A Hierarchical Bayesian Model of Learning and Decision Making in Anxiety

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1. Introduction

Anxiety has broad-ranging effects in learning and decision making. Recent work suggests that healthy volunteers are more likely to adapt their learning rate in response to changes in environment (1, 4).

In this project, our goal is to assess how state anxiety shape learning and uncertainty estimation during learning and decision making. Using the Hierarchical Gaussian Filter (HGF), we will model behavioral data during reward-based learning task.

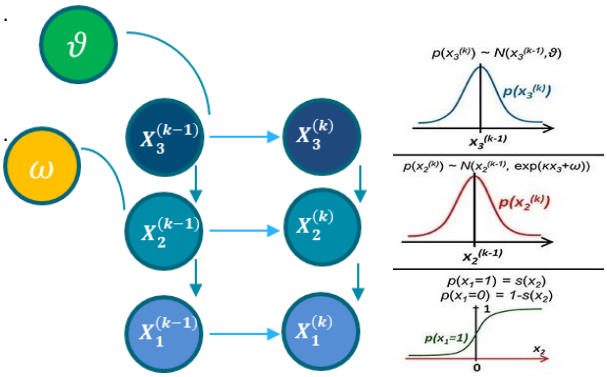
The main hypothesis is; high trait anxious participants would be less able than low trait anxious participants to adjust their updating of action-outcome expectancies in response to changes in environmental volatility (1).

2. Experimental Setup and Methods

The reward learning task is consist of 2 groups (22-30 years old) and 2 outcomes. State anxiety group (experimental, n=20) and control group (n=20), outcomes (win or lose). Participants learned a probabilistic mapping between visual stimuli and reward.

The probabilistic mapping from stimulus to outcome shifted over the course of the experiment. The probabilities governing each block varied: (90/10), (70/30) and unbiased (50/50). To generate 10 blocks in total: two for each bias direction and two repeats of the (50/50).

3. Data Analysis

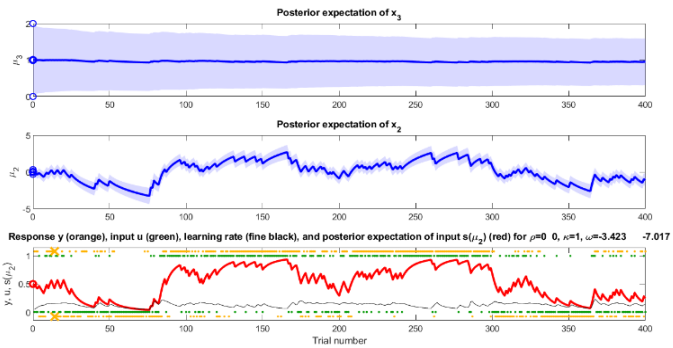


Hierarchical Gaussian Filter Model

- Particular model within Bayesian brain hypothesis
- A hierarchical model of Bayesian learning through perception
- Deterministic and probabilistic relationships between environment and perception.
- Parameters of the model can account for individual differences between agents and can be used to explain behavior.

Fitting HGF allows for variance between participants and the model has two free parameters. Gaussian distributions (characterized by means and variances) represent beliefs at the three levels of the probabilistic hierarchy. Each level influences by the estimate at the level above. HGF updates beliefs on the basis of precision-weighted prediction errors (2).

There are different sources of uncertainty: irreducible uncertainty resulting from probabilistic relationships between predictors and outcomes, estimation uncertainty resulting from missing knowledge of those probabilistic relationships and volatility uncertainty projecting environmental instability (2).



Statistical Analysis

Parameters μ_3 (belief about volatility), μ_2 (belief about tendency for a stimulus to be rewarding), σ_2 (variance, uncertainty, level 2), σ_3 (variance, uncertainty, level 3) and learning rate will be averaged in bins of 100 trials. For each parameter, four mean will be obtained. These four mean will be examined in between-group comparisons using t-tests.

4. Predicted Results

- ✓ The learning rate in high anxious participants will be less than low trait anxious individuals.
- ✓ Belief on volatility will be higher in state anxiety group.
- ✓ High trait anxious individuals will show less ability to adjust updating of outcome expectancies between stable and volatile environments.
- ✓ Learning rate should be higher when the environment is not stable.

References

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