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Microcognition by Andy Clark

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Author
Fantuzzi, Cheryl

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As an introductory linguistics text, one expects the goal of *Contemporary Linguistics* to be to get people started in the field of linguistics and related disciplines. In spite of a few minor problems, the authors have not only achieved this goal in a more-than-adequate fashion, they have also demonstrated that an introductory text can be comprehensive enough for the non-initiated to become acquainted with the complexities which the study of language entails. For the practicing linguist, *Contemporary Linguistics* could be a good reference source. For the linguistics teacher, it should serve as an excellent course text. For the student, it is particularly helpful because of the straightforward, explanatory style the authors have adopted. In all, *Contemporary Linguistics* fills a major gap, since state-of-the-art introductory linguistics texts are not plentiful on the market.

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Stephen Adewole is a Ph.D. student in the Department of Linguistics at UCLA. His interests include the teaching and analysis of African languages.

Microcognition by Andy Clark. Cambridge, MA: MIT Press, 1989. 226 pp.

Reviewed by
Cheryl Fantuzzi
University of California, Los Angeles

In the true spirit of integrative, interdisciplinary cognitive science research, philosopher Andy Clark seeks to call a truce to what he aptly refers to as the "holy war" of cognitive modeling. In complex matters of the mind, it is Clark's contention that since the brain may simply need and use more than one mode of information-processing to perform such tasks as comprehending and producing human language, a more integrative theory of cognition is therefore needed. In *Microcognition*, Clark introduces the reader to some of the major issues and conundrums of 20th-century philosophy and cognitive science: What is the mind, and what is its relationship to the brain? How does the mind work, and how does it affect behavior? How do seemingly abstract entities, such as personal beliefs and desires, influence bodily movement, and how might sentential propositions actually be instantiated in "neural stuff?" Clark gives us a quick overview of the modern answer to the mind/body dilemma: the computational model of mind. Most interestingly, he brings us into the heart of the currently lively debate between two competing computer models of the mind: the "classical" symbol systems of AI (Artificial Intelligence) and the "new connectionist movement," also known as PDP (Parallel Distributed Processing).

This new debate in cognitive science is reminiscent of the heated discussions between Chomsky and the behaviorists some 30 years ago. One central issue, now as then, concerns the systematicity of thought and language and the explanatory adequacy of a generative grammar for language, as opposed to a 'subsymbolic,' or associationist, view of both cognition and language. The symbolic computational approach of classical AI, in fact, represents the mathematical-syntactic approach of Chomskian generative grammar *par excellence*, since it conceptualizes the mind as a type of formal logic machine with mental rules operating on abstract, symbolic representations. The subsymbolic connectionist approach, on the other hand, operates without rules and without symbols. It emphasizes the "messy, biological" substrate of cognition, rather than the rational, logical nature of thinking, and uses a computational architecture closer to the distributed, parallel nature of processing in the brain, rather than the conventional sequential architecture of a digital computer. Clark's thesis is that cognitive modeling may actually require both classical and connectionist 'cognitive architecture' to model two different kinds of information processing: for some tasks, our thinking does appear to be slow, deliberate and serial, while for others, such as visual perception, it is fast, automatic and parallel.

Microcognition is divided into two parts: the "mind's-eye view," which describes classical AI and some of the philosophical criticisms against it, and the "brain's-eye view," which focuses on

the "brain-like" connectionist systems that process information as spreading activation over a connected network of neuron-like units. I find the second half of the book to be the most interesting, for it describes and compares PDP systems with classical models and presents a case for "the multiplicity of mind," that is, a hybrid cognitive architecture. One of the many examples of PDP models that Clark describes is the well-known past tense acquisition model of Rumelhart & McClelland (McClelland, Rumelhart & the PDP Research Group, Vol. 2, 1986). In addition, he also describes the representation and learning of *schemas* in PDP networks as well as how the psychological mechanism of generalization naturally derives from connectionist processing. Other topics include the flexibility and robustness of PDP systems, or their ability to "degrade gracefully" in the face of system damage or incomplete input, and the many architectural advantages that these models exhibit over a sequential symbolic processor for some tasks, such as low-level perception and motor control. For other tasks, such as conscious problem-solving and language production, Clark suggests that a classical architecture may also be required and may be much more than just a "useful approximation" of deeper psychological explanations.

As Clark points out, those most committed to a "unitary model of mind," whether connectionist or symbolic, all too often oppose each other from fiercely competing and mutually exclusive theoretical poles. Clark, however, begins with a "multiplicity" assumption, and, borrowing a term from computer science, argues for multiple "virtual cognitive architectures" implementing different aspects of cognitive functioning. In light of persuasive arguments for cognitive modularity by theorists such as Chomsky, I am sympathetic to Clark's spirited defense of integrative modularity. Theorists committed to a more holistic view of an undifferentiated neural network will, of course, find Clark's conclusions more controversial. As a philosopher, however, Clark does not present us with an explicit hybrid model, so in the long run it will undoubtedly be the empirical models themselves that will best inform this debate.

I find Clark's argument nicely illustrated, though, in his example of the past tense acquisition model. In the developmental literature this is usually described as a three-stage process of rule-formation, while in the connectionist framework the same process can be modeled completely without rules, and even without

symbols, such as "-ed" or verb roots. Clark argues that the first level of past tense learning may be implemented by a pure PDP mechanism of statistical induction, but, in the transition to the next level, the learner then organizes and restructures her internal representations, creating symbols to represent sets of distributed activity patterns. This results in the second "stage" of systematic overgeneralization of regular past endings. In transition to the third stage, a PDP mechanism of fine-tuning is again implemented, and finally, in the third stage, the learner attains "the coexistence of a pure PDP mechanism of lexical access and a nonlexical mechanism implemented with PDP" (p. 172), that is, the normal adult system of past tense.

Another important point that Clark discusses is the notion of "levels of explanation." Clark argues that several levels of analysis intervene between behavior and its physical implementation, whether in the brain or in computational systems. Just as we talk about levels of structure and function in the brain (molecular, cellular, circuitry, networks, systems, etc.), he claims that we must distinguish among levels of computer modeling: from the lowest level of the numerical specification of the input, to the subsymbolic level, to the partitioning of abstract representational space, to the conceptual level and, finally, to the folk-psychological level of belief and desire talk. Thus, in addition to multiple architectures, Clark argues for a multiplicity of levels of explanation, independent of what the architectural facts may turn out to be.

In *Microcognition*, Clark presents some of the contemporary issues of cognitive science to the non-specialist reader in a straightforward and comprehensible way. The book provides a good introduction to questions that a reader might want to explore more deeply in the vast literature of cognitive science. What I find especially appealing is Clark's attempt to integrate apparently opposing approaches into a single complex puzzle. The book is also clearly written and witty, making it truly enjoyable as well as informative, and it is very useful, I think, for second language researchers interested in the mind and in current issues of cognitive modeling.

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Cheryl Fantuzzi is a Ph.D. student in applied linguistics at UCLA, specializing in second language acquisition. Her special interests include research in cognitive science and developmental psycholinguistics.

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Announcements

At the end of Winter Quarter, 1989, Professor Evelyn Hatch retired and became Professor Emerita in the Department of TESL and Applied Linguistics at UCLA.

To honor Evelyn's many contributions as a scholar, researcher and teacher, her colleagues, friends and students (current and former) established a fund which, beginning in 1991, will reward annually the most outstanding UCLA student research paper in Applied Linguistics.

Colleagues who would like to join in honoring Evelyn's work are hereby invited to send a tax-deductible contribution to the Evelyn Hatch Award Fund. Checks should be made payable to the Regents of the University of California and should be directed to Ms. Chris Musselman, Department of TESL & Applied Linguistics, UCLA, 3300 Rolfe Hall, Los Angeles, CA 90024-1531.

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