Reward-based Decision Making

Guido Biele, Lea Krugel, Peter Mohr, Hauke R. Heekeren

Approach

- Decision making involves strategies to obtain desired outcomes.
- When descriptions of the available options are at hand, these can be used to guide a decision.
- In the absence of such descriptions, people have to learn and base their decisions on experience.
- We investigate learning and decision making processes by:
  - Developing models and algorithms describing these processes.
  - Investigating the neural representation of (latent) learning and decision parameters.
  - Determining the relationship of model parameters and dopaminergic neurotransmission, as influenced e.g. by genetic polymorphisms like the COMT Val108/158Met polymorphism.

Neurocognition of investment decisions

Background

- Normative and descriptive theories of financial decision making suggest that decision makers evaluate investments by weighting their expected return and the associated risk (e.g. Sarin & Weber, 1993).
- Recent neuroeconomics experiments claim to have identified neural representations of decision variables like expected return, expected value, risk/uncertainty, outcome probability (e.g. Knutson et al., 2000; Huettel et al., 2005).
- Only few investigations of the representation of decision variables in the decision process.

Hypothesis / Research questions

- Which models describe best how people:
  - Derive expected return of an investment, for which they saw a sample of returns?
  - Derive the risk of an investment, for which they saw a sample of possible returns?
  - Choose between a risky and a safe investment?
  - Hypothesis: A common region represents the expected return / risk of an investment during presentation of return samples and during choice between a risky and risk free investment.

Experiment

- New investment perception & choice task in an fMRI experiment, n=10
- Siemens Sonata 1.5 T, EPI, 26 slices, TR=2.5 s, TE=40 ms, 4x4x4 mm voxel size
- Independent variables: 3 tasks X 3 expected return levels X 3 risk levels (3 repetitions each)

Behavioral and Modeling Results

- Estimation of the expected return best modeled by a model giving higher weights to low expected returns.
- Subjective risk most frequently predicted by the standard deviation or the coefficient of range (range/mean).
- Decision models were similarly well predicted by a weighted additive model (Risk-Value Model) and by a lexigraphic model.

Other projects / Collaborations

- Implementation of decision thresholds in perceptual decision making (with Nikos Green).
  - In this project the decision threshold (as assumed in sequential sampling models) is manipulated by varying payoff matrices. The goal is to identify how decision thresholds are implemented and adapted.
- Instrumental learning of Parkinson patients on and off medication (with Susanne Graf; F. Klostermann & F. Marquardt, Dept. of Neurology, Charité Berlin).
  - Model based analysis of instrumental learning in Parkinson patients with high & low striatal dopamine release (on and off medication). Goals are to describe learning differences as a function of learning parameters and to relate latent learning variables to EEG signals.
- Decision making in approach avoidance conflicts (with U. Basten & C. Fiebach, University of Regensburg).
  - FMRI experiment investigating the representation of potential gains and losses in decision making.
- Learning in restless bandits (with I. Erev & E. Urt; Technion Haifa).
  - This project examines pattern learning in variable environments and aims to shed light on (sequential) pattern learning by exposing participants to different Markov Decision Processes.