Does ACT-R's Activation Equations Reflect the Environment of Early Hominids?

Lael Schooler
(ljs24@psu.edu)
Department of Psychology
Pennsylvania State University

Juan Carlos Serio Silva
(serioju@ecologia.edu.mx)
Departamento de Ecologia Vegetal
Instituto de Ecologia A.C.

Ramon Rhine
Department of Psychology
University of California

The rational analysis of memory (Anderson, 1990) proposes that human memory has evolved to cope optimally with the informational demands that the environment places on people. We have shown that human memory performance reflects patterns with which environmental stimuli (e.g., words) occur and reoccur (Anderson, & Schooler, 1991; Schooler & Anderson, 1997). Because the human cognitive system did not evolve in our modern environment, Shettleworth (1998) has questioned the validity of our previous analyses: "to consider Anderson and Schooler's results relevant to pressures that have caused memory to evolve, one has to assume that headlines in late 20th-century newspapers reflect a general and enduring property of events in the world."

It is, of course, impossible to study the informational demands that the environment placed on early hominids. About the best we can do is study the informational demands placed on animals whose current ecological niches share something in common with the ecological niches in which hominids evolved. The question, then, is which animals fill the appropriate ecological niches. Dart (1926) argued that time spent on the savanna was critical in the development of intelligence. More recently Milton (1981) has pointed out that hominids evolved first in tropical forests, where "the extreme diversity of plant foods in tropical forests and the manner in which they are distributed in space and time have been a major selective force in the development of advanced cerebral complexity in higher primates." She argues that "to understand the origins of mental complexity, one must look not only at life in the savannas but also life in tropical forests." Thus, studying how primates move through forests and savannas represent good starting points for understanding the informational demands that shaped early hominid evolution.

We have analyzed existing data on the ranging patterns of howler monkeys through forests, and baboons through savanna. Serio-Silva, using the focal animal method, recorded the identification numbers of the trees the howlers were visiting. Rhine's group used the focal animal method as well. They recorded the positions of the baboons in terms of quadrats measuring 720 m^2. It appears that the visitation patterns of howlers and baboons match up with the statistics of the modern environments. Our analyses show that there are statistical properties shared among domains as diverse as word usage in the New York Times and the ranging patterns of howler monkeys in trees. These analyses suggest that there are "general and enduring" properties shared between modern and early hominid environments. Our modeling efforts suggest these patterns arise as a natural consequence of moving through the environment.

Beyond demonstrating the feasibility of performing environmental analyses of primates in natural environments, these analyses have implications for the kinds of memory mechanisms to explore. By exploiting enduring statistical properties of the environment, the memory system could rely on mechanisms that need only infer the *parameters* of known functions. This is a far simpler task than trying to infer what these functions might be. This supports a general-purpose memory system that just estimates parameters for various memory traces.

Some have argued that such general-purpose mechanisms are unlikely to evolve. "General-purpose mechanisms can't solve most adaptive problems at all, and in those cases where one could, a specialized mechanism is likely to solve it more efficiently. " Cosmides & Tooby (1994). Implicit in their argument is the assumption that diverse domains do not share fundamental features in common. To the extent that a variety of domains do share statistical properties a general-purpose memory system would be efficient and evolvable.

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