Project Summary

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A Dynamical Model of Short-Term Forgetting

Psychological experiments have shown that humans can only store 7±2 items in short-term memory at a time (which is why our phone numbers are 7 digits long). In 1995, John E. Lisman and Marco A. P. Idiart created an elegant model to explain this phenomenon using brain oscillations. Measurements show two layers of average oscillatory activity in the brain. Gamma oscillations (around 40 Hz) occur within theta oscillations (around 6 Hz) in many regions of the brain. They have been hypothesized to serve various functions, including spatial navigation, long-term memory storage, attention, and pattern recognition. Lisman and Idiart proposed that short-term memory could be maintained by these oscillations. According to the model, gamma oscillations bind together information about an object. The ensemble of neurons corresponding to one item fire together during one gamma cycle. The ensembles corresponding to each item fire in order, all within one cycle of the theta oscillation. At the end of that theta cycle, the series repeats. Thus, the memory is maintained through continual repetition. The gamma and theta frequencies shift, but, on average, around 7 gamma cycles fit inside each theta cycle. The model, thus, nicely predicts the 7±2 limit on short-term memory. It has also been substantiated by fMRI evidence which shows that short-term memory tasks are accompanied by increased oscillatory activity in the temporal cortex.

Lisman and Idiart's model, however, predicts that the introduction of an eighth item merely pushes each item back a gamma cycle until the first item is bumped off the list. Then, everything proceeds as before. From personal experience, this seems unrealistically precise. The model also doesn't explain how the short-term memory could be lost through shifts in attention or through decay over time.

Guth will work to create a dynamical model of neural interactions that produces gamma and theta oscillations, and that explains both short-term memory and short-term forgetting. The model would, ideally, make realistic predictions about the breakdown of short-term memory in the face of an eighth item, shifting attention, or just passing time. These predictions could, then, be tested by cognitive studies of task performance. She also would like to explain why theta cycles don't grow to accommodate more items in short-term memory storage.