Age and Gender Considerations with Respect to Gambling-Disorder Severity and Impulsivity and Self-control

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ABSTRACT

Introduction: Impulsivity and self-control are often inversely related, yet little is known regarding their concurrent role in gambling disorder (GD). Therefore, we aimed to explore self-control and impulsivity with respect to GD severity, gender, and age in an adult sample with GD. The secondary aim of this study was to consider the roles of these factors by means of path analysis. **Methods:** One-hundred-and-twelve adults who met criteria for GD completed the Barratt Impulsiveness Scale (BIS-11) and the Self-Control Scale (SCS). Structural Equation Modeling (SEM) evaluated direct and indirect effects of impulsivity and self-control on GD severity. **Results:** Impulsivity and self-control were negatively correlated. The SEM identified a direct positive relationship between impulsivity and GD severity. Impulsivity also mediated a relationship between age and GD severity. **Discussion and Conclusions:** High impulsivity levels are associated with greater severity of GD. Future studies should examine treatments targeting impulsivity and self-control in individuals with GD.

Keywords: gambling disorder, impulsivity, addictive behaviors, self-control, severity, age, gender.

INTRODUCTION

Gambling disorder (GD) is a behavioral addiction characterized by a maladaptive pattern of gambling that persists despite negative consequences and negatively impacts domains of functioning (APA, 2013; Yau & Potenza, 2015). Of the clinical features associated with GD, impulsivity and poor self-control have been considered two strong contributors to GD's etiology and maintenance (Fauth-Bühler et al., 2017; Gavriel-Fried & Ronen, 2015; Leeman & Potenza, 2012; Lutri et al., 2018; Mackillop et al., 2014; Mestre-Bach et al., 2019; Reynolds et al., 2006).

One widely used definition of impulsivity is, "a predisposition toward rapid, unplanned reactions to internal or external stimuli with diminished regard to the negative consequences of these reactions to the impulsive individual or to others" (Brewer & Potenza, 2008; Moeller et al., 2001). This multifaceted construct (Gullo & Potenza, 2014; Mestre-Bach et al., 2020) includes independent elements, including difficulties in delaying gratification and pre-potent motor disinhibition (Chowdhury et al., 2017; Hamilton, Littlefield, et al., 2015; Hamilton, Mitchell, et al., 2015; Steward et al., 2017).

Self-control is the volitional competency used to regulate psychological functioning (Wojdylo et al., 2017). It has been defined as the capacity to alter responses in order to adhere to morals, values and social expectations and achieve long-term objectives (Tice et al., 2007). Self-control is also a multifactorial concept, encompassing many components (such as habit formation and breaking, control over thoughts, emotional control, impulse control, and performance regulation) that have often been approached in an isolated manner, hindering its definition (Baumeister et al., 2018; Kotabe & Hofmann, 2015). Self-control may be activated when individuals follow certain internal or external rules or inhibit immediate gratifications (Muraven & Baumeister, 2000). The self-control construct overlaps with cognitive/inhibitory control processes and self-efficacy to control behaviors including gambling (Brevet-Aeby et al., 2016; Kaur et al., 2006; Miller & Cohen, 2001; Robinson et al., 2010; Van Veen & Carter, 2006).

Relationships between impulsivity and self-control have not been concurrently studied frequently, although both constructs may relate inversely. Some have hypothesized that impulsivity may derive from impaired cognitive control, and therefore, impulsivity would be a consequence of poor self-control processes (Brevet-Aeby et al., 2016; Dalley et al., 2011). However, other authors include cognitive control as one factor of impulsivity (Dalley et al., 2011), without defining directional associations. It is not surprising, therefore, that impulsivity assessment instruments include measures seemingly related to self-control, as is the case of the Barratt Impulsiveness Scale BIS-11 (Patton et al., 1995). Differences according to gender and age have been documented in both impulsivity and self-control (Fattore & Melis, 2016; Petry et al., 2002; Steward et al., 2017; Stoltenberg et al., 2008). It has been suggested that, in general, impulsivity decreases with age (Steward et al., 2017; Steinberg et al., 2008). Gender may act as a moderating factor in the association between impulsivity levels and some health problems (Stoltenberg et al., 2018), although gender-related differences in impulsivity levels seem to be less consistent than age-related differences.

Regarding GD, impulsivity has been positively associated with GD severity (Brevers et al., 2012; Krueger et al., 2005). Individuals with GD often exhibit disadvantageous decision-making (Mallorquí-Bagué et al., 2016; Navas et al., 2016; Potenza, 2009), with tendencies to discount rewards steeply (Grecucci et al., 2014; Petry, 2001), and they frequently demonstrate impairments in delaying or interrupting inappropriate behavioral responses (Kräplin et al., 2014). GD also involves continued behavioral engagement despite adverse consequences (Potenza, 2007). Moreover, individuals with GD often report subjective perceptions of impaired control (Bergen et al., 2014). Therefore, some theories posit that impaired self-control may be a root cause of problematic gambling behavior (Blaszczynski & Nower, 2002; O'Connor & Dickerson, 2003). In adolescence, individuals with poor self-control are more likely to develop problematic gambling behaviors and other comorbid risky behaviors (Cheung, 2014). People with GD have shown lower self-control levels than those without (Bergen et al., 2012). Some have suggested that self-control may predict GD severity (Cheung, 2014; Gavriel-Fried & Ronen, 2015).

Although associations of both self-control and impulsivity with GD have been assessed, integrative studies are needed to understand how these components interact with other relevant characteristics, such as age and gender. Some studies suggest that impulsivity increases with age whereas other studies suggest the opposite (Kalapatapu et al., 2013; Petry, 2002). Similarly, mixed findings have been reported regarding whether males or females are more impulsive (Mitchell & Potenza, 2015; Weafer & de Wit, 2014). However, findings that men (versus women) and younger adults (versus older adults) are more likely to exhibit GD appear more consistent (Potenza et al., 2001, 2006). Therefore, a main aim of this research was to explore impulsivity and self-control in relation to GD severity, gender, and age in an adult sample with GD. A secondary aim was to consider a mediating role for impulsivity and self-control in relationships between gender and age and GD severity levels by means of path analysis. We hypothesized that impulsivity and self-control would display mediating roles in associations between gender and GD severity and age and GD severity.

METHODS

Participants and Procedure

The sample included 112 participants who met criteria for GD. They were recruited at a University in the Problem Gambling Clinic through advertisements. Individuals 18 years or older with a diagnosis of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) GD as determined by structured interview (Grant et al., 2004) were included.

Participants were classified into groups according to their chronological age: younger adults (between 18 and 30 years-old) middle-aged adults (31 to 49 years-old) and older adults (50 to 69 years-old). Reasons for selecting 30 years of age as an initial cut-off were: a) neurodevelopment has been proposed to reach adulthood by the age of 30 (Chen et al., 2016), and b) other studies have used this age to divide younger and older samples with addictions (Fidler et al., 2013; Steward et al., 2017). Although there may be considerable heterogeneity in the established age groups, we chose 50 years-old as the other cut-off based on previous publications in which older age was a central study element (Salazar et al., 2019).

The study was conducted in accordance with the latest version of the Declaration of Helsinki. The Human Investigation Committee approved the study, and signed informed consent was obtained from all participants.

Measures

Diagnostic and Statistical Manual of Mental Disorders (DSM-5)

The DSM-5 diagnostic criteria to diagnose GD and its severity were used in the present study.

South Oaks Gambling Screen (SOGS) (Lesieur & Blume, 1987)

This self-report 20-item screening questionnaire discriminates between probable pathological, problem and non-problem gambling and has been used as a measure of GD severity (Potenza et al., 2003). The internal consistency in the study was within the adequate range (Cronbach-alpha α=0.715).

The Barratt Impulsiveness Scale (BIS-11) (Patton et al., 1995)

The BIS-11 is a 30-item, self-report instrument that includes three subscales: (1) attentional, (2) motor, and (3) non-planning. Item responses range from 1 to 4 (Rarely/Never, Occasionally, Often, Almost Always/Always). The BIS-11 has demonstrated adequate test-retest reliability (Spearman's ρ=0.83) and acceptable internal consistency (α=0.83), with a score of 72 or higher representing high impulsivity (Patton et al., 1995). The internal consistency in the study was adequate (α=0.735).

The Self-Control Scale (SCS) (Baumeister et al., 2018)

The SCS is a 36-item measure of self-control, including five subscales (discipline, deliberative/non-impulsive action, health habits, work ethic, and reliability). Each item is scored on a Likert scale (1, not at all, to 5, very much). Higher scores reflect greater self-control. The SCS has been validated against a high number of other scales and inventories, such as the Test of Self-Conscious Affect and the Anger Response Inventory. The scale has shown considerably high internal consistency (Cronbach's α= 0.89) and good retest reliability (α= 0.89) (Baumeister et al., 2018). The internal consistency in the study was adequate (α=0.754).

Statistical analysis

Statistical analysis was conducted with Stata16 for Windows. First, associations between study variables were estimated through partial correlation coefficients adjusted by participants' gender and age. Due to the high dependence between significance tests for correlations with sample size (high coefficients could achieve statistical non-significance in small samples and low coefficients could achieve statistical significance in large samples), effect sizes for partial correlations were based on Rosnow-Rosenthal thresholds (poor-small for $|R|>0.10$, mild-moderate for $|R|>0.24$ and large-high for $|R|>0.37$, which corresponds to Cohen's-*d* values of 0.20, 0.50 and 0.80 respectively) (Rosnow & Rosenthal, 1996).

Second, path analysis (executed through structural equation modeling, SEM) tested the magnitude and statistical significance of the underlying associations between study variables (gender, age, self-control, impulsivity and GD severity). The maximum-likelihood estimation was used for parameter estimations and goodness-of-fit was tested with chi-square analysis (χ^2), root mean square error of approximation (RMSEA), Bentler's Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and standardized root mean square residual (SRMR). Adequate model fit was considered (Barret, 2007; Bentler, 1990) as follows: non-significant χ^2 ($p>.05$), RMSEA<.08, TLI>.9, CFI>.9 and SRMR<.1. In this study, to assess the potential interaction effect of gender and age in the relationships between self-control and impulsivity with GD severity, two additional multi-group SEM analyses were defined and structural invariance for both of these potential interaction variables (gender and age) was tested.

A power calculation was conducted. For a sample size N=112, the estimated power for one-sample correlation analysis based on the Fisher's-z test, null-hypothesis $\rho=0$, alpha-risk $\alpha=0.05$, bilateral test and alternative-hypothesis $\rho=0.37$ (cut-off considered for large-high correlation effect size). The estimated power is $1-\beta=0.982$. Considering stratified analysis by gender, estimated power is between 1-β=0.552 for the female subsample (n=32) and 1-β=0.926 for the male subsample (n=80).

Regarding SEM, while these models have been widely used in behavioral science research, considerations about the sample size requirements vary. Current studies using Monte-Carlo procedures have assessed the sample size requirements for some common types of SEMs, including variation by the number of factors, number of indicators, strength of the indicator loadings and the regressive paths and the amount of missing data per indicator (Wolf et al., 2013). The sample requirements fall within a very broad range (from 30 to 460), depending on the analysis characteristics, and solutions that met fitting at a given sample size remained stable relative to the results of the analysis at the next largest sample sizes.

RESULTS

Description of the sample

Most participants were men (71.4%), identified as White (63.4%) and were single (58.0%). The mean chronological age was 43.6 years-old (SD=12.1). Table S1 (supplementary material) contains descriptive for all study variables.

Associations between self-control, impulsivity, and GD severity

Table 1 includes the partial correlation matrix estimating associations between self-control (SCS total scores) and impulsivity profile (BIS-11 scores). Among the total sample (*n*=112), negative correlation parameters emerged, indicating that poor self-control was associated with high impulsivity across gender, age, and GD severity groups.

--- Insert Table 1 ---

Table 2 includes the partial correlation matrix estimating the associations between GD severity and both self-control (SCS scores) and impulsivity (BIS-11 scores). No significant associations were found among the total sample (*n*=112). Stratifying by gender, women showed negative correlations between GD severity and self-control, and positive correlations between GD severity and impulsivity; no significant correlations emerged within men. Stratifying by age, within the youngest group, GD severity was inversely related to self-control and positively related to BIS-11 non-planning and lack of self-control impulsivity. Within the middle-aged group, GD severity was positively related to BIS-11 perseverance and cognitive instability impulsivity. Finally, within the oldest-age group, GD severity was related with all SCS (inverse) and BIS-11 (positive) measures in the table, except for the BIS-11 cognitive complexity, perseverance, and cognitive instability impulsivity domains.

--- Insert Table 2 ---

Path analyses

Figure 1 contains the path diagram with the standardized coefficients obtained in the total sample (the first block of Table S2, supplementary material, includes the complete results of the SEM valuing direct, indirect and total effects). Adequate fitting was obtained (χ^2=0.71, *p*=.700; RMSEA=0.013; CFI=0.999; TLI=0.999; SRMR=0.019). Results of the SEM showed that impulsivity achieved a direct positive effect on GD severity, and that impulsivity achieved also a mediating role in the relationship between age and GD severity (younger age is related to higher impulsivity, which is a statistical predictor of GD severity). Multi-group models achieved non-significant results measuring invariance by gender (joint test: Wald=9.08, *p*=.106) and age (joint test: Wald=9.44, *p*=.093) (the second block of Table S2 includes complete results for the invariance tests).

--- Insert Figure 1 ---

DISCUSSION

The present study explored roles for self-control and impulsivity with respect to GD severity, gender, and age in an adult sample with GD. Mediating roles for impulsivity and self-control in relationships between gender and age and GD severity were explored via path analysis.

A negative association between impulsivity and self-control was observed, and this relationship persisted across gender, age, and GD-severity groups. Self-control refers to the capacity to inhibit a dominant response through top-down processes (Diamond, 2013; Nigg, 2017; Rothbart, 2011), and when defining impulsivity, an impaired ability to control, inhibit or delay behavioral responses has been highlighted (Hamilton, Littlefield, et al., 2015). Therefore, there is an overlap between constructs, with poor self-control, being more closely associated with certain dimensions of impulsivity, such as urgency, lack of premeditation and lack of perseverance, based on the UPPS-P model of impulsivity (Berg et al., 2015; Rebetez et al., 2018). Consequently, both domains have been usually considered opposite and closely related, although their interrelationship has not been concurrently investigated in depth in the addictions field (Anton et al., 2017) and specifically with respect to GD.

Regarding gender, women showed a significant negative correlation between GD severity and self-control, and a positive correlation between GD severity and impulsivity levels, while no relevant correlations emerged within men. These findings suggest that in women with GD, self-control may reduce the involvement in risk behaviors, such as GD (Baumeister et al., 2007; Cheung, 2014; Ford & Blumenstein, 2013) and that impulsivity contributes importantly to GD severity (Brevers et al., 2012; Mestre-Bach et al., 2020; Steel & Blaszczynski, 1998). That these findings have been observed in women and not in men confirms the need to examine in depth gender-related differences in GD. To date, numerous gender-related differences have been described, such as differences in prevalence, onset of GD, clinical characteristics and treatment outcome (Kim et al., 2016; Kushnir et al., 2016; Martínez-Loredo et al., 2019). In this case, impulsivity and self-control may not equally relate to GD severity in both genders, and further research is needed. However, the results have to be interpreted with caution, since the findings could be due to the difference in sample size between men and women.

GD has also been associated with different dimensions of impulsivity according to age groups. Previous studies reported that the interaction between these dimensions of impulsivity also differed by age. More specifically, lack of premeditation and delay discounting were found to be associated only in young individuals with GD (Steward et al., 2017). In addition, the results of the present study seem to indicate that as age increases, the relationship between severity of GD and impulsivity may be in part explained by neurocognitive considerations (mainly regarding cognitive instability impulsivity and cognitive complexity). These findings suggest that it is important to consider the role of age in examining impulsivity and GD severity, as other previous studies have noted (Granero et al., 2014).

Partially consistent with our hypotheses, the finding that impulsivity showed a direct positive effect on GD severity in the SEM coincides with previous studies, which found associations between both measures (Brevers et al., 2012; Odlaug et al., 2011). Impulsivity also displayed a mediational role in the association between age and GD severity. A negative correlation between chronological age and impulsivity levels has been suggested in previous studies (Galvan et al., 2007; Steinberg et al., 2008). Previous data also suggest that age and GD severity may be the best statistical predictors of individual differences in impulsivity levels (Alessi & Petry, 2003; Stea et al., 2011).

Finally, an inverse association between GD severity and self-control was observed in the young-age and the oldest-age groups, although the association was not significant in the middle-aged group. The results could be due, at least partially, to the differences in the sample sizes of the three groups.

Clinical implications

The results of the present study show that both impulsivity and self-control are associated with GD severity, either directly or indirectly. Therefore, as other authors have proposed, self-control training could have a relevant impact on impulsive behavior (Cranwell et al., 2014; Muraven, 2010). Treatment development for GD may consider aspects such as reward discrimination, effort exposure and impulse control training (Smith et al., 2019).

Moreover, Cognitive Remediation Therapy has been indicated in other mental disorders to address impulsivity, in addition to other cognitive factors that are also characteristic of GD, such as compulsivity and decision-making (Challet-Bouju et al., 2017; Tchanturia et al., 2010). However, further research is needed to better understand the mechanisms underlying the training effects, taking gender and age into account (Friese et al., 2017).

Limitations

In this study, there are some caveats that should be highlighted. First, the self-reported measures used to assess impulsivity (BIS-11) and self-control (SCS) likely do not fully capture complexities inherent in people with GD. Second, observed effects involving self-control may be influenced by social desirability biases, as other authors have suggested (Baumeister et al., 2018). Third, the cross-sectional design of the present research does not allow for the assessment of causality or directionality of effects. Fourth, the sample size (n=112) was small, and there were more male than female participants. Finally, in the field of impulsivity and self-control, there are multiple conceptualizations and theoretical models, which should be considered in future studies.

CONCLUSIONS

This study provides greater understanding of how self-control and impulsivity may relate to GD severity. The results emphasize the importance of future studies that evaluate and target both constructs in clinical populations with GD, taking gender and age into consideration.

Declarations

Conflict of interest

None of the authors have any conflicts of interest. Marc Potenza has consulted for Rivermend Health, Opiant Therapeutics, Addiction Policy Forum, Game Day Data and AXA; has received research support (to Yale) from Mohegan Sun Casino and the National Center for Responsible Gaming; has participated in surveys, mailings or telephone consultations related to drug addiction, impulse-control disorders or other health topics; has consulted for and/or advised gambling and legal entities on issues related to impulse-control/addictive disorders; has provided clinical care in a problem gambling services program; has performed grant reviews for research-funding agencies; has edited journals and journal sections; has given academic lectures in grand rounds, CME events and other clinical or scientific venues; and has generated books or book chapters for publishers of mental health texts.

Informed consent

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all patients for being included in the study.

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REFERENCES

Alessi, S. M., & Petry, N. M. (2003). Pathological gambling severity is associated with impulsivity in a delay discounting procedure. *Behavioural Processes, 64*(3), 345–354. https://doi.org/10.1016/S0376-6357(03)00150-5

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.).* American Psychiatric Association.

Anton, R. F., Schacht, J. P., Voronin, K. E., & Randall, P. K. (2017). Aripiprazole Suppression of Drinking in a Clinical Laboratory Paradigm: Influence of Impulsivity and Self-Control. *Alcoholism: Clinical and Experimental Research*, *41*(7), 1370–1380. https://doi.org/10.1111/acer.13417

Baumeister, R. F., Tangney, J. P., Boone, A. L., & Baumeister, R. F. (2018). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. In *Self-Regulation and Self-Control* (pp. 173–212). https://doi.org/10.4324/9781315175775-5

Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science*, *16*(6), 351–355. https://doi.org/10.1111/j.1467-8721.2007.00534.x

Berg, J. M., Latzman, R. D., Bliwise, N. G., & Lilienfeld, S. O. (2015). Parsing the heterogeneity of impulsivity: A meta-analytic review of the behavioral implications of the UPPS for psychopathology. *Psychological Assessment*, *27*(4), 1129–1146. https://doi.org/10.1037/pas0000111

Bergen, A. E., Newby-Clark, I. R., & Brown, A. (2012). Low Trait Self-Control in

Problem Gamblers: Evidence from Self-Report and Behavioral Measures. *Journal of Gambling Studies*, *28*(4), 637–648. https://doi.org/10.1007/s10899-011-9274-9

Bergen, A. E., Newby-Clark, I. R., & Brown, A. (2014). Gambling Increases Self-Control Strength in Problem Gamblers. *Journal of Gambling Studies*, *30*(1), 153–162. https://doi.org/10.1007/s10899-012-9350-9

Blaszczynski, A., & Nower, L. (2002). A pathways model of problem and pathological gambling. In *Addiction*. https://doi.org/10.1046/j.1360-0443.2002.00015.x

Brevers, D., Cleeremans, A., Verbruggen, F., Bechara, A., Kornreich, C., Verbanck, P., & Noël, X. (2012). Impulsive Action but Not Impulsive Choice Determines Problem Gambling Severity. *PLoS ONE*, *7*(11). https://doi.org/10.1371/journal.pone.0050647

Brevet-Aeby, C., Brunelin, J., Iceta, S., Padovan, C., & Poulet, E. (2016). Prefrontal cortex and impulsivity: Interest of noninvasive brain stimulation. In *Neuroscience and Biobehavioral Reviews* (Vol. 71, pp. 112–134). https://doi.org/10.1016/j.neubiorev.2016.08.028

Brewer, J. A., & Potenza, M. N. (2008). The neurobiology and genetics of impulse control disorders: Relationships to drug addictions. *Biochemical Pharmacology*, *75*(1), 63–75. https://doi.org/10.1016/j.bcp.2007.06.043

Challet-Bouju, G., Bruneau, M., Victorri-Vigneau, C., & Grall-Bronnec, M. (2017). Cognitive remediation interventions for gambling disorder: A systematic review. In *Frontiers in Psychology* (Vol. 8, Issue DEC). https://doi.org/10.3389/fpsyg.2017.01961

Chen, Z., Zhang, H., Yushkevich, P. A., Liu, M., & Beaulieu, C. (2016). Maturation along white matter tracts in human brain using a diffusion tensor surface model tract-specific analysis. *Frontiers in Neuroanatomy*, *10*(FEB). https://doi.org/10.3389/fnana.2016.00009

Cheung, N. W. T. (2014). Low Self-Control and Co-occurrence of Gambling with Substance Use and Delinquency Among Chinese Adolescents. *Journal of Gambling Studies*, *30*(1), 105–124. https://doi.org/10.1007/s10899-012-9351-8

Chowdhury, N. S., Livesey, E. J., Blaszczynski, A., & Harris, J. A. (2017). Pathological Gambling and Motor Impulsivity: A Systematic Review with Meta-Analysis. In *Journal of Gambling Studies* (Vol. 33, Issue 4, pp. 1213–1239). https://doi.org/10.1007/s10899-017-9683-5

Cranwell, J., Benford, S., Houghton, R. J., Golembewksi, M., Fischer, J. E., & Hagger, M. S. (2014). Increasing self-regulatory energy using an internet-based training application delivered by smartphone technology. *Cyberpsychology, Behavior, and Social Networking*, *17*(3), 181–186. https://doi.org/10.1089/cyber.2013.0105

Dalley, J. W., Everitt, B. J., & Robbins, T. W. (2011). Impulsivity, Compulsivity, and Top-Down Cognitive Control. In *Neuron* (Vol. 69, Issue 4, pp. 680–694). https://doi.org/10.1016/j.neuron.2011.01.020

Diamond, A. (2013). Executive Functions. *Annual Review of Psychology*, *64*(1), 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

Fattore, L., & Melis, M. (2016). Sex differences in impulsive and compulsive behaviors: a focus on drug addiction. *Addiction Biology*, *21*(5), 1043–1051. https://doi.org/10.1111/adb.12381

Fauth-Bühler, M., Mann, K., & Potenza, M. N. (2017). Pathological gambling: a review of the neurobiological evidence relevant for its classification as an addictive disorder. In *Addiction Biology* (Vol. 22, Issue 4, pp. 885–897). https://doi.org/10.1111/adb.12378

Fidler, J., Ferguson, S. G., Brown, J., Stapleton, J., & West, R. (2013). How does rate of smoking cessation vary by age, gender and social grade? Findings from a population survey in England. *Addiction*, *108*(9), 1680–1685. https://doi.org/10.1111/add.12241

Ford, J. A., & Blumenstein, L. (2013). Self-control and substance use among college students. *Journal of Drug Issues*, *43*(1), 56–68. https://doi.org/10.1177/0022042612462216

Friese, M., Frankenbach, J., Job, V., & Loschelder, D. D. (2017). Does Self-Control Training Improve Self-Control? A Meta-Analysis. *Perspectives on Psychological Science*, *12*(6), 1077–1099. https://doi.org/10.1177/1745691617697076

Galvan, A., Hare, T., Voss, H., Glover, G., & Casey, B. J. (2007). Risk-taking and the adolescent brain: Who is at risk? In *Developmental Science* (Vol. 10, Issue 2). https://doi.org/10.1111/j.1467-7687.2006.00579.x

Gavriel-Fried, B., & Ronen, T. (2015). Contribution of Positivity Ratio and Self-Control to Reduced Gambling Severity among Adolescents. *Health and Social Work*, *40*(3), 209–216. https://doi.org/10.1093/hsw/hlv042

Granero, R., Penelo, E., Stinchfield, R., Fernandez-Aranda, F., Savvidou, L. G., Fröberg, F., Aymamí, N., Gómez-Peña, M., Pérez-Serrano, M., del Pino-Gutiérrez, A., Menchón, J. M., & Jiménez-Murcia, S. (2014). Is pathological gambling moderated by age? *Journal of Gambling Studies / Co-Sponsored by the National Council on Problem Gambling and Institute for the Study of Gambling and Commercial Gaming*, *30*(2), 475–492. https://doi.org/10.1007/s10899-013-9369-6

Grant, J. E., Steinberg, M. A., Kim, S. W., Rounsaville, B. J., & Potenza, M. N. (2004). Preliminary validity and reliability testing of a structured clinical interview for pathological gambling. *Psychiatry Research*, *128*(1), 79–88. https://doi.org/10.1016/j.psychres.2004.05.006

Grecucci, A., Giorgetta, C., Rattin, A., Guerreschi, C., Sanfey, A. G., & Bonini, N. (2014). Time devours things: How impulsivity and time affect temporal decisions in pathological gamblers. *PLoS ONE*, *9*(10). https://doi.org/10.1371/journal.pone.0109197

Gullo, M. J., & Potenza, M. N. (2014). Impulsivity: Mechanisms, moderators and implications for addictive behaviors. In *Addictive Behaviors* (Vol. 39, Issue 11, pp. 1543–1546). https://doi.org/10.1016/j.addbeh.2014.06.005

Hamilton, K. R., Littlefield, A. K., Anastasio, N. C., Cunningham, K. A., Fink, L. H. L., Wing, V. C., Mathias, C. W., Lane, S. D., Schütz, C. G., Swann, A. C., Lejuez, C. W., Clark, L., Moeller, F. G., & Potenza, M. N. (2015). Rapid-response impulsivity: Definitions, measurement issues, and clinical implications. *Personality Disorders: Theory, Research, and Treatment*, *6*(2), 168–181. https://doi.org/10.1037/per0000100

Hamilton, K. R., Mitchell, M. R., Wing, V. C., Balodis, I. M., Bickel, W. K., Fillmore, M., Lane, S. D., Lejuez, C. W., Littlefield, A. K., Luijten, M., Mathias, C. W., Mitchell, S. H., Napier, T. C., Reynolds, B., Schütz, C. G., Setlow, B., Sher, K. J., Swann, A. C., Tedford, S. E., … Moeller, F. G. (2015). Choice impulsivity: Definitions, measurement issues, and clinical implications. *Personality Disorders*, *6*(2), 182–198. https://doi.org/10.1037/per0000099

Kaur, I., Schutte, N. S., & Thorsteinsson, E. B. (2006). Gambling control self-efficacy as a mediator of the effects of low emotional intelligence on problem gambling. *Journal of Gambling Studies*, *22*(4), 405–411. https://doi.org/10.1007/s10899-006-9029-1

Kim, H. S., Hodgins, D. C., Bellringer, M., & Abbott, M. (2016). Gender differences among helpline callers: Prospective study of gambling and psychosocial outcomes. *Journal of Gambling Studies*, *32*(2), 605–623. https://doi.org/10.1007/s10899-015-9572-8

Kotabe, H. P., & Hofmann, W. (2015). On Integrating the Components of Self-Control. *Perspectives on Psychological Science*, *10*(5), 618–638. https://doi.org/10.1177/1745691615593382

Kräplin, A., Bühringer, G., Oosterlaan, J., van den Brink, W., Goschke, T., & Goudriaan, A. E. (2014). Dimensions and disorder specificity of impulsivity in pathological gambling. *Addictive Behaviors*, *39*(11), 1646–1651. https://doi.org/10.1016/j.addbeh.2014.05.021

Krueger, T. H. C., Schedlowski, M., & Meyer, G. (2005). Cortisol and heart rate measures during casino gambling in relation to impulsivity. *Neuropsychobiology*, *52*(4), 206–211. https://doi.org/10.1159/000089004

Kushnir, V., Godinho, A., Hodgins, D. C., Hendershot, C. S., & Cunningham, J. A. (2016). Gender Differences in Self-Conscious Emotions and Motivation to Quit

Gambling. *Journal of Gambling Studies*, *32*(3), 969–983. https://doi.org/10.1007/s10899-015-9574-6

Leeman, R. F., & Potenza, M. N. (2012). Similarities and differences between pathological gambling and substance use disorders: a focus on impulsivity and compulsivity. *Psychopharmacology*, *219*(2), 469–490. https://doi.org/10.1007/s00213-011-2550-7

Lesieur, H. R., & Blume, S. B. (1987). The South Oaks Gambling Screen (SOGS): a new instrument for the identification of pathological gamblers. *The American Journal of Psychiatry*, *144*(9), 1184–1188.

Lutri, V., Soldini, E., Ronzitti, S., Smith, N., Clerici, M., Blaszczynski, A., & Bowden-Jones, H. (2018). Impulsivity and Gambling Type Among Treatment-Seeking Disordered Gamblers: An Explorative Study. *Journal of Gambling Studies*. https://doi.org/10.1007/s10899-018-9764-0

Mackillop, J., Miller, J. D., Fortune, E., Maples, J., Lance, C. E., Campbell, W. K., & Goodie, A. S. (2014). Multidimensional examination of impulsivity in relation to disordered gambling. *Experimental and Clinical Psychopharmacology*, *22*(2), 176–185. https://doi.org/10.1037/a0035874

Mallorquí-Bagué, N., Fagundo, A. B., Jimenez-Murcia, S., De La Torre, R., Baños, R. M., Botella, C., Casanueva, F. F., Crujeiras, A. B., Fernández-García, J. C., Fernández-Real, J. M., Frühbeck, G., Granero, R., Rodríguez, A., Tolosa-Sola, I., Ortega, F. J., Tinahones, F. J., Alvarez-Moya, E., Ochoa, C., Menchón, J. M., & Fernández-Aranda, F. (2016). Decision making impairment: A shared vulnerability in obesity, gambling disorder and substance use disorders? *PLoS ONE*, *11*(9).

https://doi.org/10.1371/journal.pone.0163901

Martínez-Loredo, V., Grande-Gosende, A., Fernández-Artamendi, S., Secades-Villa, R., & Fernández-Hermida, J. R. (2019). Substance use and gambling patterns among adolescents: Differences according to gender and impulsivity. *Journal of Gambling Studies*, *35*(1), 63–78. https://doi.org/10.1007/s10899-018-09824-x

Mestre-Bach, G., Steward, T., Granero, R., Fernández-Aranda, F., del Pino-Gutiérrez, A., Mallorquí-Bagué, N., Mena-Moreno, T., Vintró-Alcaraz, C., Moragas, L., Aymamí, N., Gómez-Peña, M., Sánchez-González, J., Agüera, Z., Lozano-Madrid, M., Menchón, J. M., & Jiménez-Murcia, S. (2019). The predictive capacity of DSM-5 symptom severity and impulsivity on response to cognitive-behavioral therapy for gambling disorder: A 2-year longitudinal study. *European Psychiatry*, *55*, 67–73. https://doi.org/10.1016/j.eurpsy.2018.09.002

Mestre-Bach, G., Steward, T., Granero, R., Fernández-Aranda, F., Mena-Moreno, T., Vintró-Alcaraz, C., Lozano-Madrid, M., Menchón, J. M., Potenza, M. N., & Jiménez-Murcia, S. (2020). Dimensions of Impulsivity in Gambling Disorder. *Scientific Reports*, *10*(1). https://doi.org/10.1038/s41598-019-57117-z

Miller, E. K., & Cohen, J. D. (2001). An Integrative Theory of Prefrontal Cortex Function. *Annual Review of Neuroscience*, *24*(1), 167–202. https://doi.org/10.1146/annurev.neuro.24.1.167

Mitchell, M. R., & Potenza, M. N. (2015). Importance of sex differences in impulse control and addictions. *Frontiers in Psychiatry*, *6*, 24.

Moeller, F. G., Barratt, E. S., Dougherty, D. M., Schmitz, J. M., & Swann, A. C. (2001). Psychiatric aspects of impulsivity. In *American Journal of Psychiatry* (Vol. 158, Issue 11, pp. 1783–1793). https://doi.org/10.1176/appi.ajp.158.11.1783

Muraven, M. (2010). Building self-control strength: Practicing self-control leads to improved self-control performance. *Journal of Experimental Social Psychology*, *46*(2), 465–468. https://doi.org/10.1016/j.jesp.2009.12.011

Muraven, M., & Baumeister, R. F. (2000). Self-Regulation and Depletion of Limited Resources: Does Self-Control Resemble a Muscle? *Psychological Bulletin*, *126*(2), 247–259. https://doi.org/10.1037/0033-2909.126.2.247

Navas, J. F., Verdejo-García, A., López-Gómez, M., Maldonado, A., & Perales, J. C. (2016). Gambling with Rose-Tinted Glasses on: Use of Emotion-Regulation Strategies Correlates with Dysfunctional Cognitions in Gambling Disorder Patients. *Journal of Behavioral Addictions*, *5*(2), 271–281. https://doi.org/10.1556/2006.5.2016.040

Nigg, J. T. (2017). Annual Research Review: On the relations among self-regulation, self-control, executive functioning, effortful control, cognitive control, impulsivity, risk-taking, and inhibition for developmental psychopathology. In *Journal of Child Psychology and Psychiatry and Allied Disciplines* (Vol. 58, Issue 4, pp. 361–383). https://doi.org/10.1111/jcpp.12675

O'Connor, J., & Dickerson, M. (2003). Impaired control over gambling in gaming machine and off-course gamblers. *Addiction*, *98*(1), 53–60. https://doi.org/10.1046/j.1360-0443.2003.00232.x

Odlaug, B. L., Chamberlain, S. R., Kim, S. W., Schreiber, L. R. N., & Grant, J. E. (2011). A neurocognitive comparison of cognitive flexibility and response inhibition in gamblers with varying degrees of clinical severity. *Psychological*

Medicine, *41*(10), 2111–2119. https://doi.org/10.1017/S0033291711000316

Patton, J H, Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the Barratt impulsiveness scale. *Journal of Clinical Psychology*, *51*, 768–774. https://doi.org/10.1002/1097-4679(199511)51:6<768

Petry, N M. (2001). Pathological gamblers, with and without substance use disorders, discount delayed rewards at high rates. *Journal of Abnormal Psychology*, *110*(3), 482–487. https://doi.org/10.1037//0021-843X

Petry, Nancy M., Kirby, K. N., & Kranzler, H. R. (2002). Effects of gender and family history of alcohol dependence on a behavioral task of impulsivity in healthy subjects. *Journal of Studies on Alcohol*, *63*(1), 83–90.

Potenza, M. N., Steinberg, M. A., McLaughlin, S. D., Wu, R., Rounsaville, B. J., & O'Malley, S. S. (2001). Gender-related differences in the characteristics of problem gamblers using a gambling helpline. *American Journal of Psychiatry*, *158*(9), 1500–1505. https://doi.org/10.1176/appi.ajp.158.9.1500

Potenza, M. N., Steinberg, M. A., Wu, R., Rounsaville, B. J., & O'Malley, S. S. (2006). Characteristics of older adult problem gamblers calling a gambling helpline. *Journal of Gambling Studies*, *22*(2), 241–254.

Potenza, M., Steinberg, M., Skudlarski, P., Fulbright, R., Lacadie, C., Wilber, M., Rounsaville, B., Gore, J., & Wexler, B. (2003). Gambling urges in pathological gamblers: An fMRI study. *Arch Gen Psychiatry*, *60*, 828–836.

Potenza, Marc N. (2007). To do or not to do? The complexities of addiction, motivation, self-control, and impulsivity. *American Journal of Psychiatry*, *164*(1), 4–6.

https://doi.org/10.1176/ajp.2007.164.1.4

Potenza, Marc N. (2009). The importance of animal models of decision making, gambling, and related behaviors: Implications for translational research in addiction. In *Neuropsychopharmacology* (Vol. 34, Issue 13, pp. 2623–2624). https://doi.org/10.1038/npp.2009.152

Rebetez, M. M. L., Rochat, L., Barsics, C., & Van der Linden, M. (2018). Procrastination as a Self-Regulation Failure: The Role of Impulsivity and Intrusive Thoughts. *Psychological Reports*, *121*(1), 26–41. https://doi.org/10.1177/0033294117720695

Reynolds, B., Ortengren, A., Richards, J. B., & de Wit, H. (2006). Dimensions of impulsive behavior: Personality and behavioral measures. *Personality and Individual Differences*, *40*(2), 305–315. https://doi.org/10.1016/j.paid.2005.03.024

Robinson, M. D., Schmeichel, B. J., & Inzlicht, M. (2010). A Cognitive Control Perspective of Self-Control Strength and Its Depletion. *Social and Personality Psychology Compass*, *4*(3), 189–200. https://doi.org/10.1111/j.1751-9004.2009.00244.x

Rosnow, R. L., & Rosenthal, R. (1996). Computing contrasts, effect sizes, and counternulls on other people's published data: General procedures for research consumers. *Psychological Methods*, *1*(4), 331–340. https://doi.org/10.1037/1082-989X.1.4.331

Rothbart. (2011). Becoming who we are: temperament and personality in development. *Choice Reviews Online*, *49*(04), 49-2373-49–2373. https://doi.org/10.5860/choice.49-2373

Salazar, N., Arboleya, S., Fernández-Navarro, T., de los Reyes-Gavilán, C. G., Gonzalez, S., & Gueimonde, M. (2019). Age-associated changes in gut microbiota and dietary components related with the immune system in adulthood and old age: A cross-sectional study. *Nutrients*, *11*(8). https://doi.org/10.3390/nu11081765

Smith, T., Panfil, K., Bailey, C., & Kirkpatrick, K. (2019). Cognitive and behavioral training interventions to promote self-control. In *Journal of Experimental Psychology: Animal Learning and Cognition* (Vol. 45, Issue 3, pp. 259–279). https://doi.org/10.1037/xan0000208

Stea, J. N., Hodgins, D. C., & Lambert, M. J. (2011). Relations between delay discounting and low to moderate gambling, cannabis, and alcohol problems among university students. *Behavioural Processes*, *88*(3), 202–205. https://doi.org/10.1016/j.beproc.2011.09.002

Steel, Z., & Blaszczynski, A. (1998). Impulsivity, personality disorders and pathological gambling severity. *Addiction*, *93*(6), 895–905. https://doi.org/10.1046/j.1360-0443.1998.93689511.x

Steinberg, L., Albert, D., Cauffman, E., Banich, M., Graham, S., & Woolard, J. (2008). Age differences in sensation seeking and impulsivity as indexed by behavior and self-report: evidence for a dual systems model. *Developmental Psychology*, *44*(6), 1764–1778. https://doi.org/10.1037/a0012955

Steward, T., Mestre-Bach, G., Fernández-Aranda, F., Granero, R., Perales, J. C., Navas, J. F., Soriano-Mas, C., Baño, M., Fernández-Formoso, J. A., Martín-Romera, V., Menchón, J. M., & Jiménez-Murcia, S. (2017). Delay discounting and impulsivity traits in young and older gambling disorder patients. *Addictive Behaviors*, *71*, 96–

103. https://doi.org/10.1016/j.addbeh.2017.03.001

Stoltenberg, S. F., Batien, B. D., & Birgenheir, D. G. (2008). Does gender moderate associations among impulsivity and health-risk behaviors? *Addictive Behaviors*, *33*(2), 252–265. https://doi.org/10.1016/j.addbeh.2007.09.004

Tchanturia, K., Davies, H., Reeder, C., & Wykes, T. (2010). *Cognitive remediation therapy for anorexia nervosa*. King's College London, University of London.

Tice, D. M., Baumeister, R. F., Shmueli, D., & Muraven, M. (2007). Restoring the self: Positive affect helps improve self-regulation following ego depletion. *Journal of Experimental Social Psychology*, *43*(3), 379–384. https://doi.org/10.1016/j.jesp.2006.05.007

Van Veen, V., & Carter, C. S. (2006). Conflict and cognitive control in the brain. *Current Directions in Psychological Science*, *15*(5), 237–240. https://doi.org/10.1111/j.1467-8721.2006.00443.x

Weafer, J., & de Wit, H. (2014). Sex differences in impulsive action and impulsive choice. *Addictive Behaviors*, *39*(11), 1573–1579.

Wojdylo, K., Baumann, N., & Kuhl, J. (2017). The firepower of work craving: When self-control is burning under the rubble of self-regulation. *PLoS ONE*, *12*(1). https://doi.org/10.1371/journal.pone.0169729

Wolf, E. J., Harrington, K. M., Clark, S. L., & Miller, M. W. (2013). Sample Size Requirements for Structural Equation Models: An Evaluation of Power, Bias, and Solution Propriety. *Educational and Psychological Measurement*, *73*(6), 913–934. https://doi.org/10.1177/0013164413495237

Yau, Y. H. C., & Potenza, M. N. (2015). Gambling disorder and other behavioral addictions: recognition and treatment. *Harvard Review of Psychiatry*, *23*(2), 134–146. https://doi.org/10.1097/HRP.0000000000000051

Table 1

Association between self-control (SCS total score) with impulsivity (BIS-11 scores): partial correlation

BIS scales	[1]Total sample	[2]Gender		[3]Groups by age			[1,4]Groups by GD-severity (SOGS scores)		
		Women	Men	18-30	31-49	50-69	5-10	11-14	15-20
	n=112	*n=32*	*n=80*	*n=20*	*n=60*	*n=32*	*n=36*	*n=37*	*n=39*
Total score	**-.591†**	**-.474†**	**-.648†**	**-.540†**	**-.590†**	**-.656†**	**-.580†**	**-.631†**	**-.550†**
Second order scales									
Attentional impulsiveness	**-.587†**	**-.573†**	**-.600†**	**-.522†**	**-.637†**	**-.603†**	**-.542†**	**-.651†**	**-.563†**
Motor impulsiveness	**-.493†**	**-.483†**	**-.504†**	**-.645†**	**-.403†**	**-.617†**	**-.520†**	**-.345†**	**-.547†**
Non-planning impulsiveness	**-.419†**	-.202	**-.523†**	-.193	**-.443†**	**-.486†**	**-.433†**	**-.428†**	**-.380†**
First order scales									
Attention	**-.505†**	**-.471†**	**-.528†**	**-.500†**	**-.511†**	**-.593†**	**-.488†**	**-.569†**	**-.470†**
Motor	**-.417†**	**-.461†**	**-.396†**	**-.508†**	**-.335†**	**-.554†**	**-.459†**	**-.307†**	**-.428†**
Lack of self-control	**-.439†**	-.178	**-.581†**	**-.250†**	**-.469†**	**-.469†**	**-.528†**	**-.288†**	**-.426†**
Cognitive complexity	-.219	-.144	**-.252†**	-.067	-.175	**-.347†**	-.160	**-.408†**	-.156
Perseverance	**-.422†**	**-.391†**	**-.451†**	**-.572†**	**-.367†**	**-.480†**	**-.373†**	**-.300†**	**-.499†**
Cognitive instability	**-.501†**	**-.490†**	**-.509†**	**-.493†**	**-.543†**	**-.397†**	**-.438†**	**-.551†**	**-.516†**

Note. [1]Correlation adjusted by gender and age. [2]Correlation adjusted by age. [3]Correlation adjusted by gender.

[4]Groups of GD-severity based on the terciles estimated in the sample.

†Bold: effect size into the medium-mean (|*R*|>0.24) to high-large (|*R*|>0.37) range.

Table 2

Association between GD severity (SOGS total scores) with self-control (SCS total scores) and impulsivity (BIS-11 scores): partial correlations

	[1]Total sample	[2]Gender		[3]Groups of age		
		Women	Men	18-30	31-49	50-69
	n=112	*n=32*	*n=80*	*n=20*	*n=60*	*n=32*
Self-control: SCS						
Total score	-.114	**-.284†**	-.021	**-.363†**	-.045	**-.455†**
Impulsivity: BIS						
Total score	.215	**.472†**	.100	.158	.162	**.324†**
2nd Order: Attentional impulsiveness	.132	**.409†**	.035	.013	.139	**.258†**
2nd Order: Motor impulsiveness	.207	**.485†**	.078	.097	.187	**.331†**
2nd Order: Non-planning impulsiveness	.191	**.304†**	.129	**.297†**	.069	**.240†**
1st Order: Attention	.043	**.280†**	-.028	-.015	-.044	**.279†**
1st Order: Motor	.180	**.471†**	.026	.189	.084	**.407†**
1st Order: Lack of self-control	.176	.120	.203	**.290†**	.055	**.251†**
1st Order: Cognitive complexity	.132	**.447†**	-.011	.208	.053	.146
1st Order: Perseverance	.170	**.376†**	.124	-.076	**.296†**	.096
1st Order: Cognitive instability	.210	**.410†**	.120	.055	**.313†**	.122

Note. [1]Correlation adjusted by gender and age. [2]Correlation adjusted by age. [3]Correlation adjusted by gender.

†Bold: effect size into the medium-mean (|*R*|>0.24) to high-large (|*R*|>0.37) range.

Figure 1

Path diagram: standardized coefficients obtained in the SEM

Note. Continuous line: significant parameter ($p \leq .05$). Dash line: non-significant parameter ($p > .05$).

Self-control: SCS total score. Impulsivity: BIS-11 total score. GD severity: SOGS total score.

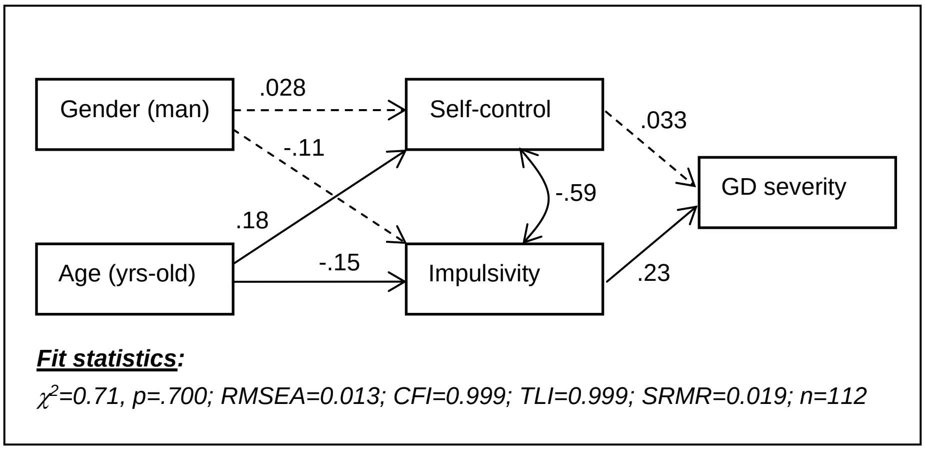

Table S1 (supplementary material)

Descriptive information of the study sample (n=112)

		n	*Percent*		*Mean*	*SD*
Gender	*Women*	32	28.6%	Age (years-old)	43.58	12.06
	Men	80	71.4%	Self control (SCS-total)	111.87	17.96
Race	*White*	71	63.4%	*Impulsivity (BIS-11)*		
	Black	38	33.9%	Total score	66.96	11.91
	Other	3	2.7%	Attentional impulsiveness	15.62	4.05
Marital status	*Single or widowed*	65	58.0%	Motor impulsiveness	24.82	5.16
	Married	19	17.0%	Non-planning impulsiveness	26.52	5.02
	Divorced-separated	28	25.0%	Attention	10.00	2.73
Education	*Postgraduate*	6	5.4%	Motor	16.72	3.80
	College grade	23	20.5%	Self-control	13.86	3.50
	Part college	42	37.5%	Cognitive complexity	12.66	2.59
	HS diploma / GED	38	33.9%	Perseverance	8.10	2.26
	Part HS or Junior High	3	2.7%	Cognitive instability	5.62	1.99

Note. SD: standard deviation. SCS: Self-control scale. BIS-11: Barrat Impulsivity Scale.

HS=high school;

Table S2 (supplementary material)

SEM: direct, indirect, total effects and invariance tests (n=112)

		Direct effects				Indirect effects				Total effects			
Structural		*B*	*SE*	*p*	*St-B*	*B*	*SE*	*p*	*St-B*	*B*	*SE*	*p*	*St-B*
Self-control	Gender	1.120	3.766	0.766	0.028	---	---	---	---	1.120	3.766	0.766	0.028
	Age	0.275	0.142	0.040	0.185	---	---	---	---	0.275	0.142	0.049	0.040
Impulsivity	Gender	-2.839	2.504	0.257	-0.108	---	---	---	---	-2.839	2.504	0.257	-0.108
	Age	-0.149	0.094	0.048	-0.151	---	---	---	---	-0.149	0.094	0.048	-0.151
GD severity	Self-control	0.007	0.025	0.776	0.033	---	---	---	---	0.007	0.025	0.776	0.033
	Impulsivity	0.074	0.038	0.040	0.226	---	---	---	---	0.074	0.038	0.050	0.040
	Gender	---	---	---	---	---	---	---	---	-0.203	0.195	0.299	-0.024
	Age	---	---	---	---	-0.203	0.195	0.299	-0.024	-0.009	0.009	0.292	-0.028

Invariance test for gender		*Wald*	*df*	*p*	Invariance test for age		*Wald*	*df*	*p*
Self-control	Age	0.260	1	0.610	Self-control	Gender	0.262	1	0.609
Impulsivity	Age	0.061	1	0.805	Impulsivity	Gender	0.305	1	0.581
GD severity	Self-control	0.443	1	0.506	GD severity	Self-control	1.720	1	0.129
	Impulsivity	1.704	1	0.192		Impulsivity	0.214	1	0.644
	Age	2.707	1	0.100		Gender	0.206	1	0.650
Joint test		9.075	5	0.106	Joint test		9.438	5	0.093

Note. B: coefficient. SE: standard error coefficient. St-B: standardized coefficient. df: degrees of freedom. --- No path. GD= gambling disorder