Sensory processing: the Eriksen flanker task

In this section we will talk about another experiment providing evidence for Bayesian inference in the brain. In this case we will start off examine our ability to pick out an individual in a crowd[1]

though in the end we appear to observe something else. In any case we begin by thinking about the selective attention and monitoring of contrast and similarity in visual input. In the task the participants are shown one of two stimuli, here a '**S**' or a '**H**' and they press a button in reponse, for example left for **S** and right for **H**. The target letter is flanked by distractors on each side the participants are told to ignore. There are two cases, one where the distractors are compatible: **HHHHH** and **SSSSS** and one where they are incompatible: **HHSHH** and **SSHSS**.

Participants are slower and less accurate when responding to incompatible flankers. This is studied from a Bayesian point of view in **?**; they use data from older experiments in which the participants were instructed to perform the task as quickly as possible. One surprising result, see Fig. 1, is that for very short reaction times the response with incompatible flankers can be worse than chance.

There are two hypothises as to what is going on, the first is that there is a compatibility bias: the brain assumes that the world is smooth, so having **S** flankers biases it towards the expectation that middle letter is also a **S**. This makes sense, visual information often has a high regularity.

[1]A still from Hitchcock's film *Strangers on a Train*.

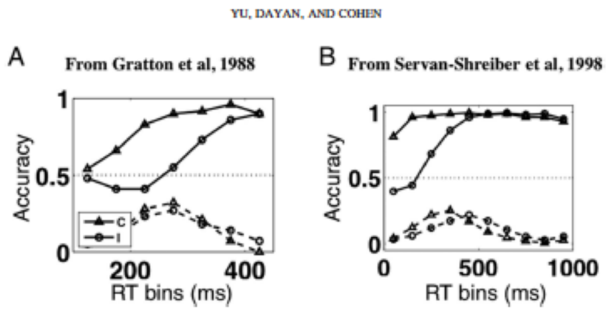

Figure 1: The solid lines show the accuracy against reaction time; the dashed lines the distribution of reaction times themselves. There are two traces, one marked C with compatible flankers, this is graphed with triangles and one marked I with incompatible flankers. The figure was taken (by Rosalyn) from **?** but they themselves have adopted it from other studies.

The second hypothesis argues that the areas of the brain that perform high level recognition assess visual stimuli over a large receptive field and so the recognition neurons are receiving cross talk from the distractors.

To see if these hypotheses account for the phenomenon we will construct a *generative model*, that is a model that could produce fictive data with a presumed similar distribution to the real data. Here, the generative model is a model of a neuronal response to the stimuli. We will couple the generative model to a *recognition model*, a model of how the brain might identify the target, based on the information encoded in the neurons. The recognition model describes the decision and ultimately determines which button will be pressed.

Let the stimuli be labels s_1, s_2 and s_3, s_2 is the target, s_1 are the letter to the left and s_3 to the right. In the experiment $s_1 = s_3$, in the compatible condition $s_1 = s_2$, in the incompatible $s_1 \neq s_2$. The three neurons corresponding to three stimuli are labelled x_1, x_2 and x_3; these will have a response which is different, on average, depending on which letter is in each part of the stimulus, but they will respond in a variable way. In fact, for definiteness, lets say the ith stimulus $s_i = -1$ when the letter is **S** and $s_i = 1$ if it is **H**; the x_I are then Gaussian distibuted around these values. Of course, in line with hypothesis two, each neuron will get an input from more than one s_i. The random variable M describes the trial condition, with $M = I$

for incompatible and $M = C$ for compatible. If $\mu_i = \mu(s_i)$ represented the zero or one at the i subinterval in the hot house then we have

$$p() \tag{1}$$