PART I

THE LIFE OF COGNITIVE SCIENCE

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Preliminaries

Let's begin prematurely. Let's try to characterize cognitive science:

> Cognitive science is the multidisciplinary scientific study of cognition and its role in intelligent agency. It examines what cognition is, what it does, and how it works.

That proposition may appear more definitive than it truly is. Which creatures or sorts of things count as intelligent agents? Insofar as cognitive science seeks to be multidisciplinary, which scientific disciplines are included? Do they interact substantively – share theses, methods, views – or do they simply converse? Finally, how does one discover what cognition is, what it does, and how it works? Cognitive scientists answer these questions in a variety of ways. No answer is without dissent. Each inspires controversy: everyone likes some answer, but no one likes every answer.

Shall we chart the answers? Only a conceptual botanist would delight in that task; besides which, it would be a premature and unhelpfully abstruse way in which to introduce both cognitive science and the content of this Companion. To those two related ends we prefer a short anecdote, then a long story – a very long story. We shall revisit the above characterization at the very end of the story, for by then the abstruse will have metamorphosed into the familiar, and any sources of controversy will be intelligible if not eliminable.

An anecdote: Building 20

Though all three of us objected to the Vietnam War, one of us (GG) was formally classified as a conscientious objector and, during the early 1970s, performed civilian alternative work service for New England Deaconess Hospital in Boston. One day – his day off – on a rather aimless walk through the campus of Massachusetts Institute of Technology in Cambridge, he came upon some stoically wooden buildings set unobtrusively in the middle of the campus. One was marked simply "Building 20." Looking for a telephone, the future co-editor asked a student standing in front of the building, "Is there a public phone in 20?" "I don't know," replied the student. "All I know about 20 is that Noam Chomsky works here."

"Noam Chomsky?" One hates to admit such ignorance, but being new to Cambridge and unfamiliar with *Syntactic Structures*, perhaps one can be forgiven.

"What?!" Befuddled, but trying to be polite: "Why, he's the world's leading linguist." In retrospect, I had stumbled into the domain of one of the prime movers of modern cognitive science. Chomsky was both icon of the Cambridge anti-war movement and hero of the battle against anti-cognitive psychology – behaviorism.

"Without Chomsky," added the student, "you would be left with B. F. Skinner and his rats up at Harvard."

It was the early 1970s. Talk of cognition thickened the air; cognitive science was growing up. So how *did* cognitive science form? How did it self-conceive and mature? Certainly Chomsky played a key role. Others did too. Time for the long story.

A predecessor: behaviorism

In North America something dramatic happened in psychological science in the 1950s, something often referred to, in retrospect, as the *cognitive revolution*, something Howard Gardner characterized as "the unofficial launching of cognitive science" (Gardner, 1985, p. 7). The revolt was against behaviorism, which was heralded in John Watson's 1913 manifesto and quickly came to largely dominate psychology and linguistics, and influence other disciplines in North America. Behaviorism turned away from earlier, mentalistic attempts to analyze the mind; instead it focused on overt behavior and the discovery of regularities involving observable events and behaviors. "Psychology," wrote Watson, "as the behaviorist views it is a purely objective experimental branch of natural science" (1913, p. 158). Behaviorism was a blend of Darwinism, functionalism in psychology, and anti-introspectionism. It was a normative meta-psychology; it tried, from its own platform, to legislate psychologists into being good empirical scientists. Here, very quickly, most roughly, and simplified stepwise, is how behaviorism said psychology should be done:

> Step One: Observe behavior.
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> Step Two: Select descriptions of behavior which are nonmentalistic – that is, which do not presuppose theorizing about the internal psychology of the organism or agent in question.
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> Step Three: Select descriptions of the environment (in which the observed behavior takes place) which themselves are nonmental in that they do not presuppose theorizing about how the organism or agent represents its environment.
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> Step Four: Note that certain nonmental aspects of behavior (such as its frequency of occurrence, physical direction, and so forth) seem to be correlated with certain nonmental aspects of the environment (physical stimuli which are present).
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> Step Five: Judiciously vary – in a laboratory model and experimental setting – the environmental aspects; thereby determine the class of environmental events and the class of behaviors covered by the correlation.

> Step Six: Speak of the behavior (response) as a function of the environment (stimuli); refer to environmental stimuli and behavioral responses as existing in a functional relationship.

A compressed example illustrates:

> A rat scurries across the alley. It turns left towards a tipped garbage can and ingests food. Remove the rat from the alley. Place it in a laboratory maze. Vary the location of food pellets with the direction of its turning (whether it turns left or right). Note that under certain conditions the behavior of turning left or right is correlated with its immediate history of ingesting food. The history is "responsible" for the direction. Left turning is a function of a food-left history; right turning is a function of a food-right history.

The specification of functionally related stimuli and responses posed a number of problems for behavioristically oriented psychology, itself sometimes called "the experimental analysis of behavior." Often, for example, stimuli and responses selected for a functional class cannot be usefully characterized in an *apsychological* (nonmental) vocabulary. Consider, for example, the temptation to classify the rat's responses as *seeking* food and *remembering* whether it was found to the left or right. Mentalistic attribution is a tough temptation to resist. In some cases – human verbal behavior, for instance – it is impossible to resist. However, let's return to the chronology.

In North America behaviorism reigned for decades as a remarkably resilient, influential, and in many ways laudable doctrine that resonated through a number of disciplines beyond psychology. In linguistics it helped to displace philology (the study of the histories of particular languages) with empirical studies of language use. Under the leadership of Leonard Bloomfield, linguistic behaviorism aspired to carry out a program in which linguists would collect speakers' utterances into a corpus and produce a grammar that described it. Explicitly excluded were any mentalistic assumptions, inferences, or explanations.

In philosophy, the logical positivism of Rudolf Carnap and Carl Hempel was congenial to behaviorism. Each tried to develop behavioristic canons for the meaningfulness and empirical grounding of scientific hypotheses. Hempel himself eventually abandoned this effort: "In order to characterize the behavioral patterns, propensities, or capacities . . . we need not only a suitable behavioristic vocabulary, but psychological terms as well" (Hempel, 1966, p. 110). Others maintained a thoroughgoing empiricism. Willard van Orman Quine imposed behavioristic standards on the task of interpreting the speech of another person (or oneself) and argued that the only evidence available was the sensory input from the environment. He argued that from this evidence alone the meaning of a sentence would always be indeterminate, and therefore concluded that the notion of meaning was vacuous. He made an exception only for those statements most firmly rooted in sensory experience (observation statements).

The story to be told

Not everyone agreed with behaviorist strictures. To such critics as the aforementioned resident of Building 20, behaviorism was a severely truncated, virtually atheoretical