Consumer choice in older adults: What happens when memory matters?

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Aging affects the neural mechanisms of value retrieval during choice, but not value-magnitude processing during encoding.

Introduction

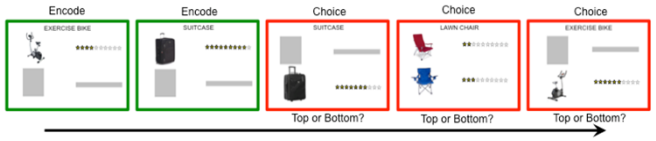
Decision making is a complex cognitive process that relies on several, more basic domains of information processing. In particular, short-term memory is likely to play a significant role in everyday consumer decisions as people often learn new information about competing products that they later retrieve during purchasing decisions.

Previous research indicates that changes in economic decision making with aging are partly explained by deficits in learning and memory (Henninger et al., 2010; Mata et al., 2011; Yoon et al., 2009). Aging may also affect the representation of value information. Studies suggest that response to reward is maintained in healthy older adults (Samanez-Larkin & Knutson, 2014), but little is known about whether aging affects numerical or abstract magnitude processing (Wood et al., 2009) – which is critical in evaluation of competing choice options.

The current study sought to examine age differences in the neural correlates of a simple choice task in which value information for pairs of competing products were presented at different delays.

Primary question: When choices rely on short-term memory, which aspects of value-based choice processing are affected by normal aging?

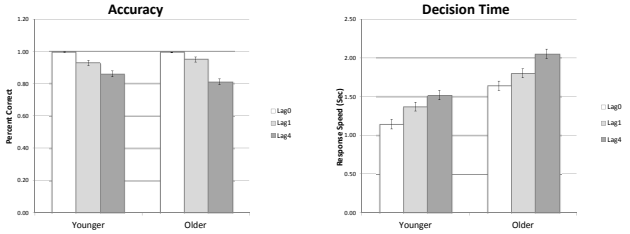
Paradigm & Behavior



- Participants were healthy younger (YAs; n=20) and older adults (OAs; n=22).
- Encoding trials: participants learned the star ratings for specific products from Amazon.com.
- Choice task: participants selected one of the competing items, which were either presented together or with a lag.
- Choice trial lags
  - -no delay (*Lag0*)
  - -immediate retrieval (*Lag1*)
  - -delayed retrieval (*Lag4*)
- Decision competence measures
  - -comprehension
  - -cognitive reflection

Performance was high overall and showed an indication of a speed/accuracy trade off in older adults.

There were no main effects of age on accuracy, but there was an age X lag effect (p<.05). Performance was similar for *Lag0* and *Lag1* trials, but marginally lower in older adults for *Lag4* (p=.06). Older adults had slower decision times overall (p<.001) and both groups were slower with increased lag (p<.001).



Results

Analytic Approach

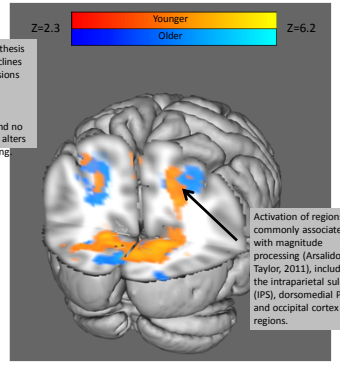
- **Model 1**: Encoding phase parametric analysis of product-value magnitude (star rating)
- **Model 2**: Choice phase effects and contrasts lag type (*Lag0*, *Lag1*, *Lag4*), accurate trials only
- **Model 3**: Choice phase connectivity analysis (PPI) with seed region from Model 2, associated with increased activation in OAs vs. YAs for accurate choice at longer vs. shorter delays (i.e., "compensatory region")
- **Region-of-interest analysis**: Zstat values were extracted from candidate regions for age-related compensation and correlated with external measures of decision competence

Imaging data was analyzed with FSL 5.0.1. All Z-stat images were thresholded at Z>2.3 with a cluster threshold of p=0.05.

Model 1: Parametric value encoding

There were no significant age differences in value magnitude processing. Both groups showed activity in standard magnitude processing regions including the IPS.

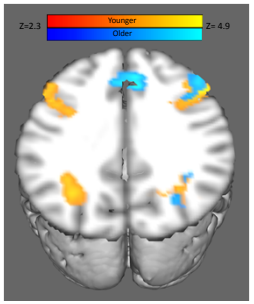
We tested the hypothesis that age-related declines in value-based decisions are attributable to declines in neural representation of magnitude. We found no evidence that aging alters magnitude processing



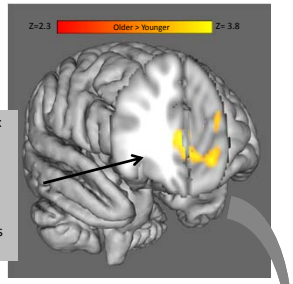
Activation of regions commonly associated with magnitude processing (Arsalidou & Taylor, 2011), including the intraparietal sulcus (IPS), dorsomedial PFC, and occipital cortex regions.

Model 2: Choice Phase: Accurate choice at longer delay (*Lag4>Lag1*)

In both age groups, accurate choices were associated with recruitment of fronto-parietal networks, visual processing regions, and regions responding to the magnitude of product values (e.g., intraparietal sulcus).



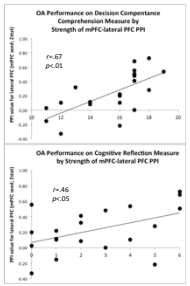
Older adults recruit additional activity in the mPFC when making choices over longer vs. shorter delays (OA>YA).



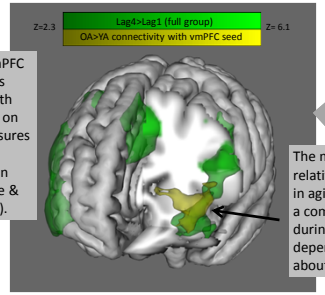
Anterior cingulate cortex and ventromedial PFC cluster. Consistent with research indicating less age-related decline in ACC/vmPFC than lateral and orbitofrontal regions (Tisserand et al., 2002)

Model 3: Older adults' show enhanced connectivity between mPFC and lateral PFC regions that support memory-dependent choice

The mPFC region that OAs overrecruit at longer delays was used a seed in a PPI analysis to determine whether this region was functionally connected to regions supporting accurate choice. Results indicated that, the mPFC has greater connectivity to lateral-frontal regions (L MFG/frontal pole) supporting accurate choice at long delays (*Lag4*).



Lateral PFC-mPFC connectivity is associated with higher scores on external measures of decision competence in OAs (Finucane & Gullion, 2010).



Seed for connectivity analysis

The mPFC, which is relatively more spared in aging, may work as a compensatory hub during memory-dependent choices about value.

Conclusions

- Encoding value magnitude for a later decisions about competing consumer products engages regions typically associated with numerical magnitude processing including the intraparietal sulcus, dorsomedial PFC, and occipital cortex regions. Engagement of this network during value-magnitude encoding is not affected by aging among healthy adults.
- Choice performance requiring retrieval of value information over longer, but still brief, delays is supported by fronto-parietal networks, visual processing and intraparietal regions. For these choices, older adults recruit medial PFC regions to a greater extent than do younger adults.
- During memory-dependent choice processing, older adults have greater connectivity between medial PFC regions and left lateral PFC regions; the latter supporting memory-dependent choice across age groups.
- Strength of connectivity between mPFC-lateral PFC in older adults is associated with external measures of decision competence. These decision measures are thought to index inductive and arithmetical reasoning abilities (comprehension) and abilities to engage analytic over intuitive judgments (cognitive reflection).
- **Summary**: Decisions involving retrieval of recently learned value information may change in healthy aging, due to changes in networks supporting episodic retrieval more than changes in value-magnitude representation. And further, older adults may compensate for declines in retrieval networks through additional recruitment of medial PFC regions that are more preserved in aging.

Citations: Arsalidou & Taylor, 2011, *NeuroImage*; Finucane & Gullion, 2010, *Psychol Aging*; Henninger et al., 2010, *Psychol Aging*; Mata et al., 2011, *Ann NY Acad Sci*; Samanez-Larkin & Knutson, 2014, In *The Neuroscience of Risky Decision Making*; Tisserand et al., 2002, *NeuroImage;* Wood et al., 2009, Yoon et al., 2009; *Cereb cortex*.
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