DECISION-MAKING IN AGING:

AGE-RELATED DIFFERENCES IN DECISION UNDER AMBIGUITY AND DECISION UNDER RISK

Alessia Rosi[1], Elena Cavallini[1], and Riccardo Russo [1-2]

[1] Department of Brain and Behavioral Sciences, University of Pavia, Italy , [2] Department of Psychology, University of Essex, United Kingdom

e-mail: alessia.rosi@ateneopv.it

Introduction

Results of studies on age-related effect on decision-making process suggest that the difficulty in older adults to make advantageous decisions seems to depend on the type of decision situation. However, these studies reported mixed results (e.g. Brand & Schiebener, 2012; Henninger et al., 2010; Zamarian et al., 2008).

Some studies showed poor performance of older adults than younger in ***decision under ambiguity***, i.e. when situation does not provide explicit information about probabilities of outcomes and individuals have to rely on experience acquired through feedback to decide. Conversely, other studies found that older than younger adults have a poor performance in ***decision under risk***, i.e. when the situation offers explicit information about decision's consequences and probabilities of outcomes.

These contrasting results could depend on (a) the complexity of the decision-making task employed, (b) how decision information is presented and/or (c) the cognitive load demanded by the task.

The main aim of the study was to better understand the age-related differences in decision-making performance under ambiguity and risk. Three different tasks were employed: one decision-making task under risk, the Game of Dice Task (GDT), and two decision tasks under ambiguity of different complexity, the Iowa Gambling Task (IGT) and a more "child-friendly" version of the IGT called Hungry Donkey Task (HDT), which should be easier than the IGT.

In addition, participants performed tasks on working memory ability and executive functioning (shifting, updating, inhibition) in order to assess the extent to which age-groups differences in cognitive abilities could account for any age-related differences in decision under ambiguity or decision under risk.

Method

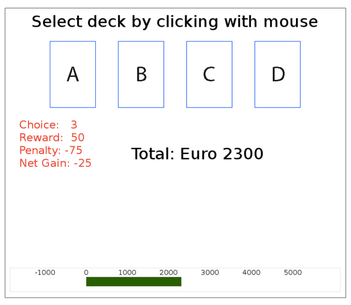
Participants: 50 young adults (age 20 to 37 years) and 50 older adults (age 60 to 85 years) participated in the study. Young adults were recruited at University of Pavia. Older adults were recruited from University of Third Age of Pavia.

	Young adults	Older adults
Age	23.02 (*3.08*)	71.78 (*6.13*)
Years of education	15.64 (*1.14*)	14.48 (*3.62*)
MMSE	-	29.34 (*1.06*)
Vocabulary	44.00 (*2.71*)	46.88 (*2.60*) *
% female	68	70

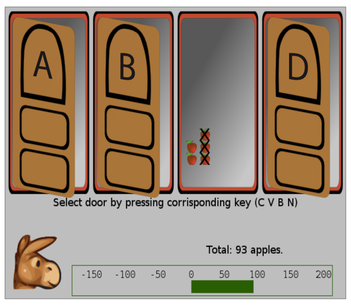
Note: MMSE = Mini Mental State Examination; Maximum MMSE score = 30; Maximum vocabulary score = 50. Standard deviations are indicated in parenthesis.
*$p < .05$

Measures:

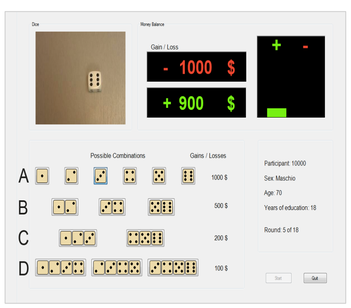
Decision-making tasks:



Iowa Gambling Task (**IGT**; Bechara et al., 2000): the computer-based version of the IGT assessed decision under ambiguity. Participants selected cards, one at the time, from each of four decks (A, B, C, D). Each deck was associated to more or less favorable contingencies of wins and losses of money, to be discovered while playing the game. The goal was to win as much as possible choosing more cards from advantageous/safe decks (C and D) than disadvantageous/risky ones (A and B) over 100 picks.



Hungry Donkey Task (**HDT**; Crone & Van der Molen, 2004): the computerized version of the HDT assessed decision under ambiguity. Here instead of decks of cards there were four doors (A, B, C, D). Participants' goal was to help the hungry donkey to collect as many apples as possible over 100 selections. Doors were associated with wins and losses of apples: doors C and D were advantageous/safe doors, while A and B were disadvantageous/risky.



Game of Dice Task (**GDT**; Brand et al., 2005): the computerized GDT assessed decision under risk. Participants are instructed to win as much money as possible within 18 throws of a single virtual dice. Before each throw, they have to guess which number or combination of numbers will be thrown. In contrast to IGT and HDT, in the GDT potential gains and losses linked to different choices are explicitly explained to the participants. The choices of one (A) or two numbers (B) were disadvantageous/risky, while the choices of three (C) and four numbers (D) were advantageous/safe.

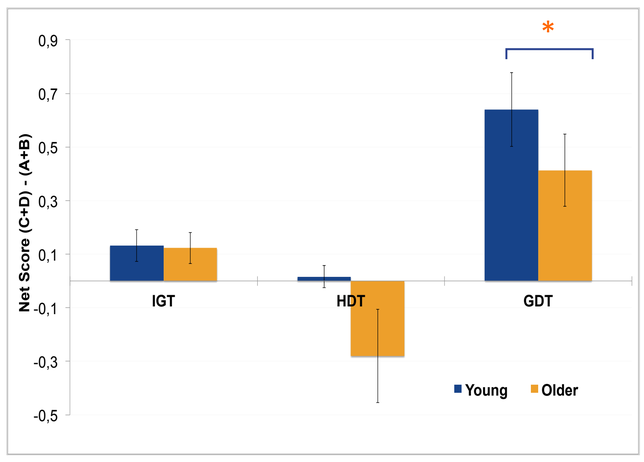
Note that IGT, HDT and GDT presented two advantageous and two disadvantageous alternatives. Hence, in order to compare performances between the three tasks, we calculated for each task a total net score [(disadvantageous choices) – (advantageous choices)] and the mean number of choices for each alternatives: risky alternatives (A and B) and safe alternatives (C and D).

Cognitive tasks:

Working Memory: Backward Digit Span (adapted from WAIS; Wechsler, 1981)
Shifting: Trial Making Test Part B (Retein & Wolfson, 1985)
Updating: Numerical Updating test (Carretti et al., 2007)
Inhibition: Stroop Test (Cafarra et al., 2002)

Results

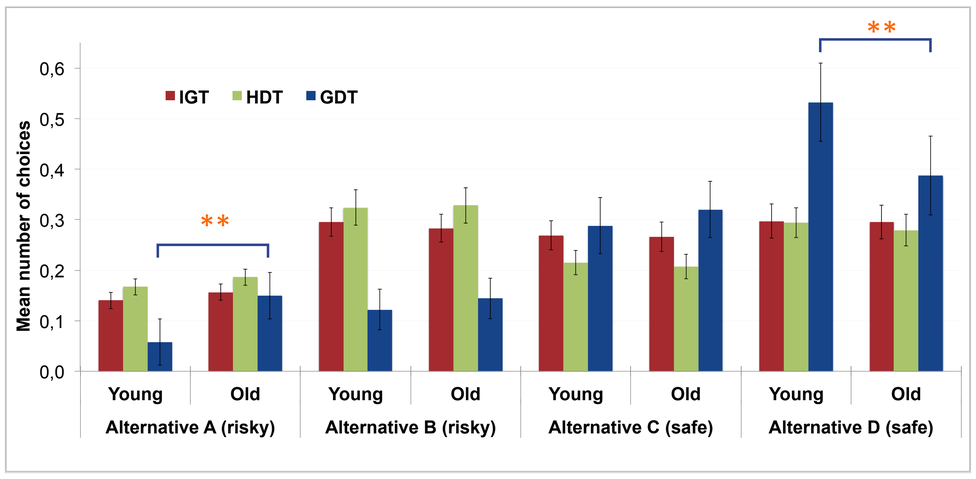
Age Differences in Decision Under Ambiguity and Decision Under Risk



Main effect of Task, $F(2, 196) = 72.29$, $p < .001$. Participants made more advantageous decision in the Game of Dice Task than in the Iowa Gambling Task, and than in the Hungry Donkey Task. Performance in the IGT was significantly higher than in the HDT.

Interaction Age by Task, $F(2, 196) = 3.22$, $p = .04$. Older made more disadvantageous choices than younger adults only in the Game of Dice Task, $t(98) = 2.30$, $p = .02$.

Age Differences in Riskiest and Safest Alternatives by Task



Interaction Age by Task by Alternative, $F(6, 588) = 3.04$, $p = .006$. In the Game of Dice, older adults preferred more the riskiest alternative, $t(98) = -2.81$, $p = .006$, and less the safest alternative, $t(98) = 2.63$, $p = .010$, than younger adults.

Only in the GDT, performance on the riskiest and the safest alternatives significantly correlated with age and with cognitive measures, ranged from $r = .26$ to $.39$.

Moderator Analysis with the Riskiest and the Safest Alternative in Decision Under Risk (GDT) as Dependent Variables

		Riskiest alternative			Safest alternative		
Predictors		***β***	***T***	***p***	***β***	***T***	***p***
Main effects	"age"	.27	2.81	.006	-.26	-2.63	.010
	"years of education"	-.36	-3.88	<.001	.25	2.65	.009
Interaction	"age" x "years of education"	-1.20	-1.16	.249	.42	.38	.701
Main effects	"age"	.27	2.81	.006	-2.26	-2.63	.010
	"working memory"	-.22	-2.18	.031	.04	.36	.719
Interaction	**"age" x "working memory"**	**.48**	**-2.20**	**.030**	.19	.44	.660
Main effects	"age"	.27	2.81	.006	-.26	-2.63	.010
	"shifting"	.22	1.75	.083	-.19	-1.52	.132
Interaction	"age" x "shifting"	.67	.646	.520	-.37	-.35	.726
Main effects	"age"	.27	2.81	.006	-.26	-2.63	.010
	"updating"	-.17	-.46	.147	.01	.12	.906
	"age" x "updating"	-.21	-.64	.525	.25	.74	.461
Main effects	"age"	.28	2.89	.005	-.25	-2.60	.011
	"inhibition"	.27	2.80	.006	-.22	-2.31	.023
	"age" x "inhibition"	.39	.90	.369	-.26	-.59	.559

Note. All predictor variables were centralized.

The interaction effect "age" multiplied by "working memory" was a significant predictor of "GDT riskiest alternative", $R^2 = .16$, $F(1,96) = 6.11$, $p = .001$.
Older adults with decreased abilities in working memory made more risky decisions in GDT.

Conclusions

- The pattern of age-related differences on decision making performance varies considerably both as a function of the task used and of the decision situation:

a) Old and young showed comparable performance in the two decision making tasks involving decision under ambiguity, i.e. IGT and HDT. Contrary to our assumption, the HDT was more difficult than the IGT.

b) Old adults showed poor performance on the GDT compared to young adults, indicating difficulty in making advantageous decision under risk condition.

- The relationship between age and GDT performance is moderated by working memory abilities. A good working memory has protective function in older adults with respect to their decision under risky condition.
- The features in which information is represented is a critical factor to consider when investigating age-related differences in decision-making process.