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Decision-making executive function profile and performance in older adults with major depression: a case-control study

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ABSTRACT

Objectives: Decision making (DM) is a component of executive functioning, essential for choosing appropriate decisions. Executive dysfunctioning is particularly common in late-life depression, however the literature is scarce on DM. This case-control study aimed to evaluate the DM profile and performance in participants with and without unipolar major depression.

Method: The DM profile and performance were assessed by the Melbourne Decision Making Questionnaire and the Iowa Gambling Task (IGT), respectively, in three groups of older adults from a university-based geriatric psychiatry clinic, i.e. current depression ($n = 30$), remitted depression ($n = 43$) and healthy controls ($n = 59$). The Hamilton Depression scale (HAM-D) 21 items, the Hamilton Anxiety scale, and the Mini-Mental State Examination were used to access depressive symptoms, anxiety symptoms, and cognitive impairment, respectively. Multinomial, nominal and binary logistic regression was used to evaluate the associations between depression, depressive symptomatology and DM.

Results: In comparison to the control group, patients with current depression presented higher scores in buck-passing and proscratination DM profiles. In the hypervigilance profile, there was a significant difference between current and remitted depression groups. A higher value in the HAM-D scale increased the probability of disadvantageous DM profiles. Depressive patients showed a tendency of a higher mean score in both disadvantageous decks (A and B) of IGT. Patients with current depression showed a worse performance compared to the remitted depression group in the IGT netscore.

Conclusion: Older adults with current depression showed DM profiles considered maladaptive or disadvantageous compared to both remitted depression and healthy controls groups.

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Decision-making; executive function; cognitive impairment; major depression; older adults

Introduction

Late-life major depressive disorder (MDD) is prevalent in geriatric psychiatry and results in adverse health outcomes such as lower quality of life, functional disability, higher morbidity burden and mortality (Wang & Blazer, 2015). It is commonly associated with cognitive impairment, especially lower processing speed and executive dysfunctioning (Gu et al., 2016; Koenig et al., 2014). The relationship between depression prior to the onset of cognitive impairment and the subsequent development of cognitive impairment after or in conjunction with depression is an area of active study. However, it remains to be understood whether the treatment of depression reduces cognitive impairment, and preliminary epidemiological studies are mixed (Pellegrino et al., 2013). Notwithstanding the above, cognitive alterations have been associated with increased rates of depression recurrence, worse response to antidepressant treatment and greater general disability (Koenig et al., 2014). The better understanding of cognitive markers and its functionality and impairment among geriatric depressed patients is an important topic of interest.

Regarding specifically to the executive dysfunction in MDD, research has focused almost exclusively on pure cognitive variables, so called 'cold' components, which are associated with the dorsolateral prefrontal cortex. However, special attention has been given to affective variables related to executive function namely 'hot' components, linked to orbitofrontal cortex, and which are required in problem resolution involving both affect and motivation, especially in the decision-making (DM) processes (Kerr & Zelazo, 2004). Whereas DM is a cognitive function and disturbed in many psychiatric disorders, it has been understudied in MDD. DM can be defined as a process of choosing between two or more competing alternatives that demand cost and benefit analysis of each option, and the estimation of its consequences in the short, medium and long term, (Da Mata, 2011; Dittrich & Johansen, 2013). According to the most accepted neurobiological theory, DM processes are evoked by the own experience of reward or punishment after each action, and those experiences induce decision process (Bechara et al., 1997; Brand et al., 2007). Investigating DM skills in older adults has major social implications. During this phase, older adults are faced with decisions that include medical care, safety to drive a vehicle, financial planning, acquisition of a

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burial site and changes in performance after the death of one spouse. A poor DM capacity in any of these domains can lead to negative results for the patient's physical, mental, and financial condition (Nguyen et al., 2013). The Iowa Gambling Task (IGT) is the gold standard and the most widely used instrument to assess DM peformance. Similarly, the Melbourne Decision Making Questionnaire (MDMQ) is the most used questionnaire to assess DM profile (Branco et al., 2014). Most investigations on DM, especially in psychiatric populations, use the IGT. Studying DM profile is recommended to complement and address some limitations associated with the IGT, such as psychological functioning, mood, or the cognitive processes underlying DM (Cotrena et al., 2017; Mann, 1982). The results provided by IGT in conjunction with the MDMQ results can therefore be used to understand DM functioning. In this way, it is possible to consider such instruments as complementary.

Few studies in the literature reported the assessment of DM cognitive process in populations with mental disorders, especially among geriatric patients. In a systematic review, de Siqueira et al. (2017) found only three studies that evaluated DM in patients with mild cognitive impairment and Alzheimer's disease with heterogeneous results. Recently, a case-control study using the MDMQ observed more dysfunctional profiles of DM in older adults with cognitive impairment when compared to healthy controls (Biella et al., 2020). Another systematic review evaluating DM in depression found a single study that evaluated older people through the IGT (de Siqueira et al., 2018) observing a significant difference from healthy participants only in a subgroup of apathic depressed patients (McGovern et al., 2014). Understanding cognitive changes caused by depression is of great importance to the diagnosis, treatment plan, therapeutic monitorization and prognosis of geriatric depression (Alexopoulos et al., 2008).

According to current literature, DM processes are a still less explored executive function in late-life MDD. DM can be a potential clinical biomarker to diagnosis of depression subtypes. New research in this area can also contribute improving the confidence and cognitive capacity of DM among depressed older adults (Harlé et al., 2010).

The primary aim of this study was to evaluate the DM profile, as assessed with the MDMQ, in late-life depression by comparing older patients, with either current or remitted depression, and non-depressed healthy participants. A secondary aim was to evaluate the DM performance assessed through the IGT in these patients.

Methods

Design and participants

This is an observational cross-sectional case-control study that evaluated the DM profile and performance of older adults with MDD compared with healthy older adults. A sample of 73 patients with MDD (43 with remitted depression between 3 and 6 months, and 30 current depressed) from a tertiary university-based psychogeriatric outpatient clinic and 59 voluntary healthy older adults from community were selected from a wellness and health promotion program from the hospital. A sequential sampling strategy was employed at the Geriatrics Division of the Hospital das Clínicas of the Medical School of the University of São Paulo from July 2018 to December 2019. The principal investigator (ASSS) was blind to the clinical diagnosis of the patients.

The inclusion criteria in the case group (depression) were patients aged 60 or over; having a diagnosis of MDD confirmed by a structured interview based on the Structured Clinical Interview for DSM-5 (SCID-5) (American Psychiatric Association (APA), 2013); be able to understand the evaluation process; presenting controlled clinical (somatic) comorbidities; have regular clinical and psychiatric follow-up; and sign a consent form. The same criteria were used for the control group except for not having MDD confirmed by a structured interview based on the Structured Clinical Interview for DSM-5 (SCID-5) (APA, 2013). The exclusion criteria for both groups were refusal to answer any questions in the evaluation protocol; have aphasia and/or difficulty in understanding or communicating; presence of degenerative neuropsychiatric disorders (all patients did a neuropsychological evaluation previously); presenting severe, terminal and/or decompensated clinical comorbidities; have functional, social or sensory impairments that limit the evaluation. The protocol was performed in a single session lasting approximately 150 min in the same day participants were in the outpatient clinic for consultation (case group) or health promotion activities (control group). This study was conducted according to the ethical guidelines of research with human beings, approved by the local Ethics Committee.

Instruments and procedures

Melbourne Decision Making Questionnaire

For this study, the MDMQ was translated and back-translated by two researchers fluent in English, taking into account the cross-cultural adaptation to Brazilian Portuguese. The final version was evaluated externally by a third researcher, totally blind to the current project. Final comments were added after this third review and the final version of MDMQ was established.

The MDMQ analyzes the profile of DM through answers given in 22 items divided into four DM profiles, which are not explicit to the patient or ordered in a way that a specific profile could be suspected. Each item describes possible reactions and behaviors in the face of uncertainty. In MDMQ, responses are obtained using a Likert-type scale, in which the subject indicates whether the description is applicable to their behavior (*True for me* – 2 points), whether it is partially applicable (*Sometimes true* – 1 point) or if he/she does not describe the way he/she normally makes decisions (*Not true for me* – 0 points).

Possible DM profiles are (1) vigilance is considered the only adaptive DM profile, in which the individual carefully analyzes situations, weighing the advantages and disadvantages of each available alternative (e.g. when you need to make a decision, do you like to consider all the alternatives?). Six items describe surveillance behaviors; (2) procrastination, in which the individual postpones DM as much as possible (e.g. when you have to make a decision, do you waste time on unimportant matters before reaching the final decision?). Five items refer to this style; (3) buck-passing (avoidance), which is also considered a procrastination style of responsibility, where the conflict generated by situations of uncertainty leads the individual to postpone the decision or transfer the responsibility for the choice to others (e.g. do you avoid making decisions?). Six items allude to avoidant behaviors and (4) hypervigilance is characterized by attempts to end the situation of uncertainty as quickly as possible, sometimes by means of impulsive decisions whose only advantage is the immediate relief of the conflict of the decision

(e.g. when you are making a decision, do you feel pressured to do this quickly?). Five items refer to this pattern.

Iowa Gambling Task (IGT)

IGT is the gold-standard instrument for the assessment of DM performance. It is a computerized task, which requires the individual to remove cards, one by one, from four decks over 100 moves (five blocks of twenty moves each). The decks are the same in appearance and size. With each card drawn, monetary gains (rewards) occur, but sometimes losses (punishment) can occur. Choices are either advantageous or disadvantageous, but each choice is full of ambiguity about the outcome. Although not obvious to the participants, two of the four decks are advantageous (C and D), resulting in moderate gains but also in potential low to moderate losses that lead to a positive final balance. The remaining two decks are disadvantageous (the first A and B), even though the gains are higher than in the other two decks, the losses are also high, resulting in a negative long-term balance. These profit and loss rules are not explained to the subjects (Bechara et al., 1997, 1998).

There are some possibilities to assess performance in the IGT. The analysis of the total score (netscore) allows to classify performance as advantageous (positive), borderline (near zero) or disadvantageous (negative). For this, the choices of decks C and D (advantageous decks) are added and the sum of decks A and B (disadvantageous decks) are subtracted from this value [(C + D) − (A + B)].

The 'score by blocks' allows the assessment of the individual's learning evolution during the task (Bechara et al., 1994). The reasoning is that in the first 40 plays of the task, decisions are made without explicit knowledge of the contingencies of reward and punishment, based on a priori on implicit processes, called affective learning. In the final 40 moves (blocks 4 and 5), there is a greater likelihood of acquiring the explicit knowledge about the risks associated with each deck influencing the choice making the executive functions assume a leading role (Bechara et al., 1997).

Secondary measures

In addition to the MDMQ and the IGT, the following instruments were used in the evaluation protocol: Hamilton Depression scale 21 items (HAM-D) (Hamilton, 1960) to evaluate the degree and intensity of depressive symptoms and also to classify patients as remitted; Hamilton Anxiety Scale (HAM-A) (Hamilton, 1959) to assess anxiety symptoms; and the Mini-Mental State Examination (MMSE) (Brucki et al., 2003) to investigate possible cognitive impairment (cutoff scores were: 20 points for illiterates; 25 points for schooling from 1 to 4 years; 26.5 for 5 to 8 years; 28 for those aged 9 to 11 years and 29 for more than 11 years).

Data analysis

All data were analyzed using SPSS software (IBM SPSS Statistics for Mac, Version 21.0. Armonk, NY: IBM Corp.). All interval data exhibited a normal distribution on the Kolmogorov-Smirnov test and analysis of skewness and kurtosis. Descriptive statistics were performed for the characterization of the sample. Categorical variables were expressed as number and percentages, while continuous variables were expressed as mean and standard deviation (SD). One-way ANOVA was used to compare continuous variables and Pearson's Chi-square test was used to compare categorical variables among healthy, remitted depression and current depression groups. Differences among DM profile and performance scores were evaluated by the ANOVA test and Tukey pos-hoc test. A multinominal logistic regression analysis was used to evaluate the association between DM profiles and depressive symptomatology according to HAM-D scale. A logistic regression was performed to assess the association between a dysfunctional DM profile and depression status (remitted and current depression, and depressive symptomatology). Finally, the probability relation of belonging to each MDMQ profile according to the HAM-D scores was evaluated through nominal logistic regression analysis. This method considers that the answer is of the attribute type and creates an equation in which the probabilities of classification of patients in each of the four profiles are obtained. As a single profile must be chosen, 11 patients with two tied profile scores (no dominant profile) were excluded for this particular analysis. There is no specific rule in the literature for choosing a dominant profile in the case of cases with a tie in two profiles derived from the MDMQ. The vigilance profile was considered the reference for all regression analysis. All p-values were tested and p values < 0.05 were considered statistically significant.

Results

Characteristics of sample

Characteristics of the sample can be observed in Table 1. A higher percentage of women and less years of education were observed in the depression group. All patients from this later

Table 1. Baseline characteristics of sample ($n = 132$).

Variable		Control ($n = 59$)	Remitted depression ($n = 43$)	Current depression ($n = 30$)	p-value*
Age, years (mean ± SD)		69.7 ± 5.8	67.9 ± 5.0	69.4 ± 5.6	0.246
Sex, n (%)	Female	39 (66.1%)	35 (81.4%)	27 (90.0%)	0.028**
	Male	20 (33.9%)	8 (18.6%)	3 (10.0%)	
Ethnic, n (%)	White	32 (54.2%)	21 (48.8%)	18 (60.0%)	0.090**
	Brown	15 (25.4%)	14 (32.6%)	11 (36.7%)	
	Black	7 (11.9%)	8 (18.6%)	1 (3.3%)	
	Asiatic	5 (8.5%)	0 (0.0%)	0 (0.0%)	
Education, years (mean ± SD)		8.7 ± 5.0	5.5 ± 3.6	5.5 ± 4.3	<0.001[a]
Marital status, n (%)	Married	38 (64.4%)	25 (58.1%)	13 (43.3%)	0.202**
	Single	6 (10.2%)	2 (4.7%)	4 (13.3%)	
	Widowed	13 (22.0%)	9 (20.9%)	9 (30.0%)	
	Divorced	2 (3.4%)	7 (16.3%)	4 (13.3%)	
HAM-D (>7)	Yes	0 (0.0%)	0 (0.0%)	30 (100%)	<0.001**
	No	59 (100%)	43 (100%)	0 (0.0%)	
HAM-A (>17)	Yes	0 (0.0%)	1 (2.3%)	2 (6.7%)	0.133**
	No	59 (100%)	42 (97.7%)	28 (93.3%)	
HAM-D score		1.2 ± 1.5	2.4 ± 2.2	13.9 ± 6.0	<0.001
HAM-A score		1.5 ± 1.6	5.3 ± 4.8	10.5 ± 5.5	<0.001
MEEM score		27.4 ± 2.0	24.6 ± 3.4	24.8 ± 3.2	<0.001[a]

Note: * One-way ANOVA; ** Chi-square test.
[a]Controls were different from depression groups; HAM-D = Hamilton Depression scale 21 items; HAM-A = Hamilton Anxiety Scale; MMSE = Mini-Mental State Examination.

group presented mild depression, higher levels of anxiety and lower cognitive performance.

A good consistency (0.76) of the MDMQ was observed through Cronbach's Alpha test, as well as for the vigilance (0.72) and procrastination (0.74) profiles. These values were slightly lower for the buck-passing (0.67) and hypervigilance (0.62) profiles.

Table 2 shows the comparison of DM profiles scores of the MDMQ between the three groups. There is no significant difference for the vigilance profile, whereas in the other 3 profile scores, higher mean values were observed in depression groups, with higher values in the current depression group. We observed a significant difference in the buck-passing and procrastination profiles between the current depression and control groups according to post-hoc Tukey tests. In the hypervigilance profile, there was a significant difference between current depression and the control and remitted depression groups.

A multinomial regression evaluated the association between HAM-D total scores and DM dysfunctional profiles (Table 3). Buck-passing and hypervigilance profiles were associated in unadjusted models and lost significance after adjustment for covariates including cognition. HAM-D total score and current depression was associated with a dysfunctional DM profile in both unadjusted and adjusted models (Table 4). Remitted depression was only associated with dysfunctional DM in the unadjusted model. Current depression presented stronger association with dysfunctional profiles than HAM-D scores.

Figure 1 shows the probability relation of belonging to each MDMQ profile according to the HAM-D scores through nominal logistic regression analysis. The results indicate that lower values in the HAM-D increase the probability of the vigilance profile, decreasing all other profiles. As the value of the HAM-D increases the probability of having the vigilance profile decrease and the other profiles grow in a very equivalent way.

Table 5 presents the IGT performance according to MDD and control groups. Depressive patients showed a tendency of a higher mean score in both disadvantageous decks A and B, especially in deck B. In other IGT decks and blocks, mean scores resulted in more discrete differences between the groups. IGT netscore presented higher negative values in the MDD group. Current MDD showed a worse performance than in remitted MDD regarding the netscore. All measures did not show significant results. In general, MDD patients showed a trend to more disadvantageous choices observed on decks results and a lower level of learning, especially in current MDD group, seen on blocks performance.

Multiple correlations were tested between IGT items (decks, blocks and netscore) and sociodemographic and clinical characteristics, yielding only two significant findings regarding anxiety symptomatology. Deck A in current MDD group was correlated with HAM-A score ($r = 0.31$; $p = 0.049$) and Deck D in remitted MDD was negatively correlated with HAM-A score ($r = -0.43$; $p = 0.005$).

Table 2. Comparison of the Melbourne Decision-Making Questionnaire (MDMQ) profile scores between healthy controls, remitted depression and current depression groups.

MDMQ profile	Control	Remitted depression	Current depression	*p*-value*
Vigilance	1.5 ± 0.5	1.5 ± 0.4	1.3 ± 0.6	0.110
Buck-passing	0.6 ± 0.3	0.8 ± 0.5	1.0 ± 0.5	0.002[a]
Procrastination	0.3 ± 0.4	0.4 ± 0.5	0.7 ± 0.7	0.001[b]
Hypervigilance	0.7 ± 0.4	0.9 ± 0.5	1.2 ± 0.6	<0.001[c,d]

Note: *ANOVA and Tukey pos hoc test; *p*-values: [a]control vs current depression = 0.001, [b]control vs current depression = 0.001, [c]control vs current depression < 0.001, [d]remitted depression vs current depression = 0.024.

Table 3. Association between HAM-D total score and MDMQ profile.

	HAM-D total score	
MDMQ profile	Model 1	Model 2
Buck-passing OR [95% CI]	1.10 (1.01–1.19)	1.09 (0.98–1.19)
p-value	0.019	0.101
Procrastination OR [95% CI]	1.13 (0.98–1.31)	NA*
p-value	0.086	NA*
Hypervigilance OR [95% CI]	1.13 (1.04–1.18)	1.09 (1.0–1.2)
p-value	0.002	0.056

Note: Vigilance profile as reference; HAM-D = Hamilton Depression scale 21 items; Model 1: mutinomial logistic regression (unadjusted); Model 2: adjusted for age, sex, ethnic, education, marital status and MEEM score; NA = not applied due to low sample of 3 persons.

Table 4. Association between depression status and MDMQ dysfunctional profile.

	OR [95% CI]	*p*-value	MDMQ dysfunctional
HAM-D (score)			24/103 (23.3%)
Model 1	1.11 (1.04–1.18)	0.001	
Model 2	1.09 (1.01–1.18)	0.023	
Remitted depression			14/43 (32.6%)
Model 1	2.68 (1.03–6.96)	0.043	
Model 2	2.53 (0.73–8.75)	0.143	
Current depression			15/30 (50%)
Model 1	5.56 (2.03–15.22)	0.001	
Model 2	4.80 (1.33–17.32)	0.017	

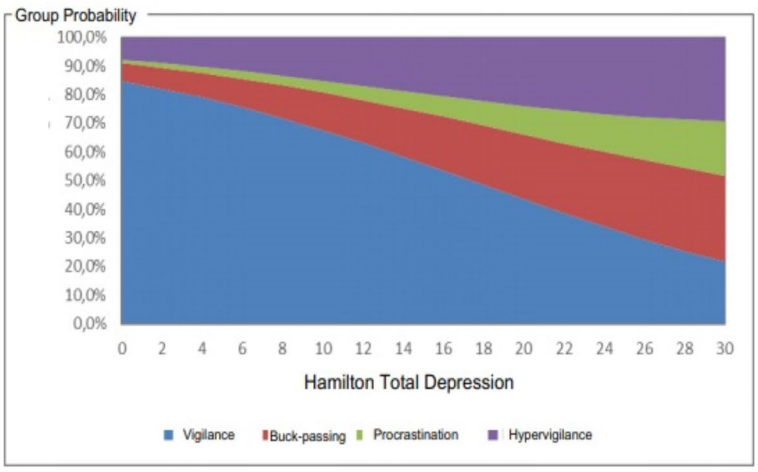
Note: HAM-D = Hamilton Depression scale 21 items; Model 1: binary logistic regression (unadjusted); Model 2: adjusted for age, sex, ethnic, education, marital status and MEEM score.

Discussion

To the best of our knowledge, this is the second study to evaluate DM executive function in a sample of older adults with MDD but the first to compare remitted and current depressed patients compared with a group of healthy seniors and the first to evaluate DM profile. The assessment of DM in older adults has been little explored in the literature, especially regarding those with neuropsychiatric disorders (de Siqueira et al., 2017, 2018). In our study, we observed a higher prevalence of disadvantageous DM profiles among depressed outpatients, especially in those with current MDD. Moreover, higher depressive symptomatology measured by the HAM-D scale led to higher probability of more disadvantageous DM profiles. Our findings demonstrate that older people with current or remitted depression have a tendency to DM impairment when compared to older people without depression.

Most studies investigating the relationship between affective disorders and DM used game-based DM tasks like the IGT (de Siqueira et al., 2018). However, some important variables in DM processing such as psychological functioning, mood, and other cognitive processes underlying DM are not assessed by the IGT (Cotrena et al., 2017). Another possible way to investigate DM function is to evaluate its profile, which is more personal and consider affect reactions to proposed questions of inventories like the MDMQ. This instrument has the additional advantage to be fast, simple and friendly in clinical practice. A comparison between DM profiles and DM tasks among depressed patients could add further information to our understanding of DM functioning in mood disorders.

Previously, the MDMQ was used in research involving DM profile and processing information styles, self-esteem, communication skills, problem-solving abilities and personality and addictive



HAM-D scores	Vigilance	Buck-passing	Procrastination	Hypervigilance
0	84.8%	6.2%	1.3%	7.7%
2	82.1%	7.3%	1.6%	9.0%
4	79.1%	8.6%	2.0%	10.3%
6	75.6%	10.0%	2.6%	11.8%
8	71.8%	11.5%	3.2%	13.4%
10	67.7%	13.2%	3.9%	15.2%
12	63.2%	15.0%	4.8%	17.0%
14	58.5%	16.9%	5.9%	18.8%
16	53.5%	18.8%	7.0%	20.6%
18	48.5%	20.8%	8.4%	22.3%
20	43.5%	22.7%	9.8%	24.0%
22	38.6%	24.5%	11.4%	25.5%
24	33.9%	26.2%	13.2%	26.8%
26	29.4%	27.7%	15.0%	27.9%
28	25.4%	29.0%	16.9%	28.7%
30	21.6%	30.1%	18.9%	29.3%

Figure 1. Probability of decision-making profile according to Hamilton Depression Scale scoring.

Table 5. Iowa Gambling Task (IGT) performance according to depressive status ($n = 132$).

Measure	Group	Remitted MDD	Current MDD	Control Group	p*
IGT	Deck A	25.9 ± 5.0	24.5 ± 5.0	24.1 ± 6.3	0.282
	Deck B	25.0 ± 5.0	27.7 ± 4.9	26.7 ± 6.5	0.133
	Deck C	23.6 ± 4.0	23.3 ± 3.6	23.0 ± 5.7	0.833
	Deck D	25.2 ± 5.1	24.5 ± 5.5	26.2 ± 6.6	0.425
	Block 1	−2.0 ± 3.9	−1.5 ± 2.7	−1.5 ± 4.8	0.796
	Block 2	−1.0 ± 4.2	−0.8 ± 3.8	−1.0 ± 4.2	0.956
	Block 3	−0.3 ± 4.6	−0.4 ± 4.9	−0.3 ± 6.1	0.994
	Block 4	−0.1 ± 4.9	−0.6 ± 3.6	0.3 ± 6.6	0.778
	Block 5	0.9 ± 6.0	−0.8 ± 5.1	0.9 ± 6.1	0.365
	Netscore	−2.3 ± 13.7	−4.3 ± 14.1	−1.5 ± 17.2	0.722

Note: *One-way ANOVA; MDD = major depressive depression.

disorders (Bouckenooghe et al., 2007; Deniz, 2011; Gorodetzky et al., 2011; Phillips & Ogeil, 2011; Phillips & Reddie, 2007; Senol et al., 2012; Shirren & Phillips, 2011). The MDMQ also appears to be a useful tool to assess the relationship between the DM profile and psychiatric symptomatology (Umeh & Omari-Asor, 2011). Among affective disorders, one single study used an adapted and validated version of the MDMQ to assess the DM profile of adults with MDD and with Bipolar Disorder Types I and II (Cotrena et al., 2017). The results of this study indicated that patients with mood disorders exhibited more hypervigilance profile and a less prevalent vigilance profile of DM than healthy adults. Therefore, adults with psychiatric affective disorders demonstrated inadequate DM strategies. Such results are in line with our study, in which older patients with current depression when compared to remitted depressed patients and healthy controls showed more maladaptive DM profiles.

In addition to psychiatric disorders, cognitive disorders can negatively affect DM (Cotrena et al., 2017) and this should be taken with caution when evaluating DM profile among depressed individuals. An adapted version of the MDMQ was used to assess the DM profile of older adults with and without cognitive impairment (Biella et al., 2020). The buck-passing profile was more associated with dementia and depression, but with less anxious symptoms. Moreover, the hypervigilant profile was also associated with lower cognitive performance. According to these results, older adults with cognitive impairment have more dysfunctional DM profiles when compared to healthy individuals.

It is already known that anxiety and depression are associated with difficulties in DM (Hamilton, 1959). Previously, McGovern and colleagues (2014) evaluated reward-related DM task using the IGT in late-life depression (60 depressed patients and 36 controls). Curiously, a subgroup of apathetic depressed patients was more efficient evaluating costs and benefits and shifted their selections to the conservative decks (an advantageous behavior). In contrast, non-apathetic, depressed older adults did not adopt an advantageous strategy and continued to make risky decisions on the task. Reasons why apathetic participants showed a favorable DM profile require further investigation. This may be explained due to lower engagement in trying to achieve more significant gains. The IGT is one of several well-studied DM tasks. Thus, it is important to determine whether other complex DM tasks or DM profiles reveal similar patterns.

In our study, current depressed individuals had a worse learning evolution when compared to the remitted group. In the first blocks, decisions are made without explicit knowledge of the contingencies of reward and punishment, based on a priori implicit processes. In the final blocks, on the other hand, there is a greater probability of acquiring the explicit knowledge about risks associated with each deck, which will influence choice making (Jollant et al., 2005). The control group showed a predilection for decks B and D, which suggests that they perceived more clearly the aspect of punishment and reward patterns, possibly developing positive somatic markers associated with these decks (Bakos et al., 2010). However, current depression group showed greater responses only in deck B. These results suggest that the worse performance seen with depression may be associated with hypersensitivity to rewards, where decisions are influenced by the prospect of receiving a reward, regardless of the presence or degree of punishment (Bauer et al., 2013). Two significant findings regarding the symptoms of anxiety were found in our study. Deck A in current depression group was correlated with the HAM-A score, and deck D in the remitted depression group was negatively correlated with the HAM-A score. In our initial hypothesis, anxiety symptomatology may influence DM processing negatively in MDD, but further exploration is needed.

Finally, this study sought to evaluate the DM profile and performance of older adults with depression compared to healthy individuals. Our findings show a disadvantageous DM profile among depressed patients and this is associated with depressive symptom severity. This negative DM profile could compromise relevant choices regarding their treatment and personal matters

such as finance decisions. Our study has strengths and limitations. This is the second study with DM in late-life depression in a specialized psychogeriatrics clinic where MDD was diagnosed using a standard protocol. Current and remitted episodes of MDD were evaluated and compared to a control group who had no previous history of depression. However, our cross-sectional design, mild depressive symptomatology and lower sample limited our findings and causality exploration. Although the temporal association between cognitive and depressive symptoms in older adults varies widely, increasing evidence suggests that depression contributes to the development of cognitive dysfunction in a subset of individuals (Aaron et al., 2014) and our study can shed light to future study's design. Also, future studies should include in-depth executive functioning protocols when evaluating DM function in depressed older adults to explore other potential correlated executive disability. Despite some limitations of our study, our data add original information regarding DM profile and performance assessment in depressed older adults.

Disclosure statement

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Data availability statement

Data is available upon request to the corresponding author.

Ethics approval statement

Local ethics committee approved the study.

Patient consent statement

All participants have signed a consent form.

References

Aaron, M. K., Rishi, K. B., & Merly, A. B. (2014). Cognitive functioning and late-life depression. *Journal of the Inter Neuropsychol Society*, *20*(5), 461–467.

Alexopoulos, G. S., Raue, P. J., Kanellopoulos, D., Mackin, S., & Arean, P. A. (2008). Problem solving therapy for the depression-executive dysfunction syndrome of late life. *International Journal of Geriatric Psychiatry*, *23*(8), 782–788. https://doi.org/10.1002/gps.1988

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

Bakos, D. S., Denburg, N., Fonseca, R. P., & Parente, M. A. d. M. P. (2010). A cultural study on decision making: Performance differences on the Iowa Gambling Task between selected groups of Brazilians and Americans. *Psychology & Neuroscience*, *3*(1), 101–107. https://doi.org/10.3922/j.psns.2010.1.013

Bauer, A. S., Timpe, J., Edmonds, E. C., Bechara, A., Tranel, D., & Denburg, N. L. (2013). Myopia for the future or hypersensitivity to reward? Age-related changes in decision making on the Iowa Gambling Task. *Emotion*, *13*(1), 19–24. https://doi.org/10.1037/a0029970

Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, *50*(1-3), 7–15. https://doi.org/10.1016/0010-0277(94)90018-3

Bechara, A., Damasio, H., Tranel, D., & Anderson, C. (1998). Dissociation of working memory from decision making within the human prefrontal cortex. *The Journal of Neuroscience*, *18*(1), 428–437. https://doi.org/10.1523/JNEUROSCI.18-01-00428.1998

Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science*, *275*(5304), 1293–1295. https://doi.org/10.1126/science.275.5304.1293

Biella, M. M., de Siqueira, A. S. S., Borges, M. K., Ribeiro, E. S., Magaldi, R. M., Busse, A. L., Apolinario, D., & Aprahamian, I. (2020). Decision making profile in older adults: The influence of cognitive impairment, premorbid intelligence and depressive symptoms. *International Psychogeriatrics*, *32*(6), 697–703. https://doi.org/10.1017/S1041610219001029

Bouckenooghe, D., Vanderheyden, K., Van Laethem, S., & Mestdagh, S. (2007). Cognitive motivation correlates of coping style in decisional conflict. *The Journal of Psychology*, *141*(6), 605–625. https://doi.org/10.3200/JRLP.141.6.605-626

Branco, L. D., Cotrena, C., Cardoso, C. O., & Fonseca, R. P. (2014). Avaliação da tomada de decisão utilizando questionários: Revisão sistemática da literatura. *Revista Avaliação Psicológica*, *13*, 67–76.

Brand, M., Recknor, C. E., Grabenhorst, F., & Bechara, A. (2007). Decisions under ambiguity and decisions under risk: Correlations with executive functions and comparisons of two different gambling tasks with implicit and explicit rules. *Journal of Clinical and Experimental Neuropsychology*, *29*(1), 86–99. https://doi.org/10.1080/13803390500507196

Brucki, S. M. D., Nitrini, R., Caramelli, P., Bertolucci, P. H. F., & Okamoto, I. H. (2003). Sugestões para o uso do Mini- Exame do Estado Mental no Brasil. *Arquivos de Neuro-Psiquiatria*, *61*(3B), 777–781. https://doi.org/10.1590/S0004-282X2003000500014

Cotrena, C., Branco, L. D., & Fonseca, R. P. (2017). Adaptation and validation of the Melbourne Decision Making Questionnaire to Brazilian Portuguese. *Trends Psychiatry Psychotherapy*, *40*, 29–37.

Da Mata, F. G. (2011). Neuropsychological assessment of the decision making process in children and adolescents: An integrative review of the literature. *Archives of Clinical Psychiatry*, *38*, 106–115. https://doi.org/10.1590/S0101-60832011000300005

de Siqueira, A. S. S., Flaks, M. K., Biella, M. M., Mauer, S., Borges, M. K., & Aprahamian, I. (2018). Decision making assessed by the Iowa Gambling Task and major depressive disorder: A systematic review. *Dementia & Neuropsychologia*, *12*(3), 250–255. https://doi.org/10.1590/1980-57642018dn12-030005

de Siqueira, A. S. S., Yokomizo, J. E., Jacob, W. F., Yassuda, M. S., & Aprahamian, I. (2017). Review of decision-making in game tasks in elderly participants with Alzheimer disease and mild cognitive impairment. *Dementia and Geriatric Cognitive Disorders*, *43*(1-2), 81–88. https://doi.org/10.1159/000455120

Deniz, M. (2011). An investigation of decision making styles and the five-factor personality traits with respect to attachment styles. *Educational Sciences: Theory and Practice*, *11*(1), 105–113.

Dittrich, W. H., & Johansen, T. (2013). Cognitive deficits of executive functions and decision-making in obsessive-compulsive disorder. *Scandinavian Journal of Psychology*, *54*(5), 393–400.

Gorodetzky, H., Sahakian, B. J., Robbins, T. W., & Ersche, K. D. (2011). Differences in self-reported decision-making styles in stimulant-dependent and opiate-dependent individuals. *Psychiatry Research*, *186*(2-3), 437–440. https://doi.org/10.1016/j.psychres.2010.07.024

Gu, C. Z., He, H., Duan, H., Su, Z., Chen, H., & Gan, J. (2016). Predictors of neurocognitive impairment at 2years after a first-episode major depressive disorder . *Comprehensive Psychiatry*, *68*, 24–33. https://doi.org/10.1016/j.comppsych.2016.03.009

Hamilton, M. (1959). The assessment of anxiety states by rating. *The British Journal of Medical Psychology*, *32*(1), 50–55. https://doi.org/10.1111/j.2044-8341.1959.tb00467.x

Hamilton, M. (1960). A rating scale for depression. *Journal of Neurology, Neurosurgery, and Psychiatry*, *23*, 56–62. https://doi.org/10.1136/jnnp.23.1.56

Harlé, K. M., Allen, J. J. B., & Sanfey, A. G. (2010). The impact of depression on social economic decision making. *Journal of Abnormal Psychology*, *119*(2), 440–446. https://doi.org/10.1037/a0018612

Jollant, F., Bellivier, F., Leboyer, M., Astruc, B., Torres, S., Verdier, R., Castelnau, D., Malafosse, A., & Courtet, P. (2005). Impaired decision making in suicide attempters. *American Journal of Psychiatry*, *162*(2), 304–310. https://doi.org/10.1176/appi.ajp.162.2.304

Kerr, A., & Zelazo, P. D. (2004). Development of "hot" executive function: The Children's Gambling Task. *Brain and Cognition*, *55*(1), 148–157. https://doi.org/10.1016/S0278-2626(03)00275-6

Koenig, A. M., Bhalla, R. K., & Butters, M. A. (2014). Cognitive functioning and late-life depression. *Journal of the International Neuropsychological Society*, *20*(5), 461–467. https://doi.org/10.1017/S1355617714000198

Mann, L. (1982). *Flinders Decision Making Questionnaire II, unpublished questionnaire*. The Flinders University of South Australia.

McGovern, A. R., Alexopoulos, G. S., Yuen, G. S., Morimoto, S. S., & Gunning, F. M. (2014). Reward-related decision making in older adults: Relationship to clinical presentation of depression. *International Journal of Geriatric Psychiatry*, *29*(11), 1125–1131. https://doi.org/10.1002/gps.4200

Nguyen, C. M., Barrash, J., Koenigs, A. L., Bechara, A., Tranel, D., & Denburg, N. L. (2013). Decision-making deficits in normal elderly persons associated with executive personality disturbances. *International Psychogeriatrics*, *25*(11), 1811–1819. https://doi.org/10.1017/S1041610213001270

Pellegrino, L. D., Peters, M. E., Lyketsos, C. G., & Marano, C. M. (2013). Depression in cognitive impairment. *Current Psychiatry Reports*, *15*(9), 384. https://doi.org/10.1007/s11920-013-0384-1

Phillips, J. G., & Ogeil, R. P. (2011). Decisional styles and risk of problem drinking or gambling. *Personality and Individual Differences*, *51*(4), 521–526. https://doi.org/10.1016/j.paid.2011.05.012

Phillips, J. G., & Reddie, L. (2007). Decisional style and self-reported email use in the workplace. *Computers in Human Behavior*, *23*(5), 2414–2438. https://doi.org/10.1016/j.chb.2006.03.016

Senol, S., Can, H. O., & Pektas, I. (2012). Decision making and problem-solving skills of midwifery students in Turkey. *Health MED*, *6*(2), 560–567.

Shirren, S., & Phillips, J. G. (2011). Decisional style, mood and work communication: Email diaries. *Ergonomics*, *54*(10), 891–903. https://doi.org/10.1080/00140139.2011.609283

Umeh, K., & Omari-Asor, L. (2011). Emotional vulnerability and coping styles for resolving decisional conflict. *The Journal of Psychology*, *145*(4), 297–312. https://doi.org/10.1080/00223980.2011.565381

Wang, S., & Blazer, D. G. (2015). Depression and cognition in the elderly. *Annual Review of Clinical Psychology*, *11*, 331–360. https://doi.org/10.1146/annurev-clinpsy-032814-112828