Effects of Aging on Maximizing Rewards and Minimizing Losses in a Choice Task

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Introduction

Several brain regions implicated in decision-making have also been shown to be susceptible to age-related deterioration.[1,2]

In experience-based decision making tasks participants must either maximize gains or minimize losses in order to reach a bonus criterion.

Older participants may be less able to maximize rewards and minimize losses, relative to Younger participants..

Aims of Study

Examine how well Older participants exploit the most rewarding options in the environment.

Compare performance of Older participants to Younger participants.

Use data from structural MRI scans to measure correlations between volumes of specific brain regions with performance measures.

General Methods

20 Older Participants (Aged 61-81) and 20 Younger Participants (Aged 18-23) participated.

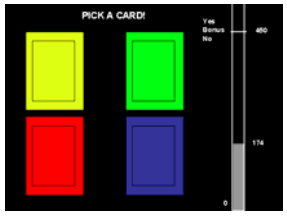
Participants were matched on scaled WAIS vocabulary (F=1.97)

Completed two sessions one week apart.

Chose from one of four decks of cards on each trial.
Gains Condition: Gained 1-10 points
Losses Condition: Lost between 1-10 points

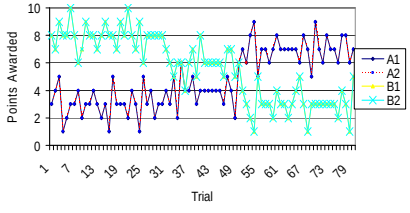
Performed Gains and Losses Tasks on separate sessions

General Methods



An exploitative strategy led to optimal performance.
Exploit the A Decks for trials 1-50
Exploit the B Decks for trials 51-80

Reward Values Given for Each Deck



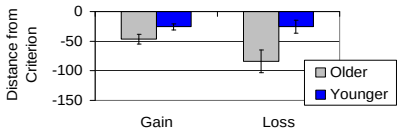
Decks A1 and A2	Decks B1 and B2
3 points over the first 30 trials	8 points over the first 30 trials
4 points over the next 20 trials	6 points over the next 20 trials
7 points over the last 30 trials	3 points over the last 30 trials

Bonus criterion was set at 550 points

Results

Behavioral Measures

Distance from Criterion



There was a significant main effect of age.
Younger participants came significantly closer to reaching the bonus criterion.

Model Based Analysis

Compared the degree to which participants exploited the best options on each trial using a simple reinforcement learning model[3]

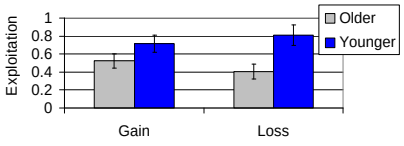
$$E_{k+1} = E_k + \alpha[r_{k+1} - E_k]$$

Updates the expected values for each option.

$$P_{a,t} = \frac{e^{(\gamma E_t(a))}}{\sum_{b=1}^{n} e^{(\gamma E_t(b))}}$$

Determines the probability for selecting each option.
Higher exploitation (γ) parameter values indicate a more exploitative strategy.

Exploitation Parameter Values



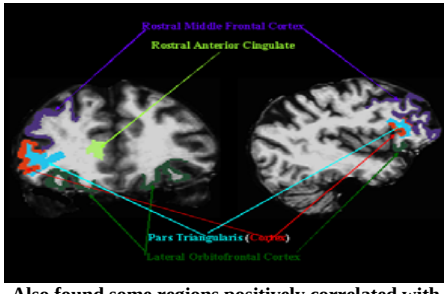
Younger participants had significantly higher exploitation parameter values.
Indicates greater exploitation of the best options for Younger participants.

Structural Imaging

Performed structural MRI scans on a subgoup of Elderly participants (N=9).
Obtained correlations between behavioral and model-based measures with volumes of specific brain regions
Positive Correlations – could suggest larger volumes in these regions lead to more exploitative decision-making strategies
Negative Correlations – could suggest larger volumes in these regions lead to more exploratory decision making.

Results

Several frontal regions were negatively correlated with performance in the Gains task
Suggests a possible role in Exploratory decision making.



Also found some regions positively correlated with performance in the Losses task.:
Left and right rostral middle frontal
Left caudal anterior cingulate
Right inferior –parietal
- Could suggest a role in loss aversion or exploitation

Conclusions

Older participants were less able to maximize gains and minimize losses relative to Younger Controls
-Possibly due to Older participants having more exploratory strategies.

The volumes of several frontal regions were negatively correlated with performance on our Exploitative task
-These areas possibly facilitate exploration

1. Marschner, A., Mell, T., Wartenburger, I., Villringer, A., Reischies, F.M., Heekeren, H.R., (2005). Reward-based decision-making and aging. *Brain Research Bulletin, 67,* 382-390. 2. Mell, T. Heekeren, H.R., Marschner, A., Wartenburger, I., Villringer, A., & Reicschies, F.M., (2005). Effect of aging on stimulus-reward association learning. *Neuropsychologia, 43,* 554-563. 3. Sutton, R.S., & Barto, A.G., *Reinforcement Learning: An Introduction* MIT Press, Cambridge, Massachusetts, 1998.

http://homepage.psy.utexas.edu/homepage/group/MaddoxLAB/ Supported by AFOSR grant FA9550-06-1-0204