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How is Information Coded in Turtle Visual Cortex?

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Information about position in visual space is coded in topographic maps within the sensory cortices of mammals. By contrast, the visual cortex of freshwater turtles does not embody topographically organized representations of the visual world. Single unit recording experiments in turtles reveal that neurons at any position in visual space respond to stimuli presented anywhere in binocular visual space. Interestingly, voltage sensitive dye (VSD) experiments with an in vitro preparation of the eyes and brain of turtles show that visual stimuli evoke waves of depolarizing activity that propagate across visual cortex. We have developed a family of biological-based compartmental network models of the turtle visual cortex. These models respond to simulated visual input in a manner similar to that observed in the turtle brain. Using KL decomposition and Bayesian analysis of these models, we have established that waves in the turtle visual cortex contain information about the positions and speeds of stimuli in visual space. To better understand their functional significance, we have enlarged the scope of our research efforts to place the neurophysiologic analysis of cortical waves within a particular behavior context, the capture of moving fish. During prey capture, the turtle must estimate the future position of its target based upon the target's past behavior. The optic tectum is implicated in this motion extrapolation process. The in vitro turtle brain is an especially favorable model in which to concurrently image dynamic behavior in both the visual cortex and optic tectum. Our preliminary voltage-sensitive dye imaging experiments of intact turtle visual systems show that visual stimuli elicit waves in the optic tectum of turtles, but the spatiotemporal properties of tectal waves are substantially different than those of cortical waves. Since cortical and tectal waves have distinctive electroencephalographic signatures, it becomes possible to use standard EEG recordings in free-behaving turtles to correlate the occurrence of waves with defined components of the prey-capture response.

Project (or PI) Website

http://visual.cs.utsa.edu/research/turtle/

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