Environmental Complexity, Signal Detection, and the Evolution of Cognition
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1. Basic Principles

What are animal minds, including human minds, *for*? Although some versions of this question are teleological in a sense that has no place within an evolutionary world-view, other versions of the question can be coherently asked. We can ask: is it possible to give a general statement about the kinds of selective pressures and advantages that have been responsible for the evolution of cognitive mechanisms? Why has the expensive and delicate biological machinery underlying mental life evolved?

I suggest that the way to approach this question is not only to stress the continuities between human mental capacities and cognition in non-human animals, but also to recognize continuities between cognition and a wider class of "proto-cognitive" mechanisms. Cognitive mechanisms are mechanisms for behavioral control. And behavioral control mechanisms comprise one subset of a larger class of mechanisms with the function of enabling organisms to adapt to changing problems and opportunities in their environments.

My work attempts to defend and develop tools for exploring, a view of the mind based on an evolutionary perspective of this kind. This involves a combination of philosophical argumentation, commentary on empirical research, and some modeling. The chief goals of this work are rather foundational; the aim is to formulate general principles that unify diverse projects of empirical work on simple forms of cognition, and make explicit the connections between this empirical work and philosophical questions about the place of mind in nature. It is also hoped that discussions of this kind might sometimes help those engaged in the empirical research.

In this paper I sketch the basic framework used, and some simple mathematical models that illustrate the framework. A range of empirical examples are discussed in Godfrey-Smith (forthcoming).

I begin with the following principle:

Environmental Complexity Thesis (ECT): The function of cognition (and of a range of proto-cognitive capacities) is to enable the agent to deal with environmental complexity.

Each of the key terms in the ECT requires clarification (see also Godfrey-Smith 1996). "Function" is understood here in a strong sense; the function of a trait or structure is the effect or capacity it has which has been responsible for its success under a regime of natural selection (see Allen et al. 1998). Cognition, as I said above, is understood very broadly. We can think of cognition as a biological "tool-kit" used to control behavior; a collection of capacities which, in combination, allow organisms to achieve various kinds of adaptive coordination between their actions and the world. This tool-kit typically includes the capacities for perception, internal representation, memory, learning, decision-making and the production of behavior.

As the term "tool kit" suggests, we need not expect to find some *single* set of tools across all the organisms with cognitive capacities; different organisms have different collections of behavior control devices, according to their circumstances and evolutionary history. Further, the list I gave of some core elements of the tool-kit (perception, internal representation of the world, memory, learning) should not be seen as describing a set of recognizable and distinct "modules" found in the same form in all cognitive systems that have them. Rather, this is a set of capacities realized in different ways in different organisms, a set of capacities which shade into each other and also shade off into other, non-cognitive parts of the biological machinery. There is no sharp line between "real" cognition and a range of processes that we can call "proto-cognitive." By any normal standard, plants and bacteria (for example) do not have minds and do not exhibit cognition. But plants and bacteria do exhibit some capacities for flexible response to environmental conditions, using environmental cues to control development and metabolism. Bacteria, for example, can modify their metabolism in order to take advantage of