Aleksandra Litvinova MSU

Report on practice in ENS [i]

The internship was held in collaboration with Sandrine Duverne, Sophie Deneve, Renaud Jardri at Ecole Normale Supérieure & INSERM, Paris, France 23/10/2010-20/01/2011.

The goal of the internship was to design a behavioural protocol to validate a Bayesian model for positive symptoms of schizophrenia using a variant of "jumping to conclusion" paradigm.

A "jumping to conclusion" phenomenon is a reasoning style in patients with delusions that is characterized by early decisions made on the basis of little evidence. Classical test for it is called "beads task". Typically, 2 jars of beads are presented to participants, one contains substantially more pink beads than green beads and the other contains the reverse (Huq et al., 1988). One by one, beads are taken from a single hidden jar and presented to the participants and participant needs to guess from which jar beads were taken. Participants with delusions tend to make firm decisions much sooner than controls, occasionally after the very first bead is presented.

To describe such decision making style Bayes rules may be used:

$$P(A|B) = \frac{P(B|A)\,P(A)}{P(B)},$$

where P(A) and P(B) are the prior probability of A and B respectively; P(A|B) is posterior probability of an event A, given the probability of an event B; P(B|A) is the conditional probability of an event B, given the probability of an event A (likelihood). B can be interpreted as a sensory evidence (beads colour in "beads task") and A as a jar from which beads come from.

Our paradigm has two main differences from classical task:

- we use a graded estimate of participant's confidence in answer as a dependent measure;

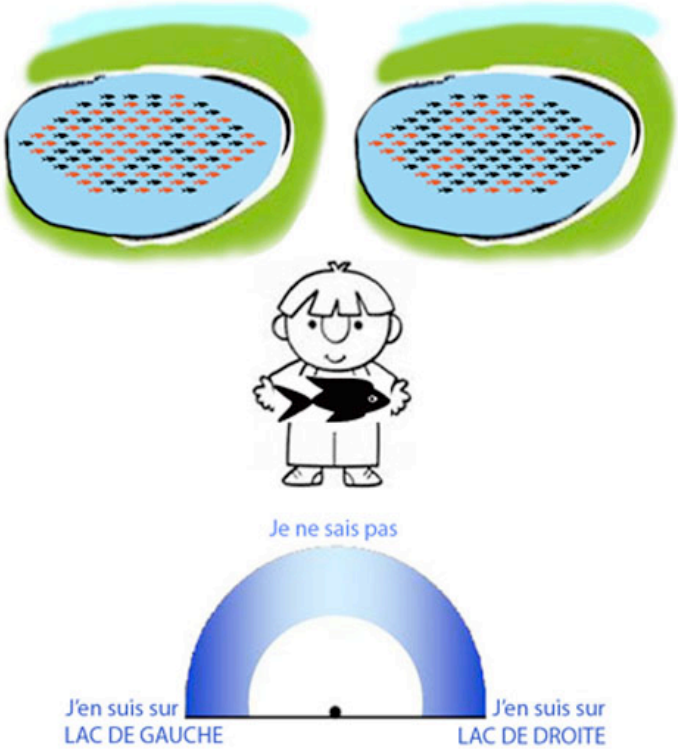
- we manipulate both the sensory evidence and the prior.

Working hypothesis is that in neural network false percepts are generated when probabilistic messages are reverberated rather than being tightly controlled. It is assumed to distinguish 3 types of prediction errors required in neural hierarchical inference: downward inhibitory loops, upward inhibitory loops and explaining away. “Downward inhibitory loops” prevents top down messages (prior beliefs) from being interpreted as external sensory signals. Without downward loops, internally generated “thoughts” and priors would be over counted. On the contrary, “upward inhibitory loops” prevents sensory signals from being reverberated as top-down expectations. Finally, “explaining away” controls the lateral propagation of messages. Deficits in any of these 3 types of mechanisms will create false percepts due to loopy belief propagation. If upward loops are injured in patients, they should over count their sensory evidence. However, patients would not over count their prior. The reverse would be true if patients are affected in their downward loops. Finally, if injured in both loops, patients would over count their prior and sensory evidence in a strongly supra-linear fashion (an extreme jump to conclusion).

In order to test the model predictions in patients and normal subjects, and particularly the dissociation between sensory interpretation and predictions behavioural protocol was designed. The protocol called “Fishing Task” was inspired from Speechley and coll., *J Psychiatry Nsci* 2010 and it was designed using MATLAB and Psychtoolbox.

Participants are presented with visual stimuli, such as two lakes and fishes within (see a picture below). First, two lakes are displayed and there are numbers inside each lake that correspond to participant’s chances to catch a fish from the lakes. The chances vary from 10% to 90% every 10%. These percentages are shown for a shot time (1 sec). After it fishes of two colours (red and black) appear inside each lake. The quantity of the fishes in the lakes is the same, but the ratio of red and black fishes is changed from 0 to 1 every 0,1.

There is also a fisherman that holds a caught fish. Participants are asked to point the lake, from which the caught fish came from and their confidence about it. To provide an answer, participants click with the mouse cursor on the scale placed at the bottom, either toward the left lake or the right lake according to their confidence.



Thereby, the strength sensory evidence is manipulated by changing the ratio of red and black fishes in each lake. The prior is manipulated by showing participant's chances to catch a fish from each lake.

As a result of the internship several variants of the behavioural protocol were designed and tested. One of them will be used for collecting experimental data.

[i] BioN Tempus #159313