# *Aplysia* as an attractive alternative for analyzing agency?

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For humans, agency is defined as the capacity to make choices and to impose those choices on the world. It is normally contrasted with natural forces, which are causes involving only unthinking deterministic processes. Because animals in general and invertebrates in particular are usually seen as deterministic input-output models, agency is generally not seen as a topic for neurobiological study, let alone for study by invertebrate neuroscience.

However, very recently the input-output consensus has come under scrutiny and a number of model systems have been shown to produce spontaneous behavior which cannot be traced back to environmental stimuli. Even isolated buccal ganglia of *Aplysia* produce spontaneous neural activity reminiscent of feeding behavior in the intact animal without any stimulation at all. Where does this activity come from? How do the buccal circuits generate spontaneity? Or is it just a slow oscillator with superimposed noise and not spontaneity at all? *Aplysia* feeding behavior is very flexible: using feedback from the environment, it can be dynamically reorganized and even operantly conditioned. We are learning more and more about the environmental contingencies and the neuronal changes they bring about in the circuit. However, we still know hardly anything about the central processes which provide the substrate for the environmental stimuli to act upon: how and why does *Aplysia* decide to engage in feeding behavior even in the absence of food? In this respect, is *Aplysia* the input-output machine as modern neuroscience depicts it? Or does it show early beginnings of agency, the simplicity of which might make it amenable for neuroscientific study?

Recent successful imaging pilot studies open the exciting prospect of recording from all neurons on the entire buccal surface during spontaneous motor program production. A two-pronged computational approach of the resulting data will answer the question of agency in *Aplysia*. First, the neural network controlling the activity leading up to a buccal motor program has to be identified. Second, the network has to be reconstructed *in silico*. The resulting understanding of the detailed neural mechanisms producing behavior in the absence of stimulation will yield decisive insights into the fundamental principle of how decisions are made in gastropod nervous systems.