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ORIGINAL PAPER

On the Processes Underlying the Relationship Between Alexithymia and Gambling Severity

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Abstract A great number of individuals with persistent problematic gambling behavior exhibit alexithymic tendencies, greater impulsivity, impaired working memory and poor mood. However, the relationship between these cognitive, affective and personality factors in problem gambling remains poorly understood. Our aim was to investigate multiple pathways of the alexithymia and problem gambling relationship. One hundred and six male subjects with different levels of gambling problem severity were recruited. Alexithymia, impulsivity and verbal working memory were evaluated, and their relationships to disordered gambling was examined by means of a path analysis. Results indicate that alexithymia is related to an increase in the severity of gambling indirectly, i.e., through distress severity. In addition, a rise of alexithymic tendencies was also associated with problem gambling severity through enhanced impulsivity that directly increased distress. Working memory capacity failed to significantly impact our path model. Overall, our findings contribute a new finding to the literature by highlighting the importance of alexithymia, in addition to impulsivity, in the understanding of gambling problem severity and its clinical course.

Keywords Alexithymia · Gambling · Impulsivity · Mood · Working memory

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Introduction

For most people, although it is just an entertaining activity, gambling behavior presents an issue for at least 0.3% of the population in Sweden, and 5.0% in Hong Kong, with these varying numbers influenced by factors such as cultural aspects, methods of assessment, opportunities to gamble, etc. For instance, among British gamblers, a quarter to half a million people encounter severe life problems due to their gambling behaviors (Wardle et al. 2011). Scientific approaches to gambling disorders posit that a better understanding of etiological and maintenance determinants of gambling will lead to better societal and clinical interventions.

At the individual level, people with gambling addiction are more likely to have limited capacities in describing their feelings, in differentiating their feelings from bodily sensations of emotional arousal, and in using imaginative processes (Bonnaire et al. 2009; Ferguson et al. 2009; Lumley and Roby 1995; Mitrovic and Brown 2009; Parker et al. 2005). However, those same factors describe a stable personality trait named alexithymia. For instance, the first published study (Lumley and Roby 1995) reported that about one in three young American adults considered as pathological gamblers, based on their scores on the South Oaks Gambling Screen (SOGS, Lesieur and Blume 1987), met the criteria for alexithymia, as assessed by the well-known self-reported Toronto Alexithymia Scale (TAS-26, Taylor et al. 1985). In more recent studies conducted with a shorter version of this scale (TAS-20, Parker et al. 1993), 22% of the pathological gamblers could be considered as alexithymic, compared to only 11% in the non-problem gamblers population (Parker et al. 2005). The current state of our knowledge suggests that the relationship between alexithymic tendencies and excessive gambling is explained by a direct pathway, i.e., alexithymia acts as a risk factor in subjects overwhelmed by their sensations, thus resorting to addictive behaviors to self-regulate these disruptive emotions (Taylor et al. 1997). However, one could argue that this explanation should be updated by elaborating on indirect pathways that include cognitive, affective and other personality factors that are correlated with both alexithymia measures, as well as the severity of excessive gambling. Three main candidates are mental distress (e.g., depressive symptoms), impulsivity, and working memory. Hence our primary goal in this study is to examine the existence of these indirect pathways. Neural models that explain addictive behaviors, including problem gambling, suggest that distress conditions, such as depression, are linked to body states (or somatic states according to Damasio 2006) that generate interoceptive signals ultimately received by the insular cortex. In turn, insular cortex activity tends to exaggerate gambling behavior by intensifying neural systems that promote impulsivity (i.e., the impulsive system mediated in part by the striatum neural circuits), and by weakening neural systems that promote executive control and working memory (i.e., the reflective system mediated in part by the prefrontal cortex) (e.g., see Noël et al. 2013). Alternatively, abnormalities in the neural systems that map and represent these body (somatic) states, such as what ay occur in alexithymia, could also exert a similar influence on the dynamics of the neural systems that promote impulsivity (impulsive system) versus executive control (reflective system).

More specifically, impulsivity is defined as a trend to act before adequate thought, and without regards to the negative consequences of immediate reactions to internal or external stimuli, as well as an inability to inhibit inappropriate behaviors (e.g., Ainslie 1975; Evenden 1999). More sophisticated definitions opted for a multidimensional approach of impulsivity, which can be addressed through self-report questionnaires (e.g., UPPS, Whiteside and Lynam 2001), or by behavioral tasks that measure overt behavior related to specific dimension of impulsivity (e.g., stop signal, go/no-go paradigm and delay discounting tasks). Impulsivity is strongly linked to both problem gambling (Blaszczynski et al. 1997; Vitaro et al. 1999; Vitaro et al. 2004, Steel and Blaszczynski 1998) and alexithymia (Gunnarsson et al. 2008; Gustavsson et al. 2003; Shishido et al. 2013; Wickens et al. 2008; Zimmermann et al. 2005, Velotti et al. 2016).

Although alexithymia was primarily framed as an emotion-processing deficit, cognitive weaknesses also account for this functional impairment (Bogdanova et al. 2010; Koven and Thomas 2010). For instance, participants with poor emotional clarity, a latent factor of alexithymia, reported difficulty with task initiation, self-monitoring, response inhibition, cognitive flexibility and planning (Koven and Thomas 2010). Processing components of alexithymia (difficulty describing feelings and externally oriented thinking) correlate with performance on measures of executive and visuospatial abilities, which supports the idea that people high on alexithymia scores reflect weakening in the frontostriatal circuits involved in the control or inhibition of impulsive behaviors (Bogdanova et al. 2010). This emphasis on the cognitive components of alexithymia raises the possibility that boosting executive functioning through training alone, or in combination with brain stimulation such as transcranial magnetic stimulation (TMS), could lead to a beneficial outcome in alexithymic individuals with lack of emotion regulation tendencies. As a recent indirect illustration, training the emotional brain, by exercising affective working memory, improves affective control (Schweizer et al. 2013).

Finally, alexithymia has been related to depression and anxiety (Lumley and Bazydlo 2000; Speranza et al. 2004; Marchesi et al. 2014), two forms of mood disorders frequently reported in pathological gamblers (e.g., Becona et al. 1996). In an attempt to conceptualize the relationship between mood disorders and alexithymia, some authors suggested that alexithymia increases vulnerability to psychological illness (Leweke et al. 2012; Tolmunen et al. 2011). Other complementary explanations could be that alexythimic tendencies represent a strategy to cope with distress (Marchesi et al. 2000), or that "difficult to identify feelings" and "difficulty communicating feelings" are too associated with negative affects, thus creating artefacts of the method and measures used (Marchesi et al. 2014). In pathological gamblers, when controlling for depression, alexithymia measured by the total score of TAS and the difficulty to identify feelings score was higher only in a subgroup of gamblers (racetracks gambling), but not for slot machine gamblers (Bonnaire et al. 2013). This finding, first, suggests that alexithymia is not a risk factor for all problem gamblers, and second, that the relation between alexithymia and gambling risk is mediated by distress.

Previous research has shown sex related differences in prevalence (Blanco et al. 2006), age of onset (Ladd and Petry 2002; Ibáñez et al. 2003), reasons to gamble (Will Shead and Hodgins 2009), motivation to gamble (e.g., gambling related urge and interpretive bias are stronger in males, Smith et al. 2015), and preference for types of gambling (Potenza et al. 2001). In addition, evidence of sex related differences on alexithymia (Levant et al. 2009), impulsivity (Cross et al. 2011), and verbal working memory (Masters and Sanders 1993) have been reported, which potentially makes gender an important discriminative factor in the relationship between alexithymic tendencies and gambling. However, the potential moderating effects of gender on processes underlying the association between alexithymic tendencies and gambling disorders requires a much larger sample size to control for these differences, which goes beyond the scope of the present study that focused on men only.

In this study, we tested whether alexithymia predisposes the development of gambling disorders notably by enhanced distress. We also hypothesized that working memory and impulsivity mediate this relationship. Put differently, we predict that alexithymia's dimension will be associated with a lower working memory (i.e., weakened reflective system), and a greater level of impulsivity and distress (i.e., strengthened impulsive system); each of them leading to higher gambling severity.

Method

Participants

One hundred and six male subjects with various gambling problem severity participated in the study (mean age: 31.55 ± 10.36). At-risk and problem gamblers were recruited through advertising (or advertisements) in different gambling areas (e.g., casino) across Belgium. Non-problem and low-problem gamblers were recruited mainly from word of mouth and through advertisement (idem) on social media (e.g., Facebook). Participants who responded to the recruitment ads were screened over the telephone to ensure eligibility. All at-risk and problems gamblers had a minimum of 3 on the Canadian Problem Gambling Index (CPGI) and fulfilled a minimum of 4 DSM-5 diagnostic criteria of gambling disorder. Low problem gamblers had a score <2 of the CPGI. Suicidal intentions, acute psychotic symptoms or current involvement in gambling treatment were exclusionary criteria. In addition, a minimum Mini-Mental State Examination (MMSE) score of 25 was required to exclude participants with severe cognitive impairment (Folstein et al. 1975). Criteria were intentionally minimally restrictive to increase generalization.

Measures

Gambling problem severity, personality trait alexithymia, impulsivity and anxiety/depression were assessed by questionnaires. Working memory was investigated with a computerized task.

The Canadian Problem Gambling Index (CPGI)

The Canadian Problem Gambling Index (CPGI) (Ferris and Wynne 2001) was used to sort participants into 3 groups according to their gambling severity scores: non-problem or low-problem gambling (score 0–2), at-risk (score of 3–7), and problem gambling (score of 8 and more). In this questionnaire, while thinking about the past 12 months participants have to fill a 9-item(s) questionnaire assessing problem gambling behavior (e.g., Loss of control; “How often have you bet more than you could really afford to lose?”) and adverse consequences of gambling (e.g., Social consequences; “How often has your gambling caused any financial problems for you or your household?”). Score 1 for each response of “sometimes,” 2 for each “most of the time,” and 3 for each “almost always.” A score between 0 and 27 points is possible. Internal consistency of this measure was good (alpha = 0.84) and higher than other measures such as DSM-IV and SOGS (Ferris and Wynne 2001). Total scores range from 0 to 27.

Toronto Alexithymia Scale (TAS-20)

The Toronto Alexithymia Scale (Bagby et al. 1994a, b) was used to measure alexithymia. It is a 20-item scale rated on 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The TAS-20 describe three factors: (a) Difficulty Identifying Feelings

(DIF, e.g., "when I am upset. I don't know if I am sad. frightened. or angry"); (b) Difficulty Describing Feelings (DDF, e.g., "I find it hard to describe how I feel about people"); and (c) Externally Oriented Thinking (EOT, e.g., "I prefer talking to people about their daily activities rather than their feelings"). The present study used a validated French translation of the scale (Loas et al. 1997). Total scores range from 20 to 100. Cronbach's α coefficients were always found to be high (≥.70 for total alexithymia and the factors DIF and DDF. For EOT, values were lower but at least reaching 0.64, which is still acceptable (Zech et al. 1999).

Short-Version of the UPPS Impulsive Behavior Scale

The UPPS-P is a 20-item scale measuring 5 impulsivity components: negative urgency, positive urgency, lack of premeditation, lack of perseverance and sensation seeking (French adaptation from Billieux et al. 2012). Psychometric properties are considered as good; the model with 5 distinct but interrelated factors of impulsivity had a good fit, the Cronbach α ranged from .70 to .84, suggesting good internal consistency for the various subscales. Total scores range from 20 to 80.

The State Trait Anxiety Inventory

State anxiety was assessed using the state form of the State Trait Anxiety Inventory (Spielberger et al. 1983). This 20-items self-report is scored on a 4-point Likert scale ranging from 1 (never) to 4 (always). The French adaptation (Bruchon-Schweitzer and Paulhan 1993) shows good psychometric properties, leading to its intensive use in health research. Cronbach's α coefficient is high (.83). Total scores range from 20 to 80.

The Beck Depression Inventory (BDI)

The severity of depressive symptoms was assessed with the French BDI short form (Beck and Beck 1972), a self 13-items report. Each item has four option responses scored from 0 to 3. The higher the score, the higher the severity is important. The internal consistency is good (Cronback's α coefficient of .85). Total scores ranged from 0 to 39.

Working Memory Task

Working memory was assessed using a complex memory span task, namely the Operation Span Task (OSPAN; Turner and Engle 1989). The requirement for this task is the pairing of a task followed by a to-be-remembered items (e.g., a letter, word, or object), so that subsequent tasks would interfere with the previous items presented. Indeed, participants were requested to solve some mathematical problems while simultaneously remembering a set of unrelated words. For each problem, participants indicate whether it is true or false, and then they are provided with a word to be recalled later (e.g., 2 + 7 = ?, 9, TABLE). Previous studies showed that problem gamblers performed lower on this task than non-problem participants (e.g., Brevers et al. 2012).

The Ospan score was calculated according to the partial credit unit (PCU) scoring procedure (Conway et al. 2005), scores ranging from 0.00 to 1.00.

Statistical Analysis

Initial data analyses assessed differences between groups on demographic and psychological variables.

A path model was tested using PLS-PM (Lohmoeller 1989; Tenenhaus et al. 2005). The PLS-PM makes it possible to study causal relations between latent variables as an alternative to structural equation models such as the LISREL. Unlike classic structural equation models, the PLS-PM does not use maximum likelihood estimations of the parameters based on the variance–covariance matrix. It is a full information procedure that iteratively performs a series of linear regressions. The PLS-PM uses ordinary least squares, allowing models to be tested with fewer distributional assumptions than structural equation models and also with smaller samples. Moreover, the PLS-PM is less sensitive to normality problems and more suitable for avoiding indeterminacy problems (Fornell and Bookstein 1982). PLS-PM loadings of observed variables on each latent variable are like principal component regression analysis loadings and path coefficients are similar to standardised beta coefficients in a classic regression analysis. The R^2 values for each dependent construct are also computed. The results are shown as path coefficients and their bias-corrected and accelerated bootstrap (5000 resamples) 95% confidence interval (CI). The overall quality of the model was assessed by examination of the measurement and structural models quality, as well as with the examination of R^2 and SRMR ($\leq$.08, Hair et al. 2016). We used SMARTPLS 3 (Ringle et al. 2015) that incorporates many recent methodological features and the most recent findings on PLS-PM. To be able to detect an R^2 around .10, assuming a significance level of .05 and a statistical power of 80%, we need 81 participants (G*Power).

Results

Demographic and Clinical Data (Table 1)

To depict the characteristics of the participants, they were classified regarding their CPGI scores per cut-off criteria of the scale. Mean comparisons (ANOVA), with Welch correction when variances were not equal are provided in Table 1. Bonferroni Post-Hoc tests were ran when group significant differences were present. The three groups are significantly different from each other on their CPGI scores (NRG < PG, $p = .00$; PG > ARG, $p = .000$) which was attended. The PG group was less educated than ARG group ($p = .034$) and NRG group ($p = .039$). There was no difference between gambling group on working memory [F(2, 103) = 1.10, ns]. NRG have lower scores than PG on DIF, EOT and TAS total scores (respectively, $p = .007$, $p = .01$, $p = .001$). For impulsivity, NRG have lower scores than PG on UPPS total scores, negative urgency and positive urgency (respectively, $p = .002$, $p = .001$, $p = .009$). Furthermore, ARG were less impulsive (UPPS total) and scored lower on negative urgency and perseverance than PG (respectively, $p = .01$, $p = .003$, $p = .009$). Finally, NRG and ARG showed a lower level of anxiety than PG ($p = .000$ and $p = .001$, respectively) and less depressed than PG participants ($p = .000$ and $p = .000$, respectively).

In summary, alexithymia, impulsivity and distress measures discriminate the three group of gambling severity.

Table 1 One way ANOVA for group comparisons

	NRG n = 46		ARG n = 33		PG n = 27		Total		F	*p*	Effect size n^2p
	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
OSPAN	.84	.11	.83	.10	.80	.10	.83	.11	$F(2, 103) = 1.10$	.34	
CPGI	.35	.71	4.82	1.31	13.93	5.01	5.20	6.07	**$F(2, 44.49) = 242.59$**	**.000**	**.81**
TAS-DIF	13.96	4.81	15.06	6.11	17.81	4.20	15.28	5.30	**$F(2, 127.82) = 6.49$**	**.009**	**.09**
TAS-DDF	12.04	4.28	13.18	4.45	13.89	4.64	12.87	4.45	$F(2, 103) = 1.6$	.21	
TAS-EOT	17.46	5.01	19.27	3.35	20.56	3.97	18.81	4.44	**$F(2, 64.07) = 4.29$**	**.011**	**.08**
TAS20 total	43.46	9.69	47.52	11.31	52.26	8.61	46.96	10.50	**$F(2, 62.33) = 8.01$**	**.002**	**.12**
UPPS total	43.54	9.03	44.33	8.91	51.00	7.88	45.69	9.18	**$F(2, 103) = 6.81$**	**.002**	**.12**
Negative urgency	8.59	2.92	8.64	2.68	11.11	2.65	9.25	2.96	**$F(2, 103) = 8.17$**	**.001**	**.14**
Positive urgency	10.04	2.72	10.45	2.65	11.93	2.11	10.65	2.64	**$F(2, 103) = 4.76$**	**.011**	**.09**
Premeditation	7.17	2.18	6.91	1.81	8.15	2.16	7.34	2.11	$F(2, 103) = 2.93$	*.058*	
Perseverance	7.39	2.86	6.61	2.46	8.85	3.25	7.52	2.95	**$F(2, 103) = 4.69$**	**.011**	**.08**
Sensation seeking	10.35	3.13	11.73	2.85	10.96	2.30	10.93	2.89	$F(2, 103) = 2.25$	.11	
Anxiety	42.59	12.99	42.70	9.97	54.33	11.59	45.61	12.73	**$F(2, 103) = 9.95$**	**.000**	**.16**
Beck	3.98	4.19	3.97	3.40	8.96	5.71	5.26	4.89	**$F(2, 57.91) = 8.84$**	**.000**	**.20**
Age	31.80	12.83	31.94	8.89	30.63	7.37	31.55	10.41	$F(2, 67.76) = .23$	.87	
Education (in years)	14.03	2.12	14.17	1.92	12.57	2.25	13.64	2.19	**$F(2, 75) = 4.30$**	**.017**	**.10**

Results in bold are significant

NRG no risk gambling, *ARG* at risk gamblers, *PG* problem gamblers

Pearson's Correlations (Table 2)

Results show a significant negative relation between working memory and alexithymia meaning that when alexithymia total score and DIF increase, performance on the OSPAN decreases. Gambling severity scores increase significantly when alexithymia dimensions increase (DIF and EOT), as well as when anxiety, depression and impulsivity (UPPS total scores) and particularly negative urgency increase. Positive urgency and perseverance climb up. However, we failed to find any significant relation between working memory and distress or gambling severity nor impulsivity dimensions, except with negative urgency.

Partial Least Square-Path Modelling

Evaluation of the Measurement Model

As working memory did not exhibit a significant relation with distress, impulsivity (except a weaker one with negative urgency) or gambling severity and due to non-differences between groups severity risk, we discarded this construct from our measurement model.

The theoretical model involved 18 measures (manifest variables) loaded on four latent constructs: (1) alexithymia, (2) distress, (3) impulsivity and (4) gambling severity. The latent and manifest variables are described in Table 3 and the overall model with parameters is provided in Fig. 1.

As our model was reflective, the manifest variables depicting the latent variable need to be unidimensional. Composite reliability assessed with the Dillon-Goldstein Rho, a more reliable indice than the Cronbach alpha, evidenced that the impulsivity dimensions failed to reflect a unique construct. A principal component analysis with a parallel analysis was ran on the five impulsivity dimensions. There was only one significant underlying factor with negative urgency, positive urgency, premeditation and sensation seeking loading significantly on this factor. As perseverance was not significant, we discarded it from further analysis.

To achieve a satisfactory measurement model and finally to ensure the final structural model validity, we have first checked about composite reliability of each construct. They were all $>.70$ and considered satisfactory (Nunnally and Bernstein 1994). Furthermore, the convergent validity of each latent construct is satisfying as all Average Extracted Variance (AVE) were $>.50$ (Fornell and Larcker 1981). All measurement indices are provided in Table 3. The discriminant validity of each construct was established since Heterotrait-Monotrait Ratio (HTMT, Table 4) were $<.73$, because an HTMT value below 0.90 means that discriminant validity is established between two reflective constructs (Henseler et al. 2015).

Evaluation of the Structural Model

First, checking for collinearity between latent variables shows that all VIF scores were below 1.51 (cut-off criteria for VIF is 5), indicating no collinearity biases.

The overall model (Fig. 1) explained 30% of the gambling problems variance ($p = .00$. 95% bootstrap CI $=$ [.13; .44]) and the SRMR was .08 with 95% CI of .05–.08, indicating a satisfying model fit for a PLs-PM model. Alexithymia, distress and impulsivity are significant predictors of gambling problems. The Q^2 values for the three endogenous constructs are above 0, providing support for the model's predictive relevance regarding

Table 2 Pearson's correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Age	1	−.140	−.028	.047	−.053	.004	.003	−.037	.116	−.109	.060	.014	−.193*	−.211*	.114
2. OSPAN		1	−.151	−.226*	−.152	−.167	−.249*	−.071	−.191*	.020	−.189	.054	.034	−.123	−.105
3. CPGI			1	.307**	.188	.270**	.349**	.351**	.376**	.333**	.120	.234*	.099	.417**	.506**
4. TAS-DIF				1	.561**	.131	.798**	.399**	.367**	.388**	.280**	.167	.164	.480**	.524**
5. TAS-DDF					1	.255**	.815**	.205*	.187	.089	.250**	.130	.064	.255**	.257**
6. TAS-EOT						1	.597**	.183	.301**	.111	.124	.058	.021	.138	.225*
7. TAS20 total							1	.366**	.391**	.280**	.299**	.164	.119	.409**	.468**
8. UPPS total								1	.775**	.799**	.669**	.543**	.611**	.373**	.415**
9. Negative urgency									1	.626**	.418**	.197*	.361**	.333**	.466**
10. Positive urgency										1	.367**	.213*	.500**	.321**	.336**
11. Premeditation											1	.444**	.181	.197*	.132
12. Perseverance												1	−.015	.317**	.313**
13. Sensation seeking													1	.084	.115
14. Anxiety														1	.579**
15. Depression															1

* $p \leq .05$; ** $p \leq .01$

Table 3 Description of manifest and latent variables. and measurement model evaluation

Latent construct	Manifest variables	Outer loadings	AVE >.50	Composite reliability >.70	Outer weight
Distress	State anxiety	.87	.79	.88	.52
	Depression	.91			.61
Alexithymia	Difficulties identifying feelings	.88	.55	.78	.65
	Difficulties describing feelings	.78			.34
	Externally-oriented thinking	.50			.33
Impulsivity	Negative urgency	.89	.55	.83	.49
	Positive urgency	.86			.40
	Premeditation	.62			.24
	Sensation seeking	.56			.14, ns
Gambling severity	Item 1	.84	.68	.95	.13
	Item 2	.70			.11
	Item 3	.82			.13
	Item 4	.78			.11
	Item 5	.89			.15
	Item 6	.83			.14
	Item 7	.84			.12
	Item 8	.86			.16
	Item 9	.85			.15

Outer loadings and outer weight are all significant ($p \leq .001$, and 95% Bca CI do not contain zero) except when mentioned

the endogenous latent constructs (gambling $Q^2 = .19$. Distress $Q^2 = .25$. Impulsivity $Q^2 = .08$).

While alexithymia was a significant predictor of Distress ($\beta = .43$. 95% bootstrap CI = [.27; .56]), its effect was partially mediated through Impulsivity (indirect effect : $\beta = .10$. 95% bootstrap CI = [.03;. 19]). The effect of alexithymia on gambling was also fully mediated by distress and impulsivity (indirect effect: $\beta = .29$. 95% bootstrap CI = [.13; .44]).

It was noteworthy that impulsivity failed to explain directly the gambling severity. Rather, its effect was fully mediated by distress (indirect effect: $\beta = .11$. 95% bootstrap CI = [.01; .23] (see Table 5).

To resume, alexithymia enhances the gambling severity through the elevation of distress and impulsivity, with impulsivity that also contributes to experiencing more distress. The more a participant experiences a higher level of alexithymia, the more he is susceptible to experience high impulsivity tendencies and increased distress levels. Thus, experiencing greater levels of distress is followed by an increased gambling severity (Fig. 2).

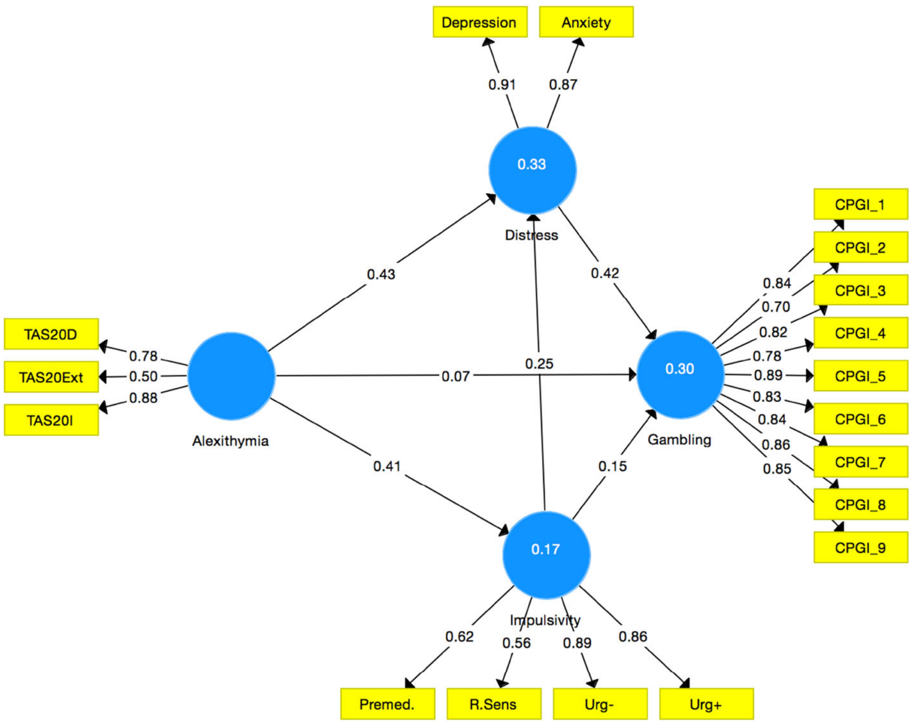

Fig. 1 PLS-PM model predicting gambling problems

Table 4 Discriminant validity of the measurement model: heterotrait-monotrait ratio

	Alexithymia	Distress	Gambling
Alexithymia			
Distress	0.73		
Gambling	0.47	0.62	
Impulsivity	0.54	0.51	0.37

Discussion

The present study investigated the relative contribution of working memory and impulsivity dimensions on the relationship between alexithymia and gambling problem severity. Our main finding was that both alexithymia and impulsivity exhibit an indirect effect on gambling severity through distress. This finding highlights the important contribution of distress in gambling severity, as well as the importance of alexithymic tendencies and impulsivity.

Alexithymia is an extensively studied construct considered as a vulnerability personality trait leading to many psychopathological disorders such as depression, anxiety or addiction (e.g., Leweke et al. 2012; Speranza et al. 2004). The effect of alexithymia is in line with previous studies reporting a high prevalence rate of alexithymia in population with gambling disorder (Bonnaire et al. 2009; Lumley and Roby 1995; Mitrovic and Brown 2009; Parker et al. 2005). Indeed, the at-risk gamblers exhibited more difficulties identifying and

Table 5 Total and direct effect between latent constructs

	Total effect				Direct effect				
	Path coefficients	t	*p*	95% BCA CI	Path coefficients	t	*p*	95% BCA CI	f^2
Alexithymia -> distress	0.53	8.07	0.00	.38–.64	0.43	5.89	0.00	.27 to .56	0.23 (medium)
Alexithymia -> gambling	0.35	4.18	0.00	.15–.49	0.07	0.52	0.60	−.18 to .32	0.00
Alexithymia -> impulsivity	0.41	5.10	0.00	.22–.57	0.41	5.10	0.00	.32 to .55	0.21 (medium)
Distress -> gambling	0.42	3.42	0.00	.16–.65	0.42	3.42	0.00	.16 to .65	0.17 (medium)
Impulsivity -> distress	0.25	2.75	0.01	.04–.40	0.25	2.75	0.01	.05 to .40	0.08 (small)
Impulsivity -> gambling	0.25	2.66	0.01	.06–.44	0.15	1.45	0.15	−.04 to .36	0.02

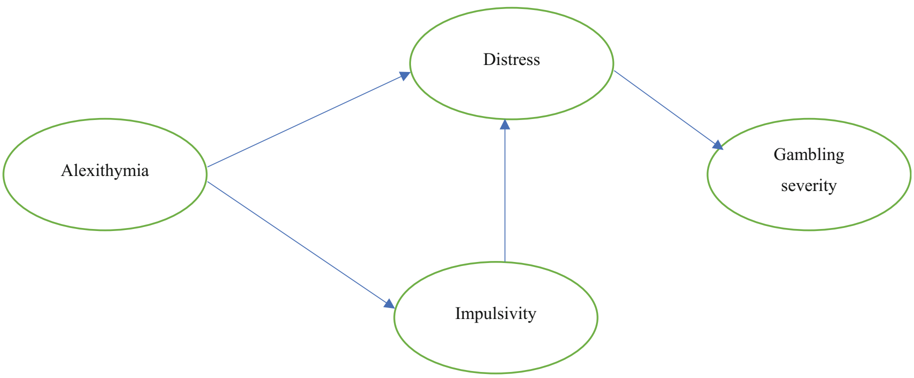

Fig. 2 Final model showing direct significant relations between constructs

describing feelings as well as a higher level of externally oriented thinking than non-risk gamblers. The relationship between alexithymia and distress is in line with the most study results (Lumley and Bazydlo 2000; Marchesi et al. 2014; Speranza et al. 2004; Tolmunen et al. 2011). Interestingly, our results emphasize the role that alexithymia plays in the vulnerability to gambling severity. Indeed, our path model suggests that alexithymia leads to a higher level of distress, which in turn increases gambling severity, in the absence of a direct relation between alexithymia and gambling severity. This relation could be explained by a lack of emotional regulation strategies characterizing those individuals with a high level of alexithymia. Indeed, it has been shown that alexithymia was associated with a lack of emotional awareness, a limited access to emotion regulation strategies and difficulties to control impulses (e.g., Kökönyei et al. 2014). Furthermore, studies suggested that individuals with alexithymia are more likely to exhibit compulsive or impulsive behaviors in order to cope with negative emotions (Taylor et al. 1991). In the absence of an efficient access to emotion representation, gambling behaviors may represent an attempt to regulate negative emotions, which in the long run favors the development of mood disorders (Blaszczynski and Nower 2002; Nower and Blaszczynski 2016). In support of this hypothesis, compared to healthy subjects, problem gamblers have a lack of emotional clarity and emotional awareness, as well as difficulties to access to emotional regulation strategies and more difficulties to control impulsivity (Williams et al. 2012). Furthermore, in addition to a higher level of alexithymia that was involved in gambling severity through enhanced distress, we found that a rise of alexithymic tendencies was also involved in problem gambling severity through enhanced impulsivity that directly increased distress. Remarkably, the association between alexithymia and impulsive actions has been documented in several recent studies (e.g., aggression; Velotti et al. 2016). The link between impulsivity and depression should be the subject of future research.

From a neural perspective, and consistent with our proposed triadic model of addiction (Noël et al. 2013), we envision alexitymia as a condition associated with abnormal insular cortex functioning, so that it exaggerates the body (somatic) states signals associated with distress. The combination of distress and alexithymia creates an exaggerated insular cortex response, which in turn strengthens activity of the impulsive (striatal) system, while weakening activity of the reflective (prefrontal cortex) system, which intensifies gambling behavior. Thus alexithymia alone does not necessarily increase gambling behavior, but it creates a vulnerable condition (i.e., abnormal insula function) where incoming interoceptive signals of distress are amplified above a threshold point that drive insular cortex activity in the direction of exacerbating impulsive, and weakening reflective, system activity. Taken together, our findings support the relevance of an alexithymia/impulsivity pathway responsible for maladjusted gambling behaviors.

The relationship between alexithymia and gambling disorders could be more sophisticated. Indeed, a higher level of restricted imagination and externally oriented thinking (EOT) could be considered as both a protection from distress and affective responses to adversities or as a risk factor to develop abnormal gambling pattern. In both cases, anti-stress effects of higher EOT found in disordered gamblers may act to the detriment of anti-stress training, thus participating to the maintenance of a problem gambling pattern. Put differently, the direct influence of EOT on the CPGI score might reflect an unbalanced relationship between resilience and adaptation processes (Davydov et al. 2010). Indeed, by distracting attention from internal thoughts to external environment, EOT represents an inhibition process of central and peripheral arousal changes association with rumination and distress (Lumley and Bazydlo 2000). On the other side, this emotional detachment might prevent the use of internally-oriented coping strategies necessary for managing, for instance, a state of craving and more generally to initiate a long-lasting change (Keller et al. 1995; Lane et al. 2015).

Another finding was that working memory performance failed to be associated with gambling problem severity. This findings is relevant in the context of the recent hope that providing people with addiction with working memory training sessions might result in (a) better working capacity, (b) better decision making and (c) better emotion regulation (Hofmann et al. 2012). However, the impact of affective working memory on the alexithymia/problem gambling association could be more significant, which clears the path for innovative treatments (i.e., exercising affective working memory) aimed at improving affective control (Schweizer et al. 2013).

Limitations

The causality cannot be assumed in this cross-sectional analysis, which requires longitudinal studies.

Our findings cannot be generalized to women since only men were included in our analysis. Yet, in addition to gender differences in the reasons to gamble (Will Shead and Hodgins 2009), evidence of sex differences on alexithymia (Levant et al. 2009), impulsivity (Cross et al. 2011) and verbal working memory (Masters and Sanders 1993) have been reported, which potentially makes gender an important discriminative factor of the relationship between alexithymic tendencies and gambling. The second main limitation is the absence of consideration for the possible influence of gambling type preference (e.g., racetrack, poker, slot machines) on the relationship between alexithymia and problem gambling (Bonnaire et al. 2013). In our study, most gamblers were approached while they were entering or leaving the casino, and a clear majority of them were slot machine users. Further research aiming at differentiating gamblers according to their gambling preference should be conducted. Finally, whereas many authors have concluded that the Problem Gambling Severity Index (Ferris and Wynne 2001) is psychometrically stronger than similar screening tools such as the South Oaks Gambling Screen or DSM based scales, some concerns have been expressed regarding the at-risk category (scoring between 3 and 7) judged as too inclusive (Currie et al. 2013). A re-calibration of those categories has been suggested by re-scoring of the low-risk (1–4) to moderate-risk (5–7) cut-off (Currie et al. 2013). Because of the shift from 3 (i.e., low, at risk and problem gamblers) to 4 (i.e., no problem, low-risk, moderate-risk and problem gamblers) categories, our sample size was too small to draw valid conclusions. Further investigations with a larger sample should be conducted to ascertain whether our findings survive those scoring changes.

The results of our study have some clinical implications. Based on our results, we consider alexithymic individuals to be at risk of developing an abnormal pattern of gambling behavior. Thus, considering alexithymia as a target for treatment should lead to full consideration regarding underlying mechanisms. Based on clinical observations along with neuroanatomical insight, one could aim at differentiating alexithymia due to affective anomia (i.e., lack of word representation of emotion) to affective agnosia (i.e., lack of emotional responses representations) (Lane et al. 2015). Given the substantial distinction between anomia and agnosia in relation to affect, therapeutic interventions should be specific. Indeed, whereas supporting an individual to "put emotions into words" is considered a top priority in people with affective anomia, affective agnosia challenges this classical view, since that person does not have access to basic emotion representations (i.e., a person does not know what s/he is feeling). In this context, clinical intervention such as the dialectical behavior therapy (Linehan et al. 1999) or the mentalization-based therapy by Fonagy (Bateman and Fonagy 2004) or the emotion focused therapy developed by Greenberg (2002) could help people to experience, understand and transform implicit to explicit emotions in a way that might prevent the need for gambling. Further research will aim at differentiating the relative contribution of alexithymia/anomia-agnosia to the elevation of excessive gambling risk.

Conclusion

Subtle alexithymia/impulsivity patterns are associated with disordered gambling. Problem gambling is a complex disorder and causality cannot be determined by one factor. Our study paved the way towards a multivariate approach that affords a better apprehension of such a complex phenomenon.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the CHU-Brugmann (Brussels, Belgium) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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