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www.elsevier.com/locate/psychres

PII: S0165-1781(17)30525-5
DOI: https://doi.org/10.1016/j.psychres.2018.02.028
Reference: PSY11202

To appear in: *Psychiatry Research*

Received date: 27 March 2017
Revised date: 4 December 2017
Accepted date: 13 February 2018

Cite this article as: P. Dunsmuir, D. Smith, A.K. Fairweather-Schmidt, B. Riley and M. Battersby, Gender differences in temporal relationships between gambling urge and cognitions in treatment-seeking adults, *Psychiatry Research,* https://doi.org/10.1016/j.psychres.2018.02.028

Number of Words (text only, omitting abstract) = 5,365
Number of words Abstract = 198
Number of Tables = 2
Number of Figures = 2
No. of pages = 33

3rd December 2017

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Running Head: Gender differences over time for gambling urge and cognitions

Submitted to: Psychiatry Research – Revision 1

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Abstract

Many gambling-specific CBT programs seek to target either gambling-related urge or cognitions or both. However, little is known of the influence of one symptom type on another across time and whether these differ for men and women help-seeking problem gamblers. The aim of this study was threefold: to determine presence of measurement invariance for urge and cognition measures over time; to investigate the effect of baseline urge on end-of-treatment gambling-related cognitions – and the reciprocal relationship; and, identify whether these pathways differ across gender. Self-reported gambling urge (GUS), and gambling-related cognitions (GRCS) data from treatment-seeking problem gamblers prior to and post treatment (N=223; 62% men) were analyzed with cross-lagged panel models, moderated by gender. Conceptualization of urge and cognitions were found to be temporally stable. There was no significant association between baseline GUS scores and post-treatment GRCS scores, nor the reverse relationship. Putatively, this infers that coexisting urge and gambling-related cognition components of problem gambling operate independently over time. Analyses revealed gambling urge had a significantly stronger tracking correlation across time for men than women when adjusting for cognition paths. This investigation provides early evidence for tailoring CBT in response to sub-population gambling-related characteristics, demonstrated across men and women.

Key words: gambling disorder, urge, cognitions, cognitive-behavioral therapy, gender, moderating effects, path analysis

1. Introduction

Problem gambling (PG) is widely acknowledged to result in significant personal and public consequences (Battersby et al., 2006; Blaszczynski and Nower, 2002; Lorains et al., 2011) This includes financial debt, relationship breakdown, comorbid substance use, illegal activity, and despite PG prevalence being relatively low (e.g., rates for 12 months range between 0.2–5.3%), the extent of lost productivity is nonetheless significant (Fong, 2005; Productivity Commission., 2010; Wardle et al., 2007). However, relatively few (i.e., ~10%) seek professional help (Cunningham, 2005; Pulford et al., 2009) for their gambling problems, and those who do, experience a high relapse rate – a common characteristic among sufferers of addiction-related disorders (Brorson et al., 2013; Melville et al., 2007). By specifically adapting and tailoring interventions to correspond with subpopulation characteristics (such as gender), it may be possible to enhance the rapidity of symptom improvement, therapy adherence, and overall therapy outcomes – particularly in relation to future relapse (Suurvali et al., 2010).

Gambling-specific cognitive behavioral therapy (CBT) currently comprises a promising evidence-based therapy for PG (Cowlishaw et al., 2012; Gooding and Tarrier, 2009). While a combination of exposure and cognitive therapy (ET and CT, respectively) has been shown to improve both gambling-related urge and cognitions, presently there is no specific research base providing evidence to demonstrate the mechanism by which cognitive and exposure therapy work together in a combined CBT treatment package. In other words, *do* urge and cognitive concepts interact under the influence of CBT? Although a number of papers have discussed neurobiological and cognitive trajectories at a theoretical level (e.g., Blaszczynski and Nower, 2002; Brevers and Noël, 2013), current evidence (examined below) is still widely based on cross-sectional data.

Two well-known integrative models inform PG research and therapy: the Pathways model

(Blaszczynski and Nower, 2002), and the Biopsychosocial model (Sharpe, 2002). Both models robustly identify and describe postulated causes of gambling disorders. Both models are also based upon cognitive-behavioral and diathesis-stress foundations, but importantly, they differ in relation to the conceptualization of gambling disorder population characteristics. The Biopsychosocial perspective considers those with gambling disorder as being essentially *homogeneous*, contrasting with the Pathways model which proposes three discrete routes of PG development, where *subpopulations* are described as possessing differing chronology and co-morbid psychological pathologies.

A burgeoning body of research is supportive of the Pathways model's distinct subpopulations perspective observes gambling motivations and associated features to vary by gender (Grant et al., 2012; Hing et al., 2016b). It may be pertinent at this point to note that recent guidelines describe the use of the terms relating 'gender' (man/men, and woman/women): gender incorporates the social, environmental, cultural and behavioral domains which have a bearing upon each individual's self-identification as a man or woman, and their respective health outcomes (Heidari et al., 2016). Gender appears to be linked to both gambling type and other psychiatric problems: (mid-age/older) women problem gamblers with psychiatric comorbidities prefer electronic gaming machines (EGMs), while (younger) men, often with comorbid substance abuse, favor sports betting/gambling (Clark, 2010; Hodgins et al., 2011; Husky et al., 2015; Petry, 2003). Notably, women gamblers commonly report using gambling as an escape from loneliness and depression (Getty et al., 2000; Trevorrow and Moore, 1998). This corresponds to Blaszczynski and Nower's (2002)'Pathway 2' ('*emotionally vulnerable problem gamblers* – who present with premorbid anxiety and/or depression, a history of poor coping skills, and negative family background experiences, developmental variables and life events', p. 97). In contrast, men gamblers are attracted to the sensation-seeking and competitive elements described in 'Pathway 3' ('*anti-social impulsivist problem gamblers* – distinguished by features of impulsivity and

antisocial personality disorder…behavioural problems independent of their gambling, including substance abuse, suicidality, irritability, low tolerance for boredom and criminal behaviours', p. 97).

Key symptoms of PG include physiological arousal and subjective excitement, particularly for men, as noted above. These features underpin urge (or craving), and, combined with mutual neurobiological factors, comprise the transdiagnostic elements uniting PG with substance use disorders (SUD). The psychophysiological response to gambling 'near misses' (similar to a drug 'hit') reinforces the urge maintaining gambling behavior (akin to substance addiction). Neuroimaging research already demonstrates correspondence between the strength of gambling urge and subsequent changes in neural activity, incorporating retrieval and processing of emotion and impulse regulation (Balodis et al., 2012; Potenza et al., 2003). A recent review addressing neural correlates of cognitive control in gambling disorder has now implicated impaired prefrontal cortex activity, and highlights the probable interaction of mood and stress with cognitive control and/or motivational drive (i.e., urge) (Di Nicola et al., 2010; Moccia et al., 2017). Thus, urge is postulated to associate with poor emotion regulation and deficient coping strategies (Michalczuk et al., 2011; Moccia et al., 2017; Williams et al., 2012).

Interestingly, investigations employing psychological measures suggest urge varies systematically by gender, where a stronger relationship between urge and gambling severity found for men (Smith et al., 2015). Aside from urge, cognitive distortions, such as erroneous beliefs about one's chances of success (implicated in risk-taking), or possessing the capacity to influence betting outcomes, are central PG *cognitive* features. These are assessed with cognition specific measures for gambling, such as Gambling Attitudes and Beliefs Survey-23 (Bouju et al., 2014) and the Gambling Related Cognition Scale (GRCS; Raylu and Oei, 2004b). Gambling-related cognitions, including gambling expectancies (GE; e.g., "Having a gamble helps reduce tension and stress"; (Raylu and Oei, 2004b) appear to be mediated by 'escapist motivation'

(Balodis et al., 2014; Bonnaire et al., 2009; Thomas et al., 2009), an effect found to be stronger in women. Further, interpretive bias (IB; e.g., "Relating my winnings to my skill and ability makes me continue gambling") varies between men and women in the general community (Raylu and Oei, 2004b). However, this body of research is based on cross-sectional methodology, and in order to robustly investigate these gender-based differences in GE and IB, further testing of Smith et al.'s (2015) findings remains to be undertaken using longitudinal data.

Recent neurocognitive-based investigations continue to reveal gender variability, including the recruitment of cognitive strategies and neural networks. For example, examination of putative mechanisms underpinning observed gender disparities in reward-based decision-making highlight a tendency for women to focus on the overall *rate* of gains and losses. In contrast, men concentrate on the *extremity* of the gains and losses and long-term decision-associated outcomes (Byrne and Worthy, 2016). Singh (2016) suggests it is possible that the aforementioned variability, and other cognitive strategy differences, are influenced by sex-specific lateralization. Hormonal-induced right-brain lateralization appears also to be implicated: minor increases in cortisol levels in women seems to enhance performance on the Iowa Gambling Task via right hemisphere activation (van den Bos et al., 2009). In contrast, boosting levels of cortisol functioned to increase *risk-taking* behavior in men, but not in women (Kluen et al., 2017).

The body of research described above provides a robust justification for investigating the longitudinal relationship between key PG constructs implicated in PG to understand how cognitive and behavioral constructs (e.g., gambling urge and cognitions) relate during therapy disaggregated by gender. Surprisingly, extant research has rarely adopted a subpopulation-nuanced approach, despite the fact that in doing so findings may reveal important implications for therapy choice and delivery methods. Thus, the overall objective of the present study is to investigate a hypothesized temporal reciprocal relationship between psychophysiological (i.e., urge as measured by Gambling Urge Scale (GUS; Raylu and Oei, 2004a; Smith et al., 2013) and

cognitive factors (assessed with GRCS) to delineate therapeutic response indicators from CBT treatment completers using pre-and post-treatment data, and whether this varies across gender among PG. Importantly, the first objective must be to determine the stability over time of participants' conceptualization of the underlying gambling-related urge, expectations and interpretative bias constructs (operationalized by comparing responses to GUS, GRCS-GE, GRCS-IB items across two time points) by assessing measurement invariance. The second, and main study objective, investigates hypothesized cognitive-exposure mechanisms underpinning PG focused CBT by examining whether (a) baseline symptom severity in gambling urge is associated with change in gambling-related cognitions (GE and IB) – and the reciprocal relationship; and, whether (b) these relationships vary by gender.

2. Methods

2.1 Setting and treatment

An outpatient problem gambling therapy service offers one-on-one therapy and is staffed by a psychiatrist and therapists with a range of professional backgrounds including psychology, mental health nursing or social work. All therapists have both mental health and masters level qualifications in CBT and 3-10 year's therapy experience and received supervision from a registered clinical psychologist with extensive experience in CBT (Ladouceur et al., 2003; Ladouceur et al., 2001) and a consultant psychiatrist (Battersby et al., 2008).

On first presentation patients underwent a 90 minutes screening interview with the objective of establishing an initial understanding of each patient's current and past gambling behavior, to determine a diagnosis, and formulate a case conceptualization to guide treatment plan formulation. Baseline measures were collected prior to the commencement of the screening interview and reviewed during the interview. The interview comprised a gambling-focused cognitive behavioral assessment, including DSM-IV criteria for identifying problem gambling,

and a functional analysis which comprised three components pertaining to a recent gambling episode. These include the autonomic or physiological reaction, the behaviour, and the cognitions across three time frames: before, during, and after the gambling session. This served as the basis for explaining the treatment rationale to the patient at the end of the screening interview. Also, a mental state examination is conducted (i.e., appearance and conversation, memory and concentration, current mood, sleep, appetite, weight loss/gain, and energy levels), an assessment for co-morbid mental illness, including substance use disorders (i.e., alcohol dependence), anxiety, and depression, and a risk assessment (i.e., suicidal ideation, history of any past suicide attempts, past or present self-harm, irritability/anger/aggression). If the screening interview identified the patient as a treatment-seeking problem gambler, then they were deemed suitable for the treatment program, which comprised predominantly CBT and CT therapy. Of those patients who continued onto treatment, follow-up data were subsequently collected with mailed questionnaires at 1, 3, 6 and 12 months post baseline.

2.2 Study design and participants

The dataset for this retrospective analysis consisted of a subset of 454 *first time* treatment-seeking adults who presented to a problem gambling therapy service from January 2012 to December 2014. The present study involved 223 of these first time treatment seekers who were assessed at baseline and subsequently attended between 4-16 therapy sessions (Mean = 7.70, SD = 3.06), completed their treatment (Ladouceur et al. 2001; i.e., 4+ sessions as defined by Ladouceur et al. 2003; see dropout definition by Melville et al., 2007), and their post-treatment assessment. Full information detailing the procedure of the full baseline cohort of consecutive patients and eligibility criteria has been published previously (Smith et al., 2015; Smith et al., 2010).

Ethics approval was obtained from the relevant health service and university human research ethics committees (Application Number: 402.13 - HREC/13/SAC/258) and all participants signed

individual consent forms.

2.3 Measures

2.3.1 Demographics: At patients' first gambling therapy service presentation, data was collected for gender, age, relationship status, gambling form, and time since onset of gambling.

2.3.2 The Victorian Gambling Screen: (VGS; Ben-Tovim et al., 2001) a screening tool developed and validated in Australia consisting of 15 items (response options: 0=never, 1=rarely, 2=Sometimes, 3=Often, 4=always) and measures both the severity and impact of gambling over the previous 4 weeks; higher scores are indicative of more severe gambling problems with validated cut score 21+ (score range: 0 – 60) indicative of problem gambling. It has previously been validated in clinical populations (e.g., Tolchard and Battersby, 2010). Baseline reliability of this scale (α=0.85) was found to be good.

2.3.3 The Kessler 10 Scale: (K10; Kessler and Mroczek, 1994) is used as a global measure of psychological distress. Participant responses relate to levels of anxiety and depression symptoms ranging from few or minimal symptoms to extreme levels of distress (Andrews and Slade, 2001; Slade et al., 2011). The K10 has ten scale items (0=None of the time to 4=All of the time) and the response frame as to how they have been feeling relates to the previous 4 weeks. Higher scores indicate greater distress. The Cronbach's alpha coefficient value for baseline study data was 0.93 and this was indicative of good internal consistency.

2.3.4 The Gambling Urge Scale: (GUS; Raylu and Oei, 2004a) is a 6-item self-report with an 8-point response format (0=Disagree to 7=Agree) where items include statements such as "It would be difficult to turn down a gamble this minute", and "I crave a gamble right now". This yields a total score between 0-42, with higher scores indicating greater gambling urge. These six items are identified in **Table 1**. The GUS is a validated measure of gambling urge for both screening, and

measuring treatment outcomes (Oei et al., 2007; Smith et al., 2013). Scores were obtained for initial presentation, termed baseline and end of treatment. GUS showed good internal reliability at both baseline and end of treatment, (α=0.95).

2.3.5 The Gambling Related Cognitions Scale: (GRCS) is a 5-factor, 23-item questionnaire, with a 7-point Likert scale enabling participants to indicate the degree of agreement with each statement, where summing item scores provides a total score. The five factors examined are Gambling Expectancies (GRCS-GE), Interpretive Bias (GRCS-IB), Predictive Control, Inability to Stop Gambling, and Illusion of Control. A high GRCS score reflects more gambling-related cognitions, and is a positive predictor for PG. The GRCS has high internal consistency and validity (e.g., Smith et al., 2016) and has been further validated internationally across different age groups (Donati et al., 2015; Raylu and Oei, 2004b; Taylor et al., 2014). In order to build on previous research (Smith et al., 2015), this study focuses on the GRCS-IB and -GE as the two theory-specific constructs of interest, as discussed earlier. Scores were collected and calculated for both baseline and at end of treatment IB and GE subscales. **Table 1** also lists the items constituting GRCS-IB and GRCS-GE subscales. In the current study, Cronbach's alpha for each GRCS sub-scale was generally satisfactory at baseline and end-of-treatment (GRCS-IB α=0.67 and α=0.84; GRCS-GE and α=0.73 and α=0.80, respectively).

[**Table 1 here**]

2.4 Statistical Methods

2.4.1 Measurement invariance

Confirmatory factor analysis (CFA) modeled associations between factor variables and observed items plus unique variances of each item for the respective GUS (items 1-6), GRCS-IB (items 5, 10, 15, 20) and GRCS-GE (items, 1, 6, 11, 16) scales using Stata 13.0 (StataCorp., 2013). Firstly,

models were fitted to baseline data to obtain the best fitting model. Post-estimation modification indices were calculated to identify any omitted covariance paths that would otherwise improve model fit based on change in χ^2 value and significant at the 0.05 level. Any additional paths added to a model were established on statistical significance, meaningfulness and relevance. The initial model was then applied to baseline and post-treatment data simultaneously to assess for configural invariance, that is, determining whether participant conceptualization of constructs relating to urge and cognitions remains consistent across time (Oort, 2005). If patterns of factor loadings were similar then configural invariance was considered to be confirmed, and subsequent testing was therefore meaningful. Model estimates were generated from maximum likelihood (ML) estimation.

2.4.2 Cross-lagged panel design

A cross-lagged panel design provided information about presumed reciprocal causation between urge and cognitions from a temporal perspective, and whether structural paths differed between men and women (Acock, 2013; Kline, 2011). Specifically, the model simultaneously tested the influence of baseline gambling urge on post-treatment gambling related cognitions and the reverse relationship – the influence of baseline cognitions on post-treatment urge, when moderated by gender. Paths within each variable were also tested (e.g., baseline GUS to post-treatment GUS) to assess the stability of concepts across time, when adjusting for all other paths. A covariance path was assumed between exogenous baseline variables. A correlated error term was specified for post-treatment variables to explain the shared variance not accounted for by the influence from baseline variables. To determine the best fitting model, structural path coefficients were initially set to vary across gender. The covariates used to calculate adjusted outcome-cross-lag parameters based on gender differences (Table 1; marital status: 0=separated/ divorced/ single/ widowed/ other, 1=married/partnered; primary form of gambling: 0=horse/ dog betting/ other, 1=EGM; and, age = continuous covariate). Wald tests were used to determine which

parameters to constrain or set free in final models – Model 1 (GUS and GRCS-GE) and Model 2 (GUS and GRCS-IB).

2.4.3 Assessing model fit

Post-estimation tests evaluated how well measurement and cross-lagged models fitted these data. Firstly, a likelihood-ratio (LR) test was used to compare each fitted model with degrees of freedom versus a saturated model (no degrees of freedom). A significant χ^2 statistic indicated a model was not perfect (i.e., $p < 0.05$). Goodness-of-fit indices (e.g., confirmatory fit index [CFI]; Tucker-Lewis index – sensitive to sample size [TFI] (Bentler, 1990); root mean squared error of approximation [RMSEA]; coefficient of determination [CD]) were also calculated to assess each model (Kline, 2011). A CFI and TLI cut score of 0.90/0.95 indicated a reasonable/strong relationship among item scores. RMSEA (cut-off value ≤0.08 indicative of good model fit) was calculated with conventional 90% confidence intervals (CI) (Browne et al., 1993). The 90% CI contains information from the corresponding likelihood ratio (Browne et al., 1993; Curran et al., 2003). If the lower bound of the CI is <0.05, then the close-fit hypothesis is cannot be rejected at the 5% level. When the upper CI bound is >0.10, the poor-fit hypothesis is cannot be rejected at the 5% level. If both the close-fit and poor-fit hypotheses are not rejected, then this is indicative of substantial sampling (Kline, 2011). Finally, a CD (proportion of variance explained by overall model) value close to 1.0 suggested good model fit.

3. Results

3.1 Sample characteristics

Table 1 illustrates baseline data for 223 gamblers. Significant age differences were found across men (n=138) and women (n=85), with women participants being older. More numerous never married men, contrasted with more separated, divorced and widowed women. Significantly more

men undertook horse/dog gambling, while the majority of women preferred EGMs. However, time between gambling onset and presentation at the help service were similar across gender. At baseline, men had a significantly higher GUS and GRCS-IB scores. Both genders had mean VGS scores well above problem gambling cut-off of 21indicative of substantial gambling problems. Baseline mean K10 scores (i.e., indicative of current psychological distress) for men (29.13, SE=9.27) and women (28.29, SE=9.38) are indicative of high distress levels and probable psychological disorder of moderate severity (Andrews and Slade, 2001).

[**Table 2 here**]

3.2 Pre-post VGS, GUS, GRCS-GE and GRCS-IB scores

Results from a mixed-effects random intercept model showed a statistically significant improvement (p<0.001) in participant gambling symptom severity (i.e., reduction in VGS) from baseline (Mean = 41.07, SD = 9.97) to post-treatment (Mean = 13.61, SD = 17.15). Similarly, there was a significant improvement in GUS total scores from baseline to post-treatment of, on average, 7.8-point reduction ($p < 0.001$), GRCS-GE (↓7.2, $p < 0.001$), and GRCS-IB (↓7.5, $p <$ 0.001). **Table 2** shows the descriptive statistics for GUS, GRCS-GE and GRCS-IB. For all items, the mean score decreased from baseline to post-treatment, suggesting an improvement in gambling-related urge and cognitions. While all item and sum score variances also decreased across time as indicating participants became generally better at self-assessing levels of gambling symptoms, men appeared to be more heterogeneous in their responses compared to women at post-treatment. This discrepancy suggested, relative to women, there was greater variability across male treatment outcomes.

3.3 Measurement invariance

For GUS data, the best fitting base model was comprised of error covariances for items 1 and 4,

and items 3 and 6 (see **Table 2** for items). The ideal result of χ^2 (7) = 6.80, p=0.45 indicated that the model reproduced the covariance matrix at a statistically significant level, and was further supported by model fit indices. The CFI value of 1.00 indicated that the model did 100 % better than a model assuming no relationship between the observed variables and was supported by the Tucker-Lewis Index (TLI = 1.00). The RMSEA value of 0.00 (90 % CI: 0.00–0.08) showed the degree of error for each degree of freedom was ideal. On average, the SRMR value indicated that the model came within 0.01 of reproducing each correlation among the 6 items. The CD value of 0.98 reflected that most variance in observed variables was explained by the latent construct. When applying the baseline model to both baseline and post-treatment data simultaneously, results indicated that the model provided a reasonable fit to these data (χ^2 (43) = 114.36, p<0.001; CFI = 0.98, TLI = 0.96, SRMR = 0.03 and CD = 0.999). The RMSEA value of 0.09 (90 % CI: 0.07–0.11) was marginally higher than the recommended cut-off value of 0.08. All factor loadings were positive and substantial at the p <0.001 level based on z statistics (coefficient/standard error). Standardized loadings ranged from 0.76–0.94 at baseline, and 0.73–0.96 at post-treatment. Model fit indices and similarity in patterns of common factor loadings between baseline and treatment-end suggested that configural invariance had been established.

The initial GRCS-GE model provided a good copy of the covariance matrix (χ^2 (2) = 2.47, p=0.29). This was mostly supported by model fit indices CFI = 0.998, TFI = 0.99, SRMR = 0.02, CD = 0.82 and RMSEA = 0.03 (90 % CI: 0.00–0.14), although the upper CI bound suggested a fair degree of measurement error for the RMSEA point estimate. This model was subsequently run for both baseline and post- treatment data, and although not perfect (χ^2 (15) = 25.94, p=0.04) it approximated good fit based on values model fit indices (CFI = 0.98; TLI = 0.96; RMSEA = 0.06 % CI: 0.01–0.10), SRMR = 0.04 and CD = 0.97. All factor loadings were positive and substantial at the p <0.001 level. Standardized loadings ranged from 0.45 to 0.82 at baseline, and 0.54 to 0.83 at post-treatment. Overall, results suggested that configural invariance had been

established.

Finally, the GRCS-IB base model provided a near perfect fit of the data (χ^2 (1) = 0.079, p=0.78). All model fit indices supported the Chi-square value: CFI = 1.00, TFI = 1.00, RMSEA = 0.00 (90 % CI: 0.00–0.07), SRMR = 0.04 and CD = 0.96. All factor loadings were positive and statistically significant at the p <0.001 level. Standardized loadings ranged from 0.45–0.65 at baseline, and 0.71–0.81 at post-treatment. The patterns indicated that configural invariance had again been established, thus participant conceptualization of gambling urge, expectations and interpretation bias had remained *consistent across time*.

3.4 Urge and GRCS-GE (Model 1)

The gender moderated cross-lagged paths model for gambling expectancies and gambling urge showed acceptable fit as indicated by fit indices (**Figure 1**). Based on post estimation tests for invariance across gender, all structural parameter estimates were set to be equal, except for the effect of baseline GUS on post-treatment GUS. There were no equality constraints on variances or covariance. There was no deterioration of fit for constrained model (i.e., cf. saturated model with no constraints and no degrees of freedom; χ^2 (15) =12.88, p=0.61; RMSEA = 0.00, CFI = 1.00, SRMR = 0.04). Path coefficients indicated gambling urge symptoms were more stable for men than women at a statistically significant level. The structural path from baseline to post-treatment GRCS-GE was not significant. Results for cross-lagged paths indicated that baseline GUS did not significantly influence post-treatment GRCS-GE; the reciprocal path was also insignificant – inferring post-treatment GUS was not a consequence of baseline GRCS-GE. The correlated errors between post-treatment GUS and GRCS-GE for both men and women were statistically significant. This indicated that some variance in post-treatment GUS, not accounted for by baseline GUS and GRCS-GE, was correlated with some variance in post-treatment GRCS-GE not accounted for by baseline GUS and GRCS-GE. The error terms between baseline GUS

and GRCS-GE scores was significantly correlated for men but not women. The covariate effects (age, marital status, and gambling type) on baseline GUS or GRCS-GE were not statistically significant.

[**Figure 1 here**]

3.5 Urge and GRCS-IB (Model 2)

Gender moderated cross-lagged paths model (**Figure 2**) provided an acceptable fit for GRCS-IB and urge, as indicated by fit indices (χ^2 (15) 9.39, p=0.86, RMSEA = 0.00, CFI = 1.00, SRMR = 0.04). Following post estimation tests, all structural parameter estimates were set to be equal, except for the effect of baseline GUS on post-treatment GUS. No equality constraints were placed on the variances or covariance. The constrained model fitted as well as the saturated model. The path coefficients indicated that gambling urge symptoms were significantly more stable for men than women. The structural path from baseline to post-treatment GRCS-IB was statistically significant, reflecting stability of the concept 'interpretive bias' across time for both men and women. Results for cross-lagged paths indicated that baseline GUS did not convey a statistically significant effect on post-treatment GRCS-IB and the reverse path was also insignificant – post-treatment GUS was not a consequence of baseline GRCS-IB. The correlated errors between post-treatment GUS and GRCS-IB for both men and women were statistically significant, inferring some of the variance in post-treatment GUS not accounted for by baseline GUS and GRCS-IB, was correlated with some variance in post-treatment GRCS-IB, similarly not accounted for by baseline GUS and GRCS-IB. The between baseline GUS and GRCS-IB error terms were significantly correlated for men and women. The covariate effects (age, marital status, and gambling type) on baseline GUS or GRCS-IB were not statistically significant.

[**Figure 2 here**]

4. Discussion

Current understanding of the mechanisms underpinning CBT treatment for problem gambling is limited by cross-sectional methodologies and little acknowledgment that subpopulations (e.g., men cf. women) may respond differently to therapy compared to undifferentiated patient populations. In response, this investigation firstly sought to determine temporal stability in measure of urge (GUS) and cognition-oriented constructs (GRCS). addressing the main study objective, that is, whether gambling urge and cognition constructs reciprocate during the CBT treatment process, and whether gender moderates this relationship. Prior research investigating hypotheses particularly relating to cognitive constructs (Smith et al., 2015) demonstrated gender differences for gambling expectations and interpretive bias, but these findings required further research with longitudinal data in order to better understand temporal associations.

Aside from satisfying the essential tests of internal reliability, results for the first objective was able to confirm measurement invariance across two time-points in all three measures (i.e., GUS, GRCS-GE and GRCS-IB). That temporal stability was confirmed in the aforementioned scales identifies patient conceptualization of gambling urge and cognitions were *comparable over time*. These findings supplement previous cross-sectional research (Smith et al., 2015) that demonstrated the basic conceptualization and relative importance of the respective latent constructs in a PG population *did not* vary appreciably between men and women. The establishment of this gender-wise invariance, and now identification of temporal stability, across these measures situates resultant findings robustly and permits legitimate comparisons for urge and cognition across gender and time.

The outcome of the second study objective revealed that baseline gambling urge symptom severity *was not associated* with reciprocal changes in gambling related cognitions (i.e., either

GRCS-GE or GRCS-IB) at treatment end. Similarly, when the reciprocal model – baseline cognitions predicting post-treatment changes in urge symptoms – was tested, data also showed no significant change in the relationship over time. Rather, these present findings are highly suggestive of urge and cognition constructs remaining temporally stable and independent. This occurs simultaneously with a reduction in the basic mean scores for scale items overtime (**Table 2**) which describe *observable trends* in gambling cognitions and urge across the CBT intervention. Although previous studies suggest corresponding changes in urge and cognitions (e.g., Ladouceur et al., 2003; Smith et al., 2010), our study queries these indications of mutual influence. Further, there is increasing evidence from addiction-based literature of distinct effects for urge/craving and cognition, suggestive of neuroendocrine-biological mechanisms (e.g., dopamine, sex hormones) and psychosocial factors operate to facilitate the observed subpopulation variability (Carroll and Smethells, 2016; Gu and Filbey, 2017).

The third objective of this study was to investigate model moderation by gender, as informed by existing gambling and addiction literatures (Carroll and Smethells, 2016; Fattore and Melis, 2016; Potenza et al., 2001). Analyses highlighted pre-post treatment gambling urge and interpretive bias did indeed vary between men and women. Specifically, gambling-related urge remained a stable construct across time for *men* (see **Figure 1** and **2**). In other words, results indicated that men were markedly consistent in their conceptualization and experience of gambling urge, contrasting to women, where gambling urge was conceptually less stable from baseline to treatment completion (i.e., may have reconceptualized urge). This apparent change over time may be signal some type of *response shift*, that is, change in participants' conceptualization, internal calibration of measurement, or prioritization the construct in question (Schwartz and Sprangers, 1999). As response shift has the capacity to obscure the actual changes to scale totals on self-reported measures (Oort, 2005), it is important to investigate variability in factor patterns pre-post intervention further.

That men's urge remained consistent at post-treatment strengthens links with neurobiological aspects of gambling, as suggested previously (e.g., Fattore and Melis, 2016). Interestingly, while the addiction literature consistently reports women as frequently exceeding men's drug use, addictive substances are noted to vary by *quantity* and *type*: men more commonly use illicit drugs – particularly stimulants and alcohol, whereas women typically use prescription sedatives and tranquilizers (Carroll and Smethells, 2016) . An additional noteworthy point is that substances used by women have fundamentally anxiolytic functions, while men seek out elevating chemicals. This has a remarkable correspondence with motivations recorded in gambling research, that is, excitement and novelty seeking is common among men, as opposed to escape or distraction motives reported by women (Grant et al., 2012; Hing et al., 2016a). Furthermore, it has intriguing connections with the differential cognitive impacts of cortisol on decision making for men and women (Kluen et al., 2017) – here, the anxiolytic-linked substances may assist decision-making among women by keeping levels cortisol from disadvantageously rising. Future work in this area is clearly warranted, where the current results support a growing body of research identifying gender-linked differences in problem gambling, addiction and behavioral dysregulation research more broadly. Extant and present study findings underpin the importance of recent moves toward better representation of women in PG studies ensuring study conclusions can be appropriately generalized/targeted.

Despite the strength of the cross-lagged panel design, there are some key limitations. First, analyses used retrospective observational data, and therefore cannot imply causal relationships. Second, our study conclusions are only generalizable to adult help-seeking gambling populations. Thirdly, self-report measures were used in our study, and although this is common practice in psychological research, it is possible that (particularly) urge is underestimated when measured following a period of minimal gambling cues. Fourth, this study focused on treatment completers, rather than attrition from therapy or relapse (but see Smith et al., 2010), and post-baseline effects

may have contributed to findings, such as number treatments completed. Fifthly, this study focused on only two of the five GRCS subscales. While this was guided by relevant theoretical considerations and specific hypotheses, there are other gambling-related cognition questions/hypotheses that remain to be explored, but are beyond the scope of this study. Finally, CBT varies with regards to the degree of cognitive and behavioral therapy components delivered between services and therapists, thus conclusions may differ from a replication study using another CBT variant. Further research employing a prospective trial incorporating a larger sample size with three treatment arms (e.g., CT, ET and CBT) may further inform the present results. Combined with tightly manualized therapy minimizing inter-therapist variability, the effect of therapy method on problem gambling-related urge versus cognitions may be accurately determined.

In sum, gambling-related urge and cognitions appear to operate as separate constructs during CBT, where therapy may target some aspects of gambling-related cognitions more than others (i.e. GRCS-IB cf. GRCS-GE). More evidence is still necessary to confirm this construct delineation in order to better define how CBT is effective for PG, particularly in sub-populations such as men and women. Importantly, further empirical support for these findings would provide a solid foundation for the development of tailored treatment for specific problem gambler subgroups, where the ultimate aim is to achieve briefer, more efficacious treatments with less recidivism.

Acknowledgements

The Statewide Gambling Therapy Service is funded through Gamblers Rehabilitation Fund administered by the Department for Communities and Social Inclusion and the Office for Problem Gambling in South Australia. In addition to this funding for service provision, the research presented here has been conducted through the Flinders Centre for Gambling Research.

The authors wish to thank Rachel Humeniuk and Margie Blackwood for assistance in data collection and management.

Conflicts of interest: none

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Listing of titles for figures

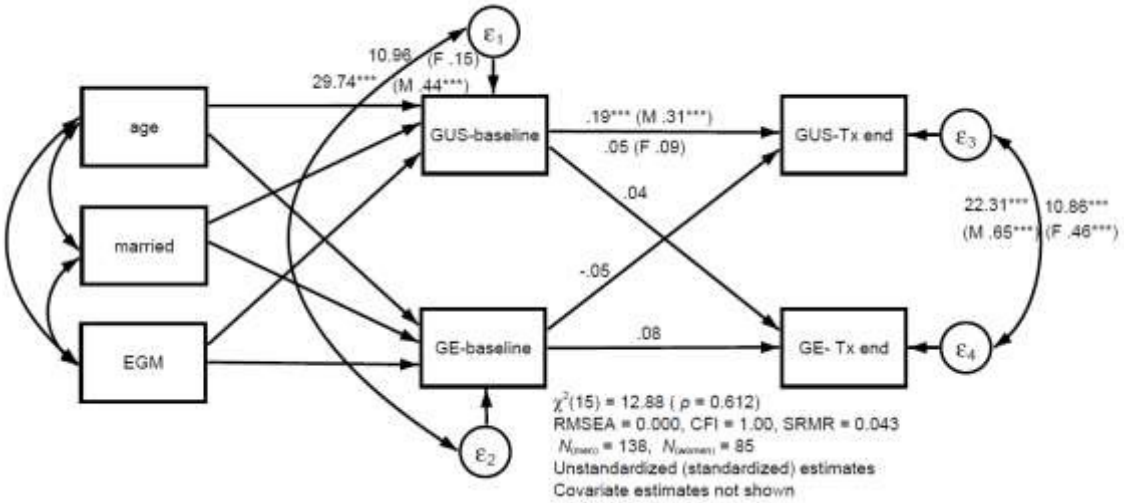
Figure 1

Estimated model for cross-lagged panel relating gambling urge and gambling expectancies by gender

Figure 2

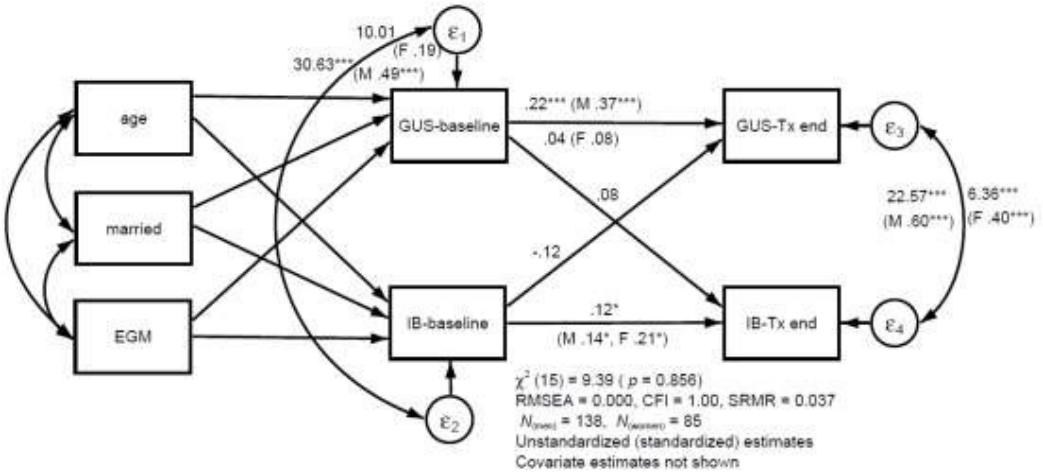
Estimated model for cross-lagged panel relating gambling urge and interpretive bias by gender

Figure 1.



Abbreviations: EGM, electronic gaming machine; GUS, Gambling Urge Scale; GE, Gambling Expectancies scale; RMSEA, Root Mean Squared Error of Approximation; CFI, Confirmatory Fit Index; SRMR, Standardized Root Mean Squared Residual; Tx, treatment M, males; F, females; (***$p <$ 0.001).

Figure 2.



Abbreviations: EGM, electronic gaming machine; GUS, Gambling Urge Scale; IB, Interpretive Bias; RMSEA, Root Mean Squared Error of Approximation; CFI, Confirmatory Fit Index; SRMR, Standardized Root Mean Squared Residual; Tx, treatment; M, males; F, females. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 1. Baseline characteristics of problem gamblers (N=223) by gender

Variable	Gender		Test statistic*	*p* value
	Men (n = 138)	Women (n = 85)		
Age	38.76 (12.00)	51.24 (12.63)	-7.39	<0.001
Relationship			20.62	<0.001
Never married	47 (34.06)	16 (18.82)		
Married	58 (42.03)	31 (36.47)		
Separated	29 (21.01)	28 (32.94)		
Other (including widowed)	0 (0)	8 (9.41)		
Unknown	4 (2.90)	2 (2.35)		
Gambling form			47.83	<0.001
EGMs	78 (56.52)	81 (95.29)		
Horse/dog	39 (28.26)	0 (0)		
Other	20 (14.49)	0 (0)		
Unknown	1 (0.72)	4 (4.71)		
Time since onset of problem gambling			0.211	0.900
<2 years	23 (16.67)	13 (15.29)		
2-5 years	29 (21.01)	16 (18.82)		
>5 years	80 (57.97)	51 (60.00)		
Unknown	6 (4.35)	5 (5.88)		
VGS	40.94 (9.93)	41.28 (10.08)	-0.25	0.789
GUS	12.07 (12.29)	8.74 (10.73)	2.06	0.040
GRCS-IB	10.67 (6.04)	8.25 (5.05)	3.09	0.002
GRCS-GE	10.81 (5.71)	9.61 (5.60)	1.54	0.126
K10	29.13 (9.27)	28.29 (9.38)	0.65	0.515

Data reported as: mean (SD), or n (%)
*From t-tests for continuous data and Pearson Chi-squared tests for categorical data
Abbreviations used: EGM = Electronic Gaming Machine VGS = Victorian Gambling Screen; GUS = Gambling Urge Scale; GRCS-IB = Gambling Related Cognitions Scale – Interpretive Bias; GRCS-GE = Gambling Related Cognitions Scale – Gambling Expectancies; K10 = Kessler 10 Scale.

Table 2. Descriptive statistics for Gambling Urge Scale, Interpretive Bias and Gambling Expectancies item scores

	Baseline						End-of-treatment					
	Men			Women			Men			Women		
Items	*N*	*M*	Var	*N*	*M*	Var	*N*	*M*	Var	*N*	*M*	Var
GUS												
1. All I want to do now is gamble	138	2.42	4.86	85	1.72	4.87	138	0.57	1.84	85	0.59	1.91
2. It would be difficult to turn down a gamble this minute	138	2.59	6.05	84	2.32	6.49	138	0.71	2.28	85	0.71	2.40
3. Having a gamble now would make things seem just perfect	138	1.70	4.43	85	1.11	3.43	137	0.50	1.74	85	0.26	0.77
4. I want to gamble so bad I can almost feel it	138	1.75	4.79	85	1.29	3.92	138	0.49	1.76	85	0.35	0.97
5. Nothing would be better than having a gamble right now	138	1.68	4.96	85	1.00	3.29	138	0.46	1.63	85	0.29	0.83
6. I crave a gamble right now	138	1.94	5.27	85	1.33	4.75	138	0.54	1.77	85	0.36	1.19
GRCS-IB												
5. Relating my winnings to my skill and ability makes me continue gambling	135	2.50	4.22	84	1.49	3.22	137	0.64	2.05	84	0.18	0.29
10. Relating my losses to bad luck and bad circumstances makes me continue gambling	138	2.40	4.14	83	1.63	3.68	136	0.52	1.60	85	0.22	0.65
15. Relating my losses to probability makes me continue gambling	138	2.58	4.19	85	2.02	3.67	137	0.74	2.32	85	0.35	0.80
20. Remembering how much money I won last time makes me continue gambling	138	3.24	4.62	84	3.20	4.36	137	1.00	3.16	84	0.54	1.72
GRCS-GE												
1. Gambling makes me happier	137	3.25	3.64	83	2.89	4.10	138	1.11	3.06	85	0.67	1.65
6. Gambling makes things seem better	138	2.78	3.89	83	2.57	4.00	137	0.84	2.42	85	0.53	1.39
11. Gambling makes the future brighter	137	1.27	2.93	83	1.07	2.85	137	0.35	1.14	85	0.16	0.42
16. Having a gamble helps reduce tension and stress	137	3.57	3.36	84	3.27	4.49	137	1.25	3.25	85	1.16	3.52

Abbreviations: GUS = Gambling Urge Scale; GRCS =Gambling Related Cognitions Scale; IB = Interpretive Bias; GE = Gambling Expectancies.

Highlights

Urge and cognitive components are key constructs involved in problem gambling behavior

A cross-lagged panel design showed no significant association between baseline urge and end-of-treatment cognitions, nor the reverse relationship.

Cross-lagged results inferred coexisting urge and gambling-related cognition components of problem gambling operate independently over time.

The relationship between urge at baseline and at end-of-treatment was identified as being significantly stronger for males than females.