unchanged. Of eight additional items, five were retained. Five individual items were deleted, prior to conducting the CFA, due to the fact that they either loaded poorly onto the extracted factors (i.e. had loadings under .32) or that they cross-loaded onto more than one factor, thereby justifying their removal (Costello & Osborne, 2005). Interestingly, the majority of these items can be seen to share a common theme: they are all cognitions which relate to a lack of understanding concerning the nature of probability. A further seven items were removed in order to improve factor validity and reliability. All had loadings of less than .67, meaning that those retained can be considered “substantial” (DeVellis, 2003), thereby producing robust factors. The deletion of these items can also be justified theoretically, in addition to the methodological justification detailed above. First, PBC3 is not an item that fits with the others in the factor (IC) as it describes a cognitive error concerning the nature of probability, rather than addressing the conceptualisation of luck. From the same factor, IOC1 can be considered as constituting a specific example of the more general concepts captured by IOC4. In regard to IOC, ICL1 and ICL3 address the concept of luck as an inherent state, one in which individuals are either abundant or deficient. All the other items are concerned with acquiring luck, meaning that it is viewed as something transitory, something which can be accrued or encouraged. These two views are mutually exclusive, justifying the decision to delete ICL1 and ICL3.

Factor PGS contains items which reflect cognitions concerning personal skill, as such the removal of PDC3 can be theoretically justified as it is not directly associated with this idea; indeed, the wording of the item could equally apply to outcomes which are seen to be affected by luck or superstition. Item INB1 can be seen to act as a potential driver of gambling activity, rather than a beneficial effect in the same way as the other items in factor BOG. In addition, it relates solely to the financial outcomes, whereas the other items in the factor refer to more general concepts of well-being, as such it is theoretically divergent from the other items in the construct. Finally, GEX4 can be seen as a specific example of the more general concepts captured by other items, once again justifying its removal.

All deleted items are detailed in appendix D for reference.

It is worth noting that the construct “Inability to Stop Gambling” (IS), part of the original GRCS, is the only one to remain unchanged throughout, meaning that it can be considered highly robust. At the other extreme “Interpretive Bias” (IB) entirely disappeared, with only one of the original items being retained at the conclusion of the CFA. This is perhaps unsurprising due to the high level of inter-factor correlation between IB and others found in study 1.

The construct “Predictive Control” (PC) also underwent radical change, with only one of the original six items being retained. Once again, a likely outcome of the high amount of inter-factor correlation with two other factors which was revealed in study 1. The newly amended construct has been named “Perceived Gambling Skill”. Of the six original items only two PDC1 was retained; it references a form of personal agency that is dependent upon skill rather than on more “irrational” concepts such as instinct (PDC4) or fate (PDC2). Item INB2 features in the new factor, it deals explicitly with the idea of skill as an influence on the outcome of gambling events. This perspective is further addressed by the items IOC5_PS and IOC6_PS, which both refer to “skills” and “knowledge” as important factors in deciding outcomes.

The GRCS included a construct named “Gambling Expectancies” (GE) in this study (3), the core principle of the original construct remains, with three of the four items belonging to the original construct. The finalised construct has been re-named “Benefits of Gambling” as it is felt that this is more descriptive.

Originally, the emphasis of the construct “Illusion of Control” (IC) was exclusively on the ways in which gamblers attempted to influence or control the outcomes of gambling events. The addition of items ICL2 and ICL4 complement this theme in that they address conscious efforts to acquire, and control, the somewhat nebulous concept of “luck”.

We can see, therefore, that the items constituting the revised four-factor model satisfy face validity. Furthermore, the five model fit indicate that the additional items and re-formulated factors constitute an effective measure.

In summary, several core concepts of the GRCS have been retained: the fact that, for some, gambling is an addiction or compulsion; that gambling is an attractive activity as it offers particular benefits to participants; and that certain ideas are present which reflect attempts to control potential outcomes. The last of these has benefitted from being re-framed in terms of active attempts to influence events based on either rational or irrational terms, i.e. skill and knowledge versus luck and fate.

The initial aim of the work was to supplement the GRCS with additional items, however, the work described in this stage has resulted in a scale which is significantly different from the GRCS. The final outcome is a scale which is particularly suited to for use in a population of video gamers who gamble. As such, an appropriate name for this new measure is: GamCog – A Scale for Video Game-Related Gambling Cognitions.

7 General Discussion.

A primary aim of this work was to examine the suitability of the GRCS as a robust measure for use with a population who participate in the growing area of video game-related gambling. The GRCS was found to be unsuitable for use in the context of video game players who gamble as there were problems with the model fit indices, convergent validity, discriminant validity, composite reliability, and inter-factor correlation. As such, items originally intended to supplement the GRCS were pooled with the original items, and subjected to EFA which revealed a four-factor structure, in place of the original five-factors. A key point of interest regarding the reframed GRCS constructs is that Illusion of Control (IC) and Predictive Control (PC) were amended to account for the way in which luck and skill were perceived by the sample. The revised version of IC reflects attempts to actively acquire good fortune, rejecting those items from the original GRCS which described a more passive stance on the part of the game player. In much the same way, PC underwent a number of changes which resulted in the finalised items referencing a form of skill-based personal agency on the part of the players.

Finally, the large samples aided the conduct of this work, lending weight to the findings as all stages utilised datasets where the ratio of the sample to items exceeded10:1, meaning that stable factors could be extracted (Fabrigar et al., 1999; Kaiser, 1970).

7.1 Implications

The growing convergence of video games and gambling means that the new scale is a potentially beneficial tool for identifying cognitions that may lead to problematic gambling in regular video game players. Furthermore, it provides a way to direct, and to enhance, treatments, such as CBT, for problematic gamblers from this specific population.

The revised scale, GamCog, presented in this work naturally requires further validation in different populations in order to assess whether it is an effective measure for gambling related cognitions in general, or if the findings are specific to those regular video game players who also gamble. No matter the outcome of such a study, it appears as though the GRCS itself would benefit from the addition of more items specifically addressing conceptualisations of skill and luck as this is a fundamental aspect of understanding gambling experiences.

Of the five sub-scales constituting the GRCS, Predictive Control was found to be the only one which could not significantly predict problem gambling scores, with its effect seemingly masked by Illusion of Control (Raylu and Oei, 2004). The authors stated that the sub-scale was intended to address cognitions concerning attempts to control the outcome of gambling events (hence the inclusion of items addressing skill, luck, and misunderstanding probability). However, the results of this research suggest that skill-based attempts to control outcomes differ significantly from luck-based approaches and that separating such cognitions results in more robust sub-scales. It would be highly beneficial to examine this approach in light of other gambling populations and of the general population as it is likely to improve the predictive capabilities of the GRCS in all contexts.

7.2 Limitations and directions for future research

A potential limitation of this work is that the factor structure of the finalised measure was initially identified, via EFA, using a data sample which was highly skewed towards young males, and as such may have unduly affected the retained items. An example of the potential way in which this particular sample may have influenced the final measure is in the removal of an item reflecting “the gambler’s fallacy” (PBC4). Although the removal was justified, even required, by established methodological practice, it runs counter to established theory and requires further attention. The example of the gambler’s fallacy is particularly interesting as previous work has found evidence that it, and other cognitive biases based on misunderstanding probability, are more common in males than females (Suetens and Tyran, 2012; Donati, Chiesi and Primi, 2013). However, given that the effects of the gambler's fallacy have also been found to decrease with age (Fischbein and Schnarch, 1997) it seems likely that this result is directly associated with the preference for video gaming, rather than the age or gender of respondents in dataset 2. This position is supported by the fact that the subsequent CFA was conducted using a sample in which 58% (approx.) were males and more than 60% were over 30 years of age. In order to counter any potential effects of age and gender on the factor structure of the finalised GamCog measure it is recommended that any future validation of GamCog includes all deleted items (see appendix. D).

A further potential limitation could be the reliance on theoretical perspectives, identified by literature review, to develop additional items. This could be addressed through the use of the "thinking aloud" method, or by conducting interviews with a range of esports viewers who gamble. The results of such studies could then be compared to the finalised model, GamCog, in order to identify discrepancies. Any new items resulting from such work would require testing and validation.

Finally, the clinical validity of this model is reduced as a result of the self-selected nature of the three datasets, however, this means it is likely to hold true as a measure for the wider population of esports fans and regular video game players.

8 Conclusion.

This study has found that the Gambling Related Cognitions Scale is not a robust measure for use in a population of video game players who gamble, either in respect to established activities or those newly-emergent forms facilitated by video games. As the GRCS has been designed for use in non-clinical populations and is broader in scope than many other scales addressing gambling related cognitions, it is likely that the above finding holds true for all extant measures.

Perceptions of skill and luck were found to be the principle factors which accounted for the GRCS's lack of suitability for the sample population. Therefore, it seems that an interest in video games and esports is associated with the development of cognitive biases which differ from the non-gaming population. With these facts in mind, the GamCog scale was formulated for use in the target population, incorporating items both from existing measures and those theorised by researchers in the field but not previously tested. A full list of items and constructs constituting the GamCog scale is provided in Appendix E, and a manual describing the implementation of GamCog is included in appendix F.

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10 Appendices

Appendix A:

Items Supplementing GRCS

Theory	*Item Code*	*Item*	*Source*
Influence of Skill	IOC5 - PS	My knowledge and skill in gambling contribute to the likelihood that I will make money.	Steenbergh et al., 2002
	IOC6 - PS	My gambling wins prove that I have skills and knowledge related to gambling.	
Predictive Control	PDC4	I use instinct or feelings to guide my choices when I gamble.	Toneatto et al., 1997
	PBC1	If I am on a losing run, I just have to keep going until I start winning again.	
	PBC2	There are certain circumstances or situations that increase my chances of winning.	

Concepts of Luck	ICL1	I often wait until I am experiencing a period of good luck before gambling.
	ICL2	I have some superstitions which make me lucky when I gamble.
	ICL3	I believe that some people are naturally luckier than others when they gamble.
	ICL4	If I know someone who is lucky, I try to be around them so that their luck rubs off on me.

Appendix B:

Pattern Matrix

	Factor			
	IOC	PGS	ITSG	BOG
IOC3	0.747			
ICL2	0.704			
IOC2	0.661			-0.117
ICL1	0.657			
IOC4	0.652			
ICL4	0.633			
IOC1	0.600			
PBC3	0.501			
ICL3	0.468			
PBC4[1]	**0.326**			0.311
INB2		0.928		-0.214
IOC6_PS		0.842		
IOC5_PS	-0.171	0.722		0.161
PDC3		0.634		
PBC2	0.225	0.622		
PDC1	0.121	0.596		
ISG3			0.968	
ISG2			0.812	-0.121
ISG4			0.684	-0.112
ISG5	-0.114		0.604	0.297
ISG1			0.559	
GEX2		-0.125		0.852
GEX3				0.752
GEX1	-0.152	0.181		0.660
GEX4				0.548
INB1			0.128	0.540

Legend: [1] Deleted due to crossloading;
Note: Items with loadings under .32 not shown here.

Appendix C:

Table X: Initial Validity and Reliability Table for CFA of GamCog

	CR	AVE	MSV	MaxR(H)	Factors			
					IOC[1,2,3]	PGS[1]	ISG	BoG[1]

Factors	IOC[1,2,3]	0.877	0.451	0.637	0.895	0.671			
	PGS[1]	0.886	0.567	0.696	0.901	0.784***	0.753		
	ISG	0.889	0.617	0.56	0.893	0.728***	0.641***	0.785	
	BoG[1]	0.856	0.547	0.696	0.873	0.798***	0.834***	0.748***	0.74

Legend. 1Discriminant Validity (DV) concern: square root of the AVE for factor is less than its correlation with other factor(s); 2DV concern: AVE for factor is less than MSV; 3Convergent Validity concern: AVE is less than .5.

Appendix D:

List of Deleted Items

Item Code	*Deleted Item*	*Reason for Deletion*	*Stage Deleted*
PDC2	When I have a win once, I will definitely win again.	Cross-/low-loading (under .32)	EFA
PDC4	I use instinct or feelings to guide my choices when I gamble.	Cross-/low-loading (under .32)	EFA
INB3	When I lose it is because I was unlucky, or there were circumstances that could not be predicted.	Cross-/low-loading (under .32)	EFA
INB4	Relating my losses to probability makes me continue gambling.	Low-loading (under .32)	EFA
PBC1	If I am on a losing run, I just have to keep going until I start winning again.	Cross-/low-loading (under .32)	EFA
PBC4	Losses when gambling are bound to be followed by a series of wins.	Cross-loading	EFA
GEX4	Gambling helps me reduce my levels of tension and stress.	Loading under .65	CFA
IOC1	Praying, or thinking positively, helps me win.	Low-loading (.67) and redundancy	CFA
PBC3	If I keep changing my numbers, I have less chance of winning than if I keep the same numbers every time.	Loading under .65	CFA
PDC3	I have some control over predicting my gambling wins.	Loading under .65	CFA
INB1	Remembering how much money I have won previously makes me want to continue gambling.	Loading under .65	CFA
ICL1	I often wait until I am experiencing a period of good luck before gambling.	Loading under .65	CFA
ICL3	I believe that some people are naturally luckier than others when they gamble.	Loading under .65	CFA

Legend: CFA = Confirmatory Factor Analysis; EFA = Exploratory Factor Analysis

Appendix E:

GamCog Scale: List of Items by Sub-Scale

Sub-Scale	*Short Name*	*Item*
Benefits of Gambling	BOG	Gambling makes me happier.
		Gambling makes things seem better.
		Gambling makes the future seem brighter.
Inability to Stop	IS	I can’t function without gambling.
		It is difficult to stop gambling as I am so out of control.
		My desire to gamble is so overpowering.

		I'm not strong enough to stop gambling. I will never be able to stop gambling.
Illusion of Control	IC	Specific numbers and/or colours help me win. I collect specific objects that help increase my chance of winning. I have specific rituals and behaviours that increase my chance of winning. I have some superstitions which make me lucky when I gamble. If I know someone who is lucky, I try to be around them so that their luck rubs off on me.
Perceived Gambling Skill	PGS	There are certain circumstances or situations that increase my chances of winning. A series of losses will provide me with a learning experience that will help me win later. My knowledge and skill in gambling contribute to the likelihood that I will make money. My gambling wins prove that I have skills and knowledge related to gambling. When I win it is mainly due to my skill and knowledge in the area.

Appendix F:

GamCog: A Scale for Measuring Gambling-Related Cognitions in Video Game Players.

The following statements relate to gambling experiences, please indicate the extent to which you agree or disagree with each. (1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Neither Agree Nor Disagree, 5 = Somewhat Agree, 6 = Agree, 7 = Strongly Agree)		Please use this column to respond to each statement. 1 2 3 4 5 6 7
1	I will never be able to stop gambling.	○ ○ ○ ○ ○ ○ ○
2	A series of losses will provide me with a learning experience that will help me win later.	○ ○ ○ ○ ○ ○ ○
3	I have some superstitions which make me lucky when I gamble.	○ ○ ○ ○ ○ ○ ○
4	I'm not strong enough to stop gambling.	○ ○ ○ ○ ○ ○ ○
5	Specific numbers and/or colours help me win.	○ ○ ○ ○ ○ ○ ○
6	It is difficult to stop gambling as I am so out of control.	○ ○ ○ ○ ○ ○ ○
7	My knowledge and skill in gambling contribute to the likelihood that I will make money.	○ ○ ○ ○ ○ ○ ○
8	There are certain circumstances or situations that increase my chances of winning.	○ ○ ○ ○ ○ ○ ○
9	If I know someone who is lucky, I try to be around them so that their luck rubs off on me.	○ ○ ○ ○ ○ ○ ○
10	My desire to gamble is so overpowering.	○ ○ ○ ○ ○ ○ ○
11	Gambling makes me happier.	○ ○ ○ ○ ○ ○ ○
12	Gambling makes the future seem brighter.	○ ○ ○ ○ ○ ○ ○
13	My gambling wins prove that I have skills and knowledge related to gambling.	○ ○ ○ ○ ○ ○ ○
14	I can't function without gambling.	○ ○ ○ ○ ○ ○ ○
15	When I win it is mainly due to my skill and knowledge in the area.	○ ○ ○ ○ ○ ○ ○
16	I collect specific objects that help increase my chance of winning.	○ ○ ○ ○ ○ ○ ○

17	I have specific rituals and behaviours that increase my chance of winning.	○ ○ ○ ○ ○ ○ ○
18	Gambling makes things seem better.	○ ○ ○ ○ ○ ○ ○

To obtain scores for each sub-scale, sum the individual scores for each item in the sub-scale.
To obtain the overall GamCog score, sum the individual scores for the six sub-scales.
To obtain mean scores for each sub-scale, sum the individual scores for each item in the sub-scale and divide by total number of items in the sub-scale (see table below).
To obtain the overall mean GamCog score, sum the mean scores for all sub-scales.

Sub-Scale	*Sub-Scale Code*	*Number of Items*	*List of Items by number*
Benefits of Gambling	BOG	4	11, 12, 18
Inability to Stop Gambling	IS	5	1, 4, 6, 10, 14
Illusion of Control	IC	5	3, 5, 9, 16, 17
Perceived Gambling Skill	PGS	6	2, 7, 8, 13, 15