Introduction

The goal of this project is to evaluate the potential influence of positive and negative incentives on memory encoding and its subsequent retrieval in both an aging sample and in participants with Parkinson’s disease (PD) both ON and OFF medication.

Healthy older adults (OA) display a proclivity to avoid loss and maintain resources, whereas younger adults (YA) are actively goal-oriented and focus efforts on maximizing gains. Individuals with PD have diminished levels of dopamine, a neurotransmitter which has been tied to increased positive reward sensitivity. Alterations in dopamine or norepinephrine levels in both healthy OA and individuals with PD may be mediating these reward sensitivity changes in goal-oriented behavior and impacting broader cognitive functions.

This study will examine the differential effects of positive and negative incentives on encoding memory strength in an episodic memory task, using both pupil dilation and recognition performance as proxy measures of memory strength. Investigating how positive and negative incentives may differentially affect memory encoding and subsequent retrieval across these groups via the lens of pupillometry will provide further insight into the role of norepinephrine and dopamine in the domain of incentivized behavior.

Methods

1) Pupillometry
   A. Pupil dilation: indirect biomarker of activity in the locus coeruleus-noradrenergic system (LC-NA).
   B. Associated with changes in attention, mental effort, and arousal.
   C. Also associated with memory retrieval, with previously-studied old items eliciting greater pupil dilation than new items (termed the old-new effect) and may reflect the strength of the memory trace.
   D. May work in parallel with the dopaminergic system.

2) Behavioral Paradigm
   A. Study/Encoding: Participants will study 45 words presented in three conditions: low-gain, high-gain and high-loss. These words were presented in one of three colors to denote their assigned value and would require successful recognition during the test phase in order to gain points or avoid losing points. Stimuli will be presented one at a time in the center of the screen following a fixation cross.
   B. Test/Retrieval: Participants will view all 45 old words along with 45 new words in random order and will be asked to make an old or new judgment on whether they recognized the word or not while measuring their pupillary response at the presentation of each stimulus, as well as during encoding. After the judgment, participants will be told if they were correct, incorrect or if the word was a new word they had not seen before.

Hypotheses

Experiment 1: YA & OA Participants
1) We expect age-related differences in sensitivity to gains and losses, wherein OA display higher average recognition for high-loss words as well as an increased pupillary response both during encoding and retrieval.
2) YA should display comparably high behavioral and pupillary results for both high-gain and high-loss.

Experiment 2: PD Participants
1) Participants both ON and OFF medication with display a favoritism towards high-loss words in both the behavioral and pupil data.
2) Participants ON dopamine medication will display an overall greater pupil dilation and increased recognition for high-gain words.

Results: Pilot Study

1a) In line with our pilot study, we believe that similar patterns of recognition will arise in Experiment 1 due to theories of the differential salience of negative or loss-oriented stimuli/choices in older adults.
1b) OA pupil data may follow the behavioral patterns in that high-loss words will elicit the greatest pupil response during encoding and retrieval, whereas high-gain and high-loss will be equally salient for YA.
2a) In Experiment 2, PD patients will exhibit an increased favoritism towards high-loss words, similar to that of the OA participants in Experiment 1, but recognition for high-gain words will increase for patients ON dopamine medication.
2b) PD patients OFF medication should exhibit blunted pupil response during retrieval of all incentive conditions, but this should significantly increase while ON medication.
2c) High-loss words should elicit an increased pupil dilation in both conditions, but dopamine medication should increase pupil response when retrieving and encoding high-gain words.

If no significant difference in pupil response between the three incentive conditions arises, this could point toward the existence of a dissociation between visual perception and strategic processes and simply a strict change in strategy and behavioral patterns.

Conclusion/Implications

This research project will serve to inform the field’s knowledge on lifestyle and age-related changes in perceptions of positive and negative incentives. Additionally, by incorporating PD patients, possible effects from dopamine therapy can be more cleanly analyzed for not just its role in positive and negative reward sensitivity, but also in conjunction with pupillary analysis in the same paradigm.