Brain Potentials Reflect Changes in Memory with Age

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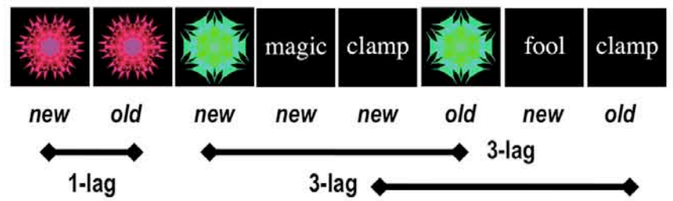
Introduction

- Many behavioral and Event-Related Potential (ERP) studies have shown that recognition memory declines with typical human aging; however, declines in explicit memory are even greater in patients with amnestic Mild Cognitive Impairment or probable Alzheimer's disease.
- Recent evidence using an incidental-learning paradigm (Olichney et al., 2008, *Neurology*) has suggested that ERPs can be effective predictors of the transition from normal to pathological aging.
- ERPs can be used to differentiate explicit and implicit contributions to recognition memory performance (Voss & Paller, 2008, *Neuropsychologia*).
- In the present study we utilized a continuous recognition paradigm with words and kaleidoscope images to elicit ERPs in younger and older adults for the purpose of developing a method to measure explicit memory in older adults and to serve as an Alzheimer biomarker.

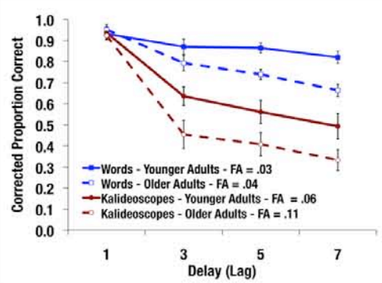
Method

- There were 10 blocks of trials, each containing: 20 "new" stimuli, 8 "old" immediate repetitions (1-lag), and 4 each of 3-, 5-, 7-lag old stimuli. Half of the stimuli were words and half kaleidoscopes. Each stimulus was only used in a single block. Each block began with a filler trial and participants received a 30 s break between blocks.
- During each trial, the stimulus was presented for 1 s and then replaced by a fixation cross until response. Participants were told to press one button for "new" stimuli and one button for "old" stimuli.
- EEG data were collected for 38 channels (sampling rate 512 Hz) using Biosemi Active2 electrodes, including 4 channels for EOG. Data were filtered offline (0.01-Hz high-pass and 59-61 Hz) and all channels were corrected for ocular artifacts using a PCA-based algorithm in EMSE (Source Signal Imaging).



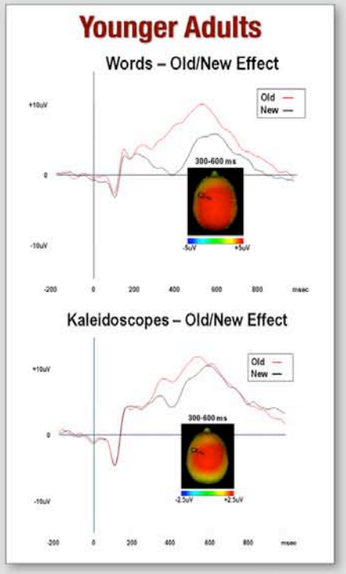
Sample trial sequence from the continuous recognition paradigm. Each stimulus was presented for 1 s followed by a fixation cross until response. Each block of trials had lags of 1, 3, 5, and 7 for both words and kaleidoscopes.

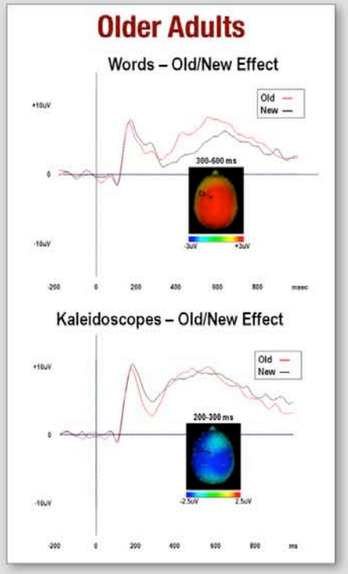
- Participants:
  - 13 younger adults (age *M* = 20 yrs, *SD* = 1) recruited from Loyola and Northwestern Universities.
  - 7 older adults (age *M* = 72 yrs, *SD* = 2) recruited from Northwestern University's CNADC Clinical Core, all within 1.5 *SD* of age-based norms on a neuropsych battery, including several measures of long-term memory.



Older adults performed worse than younger adults with both stimulus types at 3-, 5-, and 7-lags, but not at 1-lag trials (scores for lags 3, 5, and 7 were corrected for guessing by subtracting the false alarm rate (see legend) calculated from new trials). Error bars are ±1 SEM.

- ERPs elicited by new and old words and kaleidoscopes were averaged separately for each response type (ERPs shown for correct trials only). Waveforms were smoothed with a 20-Hz low-pass-zero-phase-shift Butterworth filter for presentation purposes only.
- ERP old/new effects tended to take the form of greater positive ERPs for old compared to new stimuli — an effect commonly attributed to an LPC component (late positive complex).





Summary

- Older adults showed impaired memory when tested beyond the span of immediate memory (lags 3-7).
- ERP results provided signs of impaired memory function.
  - For words, old/new effects were smaller in amplitude for older compared to younger adults.
  - For kaleidoscopes, younger adults exhibited positive old/new effects whereas older adults exhibited negative old/new effects possibly indicative of the use of implicit memory (Voss & Paller, 2009, *Nat Neurosci*).

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