Reward, Risk and Ambiguity in Human Exploration: A Wheel of Fortune Task

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Introduction

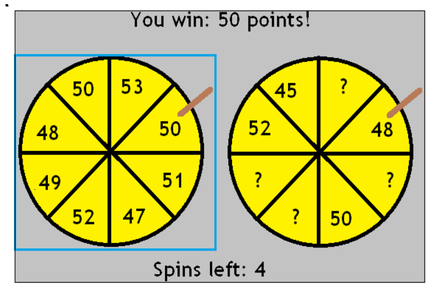
How does environmental uncertainty influence exploration?

Sources of uncertainty:
Risk (expected uncertainty) and
Ambiguity (unexpected uncertainty)

Types of exploration:
Random and Directed

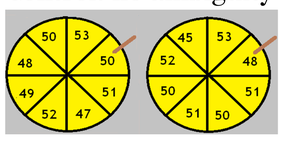
Separate roles of risk and ambiguity in human exploration?

Wheel of Fortune Task



n = 30
350 games

Control: no ambiguity



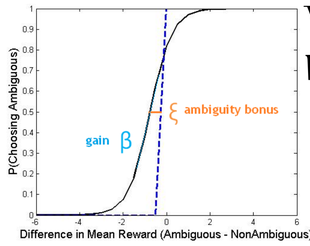
Reward: mean of visible slices
Risk: variance of visible slices
Ambiguity: number of "?"s

Decision Horizon: number of spins (1-short horizon, 5-long horizon)

Information more useful in long horizon

Model and Analysis

Estimate and update distribution of "?"
Choose based on value of the two wheels (ΔV)



Value of Wheel i:

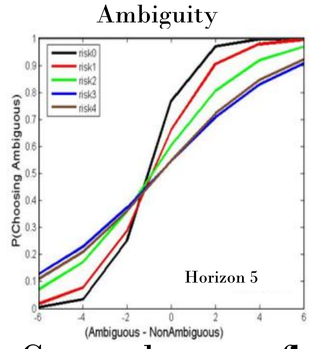
$$W_i = \mu_{uncovered} + \mu_{covered} + \xi$$

Choice:

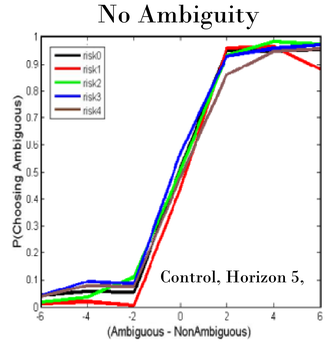
$$P(W_i) = \frac{1}{1 + e^{-\beta \Delta V W_i}}$$

Results

Choice curves shift with risk level

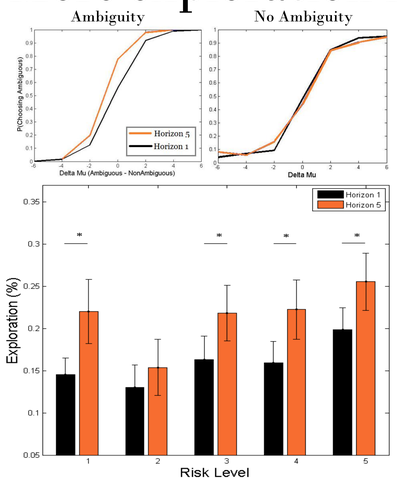


- Curves become flatter (more noisy) and shifted to the right (less ambiguity-seeking)



- Effect disappears when there is no ambiguity

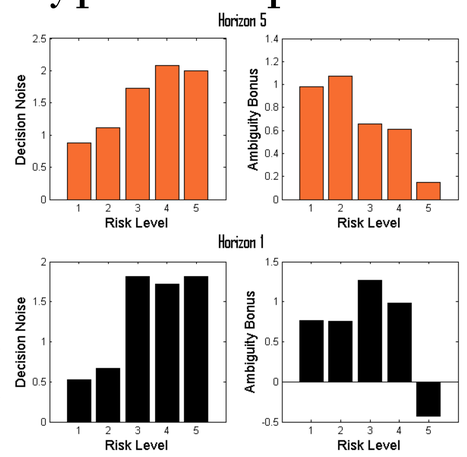
More exploration in longer horizon



- Higher ambiguity bonus for long horizon (H5)
- More overall exploration for H5 than H1
- Similar overall exploration across risk levels

Trading off different types of exploration?

- Decision noise increases with risk level (more for H5)
- Ambiguity bonus decreases with risk level for H5
- Reduced ambiguity level correlates with increased noise in H5, not in H1



Discussion

- People are more exploratory at longer decision horizons (when information is more useful)
- Risk level influences choice – in the presence of ambiguity
- Increased risk in the environment reduces ambiguity bonus, but increases decision noise
- Trading off directed for random exploration: potential way to insure exploration despite risk aversion?

Yu & Dayan (2005) Cohen, McClure & Yu (2007)

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