Modeling decision making under ambiguity

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Ecologic and economic theories of decision making under uncertainty emphasize the importance of correctly evaluating expected reward and risk. Within neuroscience, the idea obtains strong support from the fact that the human brain reflects both mathematical expectation of reward (mean) and risk (variance) in situations under pure risk \cite{1}. Pure risk is often dissociated from “true” uncertainty or ambiguity in which probabilities of outcomes are unknown.

In situations that involve neither risk nor ambiguity, organisms prefer higher expected rewards over lower expected rewards. In situations that involve ambiguity lower ambiguity is generally preferred by human decision makers, although the reverse is not uncommon.

The present study explores different models of decision making under ambiguity. In a simple gambling task, subjects had to choose between two ambiguous gambles while their brain activity was being recorded using functional imaging (fMRI). Preferences were modeled in terms of (i) Bayesian hierarchical priors, (ii) a trade-off between expected payoff (at un-informed priors) and the amount of ambiguity in the available options, and (iii) alpha-maxmin utility theory. We first evaluate the relative power of the three different approaches to predict subjects’ choices. Using the parameter values estimated from the behavioral data, we subsequently determine which model best fits the functional imaging data throughout the task. We focus on brain regions that are known to be differentially activated during decision making under uncertainty \cite{2}. Our results show that activation during reward anticipation reflects separate encoding of mean probability and variance of probability as estimated by a trade-off between expected payoff and the amount of ambiguity.

References
