



Invertebrate Learning and Memory: Chapter 1. Beyond the Cellular Alphabet of Learning and Memory in Invertebrates (Handbook of Behavioral Neuroscience)

Randolf Menzel, Paul R. Benjamin

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In 1984, Hawkins and Kandel published a seminal paper titled “Is There a Cell-Biological Alphabet for Simple Forms of Learning?” Based on their early findings of the cooperative regulation of adenylyl cyclase in sensory neurons of *Aplysia*, an overarching concept was presented which opened our mind to molecular mechanisms of experience-dependent neural plasticity. Several basic forms of nonassociative and associative learning (habituation, sensitization, and classical conditioning) were explained on the level of rather simple molecular reaction cascades in specific neurons. At that time, these were radical ideas, and even today we struggle with the question whether cognitive faculties such as learning and memory formation can be reduced to ubiquitous cellular functions, and what such a reduction might mean. The concepts presented in this paper were also radical in the sense that they broke with the speculation that the information of acquired memories is stored in molecules like RNA. Meanwhile, it is well accepted in neuroscience that neural circuits acquire new information by changing network properties on the level of specified neurons and their synaptic connections. Multiple key elements contribute to these adaptations, and it is the task of today’s neuroscience to unravel the complex hierarchies of interactions from the molecular to the systems level in solving the problem of predicting future behavior from experience in the past.

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