LITERATURE REVIEW

Normal aging and decision-making: a systematic review of the literature of the last 10 years

Envelhecimento normal e tomada de decisão: uma revisão sistemática da literatura dos 10 últimos anos

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ABSTRACT

Objective: Conduct a systematic review to investigate whether healthy elderly have deficits in the decision-making process when compared to the young. **Methods:** We performed a systematic search on SciELO, Lilacs, PsycINFO, Scopus and PubMed database with keywords decision making and aging (according to the description of Mesh terms) at least 10 years. **Results:** We found nine studies from different countries, who investigated 441 young and 377 elderly. All studies used the IOWA Gambling Task as a way of benchmarking the process of decision making. The analysis showed that 78% of the articles did not have significant differences between groups. However, 100% of the studies that assessed learning did find relevant differences. Furthermore, studies that observed the behavior of individuals in the face of losses and gains, 60% of articles showed that the elderly has more disadvantageous choices throughout the task. **Conclusion:** The consulted literature showed no consensus on the existence of differences in performance of the decision-making process between old and young, but it is observed that the elderly has deficits in learning and a tendency to fewer advantageous choices.

Keywords
Decision-making, aging, IOWA Gambling Task.

RESUMO

Objetivo: Realizar uma revisão sistemática para investigar se idosos saudáveis apresentam disfunções no processo de tomada de decisão quando comparados a jovens. **Métodos:** Foi realizada uma busca sistemática nas bases de dados SciELO, Lilacs, PsycINFO, Scopus e PubMed, com as palavras-chave *decision making* and *aging* (de acordo com a descrição dos termos Mesh) dos últimos 10 anos. **Resultados:** Foram encontrados nove estudos de diferentes países, que investigaram 441 jovens e 377 idosos. Como resultado, observou-se que 78% dos artigos não encontram diferenças significativas entre os grupos. Porém, 100% dos estudos que avaliaram o aprendizado encontram diferenças significativas. Além disso, dos estudos que observaram o comportamento dos indivíduos perante as perdas e ganhos, 60% mostraram que os idosos apresentam mais escolhas desvantajosas ao longo do teste. **Conclusão:** Os artigos avaliados não apresentaram um consenso em relação à existência de diferenças no processo de tomada de decisão entre idosos e jovens, porém observa-se que os idosos apresentam dificuldade no aprendizado e tendência a escolhas menos vantajosas.

Palavras-chave
Tomada de decisão, envelhecimento, *IOWA Gambling Task*.

Received in
3/25/2014
Approved in
8/31/2014

DOI: 10.1590/0047-2085000000033

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INTRODUCTION

As the world's population is aging, the cognitive decline impacts the quality of life and feeling of well-being in this age range so that behavioral and cognitive changes should be better understood[1,2]. Making decisions is part of everyday life and is an important aspect in the aging because of problems associated with the lifetime, such as retirement, health problems, loss of loved ones and others. In aging it has been increasingly common the maintenance of a productive lifestyle, so that they continue facing complex decisions such as selection of financial options, managing their lifetimes, treatment of multiple diseases and the decision of how to live the following year in the best way. Understanding the decision-making process in the later stages of life, therefore, becomes extremely important[3-5].

The neural mechanisms involved in the decision-making process are a major target of research in the field of cognitive and behavioral neuroscience[6,7]. It is known that the best decision is related to the ability to choose strategies that are part of a particular context, from the anatomical point of view, involves the prefrontal cortical region, especially the ventromedial portion, essential for reasoning and decision-making. However, this is not an only region involved that is vulnerable to aging the neuroanatomical circuitry also include the cingulate cortex, amygdala, striatum, supplementary motor area and dopaminergic circuits, the latter being also related to the reward and learning. With increasing age, these brain circuits become less efficient and can provoke changes in decision-making and reward-related learning[8-16].

Functionally, the process of decision-making has been assessed by neuropsychological tests, being IOWA Gambling Task (IGT) the most used to evaluation of possible cognitive deficits in healthy, neurological, and/or psychiatric populations[17-22]. The IOWA Gambling Task was developed by Bechara *et al.*[23] to evaluate this process in patients with lesion of ventromedial prefrontal cortex. The internationally most-used score is the performance overall value by blocks of cards. In the comprehensive assessment, the performance of a participant is judged by the choices of advantageous decisions quantified by the number of cards chosen from "good" blocks (blocks C and D) minus the number of cards chosen from "bad" blocks (blocks A and B) or [(C + D) - (A + B)][24,25]. At the beginning of the task, individuals choose often cards with higher gains and also with higher losses and, subsequently with experience. Individuals without cognitive impairment learn to choose the best cards and so they maximize gains[19]. The calculation by blocks indicates the learning capacity during testing[24]. The IOWA allows classifying the behavior of individual in terms of skill in adaptive or impaired decision-making[25].

In this way, the aim of this review is to understand the influence of aging in the decision-making process in healthy elderly through studies that used the IOWA Gambling Task as evaluation method, since this is the most used.

METHODS

We performed a systematic search in the database SciELO, Lilacs, PsycINFO, Scopus and PubMed with the keywords *decision-making* and *aging* (according to the description of the Mesh terms). The keywords were combined using the Boolean operator AND, without language restriction. The inclusion criteria were: clinical trials in healthy humans (screening for neurological and psychiatric diseases), comparison of results between young and old subjects, and the last 10 years that used the IGT to analyze the decision-making. We excluded studies involving elderly subjects with neurological pathologies or without comparison with younger individuals. It was considered as the primary outcome the decision-making in healthy elderly. The method used to accomplish this revision followed the model Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[26]. The search result and the selection process are shown in figure 1.

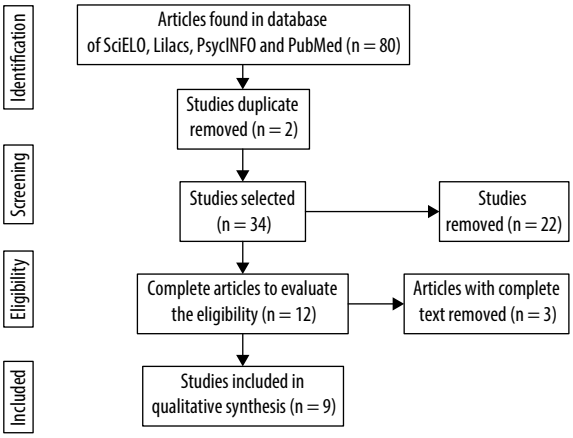

Figure 1. Flowchart illustrating the process of selection and analysis of articles.

RESULTS

We found nine studies from different countries, who investigated 441 young and 377 elderly, and played the IGT as a way of benchmarking the decision-making process. Only two articles showed significant difference in the experiment between young and elderly groups according to the evaluation of the overall performance index. Two studies evaluate the learning during the task proposed by IGT, and these showed differences, with young group presenting better performance (Table 1).

The age-related characteristics of the individuals included in the studies were similar. Neuropsychological assessment applied to the individuals showed wide variation, but all

studies performed exclusion for neurological and/or neuropsychiatric changes to ensure that the findings relate to the healthy elderly. No studies included in this review conducted an evaluation with neuroimaging techniques, which reinforces the need for studies with structural analysis on this subject.

Table 1. Study characteristics and results

Reference	Population	Results
MacPherson *et al.*, 2002[27]	n: 30 young, age: 28.8 ± 6,0 n: 30 adults, age: 50.3 ± 5,7 n: 30 elderly, age 69.9 ± 5,5	Statistically significant differences have not been found between age groups in the performance of IGT
Lamar and Resnick, 2004[28]	n: 23 young, age: 28.4 ± 5,9 n: 20 elderly, age: 69.1 ± 5,0	Differences have not been found between elderly and young individuals in the performance throughout IGT
Wood *et al.*, 2005[29]	n: 88 young, age: 22.14 ± 4,47 n: 67 elderly, age: 77.3 ± 4,61	Elderly and young individuals didn't presented difference in the performance throughout the task. Both groups presented quick learning of the task
Denburg *et al.*, 2005[24]	n: 40 young, age between 26 and 55 years n: 40 elderly, age between 56 and 85 years	Elderly presented significant difference of performance compared with young individuals showing difficulty to choose advantageous cards
Schneider and Parente, 2006[30]	n: 42 young, age: 24 ± 4,43 n: 40 elderly, age: 68 ± 5,01	There was no significant difference in performance and learning among groups of elderly and young
Fein *et al.*, 2007[31]	n: 112 young, age: 37,8 ± 10,8 n: 52 elderly, age: 73.7 ± 7,4	The elderly group played fewer decisions advantageous when compared to young subjects
Zamarian *et al.*, 2008[32]	n = 33 young adults age: 36,1 ± 13,7 n = 52 elderly age: 69,3 ± 7,0	Old and young had similar performance but the elderly showed lower performance compared to young people in the choice of advantageous cards, but no significance
Bakos *et al.*, 2010[33]	n = 36 young adults, age: 29.8 ± 4,63; n = 36 elderly, age: 66.8 ± 5,19	There was no difference in performance between young and old in the overall performance
Carvalho *et al.*, 2012[34]	n: 40 young, age: 25.5 ± 4,7 n: 40 elderly, age: 67.4 ± 5,02	There was no difference in overall IGT performance between young and old There was significant difference to learning throughout the task between the groups, with only learning in young people

DISCUSSION

The objective of this review was to survey the literature on the decision-making process in the old persons compared to young subjects, having as a parameter the analysis of IGT. The results of the studies are contradictory and suggest that the literature don't have consensus about behavioral pattern in the elderly. Most studies do not point difference between elderly and young people in this process. Another outcome presented in studies was about the learning process, only two studies carried out this evaluation and showed differences in the learning process, which is faster and more efficient in young individuals.

Denburg *et al.*[24] proposed an additional classification based on behavior acquired during decision-making, it was about monetary choices in the short and long-term, and thus evaluated the participant with advantageous, borderline or impaired behavior. Using this same classification, four articles evaluated the volunteers' behavior and three of them found elderly patients with significantly impaired performance compared to young subjects[24,31,32]. According to Peters *et al.*[35], changes in the decision-making process related to age favor a poorer quality decision, so that the adaptive processes include greater emotional selectivity and life experience to predict better or worse decisions depending on the situation.

Wood *et al.*[29] also conducted a modified analysis of the IGT proposed by Busemeyer and Strout[36] which evaluated the decision-making with mathematical calculations based on the model of expectancy valence. These authors found a higher valuation gains and expected reward in the elderly group. They also showed that the groups used different strategies: young people used more memory and learning whereas elderly gave more importance to losses and gains. Furthermore, it was also observed that younger individuals showed greater negativity bias at neural and behavioral level whereas elderly did not increase the level of attention before a negative information. It is known that the age-related changes in cognitive abilities such as memory and processing speed as well as increased reliance on automatic and adaptive motivational processes in older adults focus more on affective information (especially positive), what can explain why older and younger adults respond differently to information about risk[3,37].

Regarding knowledge acquired during the task, only two studies conducted this analysis in which was found a significant difference between young and old, with young people showing better learning. Brand *et al.*[38] showed that a poor performance during the IGT can be caused by the deficit in implicit learning, as people can train these skills during the experience gained in the test. Since in IGT, there is no information regarding the likelihood, participants need to learn about the value of the options selected and feedback throughout their choices. The decreased of cognitive stability and flexibility in reaction to advantageous decisions facing negative feedback in the elderly, can lead in learning difficulties in this group associated to these ambiguous conditions[37].

This review has some limitations as the divergence of tests used in neuropsychological assessment, the small number of databases consulted and a possible low sensitivity of IGT as a parameter for comparison, suggesting the investigation of other tests to elderly evaluation.

In fact, our results suggest there is no difference in the decision-making process in the elderly. Still, it is necessary further studies to investigate the performance between young and old, as well as evaluation of the analytical and emotional performance. Furthermore, it is important to have a greater understanding of the strategies used in the process of decision-making and the anatomical areas involved in performing this task, since authors point out that the similarities regarding performance can exist thanks to the involvement of different brain structures and networks (compensatory) in the elderly.

The dorsolateral dysfunction is more sensitive than the ventromedial to the effects of aging, so that changes in executive functioning and working memory are more sensitive to changes at this life stage. By this reason the effects of aging and emotional processing in decision-making are less apparent because they are more specific to the ventromedial area[27].

Rogalsky *et al*.[21] states that elderly without neurological disorders shows impared decision making, like IGT. Through behavioral analysis of include studies, it was observed that five studies classified the behavior of decision-making, and between them three showed that olders have less advantageous decision compared to the young individuals. Beitz *et al*.[39] states that older adults were more likely to forget about recent outcomes and this fact could influence of cognitive ability at IGT with lowered performance in older adults. Bechara *et al*.[40] points out that besides the cognitive deficit, impulsivity can also generate deficit in performance of IGT.

Denburg *et al*.[24] showed that differences in decision-making between young and elderly may be due to disproportionate aging of ventromedial cortex that could explain the slowness in learning and the presence of impulsivity. MacPherson *et al*.[27] asserted that, by the frontal lobe aging theory, the alterations are more evident was in the dorsolateral and therefore, the differences are not observable in the IGT, since this test involves the more ventromedial area. More recently, Lamar and Resnick[28] observed the existence of this disproportionate susceptibility, where the tasks related to the orbitofrontal cortex function has greater sensitivity to the aging effects when compared to the one related with dorsolateral prefrontal cortex function. So, the lack of difference may be due to low sensitivity of IOWA for healthy aging[33,34].

CONCLUSION

Articles evaluated showed there is no consensus on the existence of differences in performance of the decision-making process between old and young. Those who observed the behavior of individuals in the face of losses and gains, 60% of articles showed that the elderly has more disadvantageous choices throughout the task. These findings may be attributed to the use of different cognitive strategies on the part of the elderly and the low sensitivity of IOWA Gambling Task in detecting changes in this population.

INDIVIDUAL CONTRIBUTIONS

Carine Wiesiolek – Substantially contributed to conception, analysis and interpretation of data.

Maria Paula Foss and **Paula R. Beserra Diniz** – Substantially contributed to drafting the article and revising it critically for important intellectual content. They had given the final approval of the version to be published.

CONFLICTS OF INTEREST AND FINANCIAL DISCLOSURES

There were no conflicts of interest and financial support.

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