Modeling Preference Formation of Risky Decisions via Eye Tracking

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*Equally contributed

Introduction

• Cognitive accumulation models assume that information (sensory input) is sampled rapidly in small portions until a threshold is reached and the competition is decided.

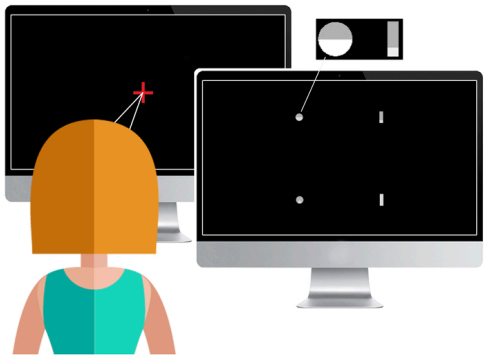
• **We aspire to create integrated models that take into account both the perceptual process and the value of attributes in decisions.**

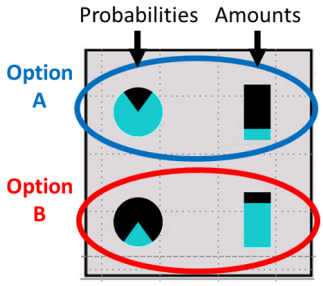
• The eye-tracker is a significant research tool for this purpose as it allows monitoring the participant's visual attention at high temporal resolution (300 Hz).

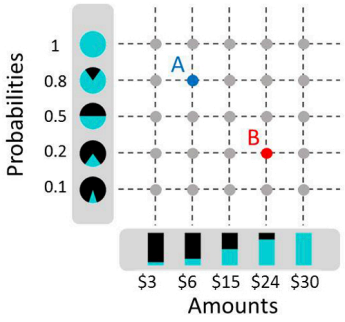
Expected Value	*Expected Utility*	*Prospect Theory*
$\sum x_i \cdot p_i$	$\sum x_i^{\alpha} \cdot p_i$	$\sum \pi(p_i) \cdot v(x_i)$

Method

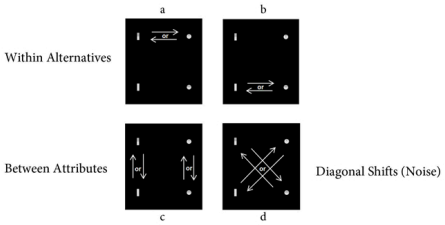
- 31 Participants
- 104 Trials
- Free response
- Incentive compatible



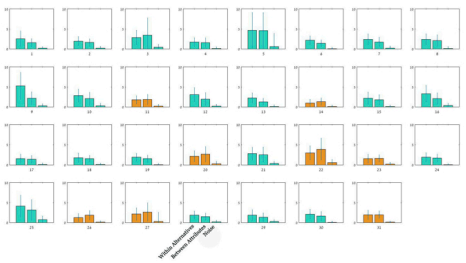


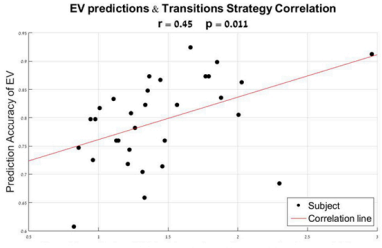


Individual Differences



Individual Mean Number of Transitions





Transitions Ratio $= \frac{\text{Transitions Within Alternatives}}{\text{Transitions Between Attributes+Noise}}$

Models

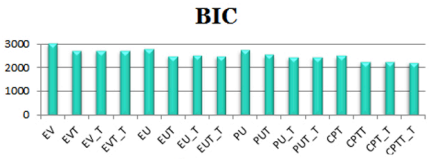
Model Types

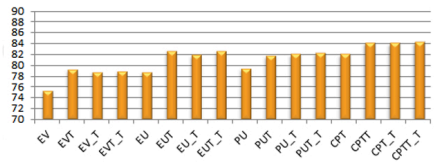
Descriptive $f(EU_{regression}) = \frac{1}{1+e^{-\beta(x_1^{\alpha}p_1 - x_2^{\alpha}p_2)}}$

Multiplicative models $f(EUT_{regression}) = \frac{1}{1+e^{-\beta(x_1^{\alpha}p_1 x_1^{\phi} - x_2^{\alpha}p_2 x_2^{\phi})}}$

Additive models $f(EU\_T_{regression}) = \frac{1}{1+e^{-(\beta_1(x_1^{\alpha}p_1 - x_2^{\alpha}p_2)+\beta_2(t_1-t_2))}}$

Multiplicative & Additive $(EUT\_T_{regression}) = \frac{1}{1+e^{-(\beta_1(x_1^{\alpha}p_1 x_1^{\phi} - x_2^{\alpha}p_2 x_2^{\phi})+\beta_2(t_1-t_2))}}$





Cumulative Process Model

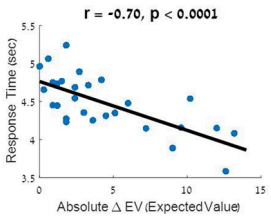
a	b
$A1 = Leak \cdot A1 + x_1^{\alpha} \cdot p_1 - \theta \cdot x_2^{\alpha} \cdot p_2$ $A2 = Leak \cdot A2$	$A2 = Leak \cdot A2 + x_2^{\alpha} \cdot p_2 - \theta \cdot x_1^{\alpha} \cdot p_1$ $A1 = Leak \cdot A1$
c	**d**
$A1 = Leak \cdot A1 + x_1^{\alpha} \cdot p_1 - \theta \cdot x_2^{\alpha} \cdot p_2$ $A2 = Leak \cdot A2 + x_2^{\alpha} \cdot p_2 - \theta \cdot x_1^{\alpha} \cdot p_1$	$A1 = Leak \cdot A1$ $A2 = Leak \cdot A2$

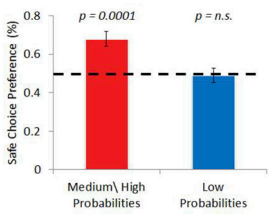
Model Comparison

Averaged Fit (and standard dev.)

Model	BIC*	Accuracy
EU	2623.74	76.4% (.06)
EUT	2440.27	80.3% (.06)
Cumulative EU-based transitions model	2266.07	83% (.06)

Results





Conclusions

• Eye scanning patterns (proportion of within transitions) are associated with EV choice.

• Using dwell time/number of fixations can improve the accuracy of prediction.

• Processes models can further improve the accuracy of prediction, and elucidate the dynamics of preference formation

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