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Relapse in pathological gamblers: A pilot study on the predictive value of different impulsivity measures

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INTRODUCTION

With lifetime prevalence between 0.8% and 1.6% in the adult population pathological gambling (PG) is a relatively common psychiatric disorder that is associated with severe socio-legal problems and frequent comorbidity with other psychiatric disorders (Lederwood & Petry, 2006a). In spite of these high prevalence rates and severe consequences, few studies have explored the processes that contribute to the continuation and relapse of pathological gambling.

Pathological gambling is currently categorized in the Diagnostic and statistical manual (DSM-IV text revision, American Psychiatric Association, 2000) as an impulse control disorder, and thus hypothesized to lie among an impulsive-compulsive spectrum, also representing obsessive-compulsive spectrum disorders (e.g., Brewer & Potenza, 2008). Although individuals with impulse control disorders engage in repetitive behaviors with great urges, these behaviors are egosyntonic (e.g., Andrade & Petry, 2012; Brewer & Potenza, 2008), whereas repetitive behaviors or rituals in obsessive-compulsive disorders are generally egodystonic (e.g., Brewer & Potenza, 2008). Furthermore, on a phenotypical and pathological level there are striking similarities with substance use disorders (SUD), even though there is no administration of an exogenous substance to cause harmful effects in the brain (e.g., Potenza, 2001). Impairments in self-regulatory behavior and underlying brain processes for instance are hypothesized to be central in the development and maintenance of both pathological gambling and SUD (Alvarez-Moya et al., 2010; Koob and Volkow, 2010; Leeman & Potenza, 2012). These and other similarities have given ground for the suggestion that gambling disorders should be reclassified within the upcoming DSM-V within the category substance use and addictive disorders (American Psychiatric Association, 2012, www.DSM5.org).

Relapse is a central phenomenon characterizing these disorders. Recent research findings in substance dependent patients have shown that impairments in neurocognitive self-regulatory processes are associated with an individual’s vulnerability to relapse and can differentiate between those patients who do relapse and those who remain abstinent after treatment. Specifically, tasks measuring risk/reward decision-making like the Iowa Gambling Task (IGT, Bechara, * Corresponding author: Bieke De Wilde, MA, Psychiatrisch Centrum Broeders Alexianen, Boechout, Belgium; Collaborative Antwerp Psychiatric Research Institute, Universiteit Antwerpen, Wilrijk, Belgium; Phone: +32 3 217 77 63; Fax: +32 3 217 77 52; E-mail: Bieke.DeWilde@zna.be

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Damasio, Damasio & Anderson, 1994) have proven promising within this context (e.g., Bowden-Jones, McPhillips, Rogers, Hutton & Joyce, 2005; De Wilde, Sabbe, Hulstijn & Dom, 2013; Passetti, Clark, Mehta, Joyce & King, 2008). Since it has been suggested that these neurocognitive performance deficits are reflective of central underlying neurobiological vulnerabilities or changes (e.g., Verdejo-Garcia, Lawrence & Clark, 2008), it is remarkable that, contrary to chemical addictions, studies exploring neurocognitive performance on impulsivity and decision-making and their association with treatment outcome or relapse within pathological gamblers (PGs) have been limited until now. Álvarez-Moya et al. (2011) recently explored possible associations between decision-making (Iowa Gambling Task, ABCD & EF GH versions) and self-reported impulsivity (Temperament and Character Inventory—Revised) on the one hand and treatment outcome on the other. Goudriaan, Oosterlaan, de Beurs and van den Brink (2008) examined the role of self-reported (impulsivity—reward sensitivity) versus neurocognitive (disinhibition [Stop Signal Reaction Time] – decision-making [Card Playing Task]) measures in the prediction of one-year relapse in PGs. Both research groups concluded that self-reported measures and neurocognitive measures of cognitive flexibility/involuntary attention (Stroop) did not affect outcome measures (Álvarez-Moya et al., 2011: relapse during treatment; Goudriaan et al., 2008: one-year relapse). Neurocognitive indicators of disinhibition together with longer duration of the disorder predicted one-year relapse (Goudriaan et al., 2008). Poor decision-making finally predicted dropout (Álvarez-Moya et al., 2011) and one-year relapse (Goudriaan et al., 2008) but not relapse during treatment (Álvarez-Moya et al., 2011).

Reasons for these inconsistent findings may be numerous. First, the processes controlling vulnerability to relapse may be different during treatment (Álvarez-Moya et al., 2011) and at follow-up one year after treatment (Goudriaan et al., 2008). Second, the nature of the examined neurocognitive measures assessing decision-making might be different. Third, the heterogeneity of the PGs group might have affected research findings. Indeed, PG is frequently associated with other Axis I and II psychiatric comorbid disorders. Substance use disorders (SUD) and personality disorders (PD) are often associated with pathological gambling (e.g., Petry, 2006; Wareham & Potenza, 2010). Of importance, earlier studies indicate that these disorders in themselves are associated with changes in impulsivity measures (and underlying neurobiological processes). Thus, comorbidity within PGs may confound both relapse risk, the changes found on the neurocognitive level, and their association.

We hence decided to do a pilot study examining the role of different self-report and neurocognitive measures on one-year relapse of pathological gamblers. We focused upon the Iowa Gambling Task (IGT, Bechara et al., 1994), a measure known to predict relapse in substance dependent patients (e.g. Bowden-Jones et al., 2005; De Wilde et al., 2013; Passetti et al., 2008) and included the Delay Discounting Task (DDT, Richards, Zhang, Mitchell & de Wit, 1999), a measure related to immediate reward. Both neurocognitive measures were found to differentiate between PGs and healthy controls (e.g., Petry, 2001). We finally included a Stroop Gambling Task, measuring attentional bias specifically for gambling stimuli. All neurocognitive measures together with self-report measures of impulsivity were completed by a small group of PGs without manifest other psychiatric disorders, enrolling in a longitudinal (12-month follow-up) outcome study. In line of the earlier research in substance use patients and PGs, we hypothesized that performance deficits on neurocognitive impulsivity measures but not impulsivity on self-report measures of impulsivity would relate to an increase in relapse risk.

**MATERIAL AND METHODS**

**Participants**

Twenty-two outpatient lifetime pathological gamblers (PGs, slot players) and 31 healthy controls (HCs) participated in this pilot study. The principal researchers (BDW and GD) informed regional addiction counselors and chairmen of two self-help groups about the present research (mainly about the hypothesis and procedure). They asked them to transmit this information to their patients and to motivate them to participate. Contact data of interested pathological gamblers were then given to the principal researchers who then got in touch with the patients. Seventeen patients were found through local addiction counselors and thus in active treatment, five patients through self-help groups. Two of them were in full remission when they signed the informed consent. They all were slot machine players, frequenting bars and casinos. The HCs responded to an ad in a local newspaper. Participants were excluded if they demonstrated signs of lifetime substance use disorders (with the exception of caffeine or nicotine abuse or dependence, n = 1; Structured Clinical Interview for the DSM-IV disorders, axis I disorders; First, Spitzer, Gibbon & Williams, 1996), psychotic disorders (n = 0; Structured Clinical Interview for the DSM-IV disorders, axis 1 disorders; First et al., 1996), organic deterioration or amnesic disorders (n = 0; Structured Clinical Interview for the DSM-IV disorders, axis 1 disorders; First et al., 1996), physical handicaps (n = 0; medical examination), severe somatic disorders (n = 0; medical examination) or illiteracy (n = 0; Revised National Adult Reading Test; Nelson & Willison, 1991). Healthy controls were excluded when they showed signs of pathological gambling (n = 0; South Oaks Gambling Screen; Lesieur & Blume, 1987).

**Measures**

**Gambling.** Local addiction counselors and researchers (BDW) used the Structured Clinical Interview for the DSM-IV disorders, Axis I disorders (SCID-I; First et al., 1996) and the South Oaks Gambling Screen (SOGS, Lesieur & Blume, 1987) to identify pathological gamblers. The SCID-I is a semi-structured interview for making the major DSM-IV Axis I diagnoses (First et al., 1996). The SOGS (Lesieur & Blume, 1987) is a questionnaire containing twenty questions examining lifetime gambling behavior. Participants scoring five or more are generally seen as ‘probable pathological gamblers’.

**Substance use disorders.** The CAGE (Ewing, 1984) and the Drug Abuse Screening Test (DAST-10) (Skinner, 1982) were used to detect substance use disorders. The CAGE (Ewing, 1984) is a short four-question screening instrument for lifetime alcoholism. The DAST-10 (Skinner, 1982) is a self-report questionnaire that holds ten questions concerning information about patients’ potential involvement with
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Additional measures. The Revised National Adult Reading Test (NART, Nelson & Willison, 1991) and the Raven Progressive Matrices (Raven PM, Raven, 1936) were used to assess participants’ intelligence. The first test is a reading test; patients read fifty words at loud and get points for correct pronunciation. The total score stands for participants’ premorbid intelligence. The second test is a nonverbal test made of sixty multiple choice questions, listed in order of difficulty. It is designed to measure current reasoning ability (general intelligence).

Procedure

Pathological gamblers and HCs were seen over two appointments. During the first appointment, participants were asked about their substance use and gambling behavior. Additionally, we administered the NART and the Raven PM (intelligence) during the first session. A week later, at the second appointment, we administered tests to obtain information on neurocognitive measures of decision-making and impulsivity (DDT, IGT, SCWT). Additionally, participants returned the completed self-report questionnaires on impulsivity and personality disorders (ADP-IV, BIS, SPSRQ). One year after this last appointment, PGs were questioned about their gambling activities over the past year. Relapse was defined as the presence of any gambling behavior (Ledgerwood & Petry, 2006b) and coded as a binary variable (abstinent/non-abstinent). Participants were asked questions from the SCID-I and the SOGS to determine abstinence.

All participants gave written informed consent prior to study entrance. The research protocol was approved by the Ethical Committee of the Antwerp University.

Design and statistical analyses

Differences in demographic, personality and additional variables were analysed by means of χ²-tests (gender) or univariate analyses of variance (other variables). T-tests were used to examine differences in pathological gambling. Multivariate analyses were used to measure differences in impulsive personality between groups. GLM repeated measures (DDT, IGT, SCWT) were used to examine differences in neurocognitive measures of decision-making and impulsivity. Helmert contrasts were used to clarify possible differences between the HCs and the PGs and later on between the abstinent and non-abstinent PGs. Estimates of effect sizes were added to the tables.

RESULTS

Demographic and addiction variables

When they signed the informed consent, there were no differences in demographic variables and or addiction variables between the pathological gamblers in formal treatment (n = 17) and those in self-help (n = 5). The PGs in the first group were as old as the PGs in the latter group (t(20) = –0.291, p = 0.774). Age of onset respectively was 18.47 ± 5.90 and 23.40 ± 13.32 years (t(20) = –1.218, p = 0.237), meaning that they had been gambling for 13.18 ± 9.95 and 10.00 ± 6.93 years (t(20) = 0.662, p = 0.515). There also was no difference in gambling severity as assessed by the SOGS (t(20) = –0.286, p = 0.778).

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### Table 1. Demographic, personality, addiction and additional variables

| Data Group effects | Group contrasts |
|--------------------|-----------------|
| HC(s) | APGs (N = 9) | NAPGs (N = 13) |
| T, F or χ² | P |
| HCs vs. PGs | APGs vs. NAPGs |

#### Gender

| | HCs | APGs | NAPGs |
|---|---|---|---|
| | 27♂ – 4♀ | 8♂ – 1♀ | 12♂ – 1♀ |
| χ² | 0.25 | 0.883 |

#### Age

| | HCs | APGs | NAPGs |
|---|---|---|---|
| | 28.06 ± 7.79 | 37.00 ± 10.98 | 31.08 ± 7.66 |
| T | 4.06 | 0.023 |
| F | 1.00 | 0.378 |
| χ² | 0.014 | 0.108 |

#### NART

| | HCs | APGs | NAPGs |
|---|---|---|---|
| | 107.13 ± 7.62 | 108.83 ± 8.68 | 104.00 ± 6.57 |
| T | 1.00 | 0.378 |
| F | 0.762 | 0.213 |

#### Cluster A presence

| | HCs | APGs | NAPGs |
|---|---|---|---|
| | 0 present | 0 present | 0 present |
| χ² | 0.07 | 0.214 |

#### Cluster B presence

| | HCs | APGs | NAPGs |
|---|---|---|---|
| | 3 present | 1 present | 3 present |
| χ² | 0.12 | 0.224 |

#### Cluster C presence

| | HCs | APGs | NAPGs |
|---|---|---|---|
| | 2 present | 0 present | 2 present |
| χ² | 0.29 | 0.224 |

#### Age of onset

| | HCs | APGs | NAPGs |
|---|---|---|---|
| | 24.22 ± 10.92 | 16.38 ± 2.57 | 2.52 |

#### Duration

| | HCs | APGs | NAPGs |
|---|---|---|---|
| | 9.22 ± 8.00 | 14.69 ± 9.77 | 0.29 |

#### SOGS

| | HCs | APGs | NAPGs |
|---|---|---|---|
| | 11.44 ± 4.39 | 10.92 ± 3.93 | 1.39 |

APGs: abstinent pathological gamblers; HCs: Healthy controls; NAPGs: non-abstinent pathological gamblers; NART: Revised National Adult Reading Test; PGs: pathological gamblers; SOGS: South-Oaks Gambling Screen. The cluster A, B & C presences were assessed by means of the ADP-IV (The Assessment of DSM-IV Personality Disorders questionnaire). Group contrast was only mentioned when group effects were significant.

### Table 2. Correlation matrix impulsivity measures at follow-up, nine PGs were abstinent, thirteen PGs were relapsed

#### Part A: Healthy controls (N = 31)

| | Age | SOGS | BIS_Att | BIS_Mot | BIS_NP | BIS_Tot | SPSRQ_SP | SPSRQ_SR | DDT_logk10 | DDT_logk30 | DDT_logk100 | IGT_Netscore | SCWT_RT_N | SCWT_RT_G |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1 | -0.12 | -0.10 | 0.02 | -0.08 | -0.09 | 0.07 | -0.36 | 0.28 | 0.26 | 0.17 | -0.11 | -0.03 | -0.25 |
| SOGS | 1 | -0.19 | 0.04 | 0.06 | 0.14 | 0.19 | 0.13 | 0.28 | 0.10 | -0.24 | 0.25 | 0.27 |
| BIS_Att | 1 | 0.55** | 0.78** | 0.51* | 0.07 | -0.12 | 0.16 | -0.23 | 0.03 | -0.47* | -0.54** |
| BIS_Mot | 1 | 0.64** | 0.74** | 0.14 | 0.24 | 0.13 | 0.41* | 0.36 | 0.17 | 0.08 | 0.01 |
| BIS_NP | 1 | 0.91** | 0.10 | 0.17 | 0.09 | 0.01 | 0.11 | 0.15 | 0.22 | -0.03 | 0.11 |
| BIS_Tot | 1 | 0.42* | 0.17 | 0.01 | 0.25 | 0.09 | 0.15 | 0.19 | 0.22 | -0.03 | 0.11 |
| SPSRQ_SP | 1 | 0.10 | -0.20 | 0.15 | -0.01 | 0.01 | -0.27 | -0.41* |
| SPSRQ_SR | 1 | 0.15 | 0.27 | 0.19 | 0.26 | 0.07 | 0.11 |
| DDT_logk10 | 1 | 0.51** | 0.64** | 0.07 | 0.10 | 0.12 |
| DDT_logk30 | 1 | 0.50** | 0.20 | 0.20 | 0.08 |
| DDT_logk100 | 1 | 0.40* | 0.08 | 0.13 |
| IGT_Netscore | 1 | 0.07 | 0.15 | 0.05 |
| SCWT_RT_N | 1 | 0.77** |
| SCWT_RT_G | 1 |

#### Part B: Pathological gamblers (N = 22)

| | Age | Age of onset | Duration | SOGS | BIS_Att | BIS_Mot | BIS_NP | BIS_Tot | SPSRQ_SP | SPSRQ_SR | DDT_logk10 | DDT_logk30 | DDT_logk100 | IGT_Netscore | SCWT_RT_N | SCWT_RT_G |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1 | 0.39 | -0.14 | -0.01 | -0.21 | -0.22 | -0.19 | -0.20 | -0.45 | 0.24 | 0.32 | 0.28 | -0.17 | 0.53* | 0.54* |
| Age of onset | 1 | -0.45* | -0.19 | -0.48* | -0.44 | -0.40 | -0.54* | -0.18 | -0.37 | 0.36 | 0.55* | 0.41 | -0.12 | 0.03 | -0.00 |
| Duration | 1 | 0.16 | 0.21 | 0.17 | 0.17 | 0.22 | -0.00 | -0.02 | 0.04 | 0.07 | 0.01 | -0.11 | 0.37 | 0.36 |
| SOGS | 1 | 0.46 | 0.38 | 0.34 | 0.31 | 0.21 | 0.53* | 0.04 | 0.19 | 0.12 | 0.20 | 0.29 | 0.30 |
| BIS_Att | 1 | 0.35 | 0.58* | 0.78** | -0.06 | 0.09 | -0.35 | -0.29 | -0.32 | -0.06 | 0.05 | 0.08 |
| BIS_Mot | 1 | 0.57* | 0.79** | -0.10 | 0.37 | 0.06 | 0.03 | 0.01 | -0.20 | 0.09 | 0.14 |
| BIS_NP | 1 | 0.88** | 0.04 | 0.14 | -0.24 | -0.12 | -0.24 | -0.16 | 0.16 | 0.24 |
| BIS_Tot | 1 | -0.06 | 0.26 | -0.20 | -0.15 | -0.22 | -0.17 | 0.12 | 0.19 |
| SPSRQ_SP | 1 | 0.34 | -0.02 | 0.03 | 0.12 | 0.39 | 0.42 | 0.36 |
| SPSRQ_SR | 1 | -0.04 | 0.26 | -0.26 | -0.26 | 0.26 | 0.16 | 0.07 |
| DDT_logk10 | 1 | 0.81** | 0.91** | 0.34 | 0.01 | 0.01 |
| DDT_logk30 | 1 | 0.95** | 0.31 | 0.16 | 0.14 |
| DDT_logk100 | 1 | 0.40 | 0.15 | 0.16 |
| IGT_Netscore | 1 | 0.07 | 0.34 | 0.16 |
| SCWT_RT_N | 1 | 0.97** |
| SCWT_RT_G | 1 |

*p < 0.05; **p < 0.005. BIS: Barratt Impulsiveness Scale; BIS_Att: BIS Attentional; BIS_Mot: BIS Motor; BIS_NP: BIS Non-Planning; BIS_Tot: BIS Total; SPSRQ: Sensitivity to Punishment and Sensitivity to Reward; DDT: Delay Discounting Task; IGT: Iowa Gambling Task; SCWT_RT_G: Stroop Color Word Test_Reaction Time_Gambling words; SCWT_RT_N: Stroop Color Word Test_Reaction Time_Neutral words; SPSRQ_SP: SPSRQ_Sensitivity to Punishment; SPSRQ_SR: SPSRQ_Sensitivity to Reward.
At follow-up, nine PGs were abstinent, thirteen PGs were relapsed. The HCs (n = 31), abstinent (n = 9) and non-abstinent (n = 13) PGs groups did not differ in gender (2, 52) = 0.248, p = 0.883. They did differ in age (2, 52) = 4.06, p = 0.023. Both abstinent and non-abstinent PGs groups indeed were older than the HC group (see Table 1). As seen in Table 2, age was correlated with self-report measures of impulsivity. We used this variable as a covariant in the analyses. Results were not affected hereby.

Abstinent and non-abstinent PGs groups did not differ in demographic variables (gender–age). They did differ in gambling history: PGs were abstinent at follow up were older when they started to gamble than PGs who relapsed (20) = 2.515, p = 0.021. Both groups, however, did not differ in gambling involvement (20) = 0.292, p = 0.773 and severity (20) = 1.386, p = 0.181 (Table 1). As seen in Table 2, gambling involvement affected neurocognitive measures of impulsivity. We used this variable as a covariant in the analyses. Results were not affected hereby.

Impulsivity measures

Self-report questionnaires. As can be seen in Table 3, both PGs groups were more impulsive than the HCs on the BIS (Total, Motor and Non Planning subscales) but not on the BIS Attentional subscale and the SPSRQ. There thus were no differences in impulsivity self-report questionnaires for PGs who remained abstinent and PGs who were non-abstinent at follow-up.

Neurocognitive measures. Decision-making. GLM repeated measures analyses of variance with Block (Block 1 to 5) as within subjects factor and Group (HCs vs. PGs – abstinent PGs vs. non-abstinent PGs) as between-subjects factor showed that HCs and PGs on the one hand and abstinent and non-abstinent PGs on the other did not differ in IGT performances (2, 50) = 1.12, p = 0.335 – effect size: 0.043). IGT performances changed over Blocks (2, 48) = 6.183; p < 0.001). There was no significant Block*Group interaction effect (F(8, 48) = 1.206; p = 0.297) (Figure 1).

GLM repeated measures analyses of variance with amount (10S, 30S, 100S) as within-subjects factor and group (HCs vs. PGs – abstinent PGs vs. non-abstinent PGs) as between-subjects factors showed that HCs and PGs on the one hand and abstinent and non-abstinent PGs on the other did not differ in DDT (2, 46) = 1.57, p = 0.219 – effect size: 0.064). There was a significant amount (2, 46) = 13.082; p < 0.001) but no amount*group interaction effect (F(4, 44) = 0.807; p = 0.524) (Table 4).

Impulsivity. As shown in Table 4, both PGs groups were as slow and significantly slower on the SCWT than HCs. Word class did not affect reaction times.

| Table 3. Impulsivity as measured by self-report questionnaires |
|------------------|----------|-----------|----------|----------|----------|
|                  | HCs (N = 31) | APGs (N = 9) | NAPGs (N = 13) | F | P |
| BIS_Tot          | 54.13 ± 9.04 | 68.67 ± 11.09 | 70.91 ± 9.85 | 16.34 | < 0.001 | < 0.001 |
| BIS_Att          | 14.83 ± 3.77 | 17.89 ± 5.47 | 17.27 ± 2.65 | 2.95 | 0.062 |
| BIS_Mot          | 18.63 ± 2.93 | 24.22 ± 4.44 | 24.36 ± 4.43 | 15.02 | < 0.001 | < 0.001 |
| BIS_NP           | 20.73 ± 4.29 | 26.56 ± 3.81 | 29.27 ± 4.17 | 19.36 | < 0.001 | < 0.001 |
| SPSRQ_SP         | 11.25 ± 5.90 | 7.00 ± 5.00 | 9.44 ± 6.06 | 1.91 | 0.161 |
| SPSRQ_SR         | 10.36 ± 3.74 | 10.78 ± 6.92 | 10.00 ± 3.39 | 0.07 | 0.934 |

APGs: abstinent pathological gamblers; BIS: Barratt Impulsiveness Scale; BIS.Att: BIS Attentional; BIS_Mot: Bis Motor; BIS_NP: BIS Non Planning; BIS_Tot: BIS Total; HCs: Healthy controls; NAPGs: non abstinent pathological gamblers; PGs: pathological gamblers; SPSRQ: Sensitivity to Punishment and Sensitivity to Reward; SPSRQ_SP: SPSRQ_Sensitivity to Punishment; SPSRQ_SR: SPSRQ_Sensitivity to Reward. Group contrast was only mentioned when group effects were significant.

| Table 4. Impulsivity as measured by neurocognitive measures |
|------------------|----------|----------|----------|----------|----------|
|                  | HCs (N = 31) | APGs (N = 9) | NAPGs (N = 13) | F | P | HCs vs. PGs | APGs vs. NAPGs | η² | Power |
| IGT              | 1.12      | 0.335     | 0.043    | 0.236 |
| IGT_Block 1      | –2.19 ± 8.40 | 1.56 ± 5.55 | –2.77 ± 6.25 | 1.57 | 0.219 | 0.12 | 0.064 | 0.316 |
| IGT_Block 2      | 4.39 ± 9.68 | 1.78 ± 5.52 | –2.77 ± 6.25 | 6.183 | 0.001 | 0.04 | < 0.001 | < 0.001 |
| IGT_Block 3      | 6.13 ± 9.48 | 1.56 ± 8.59 | 4.31 ± 11.46 | 4.16 | 0.089 | 0.03 | 0.365 | 0.597 |
| IGT_Block 4      | 5.65 ± 9.38 | 4.22 ± 7.17 | 4.46 ± 11.02 | 8.58 | 0.003 | 0.03 | 0.17 | 0.19 |
| IGT_Block 5      | 8.58 ± 10.34 | 4.44 ± 9.20 | 5.08 ± 7.51 | 2.79 | 0.099 | 0.03 | 0.51 | 0.005 |
| DDT              | 38.20 < 0.001 | 0.914 | 0.614 | 1.000 |
| DDT_logk10      | –1.77 ± 0.59 | –1.45 ± 1.12 | –1.47 ± 0.63 | 0.52 |
| DDT_logk30      | –2.00 ± 0.54 | –1.39 ± 0.89 | –1.58 ± 0.67 | 0.52 |
| DDT_logk100     | –2.19 ± 0.77 | –1.95 ± 1.26 | –1.94 ± 0.90 | 0.52 |
| SCWT_RT          | 0.13 | 0.98 | 0.96 | 1.00 |
| SCWT_RT_Gambling | 523.19 ± 47.33 | 702.08 ± 98.99 | 689.88 ± 100.65 | 1.206 | 0.297 |
| SCWT_RT_Neutral  | 531.35 ± 37.60 | 700.18 ± 115.85 | 696.57 ± 89.04 | 1.206 | 0.297 |

APGs: abstinent pathological gamblers; DDT: Delay Discounting Task; HCs: Healthy controls; IGT: Iowa Gambling Task; NAPGs: non abstinent pathological gamblers; PGs: pathological gamblers; SCWT_RT: Stroop Color Word Test_Reaction Time. Group contrast was only mentioned when group effects were significant.
Personality and additional measures

The presence of personality disorders was rare. Results showed that neither HCs and PGs nor abstinent PGs and non-abstinent PGs differed in personality disorders (Table 1). There were no differences in IQ as measured with the NART (Table 1).

Correlation analysis

There proved to be weak, non-significant correlations between both self-report questionnaires of impulsive personality (BIS, SPSRQ). In addition, weak, non-significant correlations were found between all neurocognitive measures of decision-making and impulsivity (DDT, IGT, SCWT). Age of onset was associated with BIS and DDT scores indicating that younger participants scored higher on self-report measures of impulsivity and were more inclined to save their money. Gambling severity (SOGS-scores) finally was positively associated with sensitivity to reward (SPSRQ_SR), indicating that participants with more severe gambling problems were more inclined to respond to rewards (Table 2).

DISCUSSION

Contrary to our initial hypothesis, PGs who relapsed did not differ on self-report and neurocognitive measures of impulsivity with PGs who did not relapse. However, both groups did differ in age at onset. Finally, healthy controls and PGs differed in some (BIS, SCWT), but not all impulsivity measures (DDT, IGT, SPSRQ).

Contrary to our hypothesis, neither self-reported impulsivity nor neurocognitive measures of decision-making and impulsivity were associated with relapse risk. This result is partially in agreement with earlier research findings documenting possible risk factors for relapse in pathological gambling. Indeed, both Goudriaan et al. (2008) and Álvarez-Moya et al. (2011) found weak, non-significant associations with self-reported impulsivity or Stroop interference scores and relapse risk. In addition and in further agreement with our data, no relations were found between measures of decision-making (IGT) and relapse risk. In these studies in contrast a significant relation was found with a measure of response inhibition (SST, Goudriaan et al., 2008) and an alternative measure of decision-making, the Card Playing Task (Álvarez-Moya et al., 2011; Goudriaan et al., 2008). Goudriaan et al. (2008) suggested that differences between the IGT and the CPT may explain this particular finding. They suggest that a simple task as the CPT may tap into separate aspects of executive functioning, while a more complex task as the IGT may rely upon a mix of cognitive demands diluting the predicting power of an aspect such as “disinhibition”. However, it remains a remarkable finding that IGT performance does not relate to relapse within PGs. This is in clear contrast with the growing literature relating decision-making impairments with an increased risk on relapse after treatment (or drop out during treatment) in substance abusing patients (e.g., Bowden-Jones et al., 2005; Passetti et al., 2008). These differences in neurocognitive functioning and its consequences between pathological gamblers and substance abusers need to be explored. One possible explanation is that risk/reward decision-making is more impaired in pathological gamblers compared to substance abusing patients and an overall characteristic of pathological gamblers, leaving less room to differentially impact relapse risk. Indeed, in a recent review Leeman and Potenza (2012) suggested that PGs versus substance dependent patients, were characterized by less impairments in basic executive functions (i.e. working memory and attention) but by more severe impairments in reward/risk decision-making.

In contrast to the neurocognitive measures age of onset proved to be significantly associated with relapse. This finding is in accordance with the current literature on relapse in pathological gambling, showing that measures of gambling severity, including age of onset and years of gambling experience, were associated with successful abstinence. Pathological gamblers that began gambling at a younger age showed higher relapse risks than PGs that started gambling at a later age (e.g., Blaszczynski & Nower, 2002; Dowling, 2009; Goudriaan et al., 2008; McCormick & Taber, 1991). This finding further is consistent with studies within substance abusing samples, where age at onset is a significant marker associated with the severity and prognosis of the disorder (Dom, Hulstijn & Sabbe, 2006).

Finally and most remarkably, our PG and HC groups did not differ on self-report measures or on neurocognitive measures of impulsivity, with the exception of higher BIS scores in PGs compared to HCs. This finding is inconsistent with earlier studies demonstrating impairments in decision-making (DDT and IGT) in PGs versus controls (Goudriaan, Oosterlaan, de Beurs & van den Brink, 2005; Petry, 2001; for a review see Leeman and Potenza, 2012). However, this discrepancy may have resulted from our strict sample selection. Indeed, we selected a group of pathological gamblers specifically excluding psychiatric co-morbidity in order to avoid confounding effects on our measures by co-morbid disorders. Indeed, frequent co-morbid disorders in PGs samples such as SUD and (cluster B) personality disorders are themselves associated with higher self-reported and neurocognitive impulsivity measures. Overall it seems that our sample is reflective of a subgroup of non-impulsive PGs. This finding is in accordance with recent data published by Dannon, Shoenfeld, Rosenberg, Kertzman and Kotler (2010) indicating that PGs were no more impulsive than HCs, or even less impulsive in some instances. Overall, an increasing number of authors currently suggests the existence of different subtypes of pathological gambling (Álvarez-Moya et al., 2010; Blaszczynski & Nower, 2002; Shead, Callan and Hodgins, 2008). Our PG sample best resembles the conditioned or emotionally vulnerable problem
gamblers as defined by Blaszczynski and Nower (2002) or type IV or high-functioning problem gamblers described by Alvarez-Moya et al. (2010). All of these PGs subgroups are defined as having a more adaptive personality profile, lower levels of substance use, and fewer psychopathological disturbances (Alvarez-Moya et al., 2010; Blaszczynski & Nower, 2002) and thus fewer impulsivity deficits. In contrast, the other subtypes as defined by these authors are characterized by a higher prevalence of (externalizing) psychiatric co-morbidity such as SUD and (impulsive) personality types (cluster B). It is an interesting hypothesis to be explored in future research, whether those subgroups (based on clinical variables) can be differentiated based upon their underlying neurocognitive profile. Our data suggest at least, that a non-impulsive subgroup exists and is characterized by normal performance on measures of inhibition and decision-making.

The limited sample size is undoubtedly the most serious limitation of the current study, warranting replication within larger samples. Main strengths, however, are the homogeneous sample of PGs without psychiatric co-morbidity, the long-term follow-up of 12 months and the very low number lost to follow-up.

Taken together, the results of our pilot study show that one-year relapse in a small group of PGs without comorbid other psychiatric disorders is not predicted by self-report or neurocognitive measures of impulsivity and decision-making. The absence of differences on self-report and neurocognitive measures of impulsivity and decision-making between HCs and PGs illustrates the relative health of the examined PGs group, regardless of their pathological gambling. This particular finding emphasizes the need to further look into the differences between subtypes of pathological gamblers in future studies exploring neurocognitive mechanisms underlying the pathogenesis and chronicity of this disorder.

REFERENCES

Alvarez-Moya, E. M., Jiménez-Murcia, S., Aymami, M. N., Gómez-Peña, M., Granero, R., Santamaría, J., Menchón, J. M. & Fernández-Aranda, F. (2010). Subtyping study of a pathological gamblers sample. Canadian Journal of Psychiatry – Revue Canadienne de Psychiatrie, 55, 498–506.

Álvarez-Moya, E. M., Ochoa, C., Jiménez-Murcia, S., Aymami, M. N., Gómez-Peña, M., Fernández-Aranda, F., Santamaría, J., Moragas, L., Bove, F. & Menchón, J. M. (2011). Effect of executive functioning, decision-making and self-reported impulsivity on the treatment outcome of pathological gambling. Journal of Psychiatry and Neuroscience, 36, 165–175.

American Psychiatric Association (2000). Diagnostic and statistical manual of mental disorders. (4th ed.). Washington, DC: American Psychiatric Association.

American Psychiatric Association (2012). www.DSM5.org.

Andrade, L. F. & Petry, N. (2012). Delay and probability discounting in pathological gamblers with and without a history of substance use problems. Psychopharmacology, 219, 491–499.

Bechara, A., Damasio, A. R., Damasio, H. & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. Cognition, 50, 7–15.

Blaszczynski, A. & Nower, L. (2002). A pathways model of problem and pathological gambling. Addiction, 97, 487–499.

Bowden-Jones, H., McPhlllips, M., Rogers, R., Hutton, S. & Joyce, E. (2005). Risk-taking on tests sensitive to ventromedial prefrontal cortex dysfunction predicts early relapse in alcohol dependency: A pilot study. Journal of Neuropsychiatry and Clinical Neurosciences, 17, 417–420.

Brewer, J. A. & Potenza, M. N. (2008). The neurobiology and genetics of impulse control disorders: Relationships to drug addictions. Biochemical Pharmacology, 75, 63–75.

De Wilde, B., Sabbe, B., Hulsstijn, W. & Dom, G. (2013). Affective decision-making is predictive of three-month relapse in polysubstance dependent alcoholics. European Addiction Research, 19, 21–28.

Dannon, P. N., Shoenfeld, N., Rosenberg, O., Kertzman, S. & Kotler, M. (2010). Pathological gambling: An impulse control disorder? Measurement of impulsivity using neurocognitive tests. Israel Medical Association Journal, 12, 243–248.

Dom, G., Hulsstijn, W., Sabbe, B. & Van der Wilt, J. (2005). Differences in impulsivity and sensation seeking between early- and late-onset alcoholics. Addictive Behaviors, 31(2), 298–308.

Dowing, N. (2009). Client characteristics associated with treatment attrition and outcome in female pathological gambling. Addiction Research and Theory, 17, 205–219.

Ewing, J. A. (1984). Detecting alcoholism. The CAGE questionnaire. JAMA, the Journal of the American Medical Association, 14, 1905–1907.

First, M. B., Spitzer, R. L., Gibbon, M. & Williams, J. (1996). Structured clinical interview for DSM-IV Axis I Disorders – Patient Edition (SCID-I/P, Version 2.0). New York: New York State Psychiatric Institute.

Goudriaan, A. E., Oosterlaan, J., de Beurs, E. & van den Brink, W. (2005). Decision-making in pathological gambling: A comparison between pathological gamblers, alcohol dependent persons, with Tourette syndrome, and normal controls. Cognitive Brain Research, 23, 137–151.

Goudriaan, A. E., Oosterlaan, J., de Beurs, E. & van den Brink, W. (2008). The role of self-reported impulsivity and reward sensitivity versus neurocognitive measures of disinhibition and decision-making in the prediction of relapse in pathological gamblers. Psychological Medicine, 38, 41–50.

Koob, G. F. & Volkow, N. D. (2010). Neurocircuity of addiction. Neuropsychopharmacology, 35, 217–238.

Ledgerwood, D. M. & Petry, N. M. (2006a). Psychological experience of gambling and subtypes of pathological gamblers. Psychiatry Research, 144, 17–27.

Ledgerwood, D. M. & Petry, N. M. (2006b). What do we know about relapse in pathological gambling? Clinical Psychology Review, 26(2), 216–228.

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, 469–490.

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

McCormick, R. A. & Taber, J. I. (1991). Follow-up of male pathological gamblers after treatment: The relationship of intellectual variables to relapse. Journal of Gambling Studies, 7, 99–108.

Nelson, H. E. & Willison, J. R. (1991). The Revised National Adult Reading Test–Test manual. Windsor: NFER-Nelson.

Passetti, F., Clark, L., Mehta, M. A., Joyce, E. & King, M. (2008). Neuropsychological predictors of clinical outcome in opiate addiction. Drug and Alcohol Dependence, 94, 82–91.

Paton, J. H., Stanford, M. S. & Barratt, E. S. (1995). Factor structure of the Barratt Impulsiveness Scale. Journal of Clinical Psychology, 51, 768–774.

Petry, N. M. (2001). Pathological gamblers, with and without substance abuse disorders, discount delayed rewards at high rates. Journal of Abnormal Psychology, 110, 482–487.
Petry, N. M. (2006). Should the scope of addictive behaviors be broadened to include pathological gambling? *Addiction, 101*, 152–160.

Potenza, M. N. (2001). The neurobiology of pathological gambling. *Seminars in Clinical Neuropsychiatry, 6*, 217–226.

Raven, J. C. (1936). Mental tests used in genetic studies: The performance of related individuals on tests mainly educative and mainly reproductive. MSc Thesis. London: University of London.

Richards, J. B., Zhang, L., Mitchell, S. H. & de Wit, H. (1999). Delay or probability discounting in a model of impulsive behaviour: Effect of alcohol. *Journal of the Experimental Analysis of Behavior, 71*, 121–143.

Schotte, C. & De Doncker D. (1994). *ADP-IV questionnaire*. Antwerp: University Hospital Antwerp.

Schotte, C. & De Doncker, D. (1996). *ADP-IV questionnaire: Manual and norms*. Antwerp: University Hospital Antwerp.

Shead, N. W., Callan, M. J. & Hodgins, D. C. (2008). Probability discounting among gamblers: Differences across problem gambling severity and affect-regulation expectancies. *Personality and Individual Differences, 45*, 536–541.

Skinner, H. A. (1982). The Drug Abuse Screening Test. *Addictive Behaviors, 7*(4), 363–371.

Torrubia, R., Ávila, C., Moltó, J. & Caseras, X. (2001). The sensitivity to punishment and sensitivity to reward questionnaires (SPSRQ) as a measure of Gray’s anxiety and impulsivity dimensions. *Personality and Individual Differences, 31*, 837–862.

Verdejo-Garcia, A., Lawrence, A. J. & Clark, L. (2008). Impulsivity as a vulnerability marker for substance-use disorders: Review of findings from high-risk research, problem gamblers and genetic association studies. *Neuroscience and Biobehavioral Reviews, 32*, 777–810.

Wareham, J. D. & Potenza, M. N. (2010). Pathological gambling and substance use disorders. *American Journal of Drug and Alcohol Abuse, 36*, 242–247.