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NEURAL MECHANISMS OF DECISION MAKING

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Combining neuroimaging with psychophysics:
A new collaboration with Prof. Keiji Iramina

Psychophysics aims to develop mathematical functions that can account for the relation between stimuli and responses in a variety of decision-making contexts. Well-known psychophysical models of decision-making include Signal Detection Theory as well as various reaction-time models. One important approach to understanding the neural mechanisms of decision-making, then, is to combine these psychophysical approaches with neural measurements.

Behavioral analysis can be employed as a tool to decompose decision-making into synergistic (sensory) processing versus anticipatory processing in a way that affords close comparison with neuronal signatures of, respectively, sensitivity and bias. Here, sensitivity refers to the quality of decision-making as a function of the ratio between signal and noise. In contrast, bias refers to the *a priori* likelihood of making one decision rather than another, regardless of incoming perceptual information.

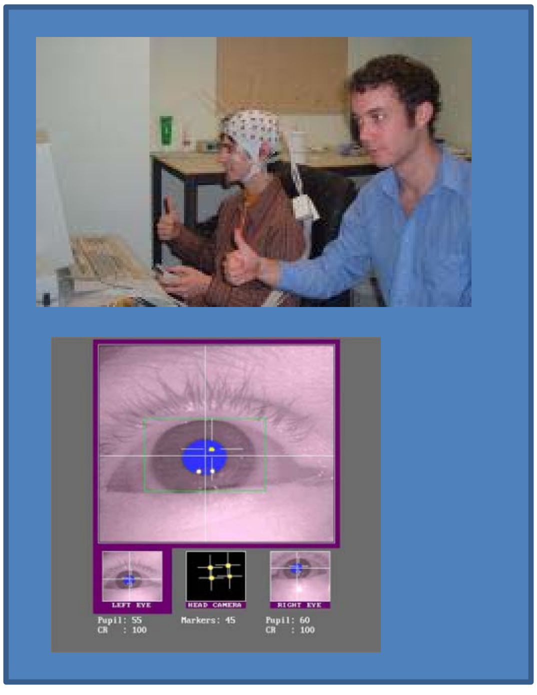
EEG, MEG, NIRS

Neuroimaging →

+

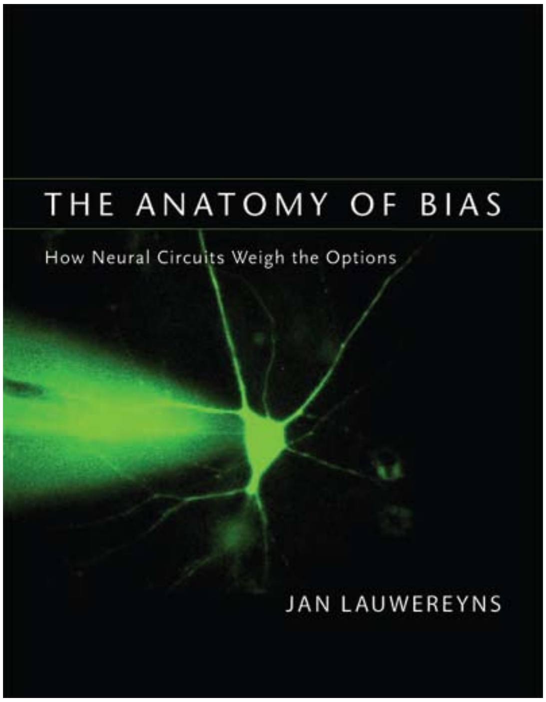
Psychophysics →

Behavioral analysis



Taking the view that the decision-making process consists of a decision signal that linearly rises to a decision threshold, reaction-time data can be modeled using several parameters reflecting the slope of the decision signal, the starting point of the decision signal, and the level of the threshold. Changes to these parameters provide characteristic signatures in the reaction-time distributions that correspond with variation in terms of “distance to threshold” (bias) versus “gradient of information-processing” (sensitivity).

In addition to behavioral analyses on the basis of rates of responding, particularly the analysis of reaction times is useful as it focuses on process rather than outcome of decision-making. It is based on trial-by-trial variation and so it is also a statistically powerful tool for comparisons with trial-by-trial variation in neural activity.



THE ANATOMY OF BIAS

How Neural Circuits Weigh the Options

JAN LAUWEREYNS

Key References

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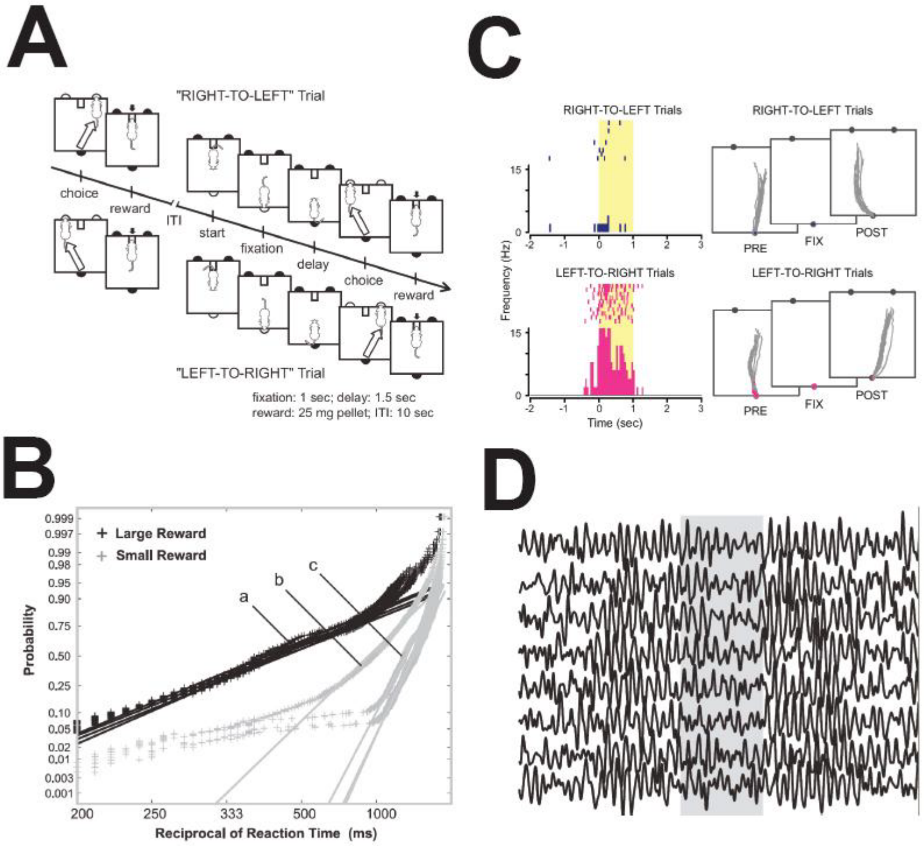
Lauwereyns, Wisnewski (2006) “A reaction-time paradigm to measure reward-oriented bias in rats” *J Exp Psychol Anim Behav Process* 32: 467-473.

Lauwereyns, Takikawa, Kawagoe , Kobayashi, Koizumi, Coe, Sakagami, Hikosaka (2002b) “Feature-based anticipation of cues that predict reward in monkey caudate nucleus” *Neuron* 33:463-473.

Lauwereyns, Watanabe, Coe, Hikosaka (2002a) “A neural correlate of response bias in monkey caudate nucleus” *Nature* 418:413-417.

Also… similar work in rats:

In collaboration with AD Redish, I Tsuda, E Wood, & P Dudchenko



A Nose-poke task. Rats are trained to poke their nose into different choice ports, depending on visual stimulation and reward.

B Analyses of reaction-time distribution to dissociate bias from sensitivity processes in decision making.

C Spatial bias as observed in the spike rate of a hippocampal CA1 neuron during a fixation period before the cue to respond.

D Theta band analysis during the fixation period, when CA1 neurons show spatial bias; with reduced theta-1 but increased theta-2.