**Raven Consciousness**
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In my most recent research I tried to figure out if ravens can think, that is, if they have the ability to execute the best solution to a simple, but at least novel problem, without first being programmed to do it (such as by purely hard-wired responses or by trial-and-error learning). Before starting this project, I had not given much thought to the idea of trying to get data on what may or may not be occurring in an animal's mind, largely because I was skeptical of being able to get results. My intent here is to provide an overview of a research trajectory that spans a range of taxa with whom I've had experience, and to provide my assumptions and approaches. The results, conclusions, and steps in the logic have been published elsewhere.

**Beginning With The Bees**

Starting with insects in the 1960s, I tried to solve questions that involved primarily physiology and evolution, such as: is body temperature regulated, and if so, how and why? Relatively clear answers could be found through long-standard methods of measuring body temperature, blood flow, energy expenditure, heart and breathing rates, heating and cooling rates and so forth, in the context of comparative physiology. However, when trying to solve puzzles of evolution and adaptation, the ultimate reference is the field where there is no clear boundary between physiology and behavior. The lab situation, because it is controlled and thus contrived, allows discreet answers to the most basic, fundamental of mechanisms that, like "bricks", build the whole animal. Thus, a bumblebee might at one kind of flower, in one kind of weather, under one condition of the colony, precisely regulate a thoracic temperature within a degree of 42C and have a variable abdominal temperature of 25 - 30C. Change any of the above and thoracic temperature might be 30C and abdominal temperature 10C, or both temperatures might be regulated near 35 - 40C (Heinrich 1979b). In another taxon the data would likely be radically different, despite similar underlying generalities that apply to all. Details matter profoundly. The complexity that was revealed in insects hinted at sophistication that seemed unanticipated and surprising, but it ultimately "made sense" after all when seen in terms of the larger picture of adaptation (Heinrich 1993).

Not every potentially-relevant factor could be measured. For example, it seemed that a bee exhibited something akin to "excitement" when it found flowers with a high nectar content: its breathing rate and body temperature shot up immediately, it flew much faster, its flight tone went from a hum to a buzz, it became more selective in flower choice, and it made more frequent foraging trips. The change of behavior clearly and unambiguously registered that the animal could measure food quality, but whether it might know this consciously, as opposed to reflexively, was of no relevance to the questions I asked or felt I could ask. The behavior could be accounted for in terms of rote learning superimposed on innate programming (Heinrich 1976, 1979b, Heinrich et al. 1977). Bumblebees have a relatively open program concerning which flowers to visit and how to manipulate them to most quickly extract either pollen or nectar (Heinrich 1979a), but within a few flower visits they learn to heed specific flower signals and adjust their foraging routes and flower-handling skills accordingly.

The bees' behavior was, after all, predictable, and much like their physiology the responses served specific functions either in the context of predictable environment or predictable changes of the environment. They were ideal organisms for demonstrating often highly intricate evolved responses, including specific learning tendencies, to all sorts of environmental contingencies. Although I saw no evidence that their sometimes complex responses could not be accounted for by programming alone, there was, of course, no objective reason to either exclude or accept the possibility that they consciously "knew" what they were doing after they were doing it.

In the whole animal the various responses are integrated and "make sense" in terms of