Consumer choice and cognitive load: Negative effects on economic decision making

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Increasing test load during retrieval delay results in shifts in neural recruitment and decreased choice performance.

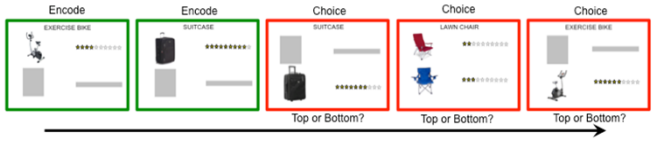
Introduction

Value-based decision making is a complex cognitive process that is dependent on several domains of information processing. The reliance on short-term and long-term memories, along with integrated deliberative and affective processing creates a large cognitive network that must communicate throughout everyday decisions. Value processing, in particular, plays a significant role in economic decisions, as people are constantly interpreting the prices and ratings of different consumer products. In every purchasing decision, areas associated with these executive functions play a role in determining the best possible product.

In the broader decision making realm, there exists a large body of evidence that points to the role that cognitive load plays on decision quality. The current study seeks to elucidate the negative effect of **test load** in economic decisions that are specifically value-based by determining the neural correlates of a simple choice task.

Primary question: How does neural recruitment adjust for increased test load during retrieval delay in economic decision-making?

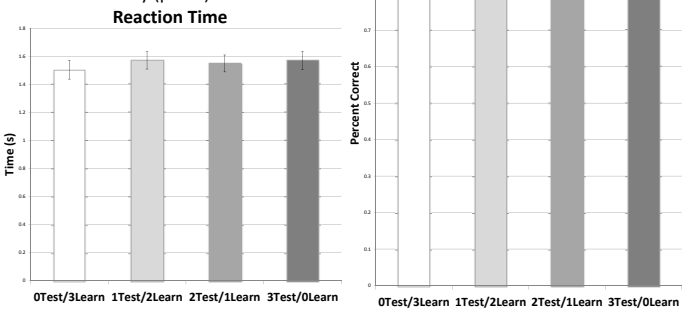
Paradigm & Behavior



- Participants were healthy younger adults (n=20) with no history of neurological or psychological disorders
- Encoding trials: participants learned the star ratings for specific products from Amazon.com.
- Choice task: participants selected one of the competing items based on star ratings
- Choice trial lags
  - -no delay (*Lag0*)
  - -immediate retrieval (*Lag1*)
  - -delayed retrieval (*Lag4*)
- Decision competence measures
  - -comprehension
  - -cognitive reflection
  - -effort

Performance was high overall, but showed an effect of test load on decision accuracy.

No significant effect on reaction time was found as a result of increased test load, but there was a significant linear effect on decision accuracy (p<.05).



Results

Analytic Approach

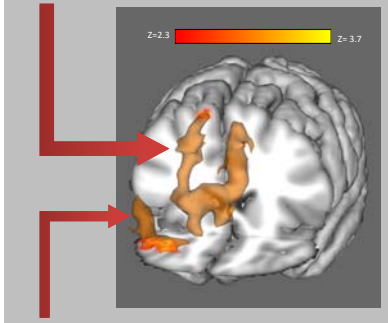
- **Effects of test load:** Parametric analysis of successful decisions with **increasing proportion** of intervening choice trials (*Lag4*)
- **Effects of encoding load:** Parametric analysis of successful decisions with **decreasing proportion** of intervening choice trials (*Lag4*)

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

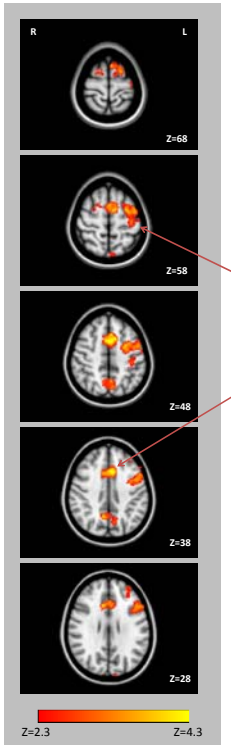
Effects of increasing test load

We tested the hypothesis that decreased accuracy is a direct effect of test load using parametric modulation of intervening trial types. Trials with more intervening test trials showed significant increases in orbitofrontal cortex and frontal pole activity compared to trials with more intervening encoding.

Bilateral frontal pole clusters. Consistent with research indicating activity modulation by maintenance of working memory (Tsujimoto et al., 2011), attentional allocation (Koechlin et al., 1999), and relational integration during difficult decisions (Kroger et al., 2002).



Right orbitofrontal cortex cluster. Consistent with research indicating correlates of decision confidence (Kepecs et al., 2008), value comparisons (FitzGerald et al., 2009), and complexity in value processing (Wallis, 2007).



Effects of increasing encoding load

Increasing encoding frequency during intervening trials correlated with greater recruitment of medial and left lateral prefrontal cortex. This shift towards a prefrontal network corresponding with easier trial structure led to greater accuracy across participants.

Increased activity in the left lateral prefrontal cortex follows theories on working memory storage (Owen et al., 1999)

Medial prefrontal cortex activity is consistent with findings on referential and attention-demanding tasks (Gusnard et al., 2001) and value computations (Hare et al., 2010).

Future directions

- **Region of interest analysis comparing activation of frontal poles to external measures of decision competence and effort**
- **Testing of OFC recruitment as a factor of value difference magnitudes during choice behavior**
- **Repeat analyses in older adult population to evaluate differences in the magnitude of the test load effect as a result of aging**

Conclusions

- Test load in value-based decision making corresponds with decreased accuracy and a shift towards regions with higher executive functioning, including bilateral frontal pole and right orbitofrontal cortex
- Greater encoding load preferentially recruits an extensive prefrontal cortex network capable of value processing and working memory storage.

Summary

- These regional differences align with current functional hypotheses from broad-scale cognitive testing, and extend the understanding into the neuroeconomic domain. Extended delays between presentation of consumer information (e.g. advertisements, product reviews and ratings) and consumer choice introduce sensory and cognitive noise that may interfere with decision quality. Finally, memory deficits that increase with aging may lead to a negative amplification of this effect.

Citations: FitzGerald et al., 2009. The Journal of Neuroscience; Gusnard et al., 2001, Proceedings of the National Academy of Sciences; Hare et al., 2010, *The Journal of Neuroscience*; Kepecs et al., 2008, *Nature*; Koechlin et al., 1999, *Nature*; Kroger et al., 2002, *Cerebral Cortex*; Owen et al., 1999, *European Journal of Neuroscience*; Tsujimoto et al., 2011, *Trends in Cognitive Sciences*; J.D. Wallis, 2007, *Annual Review of Neuroscience*.

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