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# Gambling screens and problem gambling estimates: A parallel psychometric assessment of the South Oaks Gambling Screen and the Canadian Problem Gambling Index

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**Abstract**

In 2005 the Northern Territory of Australia conducted its first population-based gambling and problem-gambling prevalence survey, administering both the South Oaks Gambling Screen (SOGS) and the Canadian Problem Gambling Index (CPGI) to the same sample of respondents. Using a sub-sample of regular gamblers (n=361), the respective problem gambling screens were subject to psychometric testing that included dimensionality, internal consistency, external validity, classification validity and screen order effects. Analyses were conducted for all regular gamblers stratified by gender. The CPGI produced a significantly lower prevalence estimate than the SOGS as well as lower rates of false-positives as measured against external criteria. Consistent with other studies, dimensionality analysis revealed a multi-dimensional factor structure for the SOGS and a single dimension for the CPGI. The CPGI displayed stronger correlations with external criteria and stronger internal consistency than the SOGS. A gender effect was observed, with both screens performing better for females. In addition, screen order significantly affected problem gambling prevalence estimates, although only for males and all persons. As a group, the psychometric analyses revealed that the results produced by the respective gambling screens are heavily context dependent, both in terms of methods of application and the characteristics of target populations. The key message of the paper is that *post-hoc* psychometric testing of gambling screens is essential in understanding the limitations of problem gambling prevalence estimates and to qualify and guide their interpretation when applied in general population surveys.

**Key Words:** Problem gambling, SOGS, CPGI, psychometric assessment, gender, Northern Territory, Australia

## Introduction

Following the first major Australian national population-level gambling and problem gambling prevalence survey, reported by the Productivity Commission in 1999, most jurisdictions in Australia have followed suit and conducted their own prevalence surveys (AC Neilsen, 2007; Gill, Dal Grande and Taylor, 2006; McMillen, Marshall, Ahmed and Wenzel,, 2004; Productivity Commission, 1999; Queensland Government, 2005; Roy Morgan Research, 2006; Schofield, Mummery, Wang and Dickson., 2004). The primary purpose of these surveys has been to estimate the percentage of problem gamblers among the adult population. However, consensus on the best way to measure problem gambling in Australia, particularly in population surveys, has not been reached (Battersby, Thomas, Tolchard and Esterman, 2002; McMillen and Wenzel, 2006). While several problem gambling screens have been employed, the two that have received the most recent attention are the South Oaks Gambling Screen (SOGS) and the Canadian Problem Gambling Index (CPGI) (Neal, Dalfabbro and O'Neil, 2005). This paper presents a parallel assessment of the psychometric properties of these two screens in order to identify their relative merits and to develop recommendations concerning their appropriateness for use in population-level research. Previous research carried out by the authors found significant gender differences in screen performance within the Northern Territory population (Young and Stevens, 2008). Therefore, the analysis contained in this paper is stratified by gender. Specifically, the paper presents information for each screen on content, dimensionality, internal consistency, external validity, classification validity, and the effect of screen order delivery on prevalence estimates.

## Psychometric Properties of the SOGS and CPGI

Given the different historical origins of the respective screens, it may be expected that they will display quite distinct psychometric properties when applied in a population context. The SOGS was conceived and developed in the late 1980s, primarily for use in clinical settings (Lesieur and Blume, 1987). It consists of 20 items. The first two items are scored on a Likert scale (and then converted to a binary scale). The next seventeen items are scored as binary 'yes' [1] 'no' [0] responses. The last item has three options ('yes', 'current', 'yes, in the past', and 'no') and is also coded to a binary scale with either 'yes' response scoring one. After conversion of items 1, 2 and 20 to the binary scale, scores for all items are summed to produce a score ranging from zero to twenty. A cut-point of five, which corresponded to DSM-III-R criteria for pathological gambling, was recommended for the classification of pathological gamblers.

The CPGI was designed by the *Canadian Centre for Substance Abuse* specifically for use in general population-based studies. It was designed to measure 'problem' as opposed to 'pathological' gambling, the definition of which was generated from a literature review and subsequent consultation with a panel of 12 gambling experts. According to this definition "problem gambling is gambling behaviour that creates negative consequences for the gambler, others in his or her social network, or for the community" (Ferris and Wynne, 2001, p. 5). The CPGI consists of 33 items, nine of which comprise the Problem Gambling Severity Index (PGSI) and are scored using a Likert scale ('never' [0], 'sometimes' [1], 'a lot' [2], and 'always' [3]). While the PGSI is the index used to produce problem gambling estimates and is a subset of the CPGI, the use of the CPGI terminology is more common in the literature and will, therefore, be used to represent the nine-item PGSI in this paper. The scores for each of the nine items are summed to produce a score ranging from 0 to 27, with respondents scoring eight or above being defined as problem gamblers (Ferris and Wynne). The CPGI was designed not only to identify problem gamblers, but also people who were at low (scores 1 to 2) to moderate (scores 3 to 7) risk of problem gambling. It, therefore, differs from the binary categorisation of the SOGS in that it conceptualises problem gambling as a continuum. However, this has not prevented use of the SOGS in a similar way, with cut-points modified to indicate various levels of problem gambling risk (e.g. Productivity Commission, 1999).

Numerous studies have presented psychometric statistics for the SOGS, although there are relatively fewer for the CPGI, largely due to its more recent development (Battersby *et al.*, 2002; Duvarci, Varan, Coskunol and Ersoy, 1997; Ladoucer et al., 2000; McMillen and Wenzel, 2006;

Poulin, 2002; Thompson, Walker, Milton and Djukic, 2005; Walker and Dickerson, 1996). For this reason, and because of the lack of other validated problem screens, the SOGS has enjoyed more extensive use than the CPGI. However, reviews of its efficacy both in and outside Australia, have uncovered grounds for criticism (Battersby et al., 2002; McMillen and Wenzel, 2006; Orford, Sproston and Erens,, 2003; Stinchfield, 2002; Walker and Dickerson, 1996; Wenzel, McMillen, Marshall and Ahmet, 2004). The most serious of these concerns is the potential of the SOGS to overestimate problem gambling when applied in a general population context (Battersby et al., 2002; Shaffer, Hall and Vander Bilt, 1999; Stinchfield, 2002). As Battersby *et al.* (2002) notes, the SOGS was developed primarily as a clinical screening tool and its reliable use in population studies has not been established. It has also been suggested that acquiesce bias, a tendency to answer 'yes' to questions in a survey regardless of content, is the cause of increased prevalence estimates when using the SOGS, although the studies by Thompson *et al*. (2005) and Ladouceur, Jacques, Chevalier, Sevigny and Hamel (2000) note that this may be a result of the misunderstanding of screen items outside a clinical setting.

The SOGS has also been criticised for incorporating a number of items that do not significantly correlate with other items in the screen, implying that different items may be measuring different constructs. McMillen and Wenzel (2006) conducted a principal component analysis (PCA) of the SOGS in a general population context and extracted seven dimensions (i.e. seven Eigen values greater than 1). In addition, seven items had loadings below 0.5 on the first un-rotated component, indicating low item correlation. This first un-rotated component explained a moderate 33% of the variation in the nineteen items available for analysis (one item had no affirmative responses). In this same study, the CPGI extracted a single component and all items had loadings greater than 0.65. Using a modified (reduced) version of the SOGS, the SOGS - RA (revised for adolescents) on a sample of high school students, Poulin (2002) found that three components best described the internal structure of the 12 screen items. This study found differences in the item loadings between male and female respondents, with female respondents showing a more consistent internal structure. Orford et al. (2003), in a PCA of the SOGS using data from the UK gambling prevalence survey, found that four factors had Eigen values greater than one, with the first factor explaining an unimpressive 26% of the variation in the 20 items. Orford et al. then applied a varimax rotation to the first two components to obtain a readily interpretable solution, one that showed items relating to money issues loading highly on the second factor, and items representing a "constellation of intentions unfulfilled, hiding the extent of gambling from others, criticisms and arguments, and feelings of guilt and wishing to stop gambling" loading on the first factor (Orford et al. p. 60). These studies show that the SOGS contains some items that do not correlate well with other items on the screen, while the CPGI has less heterogeneity amongst its items.

Given the relatively recent development of the CPGI, it is not surprising that there are fewer studies of its reliability and validity (Ferris and Wynne, 2001; McMillen and Wenzel, 2006; Neal et al., 2005). As part of the development of the CPGI, Ferris and Wynne (2001) carried out pre-testing in a population sample (n=143), followed by a general population sample of 3,120 respondents, of which 417 were retested, and a further 143 interviewed for clinical diagnosis. These tests revealed good internal reliability ($\alpha$= 0.84) and an acceptable test-retest reliability correlation coefficient ($\rho$= 0.78) (Ferris and Wynne, 2001). External validity, assessed against gambling expenditure, gambling frequency, and number of adverse events had expected correlations, although these were not reported by the authors. Other studies of the psychometric properties of the CPGI have reported favourably (Ladoucuer et al., 2005; McMillen and Wenzel, 2006). McMillen and Wenzel compared the CPGI, SOGS and the Victorian Gambling Screen (VGS), using concurrent validity methods, and found that the CPGI significantly outperformed both the SOGS and the newly developed VGS in psychometric testing. In this study, a PCA of the CPGI extracted a single factor with an Eigen value greater than one that explained 63% of the variation in the 9 items, with all items loading with values greater than 0.65, indicative of a uni-dimensional scale (McMillen and Wenzel). The same study found the CPGI to have higher correlation coefficients with known correlates of problem gambling (i.e. self-rating problem, family history, gambling as escapism, wanted help, stress, depression, suicidal tendencies, and harm symptoms), compared with the SOGS and VGS. This study also compared classification validity between the SOGS, CPGI, and VGS, and found that the CPGI produced the lowest percentage of false-positives against known correlates of problem gambling. McMillen and Wenzel caution in this study that the absolute percentage of false-positives should not be taken on face value, as no gold standard was available against which to classify problem gamblers, although relative differences are clearly important in identifying the screen with the most accurate classification validity.

In terms of problem prevalence estimates, Ladoucer et al. (2005) found no statistically significant differences between the SOGS and CPGI when applied to separate random population samples, although the SOGS did produce higher estimates (0.9% SOGS *cf.* 0.7% CPGI). Similarly, McMillen and Wenzel (2006) also found no statistical difference between problem gambling prevalence estimates produced by the SOGS (1.28%) and the CPGI (1.13%). Abbott and Volberg (2006) in a review of problem gambling screens noted that the CPGI tended to give lower problem gambling prevalence rates than the SOGS, but that the classified population were unlikely to be substantially different. However, on the basis of their review, concluded that the CPGI was the preferred problem gambling screen for use in population surveys, partly because of its good psychometric properties, but also because of ease of use (i.e. fewer items and therefore quicker administration of the screen).

There are some limitations with the psychometric analyses produced to date. Few studies present psychometric properties by gender, which is somewhat surprising given the amount of research that has clearly demonstrated different gender-based conceptions of, and motivations for gambling (Darbyshire, Oster and Carrig, 2001; Delfabbro, 2000; Mark and Lesieur, 1992), as well as in choice of gambling activities (Nower and Blaszczynski, 2006; Potenza, Maciejewski and Mazure, 2006; Volberg and Banks, 2002). In addition, as evident in the McMillen and Wenzel (2006) study, there is usually no gold standard with which to assess screen validity when applying screens in population surveys. As a result, relative assessments are relied upon. This is an issue in comparisons between different samples, one that is to an extent mitigated by the parallel comparison of gambling screens (i.e. when more than one screen is applied to the same group of respondents).

## Parallel Comparison of Screens

Few large-scale population studies have compared two or more problem gambling screens in parallel fashion, primarily due to methodological considerations of using more than one screen in population surveys (although see Delfabro et al. 2006 for use of dual screens). For example, the extent to which the order of screen delivery affects responses, and consequently produces biased problem gambling estimates, is unknown. To our knowledge, the size of the screen order effect when more than one gambling screen is administered in a survey has not been reported, although question item order effects have been investigated in other fields (Darker, French, Longdon, Morris and Eves, 2007). The most recent gambling prevalence survey carried out in Tasmania included both the SOGS and CPGI screen to all regular gamblers, though they present no data breaking down problem gambling prevalence estimates by screen order (Roy Morgan Research, 2006). This is an important issue because an increase in respondent load in population surveys may lead to an increase in measurement error, regardless of the data being collected. For these reasons, most studies of the psychometric properties of screens use different samples when making screen comparisons (e.g. McMillen and Wenzel, 2006). While administering two screens in a single survey is potentially problematic for these reasons, it has the important advantage of allowing for direct comparison of screens on the same sample of respondents (Delfabbro et al.). Specifically, parallel assessment of screens is able to determine the extent to which two different screens classify the same set of respondents, and to identify the characteristics of the screens (i.e. individual items) that are responsible for the classification of problem gambler groups, something that can not be directly answered by the administration of screens to different samples. Other benefits of parallel comparison include the ability to understand differential classification of respondents, avoidance of potential bias in sample selection (although this should be minimised with a random sample), and the ability to analyse a larger sample as opposed to dividing the sample into two or more parts for analysis (i.e. instead of half the sample receiving one screen and the other half another, the whole sample receives both screens).

## Research Rationale

The first Northern Territory population gambling prevalence survey was conducted in September 2005. Its purpose was to estimate problem gambling prevalence amongst the adult population and to describe general gambling participation. To enable comparisons with the national survey conducted by the Productivity Commission (1999) as well as more recent problem gambling estimates from other jurisdictions, respondents were administered two screens, the SOGS and the CPGI. This enabled direct comparison of the screens based on responses by the same group of individuals (i.e. a sample of regular (weekly) gamblers from the 2005 Northern Territory Gambling Prevalence Survey), a procedure not previously reported at the population level in Australia. Building on previous work by Young and Stevens (2008), this paper reports the prevalence estimates of problem gambling produced by the SOGS and CPGI and explores the psychometric properties of the respective screens. Given the significant gender differences found in the Northern Territory population with regard to problem gambling (Young and Stevens), and the lack of previous gender-based psychometric testing of screens, the present study presents the baseline psychometric properties of the SOGS and CPGI by gender. Specifically, it assesses the dimensionality, internal consistency, external validity, and classification validity of each screen. It will also determine if screen order affects estimates of problem gambling they produce, again by gender. It concludes with a discussion of the implications of the findings, and makes recommendations regarding the future use of problem gambling screens in population surveys.

## Methods

### *Survey Procedure and Content*

This section provides a brief summary of the survey protocols used in the 2005 Northern Territory Gambling Prevalence Survey (for more detail see Young et al., 2006). Given the expense of travelling to remote areas to carry out face-to-face interviews, a telephone survey was employed in a manner that largely replicated the methods of the Productivity Commission (1999). This involved a two-stage population sample (Productivity Commission, 1999; Volberg, 2002). The first stage screened respondents to identify gamblers and non-gamblers. The second stage identified regular and non-regular gamblers. Regular gamblers were defined as those who gambled at least once per week on any of the following activities: electronic gaming machines (EGMs); betting on the races (i.e. horses and greyhounds); keno (a type of continuous lottery); casino table games, such as blackjack or roulette; bingo; sports betting (on events like football, cricket, or tennis); casino games on the internet; private games for money (like cards or mah-jong); and any other gambling activity excluding raffles, sweeps, lotteries or instant scratch tickets. Socio-demographic, socioeconomic and attitudinal data was collected for all respondents. For all gamblers data was collected about gambling activity and frequency of play. Regular gamblers were asked an additional set of questions which included both the SOGS and the CPGI (with the order of screen administration randomised by gender). The final unweighted counts for the survey were: $n_{screened} = 5{,}381$; $n_{completed} = 1{,}893$ ($n_{regular\ gamblers} = 376$; $n_{non\text{-}regular\ gamblers} = 850$; $n_{non\text{-}gamblers} = 667$). All results presented in this paper pertain to the subset of respondents who received the two gambling screens (i.e. regular gamblers). The sample size of regular gamblers for which analyses could be completed was reduced from n=376 to n=361 due to missing responses for either of the gambling screens (n=9) or socio-demographic variables (n=6). Chi Squared tests of independence indicated that there were no significant differences between respondents excluded from the analyses due to missing data.

*Psychometric Analyses*

Six types of analyses were carried out on the sample of regular gamblers. They were content analysis, dimensionality, internal consistency, external validity, classification validity, and screen order effects. All analyses are completed for males, females and all persons, except the content analysis. As thorough *content analysis* of the SOGS and CPGI has been carried out in a number of studies, a relatively brief summary is provided in this paper (see Battersby et al., 2002; Ferris and Wynne, 2001; McMillen and Wenzel, 2006; Wenzel et al., 2004; Walker and Dickerson, 1996). The content domains were based on work by McMillen and Wenzel (p. 159) and were used to provide a basis for the labelling of screen dimensions and interpretation of their psychometric properties.

*Dimensionality* refers to the underlying structure of the scale items as reflected in the loadings of individual screen items on identified dimensions or components produced by a PCA solution. The factor-method PCA was employed in the current context. If the PCA solution has more than one Eigen value greater than one, then a varimax rotation will be applied to the solution in order to explore the factor structure. The number of components retained in the rotation will be determined by the minimum number of components needed for all items to load significantly ($\lambda \geq 0.4$) on at least one component.

*Internal consistency* refers to the consistency in which the items of the screen are measuring the desired construct. Good internal consistency generally indicates that there is little measurement error (e.g. misunderstanding of items). As a measure of consistency Cronbach's Alpha coefficient is calculated for the two screens. This coefficient measures the degree of inter-correlations between all items on the scale. It ranges between 0 and 1, with 1 indicating perfect inter-correlation (perfect internal consistency) between the items on the screen and zero indicating no correlation.

The inter-item covariance for each screen is also presented, which enables an assessment of absolute covariance of screen items between the screens.

*External validity* refers to the extent to which a screen measures the desired construct (i.e. problem gambling). External validity is demonstrated by strong positive correlation with known correlates of problem gambling. For example, gambling expenditure, self-rated problem gambling, depression, stress and suicidal tendencies are known problem gambling correlates that may be used as measures of external validity (Gill etal.,,2006). Constraints on questionnaire length precluded the asking of independent questions about known correlates of problem gambling apart from gambling expenditure and frequency of play, Therefore, raw screen scores were correlated (using Pearson's correlation coefficients with significance) with total gambling expenditure, gambling expenditure as a percentage of income, gambling frequency (with and without lotto and instant scratch tickets included), and with each other. Correlation coefficients were compared between males and females for each screen, and for males and females separately between screens by evaluating a Chi Squared statistic after applying Fisher Z-transformation to the coefficients.

Ideally, to assess *classification validity*, there needs to be a gold standard measure of problem gambling (i.e. a true problem gambling measure), which is usually assessed through interviews with respondents by a trained counsellor or psychologist. Given the absence of such a gold standard, and the current purpose of comparative analysis of the screens, three relative measures were used to determine differences between screens on the basis of gender. The three criteria for the SOGS are (i) CPGI problem gamblers, (ii) gambling expenditure 15% or more of individual income, and (iii) fourth quartile of total gambling expenditure for regular gamblers (≥$102 per week). The same three criteria are used for the CPGI, with the exception that the SOGS problem gambler category is substituted for CPGI problem gambler category. For each of the criteria the percentage false-positives and false-negatives are presented. Classification validity is further assessed through the use of a scatter plot representing SOGS and CPGI scores using (unweighted data), along with the cross-tabulation of SOGS by CPGI problem gamblers. Problem gambling prevalence estimates (with standard errors) within the regular gambler group are presented for each screen, adjusted for the sample design and weighting procedure. A test of proportions is used to compare the prevalence of problem gambling within the sample of regular gamblers between males and females, and screens. A one-tailed test is used to determine if the prevalence of problem gambling is significantly lower when measured using the CPGI compared with the SOGS, as suggested by previous studies. A two-tailed test is used to compare prevalence between genders within screens. Lastly, the McNemar's test of symmetry is used to assess whether the cross-tabulation of problem gamblers between the screens showed symmetry across the diagonal of the classification table.

*Screen order* effects on problem gambler classification are investigated using univariate logistic regression models. Logistic regression is the appropriate model when the outcome of interest, in this case being classified as a problem gambler, is a binary variable. Odds ratios are used to show whether respondents were more likely to be classified as problem gamblers if they received the screen in alternating order. The reference category for the independent (or explanatory) variable (i.e. screen order) is that the SOGS was administered first. Therefore, the odds ratios indicate the odds of being classified a problem gambler if the CPGI was administered first (or conversely, the SOGS was administered second). Odds above one indicate an increased likelihood of being a problem gambler when the CPGI was administered first, while the converse applies to odds below one. All odds are presented with 95% confidence intervals, and indicate a significant odds ratio if the interval does not contain one. Separate models were developed for each screen by gender. All logistic regression models were adjusted for the stratified sample design and population weighted data. Stata 9.2© was used for all statistical analyses.

## Results

*Content Analysis*

Tables 1 and 2 show the screen items classified according to content for the CPGI and SOGS respectively. Eight domains are represented in the content analysis, of which seven are represented by the twenty SOGS items and six domains by the nine CPGI items. The only domain uniquely represented by the CPGI is “tolerance”, while “loss of control” and “lying and self-deception” are unique to the SOGS. It is worth noting that the domains are unlikely to be mutually exclusive ways of categorising items. For example, “chasing” could quite easily be conceived as a “loss of control” in not sticking to gambling limits. In summary, there are no extraordinary differences between the screens in terms of the domains that they sample, though the percentage of items relating to “money issues” was considerably higher for the SOGS.

**Table 1** CPGI items and content analysis

| Screen item | | Content domain |
|---|---|---|
| **3** | In the last 12 months, when you gambled, how often did you go back another day to try to win back the money you lost? | Chasing |
| **5** | In the last 12 months, how often have you felt that you might have a problem with gambling? | Problem recognition |
| **9** | In the last 12 months, how often have you felt guilty about the way you gamble or what happens when you gamble? | |
| **2** | In the last 12 months, how often have you needed to gamble with larger amounts of money to get the same feeling of excitement? | Tolerance |
| **6** | In the last 12 months, how often has gambling caused you any health problems, including stress or anxiety? | Personal consequences |
| **7** | In the last 12 months, how often have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true? | Social consequences |
| **1** | In the last 12 months, how often have you bet more than you could really afford to lose? | Money issues |
| **4** | In the last 12 months, how often have you borrowed money or sold anything to get money to gamble? | |
| **8** | In the last 12 months, how often has your gambling caused any financial problems for you or your household? | |

**Table 2** SOGS items and content analysis

| | **Screen item** | **Content domain** |
|---|---|---|
| **1** | When you gambled, how often did you go back another day to win back money you lost? [1] | Chasing |
| **2** | Have you claimed to be winning money from gambling when in fact you lost? [1] | Lying & self-deception |
| **7** | In the last 12 months, have you hidden betting slips, lottery tickets, gambling money or other signs of gambling from your spouse/partner, children, or other important people in your life? | |
| **5** | In the last 12 months, have you felt guilty about the way you gamble or what happens when you gamble? | Problem recognition |
| **20** | Do you feel you have had a problem with your gambling? [2] | |
| **3** | In the last 12 months, have you gambled more than you intended to? | Loss of control |
| **6** | In the last 12 months, have you felt that you would like to stop gambling, but didn't think you could? | |
| **4** | In the last 12 months, have people criticised your gambling or told you that you have a gambling problem, regardless of whether or not you thought it was true? | Social consequences |
| **8** | In the last 12 months, have you argued with people you live with over how you handle money? | |
| **10** | In the last 12 months, have you lost time from work or study because of your gambling? | Personal consequences |
| **9** | In the last 12 months, have you borrowed from someone and not paid them back as a result of your gambling? | Money issues |
| **11** | In the last 12 months, have you borrowed from household money to gamble or to pay gambling debts? | |
| **12** | In the last 12 months, have you borrowed from your spouse or partner to gamble or to pay gambling debts? | |
| **13** | In the last 12 months, have you borrowed from other relatives or in-laws to gamble or to pay gambling debts? | |
| **14** | In the last 12 months, have you obtained cash advances using your credit cards to gamble or to pay gambling debts? | Serious money issues |
| **15** | In the last 12 months, have you borrowed from banks, finance companies or credit unions to gamble or to pay gambling debts? | |
| **16** | In the last 12 months, have you borrowed from loan sharks to gamble or to pay gambling debts? | |
| **17** | In the last 12 months, have you cashed in shares, bonds or other securities to gamble or to pay gambling debts? | |
| **18** | In the last 12 months, have you sold personal or family property to gamble or to pay gambling debts? | |
| **19** | In the last 12 months, have you written a cheque knowing there was no money in your account, to gamble or to pay gambling debts? | |

[1] 'Sometimes', 'often' and 'always' coded to 1, and 'never' and 'rarely' coded to 0
[2] 'Yes, in the past, but not that way now', and 'yes, I feel this way now' coded to 1, and 'no' coded to 0

*Dimensionality and Internal Consistency*

Results of the dimensionality and internal consistency analyses are presented in Tables 3, 4 and 5. Table 3 shows the un-rotated first component for males, females and all persons for the SOGS. The SOGS PCA solution for males produced seven Eigen values greater than one, with the first component summarising 26% of the variation. Six SOGS items (items 2, 3, 14, 15, 16, 17) had loadings on the first un-rotated component below 0.40 for males. The SOGS PCA solution for females produced four Eigen values greater than one, with the first component summarising 40% of the variation. Item 2 was the only item with a loading below 0.40, though items 17 and 19 had no affirmative responses for females and were, therefore, excluded from the analysis.

Table 4 presents SOGS factor loadings for the four and two-factor varimax rotated solutions for males and females respectively. The first four factors for males explained 49% of the item variation, while the first two factors for females explained 51% of the item variation. The first rotated component for males accounted for 17% of the variation in the twenty SOGS items and represented all content domains identified in the content analysis (see Tables 1 and 4). The second rotated factor for males explained a further 15% of the variation. Five of the ten money related items, as well as the social consequences item (item 8), loaded on this factor. Two items (9 and 12) relating to money issues loaded above 0.4 on rotated factor 3 as did item 2 in the lying and self-deception domain. The final rotated factor in the four-factor solution for males contained the remaining items associated with money issues (items 14, 15 and 17), which represent more extreme forms of raising money.

Only two rotated factors were required to produce an interpretable solution for females with the first and second rotated factors explaining 27% and 24% of the variation in all items respectively (except items 17 and 19 which were excluded from the analysis). The rotated first component represents all content domains except personal consequences (i.e. item 10 losing time from work or study because of gambling). It contains only one item from the content domain for money issues. The second rotated factor for females contains the remaining items from the money issues content domain, and also includes items about personal (item 10) and social (item 8) consequences of gambling, as well as one item from the lying and self-deception domain (item 7).

Box 1 describes the rotated 3-factor all person solution for the SOGS, which summarised 45% of the variation in the twenty SOGS items. The factors described in Box 1 use the labelling from the content analysis presented in Table 1. Rotated factor 1 included six of the seven represented sub-domains for the SOGS, with personal consequences (item 10) not represented until the second component. Factors 2 and 3 represent similar constructs (i.e. money issues and associated social and personal consequences and behaviours), but indicate a clustering of different sets of screen items within these domains. These results indicate that the SOGS is a multi-dimensional measure of problem gambling and that this dimensionality is more evident for males than females.

**Table 3** SOGS dimensionality and internal consistency statistics by gender: Un-rotated component loadings, percentage of variation explained, item total correlation coefficients and standardised Alpha coefficients by gender

| | **Un-rotated 1st component item loadings** | | | **Correlation coefficients¶** | | |
|---|---|---|---|---|---|---|
| Screen item§ | Males | Females | All persons | Males | Females | All persons |
| Item 1 | 0.55 | 0.56 | 0.56 | 0.59 | 0.62 | 0.61 |
| Item 2 | 0.37 | 0.35 | 0.36 | 0.40 | 0.42 | 0.40 |
| Item 3 | **0.35** | 0.52 | 0.43 | 0.49 | 0.61 | 0.54 |
| Item 4 | 0.45 | 0.69 | 0.54 | 0.52 | 0.72 | 0.59 |
| Item 5 | 0.64 | 0.67 | 0.65 | 0.70 | 0.73 | 0.72 |
| Item 6 | 0.67 | 0.76 | 0.71 | 0.69 | 0.79 | 0.74 |
| Item 7 | 0.42 | 0.63 | 0.52 | 0.45 | 0.59 | 0.51 |
| Item 8 | 0.66 | 0.64 | 0.65 | 0.61 | 0.62 | 0.62 |
| Item 9 | 0.49 | 0.51 | 0.50 | 0.40 | 0.47 | 0.44 |
| Item 10 | 0.72 | 0.67 | 0.68 | 0.63 | 0.61 | 0.61 |
| Item 11 | 0.63 | 0.77 | 0.71 | 0.61 | 0.75 | 0.68 |
| Item 12 | 0.41 | 0.50 | 0.43 | 0.43 | 0.44 | 0.42 |
| Item 13 | 0.58 | 0.69 | 0.63 | 0.50 | 0.65 | 0.57 |
| Item 14 | **0.38** | 0.71 | 0.52 | 0.43 | 0.67 | 0.52 |
| Item 15 | 0.20 | 0.64 | 0.48 | 0.20 | 0.60 | 0.45 |
| Item 16 | **0.29** | 0.61 | 0.44 | 0.24 | 0.51 | 0.36 |
| Item 17 | **-0.01** | - | **0.00** | 0.03 | - | 0.02 |
| Item 18 | 0.66 | 0.57 | 0.61 | 0.50 | 0.49 | 0.50 |
| Item 19 | 0.60 | - | **0.39** | 0.43 | - | 0.30 |
| Item 20 | 0.53 | 0.76 | 0.64 | 0.57 | 0.79 | 0.67 |
| Eigen value | 5.25 | 7.21 | 5.96 | - | - | - |
| *% of variance £* | 26% | 40% | 30% | - | - | - |
| Eigen values > 1 | 7 | 4 | 5 | - | - | - |
| **Std Alpha¥** | - | - | - | 0.81 | 0.90 | 0.85 |
| Mean inter-item covariance | - | - | - | 0.014 | 0.032 | 0.018 |

Note: Bold font indicates loading less than 0.4
§ See Table 1 for written descriptions of items and coding of measurement scales
¶ Pearson's correlation coefficient between item and overall screen score (SOGS 0 to 20)
£ Percent of variance explained on the first principal component
¥ Standardised Cronbach's Alpha coefficient

**Table 4** SOGS principal component analysis varimax rotated solutions by gender

| | **Males 4-factor varimax rotated PCA solution** | | | | **Females 2-factor varimax rotated PCA solution** | |
|---|---|---|---|---|---|---|
| Screen item§ | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 1 | Factor 2 |
| Item 1 | **0.58** | 0.19 | 0.10 | 0.00 | **0.60** | 0.17 |
| Item 2 | 0.16 | 0.10 | **0.58** | -0.05 | **0.56** | -0.09 |
| Item 3 | **0.50** | -0.03 | -0.01 | 0.10 | **0.67** | 0.03 |
| Item 4 | **0.49** | 0.01 | 0.31 | -0.05 | **0.73** | 0.23 |
| Item 5 | **0.69** | 0.09 | 0.28 | 0.00 | **0.72** | 0.19 |
| Item 6 | **0.62** | 0.22 | 0.31 | 0.00 | **0.85** | 0.19 |
| Item 7 | **0.49** | -0.02 | 0.12 | 0.27 | 0.35 | **0.54** |
| Item 8 | 0.39 | **0.41** | 0.35 | 0.10 | 0.38 | **0.54** |
| Item 9 | 0.04 | 0.37 | **0.59** | 0.19 | 0.17 | **0.57** |
| Item 10 | **0.52** | **0.58** | -0.05 | 0.17 | 0.35 | **0.61** |
| Item 11 | **0.72** | 0.28 | -0.12 | 0.01 | 0.52 | 0.57 |
| Item 12 | 0.14 | 0.08 | **0.70** | 0.12 | 0.08 | **0.65** |
| Item 13 | 0.27 | **0.55** | 0.23 | -0.11 | 0.47 | 0.51 |
| Item 14 | 0.17 | 0.14 | 0.17 | **0.72** | 0.45 | 0.55 |
| Item 15 | 0.40 | -0.01 | -0.39 | **0.42** | 0.40 | **0.52** |
| Item 16 | -0.03 | **0.52** | 0.05 | -0.08 | 0.07 | **0.83** |
| Item 17 | -0.17 | 0.00 | 0.02 | **0.66** | - | - |
| Item 18 | 0.15 | **0.89** | 0.05 | 0.05 | 0.09 | **0.76** |
| Item 19 | 0.03 | **0.88** | 0.12 | 0.04 | - | - |
| Item 20 | **0.48** | 0.20 | 0.16 | 0.12 | **0.83** | 0.21 |
| Cumulative % variance | 17% | 32% | 42% | 49% | 27% | 51% |

Note: Bold font indicates loading greater than 0.4
§ See Table 1 for written descriptions of items and coding of measurement scales

**Box 1** Summary of principal component analysis for the SOGS varimax rotated 3-factor solution for all persons (rotated Eigen-value and % variance explained).

Factor 1: *Social and personal consequences, and money issues* (3.59, 18%): Items (6) couldn't stop gambling, (5) felt guilty about gambling, (20) feel has problem with gambling, (3) gambled more than intended, (4) people criticised your gambling, (1) go back to try and win loses, (2) claim to win when lost, and (11) borrowed household money to gamble/pay debts
Factor 2: *Money issues, social and personal consequences* (2.99, 15%): Items (18) sold personal/family property to gamble/pay debts, (19) overdrawn account to gamble/pay debts, (16) borrowed from loan sharks to gamble/debts, (10) Lost time from work/study because of gambling, and (13) borrowed from relatives to gamble/debts, and (8) argued with people over money
Factor 3: *Money issues* (2.48, 12%): Items (15) borrowed from financial institution to gamble/pay debts, (14) cash advance on credit card to gamble/pay debts, (7) hidden betting evidence from important people, (11) borrowed household money to gamble/pay debts, (9) borrowed from someone and not paid back

Table 5 presents the loadings on the first principal component for the CPGI binary and 4-point Likert scale as well as the correlation coefficients between items for each scale. In contrast to the SOGS, the CPGI binary scale for males and females only had one Eigen value greater than one, with this component summarising 45% and 56% of the variation respectively. All loadings on the first component were above 0.60 for males and females. As expected, the PCA solution for the CPGI using the 4-point Likert scale also produced a single factor solution and explained more variation than the binary scale (57% and 64% variation explained for males and females respectively). These results confirm that the CPGI is uni-dimensional for males, females, and all persons, regardless of whether the binary or 4-point Likert scale is used.

**Table 5** CPGI dimensionality and internal consistency statistics by gender: Un-rotated component loadings, percentage of variation explained, item total correlation coefficients and standardised Alpha coefficients by gender

| | **Binary scale** | | | **4-point Likert scale** | | |
|---|---|---|---|---|---|---|
| | **1st component item loadings** | | | **1st component item loadings** | | |
| Screen Item§ | Males | Females | All persons | Males | Females | All persons |
| Item 1 | 0.62 | 0.70 | 0.66 | 0.66 | 0.83 | 0.73 |
| Item 2 | 0.65 | 0.71 | 0.67 | 0.71 | 0.78 | 0.73 |
| Item 3 | 0.68 | 0.68 | 0.68 | 0.80 | 0.73 | 0.77 |
| Item 4 | 0.61 | 0.65 | 0.63 | 0.74 | 0.75 | 0.75 |
| Item 5 | 0.78 | 0.85 | 0.80 | 0.83 | 0.88 | 0.85 |
| Item 6 | 0.72 | 0.81 | 0.76 | 0.74 | 0.84 | 0.78 |
| Item 7 | 0.61 | 0.72 | 0.63 | 0.73 | 0.66 | 0.69 |
| Item 8 | 0.61 | 0.81 | 0.70 | 0.74 | 0.85 | 0.79 |
| Item 9 | 0.72 | 0.81 | 0.76 | 0.83 | 0.85 | 0.84 |
| Eigen value | 4.03 | 5.06 | 4.44 | 5.14 | 5.76 | 5.37 |
| *% of variance£* | 45% | 56% | 49% | 57% | 64% | 60% |
| Eigen values > 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **Correlation coefficient¶** | | | **Correlation coefficient¶** | | |
| Screen Item§ | Males | Females | All persons | Males | Females | All persons |
| Item 1 | 0.54 | 0.60 | 0.56 | 0.70 | 0.83 | 0.76 |
| Item 2 | 0.60 | 0.65 | 0.62 | 0.73 | 0.78 | 0.74 |
| Item 3 | 0.63 | 0.61 | 0.62 | 0.80 | 0.75 | 0.78 |
| Item 4 | 0.67 | 0.64 | 0.66 | 0.71 | 0.73 | 0.72 |
| Item 5 | 0.69 | 0.77 | 0.72 | 0.84 | 0.89 | 0.86 |
| Item 6 | 0.69 | 0.74 | 0.71 | 0.72 | 0.83 | 0.77 |
| Item 7 | 0.56 | 0.65 | 0.58 | 0.73 | 0.65 | 0.68 |
| Item 8 | 0.60 | 0.72 | 0.65 | 0.71 | 0.84 | 0.77 |
| Item 9 | 0.63 | 0.71 | 0.66 | 0.84 | 0.86 | 0.85 |
| Std Alpha¥ | 0.84 | 0.90 | 0.87 | 0.90 | 0.93 | 0.91 |
| Mean inter-item covariance | 0.055 | 0.083 | 0.066 | 0.184 | 0.237 | 0.204 |

§ See Table 2 for written descriptions of items and coding of measurement scales
¶ Pearson's correlation coefficient between item and overall screen score (CPGI 0 to 27)
£ Percent of variance explained on the first principal component
¥ Standardised Cronbach's Alpha coefficient

Cronbach's Alpha coefficients indicated that the CPGI (binary - 0.87, and 4-point scale - 0.91) had marginally better internal consistency than the SOGS (0.85) (see Tables 3 and 5). Alpha coefficients for females were marginally higher than males and all persons for both screens. Item-total coefficients were consistently higher for female SOGS respondents except for item 10, while for the CPGI, items 3 (chasing) and 7 (social consequences) for the binary and 4-point scale were lower for females. All item-total coefficients were significant ($p<0.001$) for both screens, except SOGS item 17 for males ($p=0.71$), and items 17 and 19 for females, which could not be estimated because no females answered these items in the affirmative. Mean inter-item covariance for the CPGI was more than double that observed in the SOGS.

*External Validity*

Table 6 presents the correlation coefficients for the SOGS and CPGI against each other, and four external criteria (total gambling expenditure, gambling expenditure as a percentage of income, and frequency of gambling with and without lotto and instant scratch tickets). All correlation coefficients were significant ($p\leq0.01$) between external correlates and the two screens. There were no significant differences between coefficients for males and females within the same screen, and also for males and females between screens, except between male ($\rho= 0.79$) and female ($\rho = 0.88$) correlation coefficients between the SOGS and CPGI ($\chi^2 = 16.6$, $p<0.0001$).

**Table 6** External validity: Pearson's correlation coefficients between SOGS and CPGI scores, and gambling expenditure, gambling expenditure as a percentage of income and gambling frequency by gender

| | SOGS | | | CPGI | | |
|---|---|---|---|---|---|---|
| | Males | Females | All persons | **Males** | **Females** | **All persons** |
| Total gambling expenditure | 0.44*** | 0.49*** | 0.45*** | 0.43*** | 0.48*** | 0.45*** |
| % Gambling $ of total income | 0.45*** | 0.41*** | 0.43*** | 0.50*** | 0.41*** | 0.46*** |
| Gambling frequency [1] | 0.13* | 0.21* | 0.15** | 0.19** | 0.18* | 0.18*** |
| Gambling frequency [2] | 0.16* | 0.20* | 0.15** | 0.19** | 0.24** | 0.19*** |
| SOGS score | - | - | - | 0.79*** | 0.88*** | 0.83*** |
| CPGI score | 0.79*** | 0.88*** | 0.83*** | - | - | - |

Note: *** $p\leq0.001$, ** $p\leq0.01$, * $p\leq0.05$

[1] Includes lotto and instant scratch tickets

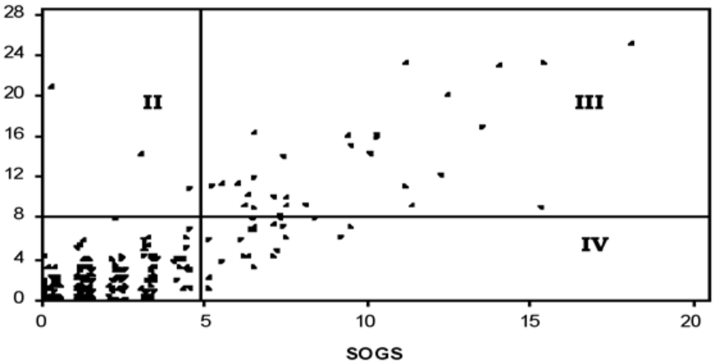
[2] Excludes lotto and instant scratch tickets

*Classification Validity*

Figure 1 graphs the cross-tabulation of problem gamblers classified by the SOGS and CPGI respectively for unweighted data. From Figure 1, five groups of problem gamblers can be described:

1. Quadrants III and IV: SOGS problem gambler (n=53);

2. Quadrants II and III: CPGI problem gambler (n=38);
3. Quadrant IV: SOGS problem gambler, but not a CPGI problem gambler (n=19);
4. Quadrant II: CPGI problem gambler, but not a SOGS problem gambler (n=4),
5. Quadrant III: both SOGS and CPGI problem gambler (n=34).




| *SOGS (5+) (no.)* | CPGI (8+) Problem gambler | | |
|---|---|---|---|
| *Problem gambler* | No | Yes | Total |
| No | 304 | 4 | **308** |
| Yes | 19 | 34 | **53** |
| **Total** | **323** | **38** | **361** |
| *SOGS (5+) %* | | | |
| *Problem gambler* | **No** | **Yes** | **Total** |
| **No %** | 98.7 | 1.3 | **100.0** |
| **Yes %** | 35.9 | 64.2 | **100.0** |
| **Total %** | 89.5 | 10.5 | **100.0** |
| *SOGS (5+) %* | **No** | **Yes** | **Total** |
| *Problem gambler* | **%** | **%** | **%** |
| No | 94.1 | 10.5 | 85.3 |
| Yes | 5.9 | 89.5 | 14.7 |
| **Total** | **100.0** | **100.0** | **100.0** |

**Figure 1** Scatter plot (points randomly perturbed) and cross-tabulation of SOGS by CPGI scores for regular gamblers.

The SOGS (quadrants III and IV combined) classified 14.7% (53/361) of regular gamblers as problem gamblers, while the CPGI (quadrants II and III combined) classified 10.5% (38/361) of regular gamblers as problem gamblers. The CPGI classified 64.2% (34 from 53) of the gamblers identified by the SOGS as problem gamblers, while the SOGS classified 92.1% (34 from 38) of the gamblers identified by the CPGI as problem gamblers (Quadrant III). Therefore, the SOGS classified approximately 40% more regular gamblers as problem gamblers compared with the CPGI, which translates to an approximate 30% reduction in the estimated unweighted prevalence of problem gambling amongst regular gamblers according to the CPGI.

Table 7 presents false-negatives and false-positives for the SOGS and CPGI by gender according to three external criteria (CPGI problem gamblers, gambling expenditure 15% or more of individual income, and the fourth quartile of total gambling expenditure for regular gamblers (≥$102 per week)) for unweighted data. Unweighted data was used for this analysis to ensure consistency with the data in Figure 1. The use of unweighted data did not change the direction of the relative differences between screens, including by gender, though the actual rates of false-positives and false-negatives obtained increased slightly with weighted data. The absolute percentage of false-positives and negatives should not be taken at face-value when using the external criteria presented, as they do not represent 'true' measures of problem gambling. However, these criteria are instructive in the comparison they enable between the screens in a relative sense. For all persons and for all criterions, the SOGS produced higher proportions of false-positives and lower rates of false-negatives than the CPGI. When analysed by gender, the SOGS produced higher rates of false-positives (and lower rates of false negatives) for males compared with females. This pattern also occurred with the CPGI, which produced higher rates of false-positives for males.

**Table 7** Classification validity of problem gambling screens against external criteria: False-positives and false-negatives by gender

| | SOGS problem gamblers | | | CPGI problem gamblers | | |
|---|---|---|---|---|---|---|
| | Males | Females | Persons | Males | Females | Persons |
| | (n=27) | (n=26) | (n=53) | (n=20) | (n=18) | (n=38) |
| False-positives | % | % | % | % | % | % |
| SOGS Problem gambler | - | - | - | 20.0 | 0.0 | 10.5 |
| CPGI problem gambler | 40.7 | 30.8 | 35.9 | - | - | - |
| Expenditure 15% or more of income | 48.2 | 30.8 | 39.6 | 40.0 | 27.8 | 34.2 |
| 4th quartile total gambling expenditure§ | 33.3 | 30.8 | 32.1 | 35.0 | 27.8 | 31.6 |
| | (n=198) | (n=110) | (n=308) | (n=205) | (n=118) | (n=323) |
| False-negatives | % | % | % | % | % | % |
| SOGS Problem gambler | - | - | - | 5.4 | 6.8 | 5.9 |
| CPGI problem gambler | 2.0 | 0.0 | 1.3 | - | - | - |
| Expenditure 15% or more of income | 13.6 | 20.9 | 16.2 | 14.2 | 23.7 | 17.7 |
| 4th quartile total gambling expenditure§ | 17.7 | 17.3 | 17.5 | 19.5 | 20.3 | 19.8 |

NOTE: Cut-off's for expenditure were researcher chosen specifically for comparison between screens, which seemed reasonable given the proven association between gambling expenditure and problems gambling (Abbott *et al*. 2006; Williams and Wood, 2004).
§ Total gambling expenditure quartiles calculated for regular gamblers.

Table 8 presents the weighted prevalence estimates for problem gambling within the sample of regular gamblers. The CPGI prevalence estimate for problem gamblers was significantly lower than the SOGS for females (9.9% *cf.* 18.7%) and all persons (8.8% *cf.* 14.2%), but not for males (8.3% *cf.* 12.3%). There was no significant difference in problem gambling prevalence between males and females for either screen. McNemar's test of symmetry between classification of problem gamblers for the two screens indicated non-symmetry for all persons ($\chi^2_{df=1}$ = 9.78, $p<0.002$) and female respondents ($\chi^2_{df=1}$ = 8.00, $p<0.005$), but not for male respondents ($\chi^2_{df=1}$ = 3.27, $p=0.071$). This indicates that there is a significant difference between classification of problem gamblers by the two screens for females and all persons, but not males.

**Table 8** Weighted problem gambling prevalence estimates within regular gamblers for the SOGS and CPGI by gender

| | Males % (SE) | Females % (SE) | All Persons % (SE) | p-value (2-tailed) [1] |
|---|---|---|---|---|
| SOGS 5+ | 12.3 (+/- 2.7) | 18.7 (+/- 4.7) | 14.2 (+/- 2.4) | ns |
| CPGI 8+ | 8.3 (+/- 1.9) | 9.9 (+/- 2.4) | 8.8 (+/- 1.5) | ns |
| Weighted sample (N) | 6,982 | 3,018 | 10,000 | |
| p-value (1-tailed) [2] | ns | p≤0.05 | p≤0.03 | |

[1] Test of proportions: between males and females
[2] Test of proportions: between screens

*Screen Order Bias*

Table 9 presents the results of the screen-order effects analysis. The top half of the table shows prevalence estimates with standard errors for both screens by screen order and gender for the weighted data. Prevalence estimates were higher for both screens when the CPGI was administered first. Odds ratios are used to test for statistical significance of screen order. They represent the odds that a respondent will be classified as a problem gambler by each of the screens when the CPGI was administered first. Both screens exhibited a statistically significant order effect for males and all persons, with more respondents classified as problem gamblers by both screens when the CPGI was administered first (or conversely less when the SOGS was administered first). However, the screen order effect was not significant for female respondents. The CPGI problem gamblers exhibited higher odds ratios, indicating a larger effect size of screen order for the CPGI.

**Table 9** SOGS and CPGI: Prevalence of problem gamblers within regular gamblers by screen order, and logistic regression odds ratios for problem gamblers and screen order by gender

| | **SOGS problem gamblers** | | | **CPGI problem gamblers** | | |
|---|---|---|---|---|---|---|
| | Males | Females | Persons | Males | Females | Persons |
| | % (+/-SE) | % (+/-SE) | % (+/-SE) | % (+/-SE) | % (+/-SE) | % (+/-SE) |
| Prevalence | | | | | | |
| SOGS first | 6.6 (+/-2.5) | 17.0 (+/-6.3) | 9.7 (+/-2.7) | 2.7 (+/-1.4) | 8.2 (+/-3.1) | 4.3 (+/-1.3) |
| CPGI first | 18.1 (+/-4.9) | 20.3 (+/-5.4) | 18.8 (+/-3.8) | 14.2 (+/-3.7) | 11.7 (+/-3.9) | 13.4 (+/-2.8) |
| Total | 12.3 (+/- 2.7) | 18.7 (+/- 4.7) | 14.2 (+/- 2.4) | 8.3 (+/- 1.9) | 9.9 (+/- 2.4) | 8.8 (+/- 1.5) |
| Weighted sample (N) | 6,982 | 3,018 | 10,000 | 6,982 | 3,018 | 10,000 |
| Odds ratio (95% CI)[§] | | | | | | |
| SOGS first | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| CPGI first | **3.15 (1.10-9.01)** | 1.24 (0.49-3.17) | **2.15 (1.02-4.53)** | **6.09 (1.79-20.67)** | 1.47 (0.47-4.58) | **3.43 (1.53-7.67)** |

[§] Logistic regression dependent variable reference category non-problem gamblers for the respective screens, independent variable reference category SOGS administered first. Standard errors adjusted for stratified sample design and population weighting: Significant Odds ratios are bolded.

## Discussion

*Psychometric Comparison of Screens*

Table 10 summarises the findings from the psychometric analyses comparing the performance of the SOGS and CPGI on a population sample of regular gamblers. The results of the psychometric analyses indicate that as applied in the population survey used in this study, the CPGI is the more psychometrically sound instrument consistent with recent studies (McMillen and Wenzel, 2006; Neal et al., 2005). The CPGI displayed a clearly interpretable uni-dimensional factor structure in the dimensionality analysis, better internal consistency (i.e. higher Alpha coefficients and inter-item co-variance); more significant correlation coefficients with the correlates of problem gambling (i.e. external validity); and produced lower proportions of false-positives (classification validity). The prevalence rates (within regular gamblers) were statistically different between the screens, with the CPGI prevalence estimates for problem gamblers being significantly lower than the SOGS for females and all persons, but not for males. The test of symmetry indicated that for all persons and female respondents, classification of problem gamblers when cross-tabulated were non-symmetric. These results support the view that the SOGS produces higher prevalence rates of problem gambling than the CPGI in population surveys (Abbott and Volberg, 1992; Battersby et al., 2002; McMillen and Wenzel, 2006; Shaffer et al., 1999; Stinchfield, 2002; Thompson et al., 2005). While there were limitations to the criteria used to identify false-positives in this study, the CPGI produced lower rates of false-positives relative to the SOGS for all external criteria. The high rates of false-positives are consistent with the cross-tabulation of the problem gambler categories produced by each screen, which illustrated that the SOGS classified approximately 40% more regular gamblers as problem gamblers than the CPGI.

**Table 10** Summary of psychometrics comparing the SOGS and CPGI for all persons

| Psychometric analysis | SOGS | CPGI |
|---|---|---|
| Content analysis | Good representation of content domains<br>High representation of money related items | Good representation of content domains |
| Dimensionality | Multidimensional with no clear interpretable factor structure | Uni-dimensional |
| Internal consistency | Acceptable alpha coefficient – eight items with correlation coefficients ≤0.50 against total score, and three ≤0.40 | Acceptable alpha coefficient – all items (binary and Likert scale) with correlation coefficients ≥0.56 against total score |
| External validity | Score showed significant (slightly lower than CPGI) associations with all external criterion | Score showed significant (slightly higher than SOGS) associations with all external criterion |
| Classification validity | Higher rates of false-positives<br>Slightly lower rates of false-negatives | Lower rates of false-positives<br>Slightly higher rates of false-negatives |
| Prevalence estimates[1] | Significantly higher than CPGI | Significantly lower than SOGS |
| Screen order effect on prevalence estimate[1] | Significantly higher when CPGI administered first for males & persons<br>Weaker significant effect | Significantly higher when CPGI administered first for males & persons<br>Stronger significant effect |

[1] Prevalence estimates of problem gambling for regular gamblers

There are several possible explanations why the SOGS identifies more problem gamblers than the CPGI in this population survey. First, the dimensionality analysis of the SOGS produced a multidimensional solution (McMillen and Wenzel, 2006; Orford et al., 2003; Poulin, 2002), which may increase its capacity to categorise a broader range of problem gambler than the CPGI (Laplante et al., 2006). It is well recognised that problem gamblers have different activity profiles based on preferences and frequency of play (Dickerson et al., 1996; Laplante, Nelson, LaBrie and Shaffer., 2006; Potenza et al., 2006; Volberg and Banks, 2002). If associations exist between these activity profiles and different 'types' of problem gamblers (Blasinzsky & Nower, 2002), then the SOGS may be better at identifying these different types of gambler, which may, indeed, differ by gender (Darbyshire et al., 2001; Potenza et al., 2001). The current study did not investigate how the screens performed by preferred gambling activity, though an investigation of gambler activity profiles, based on activity and frequency of play, is currently underway.

The proportion of false-positives (and prevalence estimates) generated by the SOGS may also be due to some respondents misunderstanding some items, which may introduce an acquiescence bias (Knowles and Condon, 1999; Krosnick, 1999). Ladouceur et al. (2000), in a group of participants recruited from newspaper advertisements, found that on average, adult non-problem and problem gamblers misunderstood approximately 26% of SOGS items. This study also noted that the misunderstanding of items tended to produce a "yes" bias, evident by the fact that the number of affirmative responses declined after the screen was re-administered with an explanation of the meaning of items. In the current survey, approximately 65% of regular gamblers had low (i.e. secondary or below) education (Young et al., 2006) and may therefore be more likely to misinterpret SOGS items, potentially leading to acquiescence bias. One argument is that this could, of course, also apply to the CPGI. However, given the CPGI uses a Likert scale that allows respondents to report problems based on a continuum, and contains fewer items, the likelihood of a similar effect is reduced.

*Screen Order Effects*

Of surprise was the extent to which screen order affected prevalence estimates. The odds of a respondent being classified as a problem gambler by the SOGS when this instrument was administered second was doubled (odds ratio 2.15 (1.02-4.53)). Conversely, the odds of being classified a problem gambler by the CPGI when this instrument was administered first were increased by a factor of three (odds ratio 3.43 (1.53-7.67)). There may be a number of reasons for this contrasting order effect. Firstly, the sample used in the development of the SOGS was educated about the concept of problem gambling prior to the selection of items (Lesieur and Blume, 1987). Secondly, it may be that administering the CPGI first in the survey acts to prime respondents to the concept of problem gambling and leads to more considered "yes" responses (Ladouceur et al., 2000). However, the opposite effect occurred for the CPGI, suggesting an influence of respondent load. That is, having just answered 20 items regarding their gambling habits, respondents may grow tired of answering and become more likely to answer in the negative (or as the case may be with the Likert scale, answer "sometimes"), and are, therefore, less likely to be classified as problem gamblers). This effect would not be observed for the SOGS because only nine questions, as opposed to twenty, would have been asked before the scale is presented. Further investigation is required to tease out why the order effect on problem gambler classification is so pronounced. Speculation aside, the powerful screen order effect highlights the potential dangers of including multiple screens in a single survey instrument. Given the current study did not have separate samples for the SOGS and CPGI it is not possible to determine prevalence estimates independently of screen order effects. However, the randomisation of screen administration is likely to have balanced out these effects and is essential when administering multiple screens in surveys.

*Gender Differences in Screen Performance*

Significant differences were observed in the psychometric properties of the SOGS and CPGI on the basis of gender (Delfabbro, 2000; Delfabbro, Lahn and Grabosky, 2006; Mark & Lesieur, 1992; Poulin, 2002). Specifically, both screens displayed better internal validity (i.e. higher Alpha coefficients), dimensionality (i.e. fewer dimensions in the PCA and higher loadings on the first un-rotated principal component and), external validity (i.e. higher correlation coefficients with external criteria), and classification validity (i.e. fewer false-positives) for females. In short, the screens psychometric properties were more stable for females compared with males in both the SOGS and CPGI.

In terms of an explanation for this finding, the data suggest that the females in the sample responded to screen items in a more homogenous way than males. The dimensionality analysis using the CPGI items produced a uni-dimensional construct for all persons, males and females, though loadings were generally lower for males. However, the dimensionality analysis of the SOGS items revealed a 4-dimensional construct for males (i.e. 4-factor rotated solution) and a 2-dimensional construct for females (i.e. 2-factor rotated solution). The 4-dimensional rotated factor solution for males clearly separated items relating to more serious money issues from other money issue domains, while for females all money items loaded highly on the second factor (Orford et al., 2003). These gender differences in factor structure may indicate the presence of different clusters of problem gamblers for males that are not so pronounced in female problem gamblers (Dickerson, Baron, Hong and Cottrell, 1996). In a sample of school students, Poulin (2002) observed differences in the SOGS-RA three-factor solution factor structure by gender, as well as differences in prevalence rates, suggesting that gender-specific cut-points may be required for the SOGS-RA. However, no explanations for these differences were provided, except a note that adolescent males had higher prevalence rates of probable pathological gambling than adolescent females. It is possible there are gender-specific threshold points at which gambling becomes a problem, and this idea is worth further exploration. In addition to more homogeneity in responses, there were lower rates of false-positives for female respondents, as assessed by the external criterion used in this study. This finding was reflected in the higher problem gambling prevalence estimates for females, although these were not statistically different from male estimates.

Interestingly, screen order and gender showed a significant interaction. For males, the odds (95% confidence interval) of being a classified a problem gambler when the CPGI was administered first were 3.15 (1.10-9.01) for the SOGS and 6.09 (1.79-20.67) for the CPGI, while there was no significant difference for females. There are a number of possible explanations for this. Male and female respondents may have different conceptions of normative gambling behaviour (Blanco, Hasin, Petry, Stinson and Grant, 2006; Dickerson *et al.,* 1996; Mark and Lesieur, 1992; Neal et al., 2005). It may be that female respondents are more aware of the problems caused by excessive gambling and are, therefore, more likely to acknowledge them when presented with a gambling screen. It is also likely that female problem gamblers have a different psychological profile to their male counterparts and this is reflected in their responses (Blanco et al., 2006; Crisp et al., 2004; Mark and Lesieur, 1992).

A final point to make is that the unique demographic profile of the Northern Territory could be contributing to the differences being observed. That is, the Northern Territory is comprised of a younger population compared to other jurisdictions in Australia, has a large Indigenous population (approximately 30%) that has comparatively lower levels of education and employment to the non-Indigenous population, and has an industry profile different to other states and territories in Australia (Australian Bureau of Statistics, 2003). Therefore, similar studies need to be conducted in other jurisdictions and population contexts before these results may be confidently generalised.

## Conclusions

This paper has laid out the psychometric properties of the SOGS and CPGI as applied in a parallel population context. It has presented analyses of dimensionality, internal consistency, construct validity, classification validity, and screen order effects. Gender proved to exert a significant effect on screen responses, and hence, in respective prevalence estimates of problem gambling produced by the screens. More research on the differences in gambling patterns and experiences of problem gambling on the basis of gender is called for, as is the effect of these differences on problem gambling measurement procedures. The gender differences make clear the fact that problem gamblers are a heterogeneous group, something that is easily overlooked in the interpretation of problem gambler categories produced by screening instruments. As a consequence, comparisons of problem gambling estimates need to be conducted with some caution and, at the very least, age-gender standardisation may be necessary for such comparisons to be validly drawn. Unfortunately, this is rarely done, and comparisons between jurisdictions are fraught. In addition, the order in the administration of screens in the survey was found to play an important role in responses of the respondents to screen items, and more research is required to find out exactly why this occurs. For example, is it simply due to the length of the questionnaire or because of contamination by previous content? This issue affects the ordering of all data items and not just those that present multiple screens. Again, these effects are mediated by gender and further testing of appropriate ordering of screens is required.

In terms of the recommendation of screen use in general population surveys, it is evident, at least from the psychometric assessment presented here, that the CPGI is the preferred instrument. The CPGI has the advantage of having fewer items and will, therefore, minimise response burden (Neal et al., 2005). In addition, the CPGI provides respondents with a choice in self-reported severity of the problem using the 4-point Likert scale, which is likely to mediate the effect of "yes" acquiescence bias (Ladouceur et al., 2000). Therefore, if the purpose is an efficient and comparable measure of problem gambling then the CPGI is the screen of choice. However, more research is required to validate the CPGI in a population context. In particular, studies that assess the classification and construct validity of the CPGI with sound external criteria would be welcome. In terms of the SOGS, further understanding of its performance in population surveys is needed, particularly in terms of its complex factor structure. This complexity may indicate that this screen has some potential in identifying particular subgroups of problem gamblers (LaPlante et al., 2006; Potenza et al., 2006). However, the lack of ease with which a readily interpretable factor solution was generated is a cause for concern. This issue needs to be further explored, particularly in diverse population contexts, before any firm conclusions may be reached regarding the context-specific utility of the SOGS.

Future surveys which present more than one gambling screen in the same instrument are advised to assess the effect of screen order by gender and, as a minimum requirement, randomise the order in which the screens are administered. Indeed, this study has highlighted the general importance of assessing *post-hoc* reliability and validity of screens when used in population surveys, as well as the attendant necessity to account for potential confounders, including screen order and gender, when presenting prevalence estimates. Prevalence estimates will vary according to population composition, questionnaire design, question presentation, and survey content, all of which introduce an element of measurement error that needs to be understood when interpreting prevalence estimates, and as importantly, translated as advice to the policy makers who use them.

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