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The Effect of Age on Decision Making According to the Iowa Gambling Task

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Aging has been associated with several brain changes that often affect the cognitive functioning of adults, but changes in executive functions, particularly in the field of decision making, have not been fully investigated. The Iowa Gambling Task (IGT) is a widely used tool to evaluate decision making, but little is known about the effect of age on its results. This study used the IGT and compared healthy young (n= 40) and elderly (n = 40) adults to evaluate their decision making processes. There were significant differences in the learning curve of the two age groups, but no difference in overall IGT performance. The results for the first IGT block were different from those of the rest of the task, and the group of elderly adults had a better performance in this block. Elderly adults also showed a preference for deck A, the one that resulted in greater losses. Findings confirmed the results of other studies, which reported that the IGT block score is the variable with the greatest sensitivity to age in this instrument.
Keywords: decision making, Iowa Gambling Task, aging, executive functions.

El envejecimiento se ha asociado con diversos cambios en el cerebro que a menudo afectan al funcionamiento cognitivo de los adultos, pero los cambios en las funciones ejecutivas, en particular en el ámbito de la toma de decisiones, no han sido investigados a fondo. La Iowa Gambling Task (IGT) es una herramienta ampliamente utilizada para evaluar la toma de decisiones, pero se sabe poco sobre el efecto que tiene la edad en sus resultados. Este estudio utilizó la IGT y comparó adultos jóvenes (n = 40) y adultos mayores (n = 40) sanos para evaluar sus procesos de toma decisiones. Se encontraron diferencias significativas en la curva de aprendizaje de los dos grupos de edad, pero ninguna diferencia en el rendimiento general de la IGT. Los resultados del primer bloque de la IGT fueron diferentes de los resultados de los bloques restantes, y el grupo de adultos mayores tuvo un mejor rendimiento en este primer bloque. Los adultos mayores también mostraron preferencia por la sección A, la que dio como resultado valores inferiores. Los hallazgos confirman los resultados de otros estudios, los cuales informaron que la puntuación del primer bloque de la IGT es la variable con mayor sensibilidad a la edad de este instrumento.
Palabras clave: toma de decisiones, Iowa Gambling Task, envejecimiento, funciones ejecutivas.

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The growth of the elderly population is an accelerating global phenomenon. Sociodemographic estimates indicate that in 10 years Brazil will have about 30 million elderly adults and will be the country with the sixth largest elderly population in the world (Carvalho & Garcia, 2003). Based on that, studies about cognitive and behavioral changes due to aging have gained importance in the last decades (Grieve, Williams, Paul, Clark, & Gordon, 2007; Nettelbeck & Rabitt, 1992).

Studies about the role of aging in human cognition found evidence of the dissociation between different cognitive components. Although some functions, such as semantic memory and language, seem to be preserved, others, such as episodic memory, prospective memory, working memory and executive components (inhibition, cognitive flexibility, etc), attention and processing speed tend to decline gradually. Although no actual deficit may be defined, it may be inferred that cognitive processing changes along the years (Ska et al., 2009).

The association between age and the processing of executive functions (EF) has been discussed in the literature (Friedman, Nessler, & Cycowicz, 2009; Friedman, Nessler, Johson, Ritter, & Bersick, 2007; Salthouse, 2009). Such interest, originally triggered by the theory of information processing speed, currently extends to other executive components. Executive functions are cognitive processes necessary in new situations for which the organism does not have an automatized behavior, that is, in which a problem is presented and has to be solved. These functions inhibit ongoing processes when they are not coherent with the context, initiate a new behavior, monitor this behavior and change the strategy whenever the environment demands it; they are also used to make decisions about the alternatives offered by the environment (Gilbert & Burgess, 2008; Lezak, Howieson, & Loring, 2004).

Based on the known association between EF and the frontal lobes and their cortical and subcortical connections, several studies showed that, in a percentage of the elderly population, there seems to be a decrease of the cognitive functions associated with the prefrontal cortex, even in the absence of any observable neurological disease (Denburg, Recknor, Bechara, & Tranel, 2006). Several neuroanatomical and neurofunctional studies found evidence of the accelerated decrease of neuronal bodies in the prefrontal region when compared with other brain areas (Grieve et al., 2007).

During EF, decision making is the primordial function for survival. The choices of an occupation, a person to marry, leisure activities and financial investment options among so many others are complex and bring immediate and future rewards and punishments (Brand & Markowitsch, 2010). However, making decisions is particularly important during aging, when biological, emotional and social changes take place (Denburg et al., 2006). Some studies indicate that difficulties in decision making in late adulthood may be compensated for by more automatic processes, which are very efficient in situations that require decision making (Wood, Busemeyer, Koling, Cox, & Davis, 2005). Other investigations, however, showed that aging is associated with impaired decision making (Denburg, Tranel, & Bechara, 2005).

Decision making, studied for several years in cognitive psychology as well as in economics, has been defined as the result of a rational and logical choice from a group of alternatives available in a certain situation. However, a new focus for decision making was described by Damásio in 1996, who suggested that it is strongly affected by emotion by means of implicit processes, which means that decision making is not guided only by rational factors (Damásio, 1996). Damásio and his team used a task which consisted of a card game, currently called the Iowa Gambling Task (IGT) to evaluate decision making based on this assumption. Since then, the IGT has been used as an efficient task to evaluate failures in decision making of patients with different diseases (Bechara & Damásio, 2002; Lawrence et al., 2006; Woicik et al., 2009). Current findings suggest that IGT, although sensitive to detect impairment in decision making, is not very specific because it does not differentiate symptoms of decision making in different diseases. In Brazil, two study groups have adapted the IGT to Brazilian Portuguese (Malloy-Diniz et al., 2008; Scheneider & Parente, 2006). Recent studies have been conducted to evaluate the validity and reliability of its content for the Brazilian population (Cardoso et al., 2011). Other studies to examine criterion validity in a clinical population are underway in Brazil.

The IGT is a game that simulates decision making in real life. The participant chooses one of four card decks in each turn. Decks A and B offer many gains in the short term, but also many financial losses, that end up bringing long term losses and are classified as risky decks. Decks C and D, in contrast, provide few short-term gains, but are better in the long run, and are classified as more conservative decks. Studies with clinical populations with impaired decision making in real life showed that these patients consistently prefer decks A and B and have a poor performance in the IGT (Bechara, Damásio, Tranel, & Damásio, 1997; Buelow & Suhr, 2009).

Although it has great validity in the evaluation of decision making in clinical populations, studies with healthy populations are scarce. The knowledge about the role of age in decision making, derived from studies using the IGT, remains insufficient for the areas of developmental and clinical neuropsychology. To understand better the role of this important sociodemographic and biological variable in decision making, this study used the IGT and compared groups of young and elderly adults to evaluate their global performance and their learning during decision making.

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Method

Participants

This study included 80 healthy adults divided into two groups according to age: young (n = 40) and elderly (n = 40) adults. All participants had at least 11 years of schooling. Participants were volunteers recruited for a convenience sample in university setting: young adults in undergraduate courses, and the elderly in community groups organized by the university. The evaluations were performed in the Service of Psychological Care and Research of Pontifícia Universidade do Rio Grande do Sul (PUCRS), Brazil, or in the participant's home, according to the participant's preference. In addition to age, the following exclusion criteria were used: any uncorrected sensory (hearing or sight) disorder (self-reported sociocultural questionnaire data); current or previous use of illicit drugs or benzodiazepine, antidepressive or antipsychotic drugs (self-reported sociocultural questionnaire data); signs suggestive of depression (Beck Depression Inventory II [Beck, Steer, & Brown, 1996], score > 19) or dementia (screening with Mini Mental adapted to the local population by Chaves & Izquierdo, 1992, score ≥ 24); history of alcoholism (CAGE scale, version used in the study by Amaral & Malbergier, 2004); and signs suggestive of other psychiatric disorders (Self Report Questionnaire [SRQ] developed by Mari & Willians, 1986). In addition to these criteria, the study only included participants that had a WAIS-II weighted scored greater than 7 in the cubes and vocabulary subtests.

Procedures and Instruments

The instruments were administered individually in an appropriate environment, that is, in a quiet room with good lighting and temperature, and all the ethical parameters for studies with human beings were followed. All participants signed an informed consent term, and the study was approved by the Ethics in Research Committee of Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Porto Alegre, Brazil (042/2009-SGL). The participants were evaluated in sessions that lasted a mean 1.5 hour, when instruments were used to define sample characteristics and inclusion criteria and to measure the dependent variables indicative of decision-making performance according to the Iowa Gambling Test (IGT).

A computer-based IGT version was used, based on the version currently used by the instrument's author and adapted to Brazilian Portuguese by Schneider and Parente (2006). The IGT is a card game that evaluates the decision making process of individuals according to risk taking or risk aversion. Two IGT scores are usually evaluated. The first is the total score, which corresponds to the sum of all choices of the favorable decks (C+D) minus the sum of choices of the decks classified as risky (A+B) during 100 trials; the result is the total score of the advantageous choices of the participant in the game. The second score, called block score, represents how much learning took place during the game. To calculate this score, the task is divided into 5 blocks of 20 trials each. The same calculation (C+D-A-B) is made for each task block. Another analysis commonly used in the literature is how much the participant's decision making is impaired during the task. For that purpose, we used a scale adopted in several international studies (Denburg et al., 2005; Weller, Lewin, & Bechara, 2009), which classifies the participant's performance as not impaired (scores greater than 18), borderline (scores from -18 to 18), and impaired (scores lower than -18).

Data analysis

Data were analyzed descriptively and inferentially. The SPSS 13.0 was used for statistical analyses, and the level of significance was set at $p \leq .05$. The Student t test was used for the independent variables age and schooling, and a chi-square test, for sex. The Student t test for independent samples was used to compare the total IGT scores of each group and the group preferences for each of the IGT decks. To compare learning during the task (calculated as blocks), repeated measures analysis of variance (ANOVA) was used. The results of a chi-square test classified groups according to decision-making impairment.

Results

Sociodemographic characteristics of the sample:

Table 1 shows the descriptive and inferential sociodemographic data for both comparison groups. There were no significant sociodemographic differences between groups, except for the variables schooling and age.

Table 1
Sociodemographic characteristics of the sample

Variables	Young Adults (n = 40)	Elderly Adults (n = 40)	p
Sex			
Male-to-female ratio	18 (45%)/22	10 (25%)/30	.061
Age M/SD	25.50 (4.70)	67.40 (5.02)	$p \leq .01$**
Schooling M/SD	15.74 (2.69)	14.68 (2.80)	.092

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Total Score – Overall Task Performance

The first analysis between the two groups was the comparison of global IGT performance using the total score. Statistical analysis revealed that there were no significant differences between young (M = 9.50; SD = 24.95) and elderly (M = 3.93; SD = 21.64) adults in the total IGT score (p = .28). The standard deviations in both groups were high, which suggests that the sample was heterogeneous.

Table 2 compares the deck choices for the two groups during the task. The group of elderly adults chose significantly more deck A cards, a deck that is classified as disadvantageous. There were no significant differences in the preference for the other decks, less implicit ones.

Learning during the IGT

One of the mains scores analyzed in the IGT refers to learning during the task (Table 3 and Figure 1). The groups were compared according to their performance in each block, as shown in Table 3. In ANOVA, the group was the intersubject factor, and the blocks that compose the task, the intrasubject factor (Figure 1).

Table 3 shows that, when the blocks were analyzed separately, there was a significant difference only in the first block of the task, that is, in the first 20 trials. The analysis of learning during the task (Figure 1) revealed significant differences between blocks in the group of young adults ($p \leq .01$), but not of elderly adults (p = .224), which is indicative of learning only in the group of young adults. There were also significant differences in learning during the task between groups (p= .021).

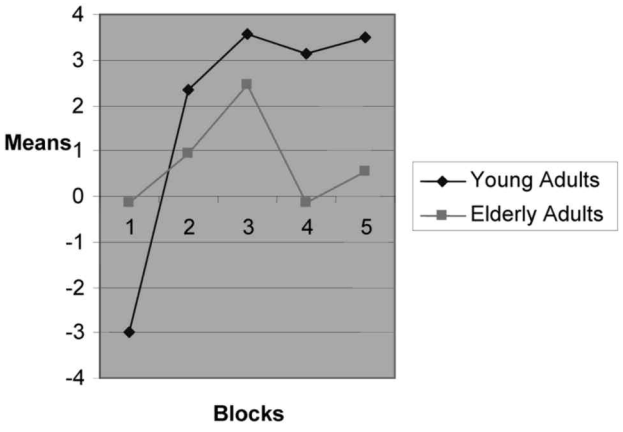

Figure 1. Group means according to task blocks.

Table 2
Deck preference according to group

		Mean/Standard Deviation	p
Deck A	Young Adults	14.75/6.27	p = .006**
	Elderly Adults	18.90/6.77	
Deck B	Young Adults	30.90/13.43	p = .54
	Elderly Adults	29.23/11.14	
Deck C	Young Adults	20.88/10.06	p = .45
	Elderly Adults	22.30/6.72	
Deck D	Young Adults	34.28/11.18	p = .07
	Elderly Adults	29.85/11.52	

** statistically significant difference: $p \leq .05$

Table 3
Performance in each of the 5 task blocks according to group

		Mean/Standard Deviation	p
Block 1	Young Adults	–3.00/6.12	**p = .031
	Elderly Adults	–0.15/5.44	
Block 2	Young Adults	2.35/4.66	p = .22
	Elderly Adults	0.95/5.54	
Block 3	Young Adults	3.55/7.33	p = .47
	Elderly Adults	2.45/6.26	
Block 4	Young Adults	3.15/9.36	p = .08
	Elderly Adults	–0.15/6.67	
Block 5	Young Adults	3.50/9.65	p = .61
	Elderly Adults	0.55/8.37	p = .148

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Table 4
Distribution of impaired, borderline and not impaired results according to group

Performance Classification	Young Adults (n = 40)	Elderly Adults (n = 40)
Not impaired	16 (40%)	10 (25%)
Impaired	5 (12.5%)	8 (20%)
Borderline	19 (47.5%)	22 (55%)

Analysis of Individual Impairment in Decision Making

The performance of groups based on the analysis of impairment is shown in Table 4, according to which there were no significant differences between groups (p = .173).

Discussion

In general, only one of the IGT scores differentiated the age groups under analysis in this study. In agreement with the studies conducted by Lamar and Resnick (2004), Schneider and Parente (2006) and Isella et al. (2008), there were no significant differences in the global IGT performance between young and elderly adults. One of the hypotheses to explain this result is that both young and elderly adults have a positive global performance in decision making, but use different cognitive strategies. According to this hypothesis, formulated by Wood et al. (2005), young adults have better working memory, recall and learning, whereas elderly adults benefit from a different emotional processing during the task. Elderly adults seem to pay greater attention to emotional information, such as task losses and gains, and this automatic and implicit processing may guide them to a global IGT performance that is as advantageous as that of young adults. Therefore, the use of analytical processing seems to guide young adults in decision making, whereas elderly adults benefit from a predominantly emotional processing (Mather, 2006). Such compensation among elderly adults has been called "positive bias" by some authors (Wood et al., 2005).

The hypothesis of differences in cognitive processing between young and elderly adults is supported by the separate analysis of each block. There were significant difference only in the first block of the task, in which the elderly adults had a better performance than young adults. This is the most implicit block in the task, and processing is totally guided by emotion. Decision making in this first stage of the task is ambiguous because the participant has no sufficient time to experience contingencies of gains and losses and, therefore, no pattern of learning during the task may be observed (Buelow & Sur, 2009). Consequently, elderly adults may have benefits in this first part of the task, in which cognitive processes that decline with aging, such as mnemonic components, are still little demanded, whereas implicit mechanisms are more important.

The learning curve during the task confirmed findings by Schneider and Parente (2006), Isella et al. (2008) and Denburg et al., 2005), as there were significant differences between age groups. Only the group of young adults learned during the task. This variable, calculated according to blocks, has been the most common in international studies using the IGT, particularly when the study aims are sociodemographic variables and their role in decision making. In several studies, this is the only variable analyzed, and learning during the task is synonymous with advantageous decision making, as, for example, in the study conducted by Denburg et al. (2005). Therefore, several international studies using the IGT considered decision making more advantageous among young adults than among the elderly because of successful learning.

In our study, the groups of young and elderly adults had a heterogeneous profile of IGT results, confirmed by the wide distribution of standard deviations in both groups. Similar heterogeneity has been found in studies with Brazilian populations conducted by Schneider and Parente (2006). Further studies should be conducted to understand such wide IGT performance variation, regardless of specific sociodemographic characteristics. One of the current hypothesis suggests that personality traits (Schneider-Bakos, 2008), a variable not often included in neuropsychology studies, should be evaluated.

The analysis of choice of decks revealed a preference for deck A, the most disadvantageous deck, among the elderly adults. This finding suggests a tendency towards risky behaviors among elderly adults, which does not confirm the popular assumption that there is a tendency towards a more conservative behavior as people grow older (Mather, 2006). This finding also differs from those reported by Caufman et al. (2010), who studied the performance of young adults, adolescents and preadolescents in the IGT and found that there was a tendency towards more conservative behavior as individuals aged. Those authors found a greater avoidance of the risky decks among young adults than among adolescents and preadolescents.

Using the classification of participants' decision making into "impaired", "borderline" and "not impaired" classes, Denburg, Bechara, Cole, and Tranel (2001) and Denburg et al. (2005) found that most elderly adults (about 33%) had an impaired decision making in the task, and this difference was significant. Based on that classification, our study found that 20% of the elderly adults and 12.5% of

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the young adults had their IGT performance classified as impaired. Although more elderly adults were classified as impaired, there were no significant differences between the two groups. However, the percentage of individuals classified as impaired or borderline in was high in both groups. As the cut-off points were those used for American populations, normative studies with healthy and clinical Brazilian populations should be conducted.

Studies about the role of age in decision making reported rather contradictory results, as seen above. In general, our data are in agreement with findings reported in international and Brazilian investigations. Different results are found for the role of age in decision making depending on which variable is used to classify decision making performance as advantageous. If the total score is used, our study, as most previous studies, found no significant differences between young and elderly adults. However, when the block score is used and the learning curve during the task is analyzed, there are significant differences between groups.

As the IGT is a complex task that demands both explicit and implicit mechanisms, as well as analytical and emotional processing, the performance of young and elderly adults should be further investigated. Both groups may have a satisfactory overall performance in decision making using different cognitive strategies. However, the difference in learning during the decision making task is evidence of a poorer task performance among elderly adults.

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