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This is a preliminary, unedited version of a manuscript that has been accepted for publication in the Brazilian Journal of Psychiatry. As a service to our readers, we are providing this early version of the manuscript. The manuscript will still undergo copyediting, typesetting, and review of the resulting proof before it is published in final form. The final version may present slight differences in relation to the present version.

Response-outcome analysis in gambling disorder

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Abstract

Introduction: Gambling Disorder is characterized by persistent betting despite financial losses and social adversities. Previous studies demonstrated that during short response-outcome analytical tests (ROAT), people with gambling disorder (PGD) presented more random responses and less use of analytical strategies on ROAT with and without a solution.

Objective: evaluate the predisposition of PGD to illusion of control and superstitious behavior in longer ROAT versions.

Method: 34 PGD to 34 Healthy Controls (HC) are compared, regarding emotional and cognitive responses, and behavioral performance.

Results: For the whole sample, perception of control while taking both long ROAT versions was predicted by a positive emotional experience. Particularly for the ROAT version without a solution, perception of control was associated with total attempts at controlling the aversive stimulus for PGD. Compared to HC, PGD found both ROAT versions more emotionally distressing, reported a lower perception of control, and presented more attempts at control in the uncontrollable ROAT version.

Conclusion: in comparison to HC, PGD insisted more on useless behaviors in tasks with no rewards and despite emotional discomfort, evidencing a splitting between negative emotions and behavioral response.

Keywords: Gambling Disorder, Response-Outcome, Cognitive Distortion, Illusion of Control, Learned Helplessness

The study protocol was approved by the Ethics Review Committee of Hospital das Clinicas, University of São Paulo under the online register #14526. This study was not preregistered: data collection was completed in 2016, prior to the widespread adoption of preregistration and open-science practices by APA, APS, and major journals.

Introduction

Gambling Disorder (GD) is characterized by maladaptive patterns of gambling behavior[1], including persistent engagement in betting despite accumulating substantial debts, suggesting a reduced sensitivity to negative outcomes[2,3], accompanied by distorted beliefs about the ability to influence or predict random events, leading to the illusion of control[4–6].

Estimating the odds of winning relies on the interaction between analytical and emotional processes, based on prior experience[7]. In people with GD (PGD), this interaction is biased toward the overestimation of positive contingencies, fostering the illusion of control and the underestimation of randomness[8]. While entertainment and financial incentives often motivate initial gambling engagement, progressive involvement is associated with superstition, reinforced by intermittent wins[9–11].

The desire for control is a fundamental aspect of human behavior[12,13], serving an adaptative function by promoting goal-directed action and persistence[14,15]. In response to perceived threats to control, individuals often attempt to restore it by relying on strategies that have proven effective in similar situations[16]. However, repeated failures to control environmental outcomes may result in learned helplessness and reduced goal-directed behavior[17]. In animal models, learned helplessness has long been considered a behavioral analogue of human depression[18].

Persistent gambling despite repeated losses may reflect the influence of illusion of control and superstitious beliefs, which could hinder the development of learned helplessness in PGD[2]. However, continued gambling may also reflect difficulties disengaging from unsuccessful behavioral strategies. Rather than withdrawing, PGD often persist in gambling behavior, a pattern associated with greater severity of comorbid conditions, including depressive symptoms[19].

Studies of action–outcome contingency judgments have a well-established tradition in cognitive psychology, particularly following Matute's[20] work using the

Response–Outcome Analysis Test (ROAT), originally introduced in Hiroto and Seligman's[17] learned helplessness paradigm. Paradigms such as the ROAT therefore provide a valuable framework for assessing perceived controllability. In the classic ROAT design[17], in the uncontrollable condition with failure feedback, healthy individuals stop trials when confronted with unsolvable contingencies, leading to learned helplessness. However, Matute[20] demonstrated that when the same paradigm was administered without negative feedback, participants tended instead to develop an illusion of control.

Building on the ROAT paradigm, our group previously compared PGD and healthy controls' performance on a shortened ROAT protocol (10 trials) with explicit failure feedback[2]. Compared with controls, PGD reported greater distress in the controllable version (CV), lower self-confidence in the uncontrollable version (UV), and exhibited a higher frequency of random responses alongside reduced use of analytical or combinatory strategies. Contrary to expectations, PGD did not show higher levels of illusion of control or superstitious beliefs. This initial study left unresolved whether extended exposure to the uncontrollable ROAT with explicit failure feedback would eventually lead individuals to recognize the absence of control or, alternatively, to develop illusion of control. Therefore, the aim of the present study was to examine whether PGD are more likely to develop illusion of control and superstitious behaviors during longer ROAT versions (40 trials), with explicit failure feedback, and to contrast these findings with those of Berg et al.[2]. Our main hypotheses were: (1) the unsolvable version would be more stressful and yield poorer affective, cognitive, and behavioral performance than the solvable version; (2) PGD would show poorer affective, cognitive, and behavioral performance than HC in both task conditions; and (3) PGD would display higher levels of illusion of control than HC.

Methods

Participants

PGD: Thirty-four individuals were recruited from an outpatient gambling treatment unit at a public university hospital. Inclusion criteria were the same as in our previous study: (1) meeting DSM-5 criteria for GD (≥4 criteria)[21]; and (2) absence of severe psychiatric comorbidities, as assessed with the Mini International Neuropsychiatric Interview (MINI)[22] by a clinical psychologist or psychiatrist.

Healthy controls (HC): Thirty-four age- and sex-matched controls were recruited from public settings. The Self-Report Questionnaire (SRQ)[23] was used to screen for psychiatric disorders. Gambling disorder was ruled out using the Lie/Bet questionnaire[24], based on DSM criteria #3 (loss of control over gambling) and #7 (lying about gambling). Participants who screened negative were additionally asked whether they had gambled more than three times in the previous year; none reported doing so.

Sample size calculation

An a priori sample size calculation based on our previous pilot study indicated that a minimum of 15 participants per group would be required to detect differences in the use of combinatorial strategies between PGD and HC (α=0.05, power=80%). To increase statistical robustness, we recruited 34 participants per group.

Procedures

After receiving general information about the study and providing written informed consent, participants completed a sociodemographic questionnaire in a private room. They then listened to recorded instructions and completed Parts 1 and 2 of the ROAT (described below). Finally, participants completed a questionnaire assessing demographic characteristics and cognitive and affective responses to the task. The entire procedure lasted approximately 45 minutes.

Instrument

The Response Outcome Analytical Task (ROAT): participants were presented with two versions of the task: CV and UV; the instructions for both tasks were identical. Specifically, participants were told that the computer would produce an annoying bell (5000 Hz, 80dB) for a maximum of 5 seconds. The goal of the task was to discover a combination of two numbers from 1 to 3 (e.g., 11, 21, 31, etc.) that could stop the noise. To standardize the instructions, the following text was read aloud to all participants:

> “The only valid keys in the computer keyboard are keys #1, #2 and #3. From time to time, a loud noise will sound for a while. You must try to find a way to stop this noise by typing a number out of the three digits we mentioned. The number may have one or two digits (for example 1,

2, 3, or 21, 32, 22, 13, etc.). If you believe you have found the correct code, you must use it to try to stop the noise whenever you hear it. If you do not believe you can control the noise by typing any number, then you must stop typing. While the noise is on, you may try as many combinations as you can type. The noises have a maximum duration of 5 seconds. We may start as soon as you are ready".

Once participants fully understood the task, the computer software was started. The test was divided into two parts consisting of 40 bell rings each separated by a 5-second interval. In the CV task the bells could be interrupted by typing 31, whereas for the UV task no combination of numbers could interrupt the bell, which would stop after 5 seconds had elapsed. The conditions were counterbalanced for both PGD and controls, with half taking CV followed by UV and vice-versa. Numbers typed during sessions were automatically recorded in computer logs for each participant.

The post-test questionnaire verified, among other information, cognitive and affective variables resulting from each test, and the evaluation of the participant comparing both tests (CV and UV).

Measures

Affective variables: Three visual analogue scales assessed emotions experienced during the ROAT: anxiety, happiness, and confidence. Scores ranged from 0 to 3 ("None" to "Extremely")[24].

Behavioral variables: Seven variables were derived from computer logs:

A) *Total number of hits*: total number of keystrokes per test;

B) *Typing strategy*: responses were classified as random (0) or combinatory (1). Two intermediate categories were also defined: Partial I (0.25), when random responses predominated, and Partial II (0.75), when combinatory responses predominated;

C) *Superstitious behavior*: repeated use of a specific incorrect code (>3 consecutive repetitions), excluding the correct code (31) in the controllable condition;

D) *Transgressions*: use of keys other than 1, 2, or 3 (e.g., letters, other numbers, or symbols);

E) *Learned helplessness/withdrawal*: fewer than 80 keystrokes during a test version, corresponding to withdrawal before approximately three minutes of task engagement, following Hiroto and Seligman[17];

F) *Trials until withdrawal*: number of trials completed before giving up the task;

G) *Trials until solution*: number of trials required to identify the correct code (31) in the controllable version.

Cognitive variables: Six variables assessed self-reported strategies and beliefs:

A) *declared use of a strategy* (yes/no);

B) *declared withdrawal from attempting to find a stopping key* (yes/no);

C) *perceived control* (percentage of noises believed to be controllable);

D) *belief in the existence of a controlling code* (yes/no);

E) *conviction regarding the existence of a controlling code* (rated from 1 to 10);

F) *identification of the correct code* (31, controllable version only).

Variables requiring external coding were independently rated by two blinded evaluators (RB and HT), who were unaware of the test condition, participant group (PGD or HC), and each other's ratings. Inter-rater agreement was 95%. The 16 discrepant cases were reviewed and resolved by consensus.

Analytical Plan

First, we compared performance across the two ROAT versions to assess the reliability of the paradigm. Second, affective, behavioral, and cognitive variables were compared between PGD and HC using univariate analyses, followed by stepwise forward logistic regressions for each ROAT version. Variables approaching significance in the univariate analyses ($p < 0.10$) were entered as predictors. Finally, linear regression analyses were conducted to identify affective, cognitive, and behavioral predictors of perceived control in the whole sample and within each group. Effect sizes were estimated for all analyses. For univariate analyses, Wilcoxon's r ($R_{Wilcoxon}$) was calculated for within-subject comparisons involving non-normally distributed continuous variables (r = 0.10, small; 0.30, moderate; 0.50, large). For between-subject comparisons, Cohen's d was used for normally distributed continuous variables (d = 0.20, small; 0.50, moderate; 0.80, large),

whereas an alternative D based on the Mann–Whitney U statistic was calculated when the normality assumption was violated. For categorical variables, odds ratios (ORs) were reported. For multivariate analyses, Nagelkerke's R^2 was reported for the final regression models, along with ORs and 95% confidence intervals (95% CIs) for all predictors[25].

Results

The PGD group was predominantly male (65%) with a mean age of 45.3 years (SD=12.3). The groups were similar in their demographic characteristics, except for marital status, with more single individuals in the PGD group (p=0.015). Marital status was included as a covariate in subsequent logistic regression analyses. Table 1 summarizes the sample characteristics.

Table 1: Socio-demographic profile of disordered gamblers (DG) and healthy controls

	DG (N=34)	Healthy Controls (N=34)	Coefficient [Degrees of Freedom]	p
Gender				
Male	22 (65%)	22 (65%)	$\chi^2_{[1]} = 0$ [b]	1.000
Female	12 (35%)	12 (35%)		
Age				
Mean [SD]	45.3 [12.32]	45.7 [12.53]	$t_{[68]} = 0{,}117$	0.910
Ethnicity				
Caucasian	23 (68%)	25 (74%)	$\chi^2_{[1]} = 0.283$	0.595
Non-Caucasian	11 (32%)	9 (26%)		
Marital status				
with mate	11 (32%)	21 (62%)	$\chi^2_{[1]} = 5.903$	0.015
without mate	23 (68%)	13 (38%)		
Number of children				
Without children	9 (26%)	15 (44%)	$\chi^2_{[2]} = 2.318$	0.130
With child	25 (74%)	19 (56%)		
Job status				
Employed	21 (62%)	25 (74%)	$\chi^2_{[1]} = 1.075$	0.310
Unemployed	13 (38%)	9 (26%)		
Socio-economic status [a]				
Mean [SD]	5,40 [2.70]	7.00 [3.40]	$t_{[68]} = 2.502$	0.015
Years of formal education				
Mean [SD]	12.4 [4.02]	13.9 [3.35]	$t_{[68]} = 1{,}640$	0.106
Place of Birth				
Sao Paulo Capital	17 (50%)	19 (56%)	$\chi^2_{[1]} = 0.236$	0.627
Others	17 (50%)	15 (44%)		
Religion				
Catholic	28 (82%)	23 (68%)	$\chi^2_{[1]} = 1.961$	0.166
Others	6 (18%)	11 (32%)		

[a] Calculated by the amount of total number of rooms, bathrooms, family cars, colored televisions, house employees, sound machines, washing machines, video cassettes, computers, refrigerators, and vacuum cleaners or similar in the house divided by the total number of inhabitants (IBGE, 1998).
Note: DG = disordered gambler; SD = standard deviation.

Comparison of performance at the CV and the UV tests

Comparing the two task versions, participants reported greater anxiety ($R_{Wilcoxon}$=0.25, small to moderate, p=0.036) in the UV condition, whereas happiness ($R_{Wilcoxon}$=-0.38, moderate, p=0.002) and confidence ($R_{Wilcoxon}$=-0.405, moderate, p=0.001) were higher in the CV condition. Behaviorally, the UV elicited a greater number of hits (Cohen's D=0.40, moderate, p=0.016), more transgressions (OR=5.0, p<0.001), more learned helplessness (OR=2.5, p=0.011), and lower number of trials until giving up (Cohen's D=3.43, large, p=0.017). Regarding cognitive variables, perceived control ($R_{Wilcoxon}$=-0.712, large, p<0.001), belief in the existence of a controlling code (OR=0.19, p<0.001), and confidence in identifying the correct code ($R_{Wilcoxon}$=-0.427, moderate, p<0.001) were all higher in the CV than in the UV. However, participants reported using combinatorial strategies at similar rates across conditions. Table 2 summarizes the main findings.

Table 2: Comparing performance at different ROAT test versions, within subjects' comparison (N=68).

Test version	Uncontrollable version	Controllable version	Coef.	p
Affective response:				
Anxiety – Median [range]	2.9 [0-10]	2.3 [0-10]	Z=2.098	0.036
Happiness – Median [range]	1.5 [0-7]	2.8 [0-10]	Z=-3.169	0.002
Confidence – Median [range]	3.7 [0-10]	4.8 [0-10]	Z=-3.331	0.001
Behavioral response:				
Number of hits – Mean [SD]	371.1 [327.4]	254.3 [247.3]	t=-2.482	0.016
Typing pattern – n [%]				
- Random – n [%]	44 [64,7%]	56 [82,4%]	Z=1,661	0.097
- Random > combinatory – n [%]	7 [10,3%]	3 [4,4%]		
- Combinatory > random – n [%]	5 [7,4%]	2 [2,9%]		
- Combinatory – n [%]	12 [17,6%]	7 [10,3%]		
Superstitious behavior – n [%]	31 [46%]	23 [34%]	*	0.230
Transgression – n [%]	24 [35%]	5 [7%]	*	<0.001
Learned helplessness – n [%]	22 [32%]	9 [13%]	*	0.011
Number of trials until giving up – Mean [SD]	37,4 [2,1]	43,8 [1,6]	t=-2,450	0.017
Cognitive response:				
Declared having used a strategy (%)	43 (63.2%)	43 (63.2%)	*	1
Declared giving up finding a key – Median [range]	26 (38%)	17 (25%)	*	0.108
Perception of control – Median [range]	0.7 (0-7)	4.6 (0-10)	Z=-5.872	<0.001

Believes there is a controlling code (%)	9 (13.2%)	48 (70.6%)	*	<0.001
Conviction about the answer – Median [range]	6.1 (0-10)	7.6 (0-10)	Z=-3.525	<0.001

*McNemar's test

Note: ROAT = Response-Outcome Analytical Tests; SD = standard deviation

The mean number of trials required to identify the correct code in the CV was 10.2 (SD=12.8). Overall, 26 participants (38.2%) identified the correct code, 33 (48.5%) identified an incorrect code, and 9 (13.2%) identified a partially correct code (i.e., 131, 231, or 331). Additionally, 31 participants (45.6%) reported using the same strategy in both tests, while 42 (61.8%) correctly recognized which version was solvable and which was unsolvable.

Comparison of performance between PGD and HC for the CV test

In the CV test, PGD reported higher anxiety (Alternative D=0.64, moderate, p=0.025), whereas HC reported greater confidence (Alternative D=0.29, small, p=0.023). Happiness scores approached significance, with HC reporting greater happiness than PGD (Alternative D=0.38, small to moderate, p=0.078). No group differences were observed in the behavioral variables or in most cognitive measures, except for perceived control, which was higher among HC (Cohen's D=0.49, moderate, p=0.046) – see table 3.

A logistic regression model including anxiety, confidence, perceived control, marital status, and socioeconomic status was significant ($\chi^2_{[2]}$=28.24, p<0.001; Nagelkerke's R^2=0.453) and correctly classified 75% of participants. Only anxiety (OR=1.44, 95% CI=1.11–1.88, p=0.007) and confidence (OR=0.79, 95% CI=0.66–0.97, p=0.020) remained significant predictors.

Perceived control was positively associated with conviction across the whole sample and both subgroups. Additionally, it was associated with happiness in the whole sample and HC, and with confidence in PGD. No significant associations were observed between perceived control and typing patterns.

Comparison of performance between PGD and HC for the UV test

In the UV test, PGD and HC reported similar levels of anxiety (p=0.573) and happiness (p=0.443), but PGD reported lower confidence than HC (Alternative D=0.31, small, p=0.004). Behaviorally, PGD showed a higher number of hits (Cohen's D=3.36, large, p=0.020) and more frequent superstitious behaviors

(OR=1.8, p=0.028), whereas no group differences were found for typing patterns, transgressions, learned helplessness, or the number of hits before quitting the task (all p>0.20). Regarding cognitive variables, no significant group differences were observed, although conviction about their appraisal of controllability approached significance, with PGD reporting lower conviction than HC (p=0.060) (Table 3).

Table 3: Comparing DG versus HC's performance on ROAT versions*, univariate analysis.

Controllable Outcome version	Group		Test	p
	DG[b] (n=34)	HC[c] (n=34)		
Affective response (visual analogue scale):				
Anxiety – Median [range]	3.0 [0-10.0]	1.6 [0-10.0]	U=745.0	0.025
Happiness – Median [range]	2.1 [0-10.0]	3.4 [0-10.0]	U=443.5	0.078
Confidence – Median [range]	3.9 [0-10.0]	5.7 [0-10.0]	U=339.5	0.023
Behavioral response:				
Number of hits – Mean [SD]	217.7 [182.3]	291 [296.9]	t=1.226	0.225
Typing pattern – n [%]			U=574.5	0.948
- Random – n [%]	28 [82%]	28 [82%]	χ^2=0	1
- Random > combinatory – n [%]	1 [3%]	2 [6%]	χ^2=0.349	0.555
- Combinatory > random – n [%]	1 [3%]	1 [3%]	χ^2=0	1
- Combinatory – n [%]	4 [12%]	3 [9%]	χ^2=0.159	0.690
Superstitious behavior – n [%]	11 [32%]	12 [35%]	χ^2=0.066	0.798
Transgression – n [%]	4 [12%]	1 [3%]	χ^2=1.943	0.163
Learned helplessness – n [%]	5 [15%]	4 [12%]	χ^2=0.128	0.720
Number of attempts at controlling the noise Mean [SD]	42.7 [14.3]	45.0 [11.8]	t=0.731	0.467
Number of attempts until finding the code Mean [SD]	9.7 [12.69]	10.8 [13.05]	t=0.349	0.729
Cognitive response:				
Declared having used a strategy [%]	19 [55.9%]	24 [70.6%]	χ^2=1.581	0.209
Declared giving up finding a key – Median [range]	11 [32%]	6 [17.6%]	χ^2=1.961	0.161
Perception of control – Mean [SD]	3.8 [3.27]	5.4 [3.28]	t=2.035	0.046
Believes there is a controlling code [%]	21 [61.7%]	27 [79.4%]	χ^2=2.550	0.110
Conviction about the answer – Median [range]	6.8 [0-10.0]	8.4 [3-10.0]	U=472.0	0.146
Stated the correct code [%]	13 [38.2%]	20 [58.8%]	χ^2=2.981	0.225
Uncontrollable Outcome version	**Group**		**Test**	**p**
	DG[b] (n=34)	HC[c] (n=34)		
Affective response (visual analogue scale):				
Anxiety – Median [range]	3.11 [0-10.0]	2.72 [0-7.0]	U=621.0	0.573
Happiness – Median [range]	1.36 [0-7.0]	1.75 [0-7.0]	U=524.0	0.443
Confidence – Median [range]	2.62 [0-10.0]	4.87 [0-10.0]	U=353.5	0.004
Behavioral response:				
Number of hits – Mean [SD]	462.3 [60.6]	279.8 [47.1]	t=2.377	0.020
Typing pattern – n [%]			U=552.0	0.707
- Random – n [%]	22 [65%]	22 [65%]	χ^2=0	0
- Random > combinatory – n [%]	5 [15%]	2 [6%]	χ^2=1.433	0.231
- Combinatory > random – n [%]	3 [9%]	2 [6%]	χ^2=0.216	0.642
- Combinatory – n [%]	4 [12%]	8 [23%]	χ^2=1.619	0.203
Superstitious behavior – n [%]	20 [59%]	11 [32%]	χ^2=4.802	0.028
Transgression – n [%]	14 [41%]	10 [29%]	χ^2=1.030	0.310
Learned helplessness – n [%]	9 [26%]	13 [38%]	χ^2=1.075	0.300
Number of attempts at controlling the noise Mean [SD]	39.8 [15.3]	35.0 [18.5]	t=0.731	0.467

Cognitive response:				
Declared having used a strategy (%)	20 [58.8%]	23 [67.6%]	χ^2=0.569	0.451
Declared giving up finding a key – Median [range]	12 [35%]	14 [41%]	χ^2=0.249	0.618
Perception of control – Median [range]	0.7 [1.6]	0.6 [1.8]	t=0.353	0.725
Believes there is a controlling code (%)	5 [14.7%]	4 [11.8%]	χ^2=0.128	0.720
Conviction about their answer – Median [range]	5.4 [0-10.0]	6.8 [0-10.0]	U=431.0	0.060

*Note: ROAT = Response-Outcome Analytical Tests; DG = Disordered Gamblers; HC = Healthy Controls; ; SD = standard deviation.

Table 4. Comparing performance on ROAT test versions, logistic regression.

Controllable Outcome version[a]	B	χ^2 de Wald	*Odds Ratio* (Exp β)	Confidence interval 95%		p
				Inferior	Superior	
Civil status	-1,963	8,907	0,140	0,390	0,510	0,003
Socioeconomic status	-0,302	7,131	0,740	0,593	0,923	0,008
Anxiety	0,367	7,359	1,444	1,107	1,883	0,007
Confidence	-0,224	5,402	0,799	0,662	0,965	0,020
Uncontrollable Outcome version[b]	B	χ^2 de Wald	*Odds Ratio* (Exp β)	Confidence interval 95%		p
				Inferior	Superior	
Civil status	-1,572	5,722	0,208	0,57	0,753	0,017
Socioeconomic status	-0,288	7,418	0,749	0,609	0,922	0,006
Confidence	-0,359	8,708	0,698	0,550	0,886	0,003
Number of hits	0,003	6,658	1,003	1,001	1,005	0,010

*Note: ROAT = Response-Outcome Analytical Tests.

[a] Model data: $\chi^2_{[2]}$ = 28,235; p = 0,001; R^2 of Nagelkerke = 0,453

[b] Model data: $\chi^2_{[2]}$ = 31,309; p < 0,001; R^2 of Nagelkerke = 0,492

A logistic regression model including confidence, total number of hits, superstitious behavior, marital status, and socioeconomic status was significant ($\chi^2_{[2]}$=31.31, p<0.001; Nagelkerke's R^2=0.492) and correctly classified 75% of participants. Only confidence (OR=0.69, 95% CI=0.55–0.88, p=0.003) and total number of hits (OR=1.003, 95% CI=1.001–1.005, p=0.010) remained significant predictors.

Unlike the CV test, perception of control in the UV showed only weak associations, correlating with the number of hits in the total sample and PGD subgroup, and with happiness in HC.

Discussion

Comparing CV and UV tests

Regarding affective variables, participants in both the present study and Berg et al[2] reported greater anxiety, lower happiness, and lower confidence in the UV than in the CV condition. Likewise, typing patterns were more structured in the CV, although this difference reached significance only in the short ROAT version, suggesting that the longer protocol may have allowed learning and improvement in response organization. Participants also perceived the CV as more controllable and expressed greater certainty that it had a solution. Overall, these findings confirm that the long ROAT versions produced the expected effects, supporting the robustness of the paradigm.

Together, the results suggest that illusion of control is less likely to emerge in the long ROAT versions, possibly because the task lacks rewarding outcomes and provides explicit failure feedback throughout.

Comparing PGD and HC – CV test

Regarding affective variables, PGD reported greater discomfort during the CV test, characterized by higher anxiety and lower confidence. Because participants were recruited while seeking treatment for gambling problems, their heightened emotional distress may have influenced their experience of the task.

No behavioral differences were observed between PGD and HC, in contrast to our previous study using a shorter ROAT protocol, in which PGD showed more random responses and less use of analytical strategies[2]. This discrepancy may reflect the longer duration of the present task, which provided participants with more opportunities to learn and develop efficient response strategies.

Regarding cognitive variables, PGD reported lower perceived controllability, replicating findings from our previous study. Notably, this occurred despite similar behavioral performance between groups, suggesting that perceptions of control may be influenced more by emotional experience than by objective performance. Consistent with this interpretation, only anxiety and confidence remained significant predictors in the regression model, indicating that the main differences between PGD and HC in the CV condition were affective rather than behavioral.

Comparing PGD and HC – UV test

Regarding affective variables, PGD reported lower confidence than HC in the UV condition, replicating the pattern observed in the CV test.

Behaviorally, PGD showed a higher number of keyboard hits and more frequent superstitious behaviors than HC. Contrary to our hypothesis, however, learned helplessness did not differ between groups. These findings suggest that PGD persisted more in their attempts to control the aversive stimulus, sometimes resorting to unusual or irrational responses despite repeated failure feedback. Such persistence may reflect not only attempts to regain control but also compulsive or habitual responding and difficulties inhibiting ineffective behavioral strategies, mechanisms frequently implicated in gambling disorder.

Importantly, this increased persistence was not accompanied by a greater perception of control. PGD and HC showed similar appraisals regarding strategy use and controllability, suggesting that the observed pattern cannot be explained solely by a cognitive illusion of control. Rather, compulsive responding, affect-driven perseveration, or deficits in response inhibition may also contribute to continued response despite repeated failure feedback. Consistent with this interpretation, perceived control was associated with the number of hits, but few other significant cognitive correlates emerged in the UV condition.

An interesting aspect of these findings is that increased behavioral persistence occurred despite emotional distress. This observation is particularly relevant given the high prevalence of depressive symptoms in gambling disorder[26]. Depressive symptoms have been associated with greater gambling severity, poorer treatment outcomes, and increased risk of relapse, suggesting that emotional distress may not necessarily discourage continued gambling behavior. Despite reporting lower confidence and greater emotional distress, PGD continued to engage more intensely with the uncontrollable task, as reflected by their greater number of hits and superstitious behaviors. One possibility is that gambling-related behaviors become less sensitive to the modulation effects of repeated failure[27]; an alternative is that negative affect itself promotes persistent efforts to regain control or alleviate distress[28]. In either case, our findings suggest that emotional suffering alone may be insufficient to interrupt maladaptive control-seeking behavior in gambling disorder.

Limitations

The present findings should be interpreted in light of some methodological considerations. Although the final sample was larger than initially estimated to achieve the required statistical power and significance level, it remained relatively small. In addition, the exclusion of individuals with PGD and severe psychiatric comorbidities may have limited the representativeness of the sample. In addition, the ROAT paradigm lacked reward elements and used a fixed five-second aversive stimulus to maintain comparability with our previous study[8]. Future studies should examine whether the present findings generalize to more ecologically valid settings involving both rewards and punishments, unpredictable stimuli, and ambiguous feedback.

Conclusion

Prevailing cognitive models attribute gambling disorder to irrational beliefs and misperceptions about the odds of winning, such as the illusion of control, superstition, selective memory, and other cognitive biases, which are considered key factors in the development and maintenance of problem gambling behaviors[15]. However, our findings suggest that negative emotional experiences associated with repeated failure are insufficient to reduce persistent control-seeking behavior in gambling disorder. Whether this pattern reflects a dissociation between affective experience and behavior, affect-driven perseveration, compulsive responding, or impaired integration of failure signals remains to be determined. Nevertheless, the results indicate that persistence in futile attempts to exert control may represent an important mechanism contributing to the maintenance of gambling-related behaviors.

Notably, depression is one of the most common psychiatric comorbidities in gambling disorder and has been consistently associated with greater gambling severity and poorer clinical outcomes[29]. In this context, the present findings suggest that negative emotional states may be insufficient to interrupt persistent control-seeking behavior and may, under some circumstances, coexist with or even contribute to its maintenance.

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Raquel Berg: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Validation, Writing – Original Draft, Writing – Review & Editing.

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