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The Role of Aging, Time Perspective, and Gambling-Related Cognitions in Affective Decision-Making

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Abstract

Several studies have examined age differences in affective decision-making utilizing the Iowa Gambling Task (IGT). However, findings are mixed, with some studies reporting impairments due to aging and others showing no age-related differences. The few studies that have explored personality correlates of IGT performance suggest that underlying personality characteristics may impact performance on the IGT beyond aging. Therefore, the present study investigated the interplay between chronological age, temporal perspective, and gambling-related cognitions in affective decision-making while controlling for gambling severity. Through snowball sampling, 302 adults aged 18–75 years were recruited. They administered the South Oaks Gambling Screen (SOGS), Consideration of Future Consequences scale (CFC-14), Gambling-Related Cognitions Scale (GRCS), and IGT. Regression analysis showed that future orientation and gambling-related cognitions (namely gambling expectancies, illusion of control, and predictive control) predicted IGT performance. Gender, age, education, and gambling severity were not included in the final model. Path analysis showed that gambling expectancies positively impacted the performance, whereas illusion of control and predictive control were detrimental to decision-making. Being oriented toward the future mitigated the negative effects of the two cognitive biases on IGT performance. The present study shows that aging does not affect negatively IGT performance. The quality of performance appears to depend upon individual characteristics, such as future orientation and gambling-related cognitions, irrespective of gambling severity. These findings suggest that individual characteristics should be considered in the clinical evaluation of IGT performance.

Keywords Affective decision-making · Iowa Gambling Task · Aging · Time perspective · Gambling-related cognitions

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Everyday life is full of decisions. Some decisions are minor while others have important future consequences for individuals' lives. If it is true that the nature of decisions changes throughout life, it is also true that individuals change with the passing of the time, if only because they grow up and get older. Studies on affective decision-making utilizing the Iowa Gambling Task (IGT; Bechara et al., 1994) have shown that the ability to make advantageous choices improves progressively from childhood to young age and then decreases in old age (e.g., Beitz et al., 2014). However, not all studies agree that aging makes affective decision-making worse. Indeed, some investigations have observed no significant impairment among old people (Henninger et al., 2010; Kovalchik et al., 2005; Lamar & Resnick, 2004; MacPherson et al., 2002; Wood et al., 2005). However, other studies have reported age-related differences resulting from an increase in hypersensitivity to reward (Bauer et al., 2013), altered reward processing (Halfmann et al., 2014), loss frequency bias (Beitz et al., 2014), or reduced executive functioning (Zamarian et al., 2008).

Although the definition of "older adults" differs significantly across studies and has led to difficulties in comparing findings (Guillou Landreat et al., 2019), there is a general agreement that neuropsychological changes, which inevitably occur with aging, can be detrimental to decision-making (for a review, see Pasion et al., 2017). However, even if brain changes due to age account for the observed age-related differences in affective decision-making, they do not explain good performance among older individuals, nor poor performance among young, healthy individuals (e.g., Steingroever et al., 2013; see also Bull et al., 2015). The substantial variability of the results suggests that, beyond aging, some individual characteristics affect IGT performance more than is generally assumed (Denburg et al., 2009; Miu et al., 2008; Suhr & Tsanadis, 2007).

Along with age-related differences, research into decision-making processes has addressed another broad issue (i.e., the fallibility of decision-making mechanisms) among individuals suffering from gambling disorder. A large body of research has demonstrated that gambling severity is one of the most powerful predictors of impaired decision-making (for reviews, see Aram et al., 2019; Ciccarelli et al., 2017; Clark, 2017; Wiehler & Peters, 2015). Although dysfunctional decision-making is a key characteristic of disordered gambling since perturbations in cost–benefit decision-making are something of a prerequisite (Cocker & Winstanley, 2019; p. 109), poor affective decision-making is not universally present in disordered gamblers. Arguably, this is because disordered gamblers are not a homogenous group, and differences in performance on neurocognitive tasks (such as the IGT) may be linked to relatively stable individual characteristics and/or to the form of gambling in which an individual chooses to engage (Goudriaan et al., 2005; Grant et al., 2012; Lorains et al., 2014; Navas et al., 2017; Sharman et al., 2019).

According to Buelow and Suhr (2013), "the results of the few studies that have explored personality correlates of IGT performance in nonclinical samples suggest that underlying personality characteristics, independent of a psychological disorder, mental disorder, or frontal lobe dysfunction, may impact performance on the IGT" (p. 109). This assertion is arguably a fundamental step towards finding an answer to the question of why (even) healthy participants can perform poorly on the IGT. In addition, it provides a rationale to examine more closely at the role of the individual characteristics in affective decision-making across the lifespan, beyond those psychological disorders typically associated with impaired decision-making, such as gambling disorder.

Evidence shows that poor IGT performance reflects an individual's inability to look to the future (i.e., myopia for the future). Indeed, while performing the IGT, participants are faced with some choices which are advantageous in the short term, but not in the long run, and some choices which are less attractive in the short term, but advantageous in the long run (Brevers et al., 2013; Dunn et al., 2006; Smith et al., 2016; Vasconcelos et al., 2015). If preferring short-term gains even at the risk of large long-term losses reflects a generalized inattention to future consequences, then, age-related differences in affective decision-making could be also tied to differences in time perspective, rather than to cognitive decline associated with aging. In a broad sense, time perspective refers to an individual's orientation toward past, present, and future, which influences choices, preferences, and behaviors in a variety of health, interpersonal, and financial decision-making contexts (Mello & Worrell, 2006; Strathman et al., 1994). Although time perspective is assumed to be a relatively stable personality trait, it can vary over time (Kübel & Wittmann, 2020; Löckenhoff & Rutt, 2015; Mikels et al., 2015; Nigro et al., 2016; Strough et al., 2016; Toepoel, 2010). Findings on age differences in temporal perspective "support William James's (1890/1950) early observation that as we age, we perceive future time as 'shorter' (p. 625). Moreover, as we age, we are less future-oriented and more present-oriented" (Fung & Isaacowitz, 2016, p. 553; see also Zimbardo & Boyd, 1999).

Moreover, since the IGT resembles a card game whose goal is to win as much money as possible and participants are instructed to treat the play money as real money (Bechara, 2007), it may be that in performing the task, participants succumb to the same gambling-related distortions that foster disordered gambling (Fortune & Goodie, 2012; Goodie & Fortune, 2013; Goodie et al., 2019). Gambling-related distortions refer to cognitive biases that motivate individuals to gamble and continue gambling, despite persistent losses (Raylu & Oei, 2004). Cognitive biases, such as illusion of control (i.e., the overestimation of the contribution of personal skills in gambling outcomes) or predictive control (i.e., the belief that it is possible to predict gambling outcomes), could have detrimental effects on IGT performance, irrespective of aging and gambling involvement, simply because such biases can also be elicited among healthy individuals (Clark, 2010; Matarazzo et al., 2019). However, considering that disordered gamblers have been found to report more gambling-related cognitive distortions than non-gamblers (e.g., Michalczuk et al., 2011), gambling involvement could be a potential confounder. Therefore, when examining age-related differences and the role of individual characteristics in decision-making, gambling severity (the potential confounding factor) should be kept under control so that it does not obscure the real effect of chronological age and personality traits on IGT performance (if any).

Because prior research on age-related differences in IGT performance did not consider gambling involvement as a potential confounder, the present study examined the interplay between chronological age, temporal perspective, and gambling-related cognitive distortions in affective decision-making while controlling for gambling severity. While the hypothesis regarding the relationships between age and decision-making remains open, it was hypothesized that both shortened time horizon and cognitive distortions would contribute to predict poor IGT performance, over and above age, and gambling severity. Additionally, the present study explored the potential causal patterns among variables contributing to affective decision-making by means of path analysis.

Method

Participants

A convenience sample of 302 Italian adults (64.9% men), aged between 18 and 75 years (M_{age} = 43.63 years; SD = 15.34), was recruited by snowball sampling. The only inclusion criteria were to be 18 years of age or over and be willing to voluntarily participate in the study. Participants were tested individually at the Department of Psychology of the research team's university. They all participated voluntarily, without any compensation. The departmental Ethics Committee approved the study. Written informed consent was obtained prior to enrolment. The research was conducted in accordance with the Helsinki Declaration as revised in 2013.

Procedure

Participants completed the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987; Italian translation: Cosenza et al., 2014) to assess the degree of problem gambling severity, the 14-item Consideration of Future Consequences scale (CFC-14; Joireman et al., 2012; Italian validation: Nigro et al., 2016) to assess time perspective, the Gambling-Related Cognitions Scale (GRCS; Raylu & Oei, 2004; Italian validation: Iliceto et al., 2015) to assess gambling-related distortions, and the computerized version of the IGT to assess affective decision-making. Half of the participants completed the computerized task at the beginning of the session, and the other half at the end. Therefore, the (potential) influence of the experimental task on the paper-and-pencil measures, and vice versa, was balanced. The psychometric scales were administered in counterbalanced order. The completion of the instruments and participation in the IGT took approximately 35 min to 1 h. For each measure, participants received detailed written instructions.

Measures

The SOGS is a self-report scale that assesses the frequency and severity of gambling problems in the past 12 months. The scale comprises 20 dichotomous (yes/no) scored items as well as some unscored items. The unscored items assess, among others, the frequency of participation in different gambling activities, the largest amount of money gambled in 1 day, and the motivations to gamble. The total score ranges from 0 to 20. For the present study, Cronbach's alpha was 0.92.

The CFC-14 is a 14-item scale that assesses the extent to which individuals weigh the immediate as opposed to distant implications of current behaviors and events. Responses to items are made on a 7-point Likert scale ranging from 1 (extremely uncharacteristic of me) to 7 (extremely characteristic of me). The CFC-14 is a two-factor scale with two dimensions, one tapping consideration of immediate consequences (CFC-I), which is the pursuit of smaller, immediate rewards, and the other tapping consideration of future consequences (CFC-F), which is seeking larger, but delayed gratification.

The GRCS is a 23-item scale that assesses the susceptibility to common gambling distortions and beliefs on five subscales. Gambling-related expectancies (GE) refer to expected benefits from gambling, the illusion of control (IC) refers to cognitions relating to ability to control gambling outcomes, predictive control (PC) refers to probability errors (such as gambler's fallacy), inability to stop gambling (IS) refers to respondents' perceived inability to control their gambling behavior, and interpretative bias (IB) refers to cognitions relating to reframing gambling outcomes to encourage further play. GE and IS are common dysfunctional beliefs present in a range of potentially addictive behavior patterns, whereas the other three dimensions (IC, PC, and IB) can be strictly considered cognitive biases in making causal inferences (Muela et al., 2020). Participants are requested to indicate the extent to which they agree with each statement on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree), with higher scores reflecting higher gambling-related expectancies and cognitive distortions. For the present study, Cronbach's alphas for the subscales were as follows: GE = 0.83; IC = 0.80; PC = 0.81; IS = 0.89; IB = 0.86. The Cronbach's α for the full scale was 0.95.

The IGT is a computerized assessment of decision-making processes, which uses four card decks, varying in amount of monetary reward and punishment and in the frequency of losses over a total of 100 trials. Participants draw a series of cards from a set of four computerized "decks of cards" labeled A, B, C, and D, respectively. At the beginning of the task, participants are given a loan of $2000 and asked to play with the aim of earning as much money as possible. Deck A and deck B (disadvantageous decks) yield large immediate monetary gains but larger monetary losses in the long term, whereas deck C and deck D (advantageous decks) result in small immediate monetary gains but smaller long-term losses. Drawing cards mostly from disadvantageous decks leads to an overall loss, while drawing from advantageous decks leads to an overall gain. The players cannot predict when a penalty will occur, nor calculate with precision the net gain or loss from each deck. Because it is impossible to calculate the best option from the beginning of the task, players have to learn to avoid bad decks by following their feeling and hunches and by using the feedback they receive after each choice. Performance on the IGT is computed by subtracting the number of disadvantageous choices (A, B) from the number of advantageous choices (C, D) on the complete task (net total score) and for each block of 20 cards to evaluate changes in decision-making strategies. Higher net scores indicate better performance on the task. A global score below 10 (out of 100) is indicative of a decision-making deficit (Bechara & Damasio, 2002).

Along with net scores (decks' payoff) and to analyze IGT performance in a more accurate way, the so-called "prominent deck B phenomenon" was also taken into account (preferring bad final-outcome deck B to good final-outcome decks C or D; Lin et al., 2007) and calculated the sensitivity to loss frequency using the scoring method proposed by Stocco et al. (2009). Frequency sensitivity (i.e., a participants' sensitivity to the frequency of punishment and reward) was obtained by subtracting the number of draws from decks with a low frequency of loss from decks with a high frequency of loss [(Deck B + Deck D) – (Deck A + Deck C)]. Higher scores indicate better IGT performance.

In analyzing IGT performance, the distinction between the two different phases of the task was also considered, known as decision-making under ambiguity or learning phase (first 40 trials) and decision-making under risk phase (last 60 trials), respectively. In the first phase, participants cannot estimate the outcome, whereas in the second one, the relative risks and benefits of each deck are better known (Brand et al., 2007; Buelow & Suhr, 2009; Buelow & Suhr, 2013) . In the present version, money was converted from U.S. dollars to euros.

Statistical Analysis

Data analyses were conducted using IBM SPSS version 27.0. The alpha level was set at $p < 0.05$. All variables were initially screened for missing data, distribution abnormalities, and outliers (Tabachnick & Fidell, 2019). Using $p < 0.001$ criterion for Mahalanobis distance, three participants were excluded as clear multivariate outliers. The relationships among the study variables were assessed using Pearson correlation coefficients. Univariate and mixed-model analyses of variance followed by Bonferroni post hoc tests were conducted to assess mean differences on continuous variables. For categorical data, differences in percentages were compared with the chi-square test. Hierarchical regression analysis (stepwise method) was performed to examine the unique contribution of gender, age, education (block 1), SOGS, CFC-14, and GRCS scores (block 2) to IGT performance. To control for the presence of multicollinearity, before interpreting the regression coefficients, the variance inflation factors (VIF) were calculated.

Finally, considering regression analysis results and evidence from prior research, path analysis was performed to analyze the potential causal relationships among variables contributing to IGT net total score. Path analysis was conducted with the EQS 6.2 software program for structural equation modeling (Bentler, 2008). For each estimated model, goodness of model fit was evaluated with the likelihood ratio chi-square test statistic corrected for data nonnormality with Satorra and Bentler's (1994) method (S-B χ^2), as well as with four descriptive fit indices: the standardized root-mean square residual (SRMR), the root-mean-square error of approximation (RMSEA) with its 90% confidence interval (90% CI), the goodness of fit index (GFI), and the comparative fit index (CFI). Acceptable fits between model and data are reflected by a nonsignificant S-B χ^2, GFI and CFI indexes of 0.95 or greater, and RMSEA of between 0.05 and 0.08.

Results

To allow comparisons with previous investigations examining the role of age on IGT performance and considering that age cut points varied across studies, age was treated as a continuous or categorical variable, depending on the demands of statistical analyses (see Denburg et al., 2009). Therefore, participants were divided into quartiles (that divide the distribution into four almost equal parts) according to their age as follows: 18 to 30 years ($N=76$; $M=23.78$; SD = 3.89), 31 to 44 years ($N=76$; $M=37.62$; SD = 4.09), 45 to 56 years ($N=76$; $M=49.82$; SD = 3.31), and 57 to 75 years ($N=74$; $M=63.84$; SD = 4.19). Means and standard deviations as a function of age quartiles and gender are presented in Table 1. Bivariate correlation analyses were conducted to test the associations between the variables included in the study (see Table 2).

To ascertain whether the four age groups differed in terms of gender distribution, chi-square analyses were performed. There were no differences between age groups in relation to gender distribution ($\chi^2(3, N=302)=5.96$, $p>0.05$). As univariate ANOVAs showed, effects of gender were observed on the SOGS score ($F_{1,300}=28.52$; $p<0.001$; $\eta_p{}^{2=}$ 0.087) and on the following GRCS subscales: gambling expectancies ($F_{1,300}=13.53$; $p<0.001$; $\eta_p{}^{2=}$ 0.043), inability to stop gambling ($F_{1,300}=13.02$; $p<0.001$; $\eta_p{}^{2=}$ 0.042), and interpretative bias ($F_{1,300}=11.04$; $p<0.001$; $\eta_p{}^{2=}$ 0.036), with males scoring higher than females.

Age groups differences in educational level, and SOGS scores were tested by means of univariate analysis of variance followed by Bonferroni post hoc test. Relative to participants in the youngest age group, participants in the oldest group reported lower educational level ($F_{3,\ 298}=18.27$; $p<0.001$; $\eta_p{}^2=0.155$) and scored significantly higher on the SOGS ($F_{3,\ 298}=7.53$; $p<0.001$; $\eta_p{}^2=0.070$). CFC-14, GRCS, and mean net score as a function of each 20-trial block were subjected to mixed-model ANCOVAs that included age group as the between-participant factor and SOGS scores as covariate. To determine if CFC-14 scores differed between age groups whilst adjusting for SOGS scores, a 4×2 repeated measure ANCOVA was performed. The analysis showed a significant between-participant effect of age group ($F_{3,\ 294}=2.93$; $p<0.05$; $\eta_p{}^2=0.029$), with the youngest age group scoring significantly lower than the oldest age group, and

Table 1 Means and standard deviations as a function of age group and gender

Age group	18–30 years (*N* = 76)				31–44 years (*N* = 76)				45–56 years (*N* = 76)				57–75 years (*N* = 74)			
	M (*N* = 45)		F (*N* = 31)		M (*N* = 45)		F (*N* = 31)		M (*N* = 50)		F (*N* = 26)		M (*N* = 56)		F (*N* = 18)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Education	12.49	3.12	13.23	3.59	10.96	3.43	12.19	3.19	10.18	3.98	9.08	2.87	9.29	3.19	8.22	3.73
SOGS[a]	3.04	3.72	1.55	3.12	5.69	4.79	2.81	4.47	6.66	5.86	1.96	3.32	6.66	5.16	4.39	5.61
CFC-14[b]																
Immediate	22.56	8.95	23.10	9.61	25.04	10.82	28.81	10.67	28.44	10.73	29.04	11.54	26.41	9.89	32.06	8.69
Future	27.60	8.88	30.97	10.03	27.29	10.42	28.48	10.30	28.72	9.76	28.00	11.81	30.66	10.83	34.22	10.26
GRCS[c]																
Gambling expectancies	8.42	5.79	6.87	4.59	11.64	7.26	8.32	5.77	11.54	6.63	8.35	5.52	13.13	7.10	11.17	7.91
Illusion of control	7.47	5.03	7.68	5.19	9.33	7.35	8.68	5.71	9.74	5.88	6.88	4.97	9.95	5.66	9.11	5.74
Predictive control	14.49	7.65	16.58	9.13	17.31	9.53	14.26	9.70	16.14	8.61	12.85	7.05	14.05	7.20	15.00	7.32
Inability to stop gambling	10.62	7.37	9.19	5.05	15.60	9.21	11.23	9.41	16.06	8.39	10.81	9.10	17.59	9.20	15.56	11.75
Interpretative bias	10.67	6.18	9.10	5.79	12.47	8.09	10.00	7.46	12.88	7.53	9.19	5.98	14.34	7.84	11.44	8.13
IGT[d] net total score	−0.89	30.65	10.84	22.40	−2.18	31.19	2.26	40.50	1.16	29.77	12.62	33.61	12.54	27.54	6.89	24.59

[a]South Oaks Gambling Screen

[b]Consideration of Future Consequences scale

[c]Gambling-Related Cognitions Scale

[d]Iowa Gambling Task

Table 2 Intercorrelations among the study variables

1	2	3	4	5	6	7	8	9	10	11
1. Age	−.375**	.272**	.202**	.077	.272**	.136*	−.042	.292**	.194**	.094
2. Education	-	−.066	−.156**	.010	−.151**	−.141*	−.095	−.184**	−.169**	.020
3. SOGS[a]		-	.215**	-.068	.504**	.566**	.378**	.673**	.587**	-.238**
4. CFC-14[b] Immediate			-	.103	.359**	.232**	.326**	.357**	.355**	−.074
5. CFC-14 Future				-	.076	−.031	.122*	.105	.158**	.283**
6. GRCS[c] Gambling expectancies					-	.613**	.660**	.789**	.732**	−.117*
7. GRCS Illusion of control						-	.643**	.662**	.660**	−.335**
8. GRCS Predictive control							-	.594**	.721**	−.300**
9. GRCS Inability to stop gambling								-	.829**	−.138*
10. GRCS Interpretative bias									-	−.183**
11. IGT[d] net total score										-

*$p < .05$; **$p < .01$

[a]South Oaks Gambling Screen

[b]Consideration of Future Consequences scale

[c]Gambling-Related Cognitions Scale

[d]Iowa Gambling Task

a significant within-subject effect ($F_{1, 297} = 24.62$; $p < 0.001$; $\eta_p^2 = 0.077$), with participants scoring significantly higher on the CFC-14 Future scale than on the immediate dimension, irrespective of age. No effect of gambling severity was observed. The effect of age group remained significant even after removing the covariate from the model ($F_{3, 298} = 3.52$; $p < 0.05$; $\eta_p^2 = 0.034$).

A 4×5 repeated measure ANCOVA with GRCS scores as the within-participant factor was performed to establish if GRCS dimension scores differed as a function of age. The analysis did not show statistically significant differences between age groups ($F_{1, 294} = 1.184$; $p = 0.316$) but showed a significant effect of the covariate ($F_{3, 294} = 174.08$; $p < 0.001$; $\eta_p^2 = 0.372$). However, after removing the covariate from the analysis, ANOVA yielded a significant effect of age group ($F_{3, 298} = 3.41$; $p < 0.05$; $\eta_p^2 = 0.033$). Taken together, these results indicated that differences on gambling-related cognitions were due to gambling severity, rather than age.

The IGT scores were subjected to a 4×5 mixed-model ANCOVA that included task block (five blocks of 20 trials each) as the within-participant factor. The analysis (Greenhouse–Geisser correction) showed a significant within-participant effect of block ($F_{3.74, 1111.01} = 4.88$; $p < 0.001$; $\eta_p^2 = 0.016$), reflecting the fact that task performance increased over time, but did not show significant between-participant effect of age group ($F_{3,294} = 0.93$; $p = 0.429$). Even after removing the covariate from the analysis, ANOVA did not yield significant effect of age group ($F_{3, 298} = 3.41$; $p < 0.05$; $\eta_p^2 = 0.033$).

Two additional ANCOVAs (4×2 and 4×3, respectively) were performed to ascertain if age affected the two different phases of the IGT, namely the learning phase and the risky phase. In the learning phase (net 1 and net 2 scores), no age-related difference was observed ($F_{3, 294} = 0.75$; $p = 0.52$). After removing the covariate from the analysis, the result did not change substantially ($F_{3, 298} = 0.73$; $p = 0.54$). Similar results were obtained as for the second phase of the IGT (net 3, net 4, and net 5 scores). The results obtained after putting the covariate in the model ($F_{3, 294} = 0.98$; $p = 0.41$) and after removing it from the analysis ($F_{3, 298} = 2.02$; $p = 0.11$) did not differ from each other.

To ascertain whether the frequency sensitivity to the decks' payoff varied according to age group, data were submitted to univariate ANCOVA. The results did not show significant effect due to age ($F_{3, 294} = 0.62$; $p = 0.60$), even after removing the covariate from the model ($F_{3, 298} = 0.46$; $p = 0.71$). In addition, to analyze participants' strategies in even more detail and to investigate the prominent deck B phenomenon, a univariate ANCOVA was performed. The analysis did not yield a significant between-participant effect due to age in deck B selection ($F_{3, 294} = 0.44$; $p = 0.73$), even after removing the covariate from the model ($F_{3, 298} = 0.98$; $p = 0.40$).

Finally, to test whether mean reaction time (the amount of time in milliseconds takes an individual to make a card choice) varied across age groups, data were submitted to univariate ANCOVA. No effect due to age group was observed even after removing the covariate from the model ($p > 0.05$ in both cases). To identify the potential predictors of IGT performance, gender (as a dummy variable), age (in years), education (in years), SOGS, CFC-14, and GRCS scores were input to a hierarchical regression analysis (stepwise method) with the net total score as the dependent measure. Gender, age, and education were included at step 1, and the remaining variables were included at step 2. Results showed that high scores on both the CFC-14 Future scale and the GRCS Gambling Expectancies subscale and low scores on the GRCS Illusion of Control and Predictive Control subscales significantly predicted IGT performance (see Table 3). The overall model explained about a quarter of the total variance of the net total score ($R^2_{adj} = 0.23$; $F_{4, 297} = 23.55$; $p < 0.001$). Age, education, and SOGS scores were excluded from the final model.

Table 3 Summary of hierarchical linear regression analysis with net total score as the dependent variable

Variable	B	R^2	ΔR^2	β	*t*	*p*	VIF
Step 1							
GRCS[a] Illusion of control	−1.729	.112	.112	−.335	−6.159	.000	1.000
Step 2							
GRCS Illusion of control	−1.714	.187	.075	−.327	−6.258	.000	1.001
CFC-14[b] Future	.814			.273	5.234	.000	1.001
Step 3							
GRCS Illusion of control	−.974	.214	.027	−.185	−2.736	.007	1.742
CFC-14 Future	.906			.304	5.814	.000	1.037
GRCS Predictive control	−.797			−.218	−3.189	.002	1.767
Step 4							
GRCS Illusion of control	−1.347	.241	.027	−.262	−3.700	.000	1.956
CFC-14 Future	.884			.297	5.756	.000	1.039
GRCS Predictive control	−1.175			−.321	−4.322	.000	2.160
GRCS Gambling expectancies	1.062			.232	3.259	.001	1.988

B, unstandardized coefficient; ΔR^2, *R* square change; β, standardized regression coefficient; *VIF*, variance inflation factor

[a]Gambling-Related Cognitions Scale

[b]Consideration of Future Consequences scale

Finally, considering the regression analysis results, the strength and direction of linear relationships among the study variables and evidence from the literature, to ascertain if cognitive biases mediated the impact of future orientation (CFC-14 Future scale scores) on net scores, or if future orientation was on the path from cognitive biases to affective decision-making, two different models were compared. Model 1 assumed that future orientation predicted IGT performance not only directly, but also indirectly via cognitive bias (scores on the GRCS predictive control and illusion of control scales). Model 2 assumed that cognitive biases (scores on the GRCS Predictive Control and Illusion of Control scales) predicted net total score not only directly, but also indirectly via future orientation. Model fit statistics clearly indicated that while the first model does not fit the data at all (S-B $\chi^2 = 371.79$; $df = 3$; GFI = 0.669; CFI = 18; RMSEA = 0.639 (0.584-0.693); SRMR = 0.302), the second one fitted the data almost perfectly (S-B $\chi^2 = 0.598$; $df = 1$; GFI = 0.999; CFI = 0.999; RMSEA = 0.000 (0.000-0.139); SRMR = 0.009). As Fig. 1 shows, gambling expectancies had a positive impact on net total scores, whereas both illusion of control and predictive control were detrimental to affective decision-making. However, being oriented toward the future mitigated the negative effects of the two cognitive biases on net total score.

Discussion

The present study is the first to investigate the role of chronological age, temporal perspective, and gambling-related cognitive distortions in affective decision-making while controlling for gambling severity. Contrary to the widely held notion that decision-making

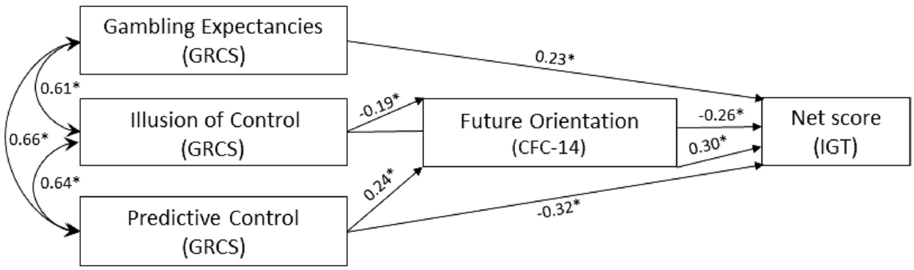

Fig. 1 Path diagram for Model 2. *Standardized solution. Note: *SOGS*, South Oaks Gambling Screen; *CFC-14*, Consideration of Future Consequences scale; *GRCS*, Gambling-Related Cognitions Scale; *IGT*, Iowa Gambling Task

faculties decline with age (e.g., Boyle et al., 2012) and evidence suggesting that older adults exhibit less resources to decide adaptively (for reviews see Mata et al., 2011; Pasion et al., 2017), the results of the present study indicated that IGT performance did not differ significantly according to age. Indeed, no significant age-related difference was observed in net total scores, frequency sensitivity to the decks' payoff, deck B preference, and mean reaction times. These findings corroborate previous studies that did not find an impact of age on decision-making utilizing the IGT (Henninger et al., 2010; Kovalchik et al., 2005; Lamar & Resnick, 2004; MacPherson et al., 2002). It may be that older adults were successful on the IGT because they applied equal weight to gains and losses, making choices that maximized expected payoff (Wood et al., 2005), or were particularly sensitive to potential losses (Depping & Freund, 2011), or because aging led to increased reliance on simpler strategies. Along with Mata et al. (2015), strategy-execution deficits among old people "may lead to interesting trade-offs such that decision makers are better off using simple, less error-prone strategies, relative to complex strategies that could, in principle, be more accurate but also lead to higher error rates" (p. 121). Alternatively, the role of age is overshadowed by individual characteristics. More interestingly and unexpectedly, the results of the regression analysis clearly indicated that gambling involvement, as well as gender, age, and education, did not significantly contribute to predict IGT performance.

Consistent with the hypothesis, both time perspective and gambling-related cognitions were found to affect decision-making. More specifically, being oriented toward the future (the foresight as opposed to the myopia for the future) improved IGT performance, while illusion of control and predictive control impaired affective decision-making. It is not surprising that future orientation appears to positively affect IGT performance. Rather, it is somewhat odd that the oldest age group scored significantly higher than the youngest age group on the CFC-14 Future scale. A possible explanation for this result comes from Strough et al. (2016) who found among older adults an association between future time perspective and less preoccupation and rumination about negative events.

Surprisingly, a positive association was found between GRCS gambling expectancy dimension and net total score. Having positive expectancies about gambling may have led participants who considered IGT as a really good card game to take the task more seriously and, consequently, devote more attention to it. Ultimately, gambling expectancies motivate gambling and continued gambling, despite losses (Raylu & Oei, 2004). Believing that gambling affects mood positively, reduces tension and stress, and makes the future brighter that are all good reasons to engage in any game, including the IGT. As one of the participants in the present study said after completing the IGT, “I really enjoyed the computer task, because it’s just a game!”. Given the positive effects of gambling expectancy on IGT performance, it could be that such a cognition, even if dysfunctional per se, may have had beneficial effects on IGT in terms of gambling motivation.

Beyond age and gambling involvement, higher scores on both GRCS illusion of control and predictive control dimensions were found to negatively affect IGT performance. Illusion of control reflects cognitions relating to ability to control gambling outcomes, whereas predictive control (equivalent to gambler’s fallacy) reflects cognitions relating to ability to predict gambling outcomes despite losses. As stressed by Goodie et al. (2019), “the illusion of control is cited regularly as a cognitive distortion among gamblers, but there is widespread inconsistency within the literature on its exact definition” (p. 50). In general, “illusion of control is defined as an expectancy of a personal success probability inappropriately higher than the objective probability would warrant” (Langer, 1975, p. 313). However, as assessed using the GRCS, illusion of control refers mainly to rituals and behaviors used to increase chances of winning (Raylu & Oei, 2004). In other words, many gamblers believe that luck can be manipulated in their favor through superstitious behavior (Langer, 1983; Toneatto, 1999). Gamblers who endorse cognitions associated with predictive control erroneously believe that it is possible to predict winning outcomes or that losses are bound to be followed by a series of wins, assuming they have the skill to forecast wins.

Although illusion of control and predictive control constitute important added ingredients in gambling behavior (Clark et al., 2014; see also Clark et al., 2013; Hunt & Blaszczynski, 2019; Labrador et al., 2020), such cognitive biases are not confined to gambling, since normal individuals often use these mental shortcuts (Kahneman, 2011). As the present findings indicated, if it is true that “decision-making biases can be observed in gambling behavior, to the extent that gambling can be fruitfully viewed as a paradigm for studying risky decision-making” (Clark, 2017, p. 340), it is equally true that gambling-related cognitive biases may affect IGT performance, over and above gambling severity. Laboratory-based tasks that mimic gambling games, such as the IGT, perhaps elicit gambling-related cognitive biases among individuals suffering from gambling disorder, as well as in “normal” individuals with a self-reported susceptibility to gambling biases (e.g., Clark et al., 2014). As observed by Sévigny and Ladouceur (2003), while gambling, some players shift “from a rational perception of gambling events (switch on) to a behavioral manifestation of irrational cognitions (switch off), and back on to a rational perception” (p. 163). Therefore, it may be that something like this double switching activates even when playing the IGT, based on the individual susceptibility of the participants, since systematic errors in the thinking of normal individuals also vary as a function of individual differences (for a review see, Aczel et al., 2015). Because the design of the IGT makes participants unable to calculate the net gains and losses that each deck affords (Damasio, 1996) , the use of mental shortcuts may represent the most available way to deal with the uncertainty associated with the game, especially for those who are more sensitive to such cognitive mechanisms.

Limitations

Although there are several strengths of the present study, including a relatively large sample of participants in an IGT study, there are some limitations that should be considered when interpreting the results. First, the participants were recruited using a snowball sampling method which limits the sample’s representativeness. Second, assessing time perspective and gambling-related cognitions using self-report scales may not fully represent the cognitive processes involved, and social desirability effects are possible. Third, gambling severity was assessed by means of the SOGS, a scale that has been subject to criticism, mostly because it has been found to produce inflated estimates of problem gambling (James et al., 2016). However, it is worth noting that in the present study, SOGS score served as a research screen and not as a tool for individual diagnosis and that the SOGS generally performs well when used dimensionally (Goodie et al., 2013). In addition, the results reported by Goodie et al. (2013) reaffirmed the utility of SOGS with both DSM-IV and DSM-5 criteria. Fourth, given the frequent comorbidity between substance and behavioral addictions (e.g., Liu et al., 2009) and the data supporting impaired decision-making in alcohol (e.g., Galandra et al., 2018) and substance disorders (e.g., Mallorquí-Bagué et al., 2016), another limitation of the present study is not having controlled for the role of comorbidity in decision-making impairment. Moreover, it is not clear whether there may be other unmeasured personality factors that might account for the observed associations. Finally, it cannot be entirely ruled out that the use of real money instead of virtual money may have influenced IGT performance. However, given that previous evidence has shown that participants who play with real money in the IGT do not differ significantly in IGT performance from those who do not (Bowman & Turnbull, 2003; Bull et al., 2015; Carter & Smith Pasqualini, 2004; Fernie & Tunney, 2006; see also Vadhan et al., 2009), the authors are sufficiently confident that such a variation did not significantly affect the results. Despite these limitations, to the authors' knowledge, the present study is the first to investigate the interplay of chronological age, time perspective, and gambling-related cognitive distortions on affective decision-making controlling for gambling severity.

Conclusions

The results of the present study indicate that aging does not negatively affect IGT performance. The quality of performance appears to depend more on individual characteristics, such as future orientation and cognitions and biases related to gambling, such as gambling expectancies, illusion of control, and predictive control, irrespective of gambling severity. While both positive expectancies associated with gambling and future orientation are beneficial to decision-making, illusion of control and predictive control have detrimental effects on IGT performance. However, being oriented toward the future appears to mitigate the negative effects of cognitive biases on decision-making. These findings suggest that when investigating the role of aging in affective decision-making utilizing the IGT, the role of relatively stable individual characteristics should also be considered, mostly when the IGT is used as a clinical tool to judge decision-making abilities among older individuals.

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Author Contribution Marina Cosenza, Olimpia Matarazzo, and Giovanna Nigro performed writing original draft and conceptualization. Maria Ciccarelli performed literature searches, data collection, and summary of previous research studies. Giovanna Nigro performed statistical analyses. All authors contributed to and have approved the final manuscript.

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Data Availability The data that support the findings of this study are available from the corresponding author, Maria Ciccarelli, upon reasonable request. The data are not publicly available due to the privacy or ethical restrictions.

Declarations

Ethics Approval Approval was obtained from the ethics committee of University degli studi della Campania "Luigi Vanvitelli." The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent to Participate Informed consent was obtained from all individual participants included in the study.

Competing Interests Mark Griffiths' University currently receives funding from Norsk Tipping (the gambling operator owned by the Norwegian Government) for gambling-related research. He has also received funding for a number of research projects in the area of gambling education for young people, social responsibility in gambling, and gambling treatment from Gamble Aware (formerly the Responsibility in Gambling Trust), a charitable body which funds its research program based on donations from the gambling industry. He also undertakes consultancy for various gaming companies in the area of social responsibility in gambling.

Conflict of Interest None.

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