NEURAL NETWORK DYNAMICS UNDERLYING THE FLEXIBLE ADJUSTMENT OF TEMPORAL EVIDENCE WEIGHTING IN PERCEPTUAL DECISIONS

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During perceptual decision-making, sensory information can be accumulated using distinct temporal weighting strategies, weighting some stimulus epochs more heavily than others. A recent study has shown that primates can flexibly switch between early weighting (primacy) and late weighting (recency) in a motion discrimination task, following the stimulus statistics. To shed light on how this flexible adjustment can be mechanistically implemented at the neural circuit level, we used a two-area firing rate model composed of a sensory and a decision circuit with bottom-up and top-down connectivity.

Due to winner-take-all dynamics, the model shows primacy weighting. Temporal attention, realized through changing the gain of the sensory circuit or through the modulation of top-down signals from the decision circuit, could not alter this pattern qualitatively, ruling out these mechanisms. We then included a time-varying modulation signal that impacted the attractor dynamics of the decision circuit by pushing the network into a competition regime, thereby accelerating or delaying the decision process, like an urgency signal. We found that the model could reproduce the experimentally observed flexible weighting when the time course of the modulation signal reflected the stimulus statistics. We reasoned that the modulation signal may be related to the subject's task engagement, which we measured as the time needed to execute a successful fixation at the start of the trial. Consistent with the model, we found that the subjects' engagement was higher (faster fixation) for early weighting and lower (slower fixation) for late weighting in humans and macaques.

Analysis of neural recordings from macaque area LIP indicated that the neuron's pre-stimulus activity was correlated with task engagement, supporting the hypothesized modulation signal. Our results suggest attractor dynamics as a plausible substrate underlying flexible evidence weighting in perceptual decision-making.