Introduction: Neurophilosophy and Alzheimer's Disease

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A topic which is at the very center of philosophy is epistemology – the nature of knowledge. Systematic inquiry began with Plato, who was deeply puzzled about how humans learned and remembered anything, including, for example, facts, faces, theories, and mathematical proofs, as well as skills such as carpentry or statecraft. In focusing on mathematics, Plato found the problem of learning so intractable that he concluded that mathematical knowledge was actually not learned at all.

Plato realized that the deepest problems were not confined to mathematics, but centered on the epistemological feats of *abstraction* and *generalization*. How, he wondered, can we learn to recognize many different entities as all examples of cats, or pots, or storms? Despairing of an answer, he argued that general knowledge was innate, and genuine learning was only illusory. Learning seemed to occur only because at birth specific knowledge was forgotten and required experience and instruction to be recovered. Ostensible learning was in fact recollection. Plato's theory had a number of grave difficulties. First, the mechanisms whereby information is stored and recovered are no less puzzling and problematic than the nature of how something might be learned in the first place. Secondly, it was troublesome because it failed to address either the source of the original knowledge or the vehicle for prenatal knowledge. The awkwardness of Plato's solution notwithstanding, the questions he posed and the alternatives he considered set the basic agenda for inquiry for about two thousand years.

Advances in empirical understanding have allowed us to approach the basic problems concerning learning and memory with more specific questions and to discern at least the form some answers will take. Evolutionary biology provides the general framework to explain how certain kinds of knowledge could come to be built into the brains of a species. The discovery of the structure of deoxyribonucleic acid provides the basis for understanding the vehicle by which certain aspects of knowledge can be specified in the brains of individuals. Developmental psychology investigates the scope and limits of innate capacities in humans and other animals, and the distinct contribution of experience to an individual's knowledge of the world. Research in experimental psychology that focuses on learning and memory continues to reveal aspects of the learning process such as time constants, the role of attention and awareness, the role of salience and context, and the durability of some kinds of knowledge relative to

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others. Neuropsychology, in analyzing the residual capacities in brain-damaged humans, provides unique links between behavior and brain structures.

Until the recent flowering of neuroscience, particularly within the last three decades, ideas about *mechanism* – about how exactly a physical organ like the brain could learn and apply the information in appropriate conditions — were necessarily vague and speculative. Indeed, until quite recently, a not uncommon opinion outside of neuroscience has been that it is not actually the physical brain that learns and remembers; it is the nonphysical, Cartesian soul. The shift from purely speculative theories to empirically grounded hypotheses about both the functional organization and the mechanisms of learning and memory implies a *naturalizing* of epistemology; that is, the acquisition and application of knowledge are seen as part of the natural world, subject to empirical investigation and understanding, just like any other natural phenomenon. Although naturalism goes against the grain of many philosophers who assume that pure reason alone, independently of empirical science, is the sole avenue to genuine understanding at these issues, the remarkable progress in empirical inquiry favors philosophy's merging with the scientific mainstream rather than perpetuating its scientific isolation.

In nervous systems there is both large-scale and small-scale organization, and different operations take place on different levels. Organization ranges from the level of the molecule, to the single neuron, to small networks, large networks, areas, systems, and finally, the whole central nervous system. One sort of account will explain how signals are integrated in dendrites; a distinct account will explain the interaction of neurons in a network or the interaction of networks in a system. A model that captures the salient features of learning in networks will have a different face from a model that describes the properties of a membrane channel such as the *N-methyl-D*-aspartate receptor-ionophore complex. Nevertheless, theories on one level must mesh with theories of levels both higher and lower, because an inconsistency or a lacunum somewhere in the explanatory chain means that some phenomenon has been misunderstood. After all, brains are assemblies of neurons, and something would be seriously amiss if neurons under one description had properties incompatible with the same neurons under another description.

A reduction in science is essentially an explanation of phenomena at one level of organization in terms of the properties and interactions of entities at a sublevel. When it is claimed that the theory of optics, for example, reduces to the theory of electromagnetic radiation, what is meant is that optical phenomena (e. g. refraction) are explainable in terms of the properties of photons. In the context of neuroscience and psychology, we want to understand such matters as visual perception, reasoning, and learning. To seek a reduction, therefore, means seeking explanations of higher level phenomena, such as the recency effect or long-term recollection of events, in terms of lower-level properties. Given the multiple levels of organization between the nervous system as a whole and the individual molecule, the reduction can be expected to proceed step-wise, from one level to the next. The process of discovery, however, requires simultaneous research on all levels of organization, so that any given line of research can profit from results discovered at other levels.