# External Representation: An Issue for Cognition

Book review on Donald's Origins of the Modern Mind

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In Origins of the Modern Mind, Merlin Donald has offered a provocative, compelling, and radically different view of cognition. It was a great pleasure to follow his convincing arguments on the evolution of the modern mind. I entirely agree on the nonbiological (external, social, cultural, and artificial) nature of cognition. In the first part of this commentary, I elaborate on some of Donald's ideas of external representations. My disagreement with him, which is minor, is on some specific properties of external representations. The second part describes the disagreement.

### External Representations are an Indispensable Part of Cognition

According to Donald, the essence of cognitive evolution is the emergence of new representational systems that has taken place at three transitional stages. The first transition was from the episodic to the mimetic culture, marked by the emergence of the most basic representation--the ability to mime events. The second transition was from the mimetic to the mythic cultural, marked by the emergence of the human speech system that is capable of representing narratives. The third transition was from the mythic to the theoretic culture, marked by the emergence of visuosymbolic representations and external memory storage. The changes in the first two transitions were in the internal biological hardware, whereas those in the third transition were in the external technological hardware. Donald's radical departure from the traditional view of cognition concerns mainly the third transition: the changes in cognitive architecture mediated by external memory technology were no less fundamental than those mediated by biological changes in the brain. The external symbolic storage is the most important representational system, responsible for much of the virtually unlimited cognitive capacity of the modern mind. And the modern human mind can be considered as a mosaic structure of the biologically based representational systems that emerged during the early transitions and the external symbolic devices that emerged during the most recent transition.

Though I have some reservations about Donald's demarcation of the three transition stages, I entirely agree that external representations have not

only played crucial roles in the evolution of the modern mind but are also an indispensable part of cognition. People behave in an information rich environment filled with natural and artificial objects extended across space and time, surrounded by other people, and grounded in complex cultural and social structures. A variety of cognitive tasks, whether in everyday activity, scientific practice, or professional life, require the processing of information distributed across the internal mind and the external environment. Internal representations cannot be the whole story of cognition. The traditional approach to cognition, however, often assumes that cognition is exclusively the activity of the internal mind. External representations, if they have anything to do with cognition at all, are at most peripheral aids.

There is no doubt that internal representations are important for cognition. However, without taking external representations into consideration, one must sometimes postulate nonexistent internal representations to account for structure in behavior, much of which is merely a reflection of the structure in the environment (e.g., Kirlik, 1989; Simon, 1981; Suchman, 1987). Thus, to study cognition, especially high-level cognitive phenomena, we need to consider internal and external representations as an integrated representational system—a system of distributed representations. Recently, the role of the environment in cognition has become the central concern in several areas of cognitive science. For example, according to the "situated cognition" approach, the activities of individuals are situated in their social and physical environment, and knowledge is considered a relation between the individuals and the situation (e.g., Barwise & Perry, 1983; Greeno, 1989; Lewis, 1991; Suchman, 1987). For the "distributed cognition" approach, cognition is distributed across internal human minds, external cognitive artifacts, groups of people, and space and time, and it is the interwoven processing of internal and external information that generates much of a person's intelligent behavior (e.g., Hutchins, 1990, in preparation; Norman, 1988, 1991, 1993; Zhang, 1992). External representations are an indispensable part of cognition and must be treated seriously in the study of cognition.

## External Memory is Only One of the Aspects of External Representations

Donald defines external memory as "the exact external analog of internal, or biological memory, namely, a storage and retrieval system that allows humans to accumulate experience and knowledge." (p. 309). Though this is a useful functional definition, it does not capture the distributed nature of external memory. For example, a written Arabic numeral is not simply an exact external analog of the internal representation. It is a distributed representation: the arbitrary shapes of the symbols and their values must be memorized (internal information), and the spatial relations of the symbols are available in the environment (external information). In this case, it is the integration of internal and external representations that characterizes the nature of external memory (Zhang & Norman, 1993).

In the discussion of external representations, Donald focuses on external symbolic storage (mainly on writ-

ing systems) but says little about other types of external representations, especially those cognitive artifacts (Norman, 1991) that people use in everyday life to aid and organize their cognitive activities (e.g., calculating, navigational, and communicative devices). External representations not only represent information, they also constrain, anchor, structure, and change people's cognitive behavior. In addition, external representations can be nonsymbolic as well as symbolic, that is, they can provide information that can be directly perceived and used without being interpreted and formulated explicitly (e.g., Gibson, 1979).

Another aspect of cognition that deserves more discussion is the dynamic, interactive nature of human activity. Human beings are not only the product of the environment, but also active agents in creating the environment. For example, the sociohistorical approach to cognition argues that it is the continuous internalization of the information and structure in the environment and the externalization of the representations in the mind that produce high level psychological functions (e.g., Vygotsgy, 1978, 1986).

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