Computation and Agency in Scientific Cognition

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Abstract

I begin with a representative example of a contemporary scientific activity, observations using the Hubble Space Telescope, and ask what approaches within the cognitive sciences seem most fruitful as aids in developing an overall account of this sort of scientific activity. After presenting the Hubble Space Telescope System and a recent result, I consider applying a standard computational paradigm to this system. I find difficulties in identifying an appropriate cognitive agent and in making a suitable place for the instrumentation that constitutes such a large part of the whole system. I next consider applying the notion of distributed cognition as developed by Hutchins (1995), and then return to the question whether The Hubble System, understood as a distributed cognitive system, should be regarded as a computational system. I find a large computational component, but also an important part, the Hubble Telescope itself, that seems better characterized as a dynamic system than as a computational system. Moreover, the group of scientists interpreting the images produced by the system seem best thought of as a human/cultural system along the lines advocated by those developing a cognitive (Lakoff, 1987) or usage-based (Tomasello, 2003) approach to language acquisition and language use. I argue next that, while cognition may be theorized as distributed among both humans and instruments, there is no need to introduce into cognitive science a notion of distributed knowledge beyond simple collective knowledge. Even less is there any need to introduce notions of distributed mind or distributed consciousness. The result is that the agency involved in distributed cognitive systems remains simply human agency as ordinarily conceived. I conclude that distributed cognitive systems like The Hubble System are *hybrid* systems composed partly of dynamic physical systems, partly of computational systems, and partly of human cultural systems.

Introduction

Science has many aspects, for example, individual, social, institutional and economic aspects. Focusing on the *activity* of doing science, it is undeniable that an important aspect of this activity is *cognitive*. In particular, the activity is supposed to produce new knowledge of the world. This must be counted as a cognitive activity, no matter what one's general characterization of "cognitive activities" might be.

From a disciplinary perspective, there are a number of ways one can approach the study of science as a cognitive activity. One way is to start from some area within the cognitive sciences and then to approach science as a subject matter to which one brings one's previously acquired methods and theories. Another way is to have been studying scientific activities from some other disciplinary perspective, for example, the history, philosophy, or sociology science (collectively, science studies), and then to look to the cognitive sciences for resources with which to enrich such studies. This has always been my strategy.

A major difficulty for this latter strategy is that the cognitive sciences are themselves diverse, ranging from artificial intelligence, neuroscience, and cognitive psychology to cognitive anthropology. Moreover, both within and across these component disciplines there are major theoretical and methodological divides. If one is to produce a coherent account of scientific activities, one cannot avoid taking sides on controversies within the cognitive sciences themselves.

I begin with a representative example of a contemporary scientific activity and ask what approaches within the cognitive sciences seem most fruitful for developing a satisfactory account of the science. Historically, most attempts to exploit the resources of the cognitive sciences for studies of science have focused on individual scientific reasoning: inference, judgment, use of analogy, hypothesis formation, etc. (Gentner and Stevens, 1983; Nersessian, 1992). For the past several decades, interest in science studies has swung towards laboratory practices, including contemporary large-scale laboratories of the type found, for example, in high-energy physics, astronomy, genomics, and neuroimaging (Galison, 1997; Knorr-Cetina, 1999). Following this trend, I take my example from astronomy, in particular, the Hubble Space Telescope.

The Hubble Space Telescope

The Hubble Space Telescope was launched on April 24, 1990 aboard the Space Shuttle Discovery. Figure 1 shows a schematic presentation of the Hubble Telescope.

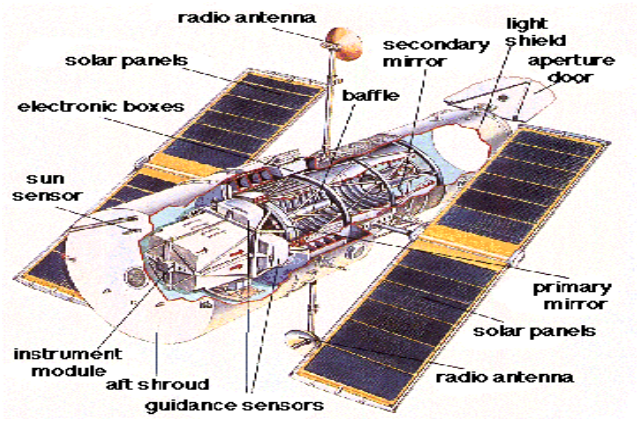

Figure 1. The Hubble Telescope.