



## Book Review

As advertised: A review of  
*The MIT Encyclopedia of the Cognitive Sciences* <sup>☆</sup>

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For me, this is an exciting time to be a cognitive scientist and a cognitive linguist. Cognitive Linguistics has developed rapidly and with enormous success over the past two decades, providing a cognitively based account of language. When results in cognitive linguistics are taken together with results in the other cognitive sciences, a radically new view of the mind and language—and their relation to the brain—emerges. As a result, the original formalist nativist paradigm of cognitive science as it developed in the 1960s and early 1970s has been stood on its head.

I was one of the originators of that paradigm, among the researchers first bringing formal logic as an account of natural language semantics into linguistics in the early 1960s. The hope then was to fit logic and Chomskyan transformational generative grammar into a unified approach to language and mind. The formalist nativist paradigm that subsequently developed tried to fulfill that dream, with the hope of merging Anglo-American analytic philosophy with formal logic, generative grammar, early AI, cognitive psychology, and cognitive anthropology.

By the mid-1970s, it was clear that the formalist nativist paradigm did not fit the facts. Research by Brown, Berlin, Kay, Slobin, Rosch, Mervis, Barsalou, DeValois, McNeill, and others indicated that words and concepts not only did not fit formal logic, but were fundamentally embodied and connected to human experience, with very different properties. For example, basic color terms in all the world's languages show commonalities derived from the neurophysiology of color vision. More generally, words and concepts show gradations, prototype structures of at least half-a-dozen kinds, radial structure, and basic-level structure deriving from many aspects of direct experience. These results and many others led to the development of cognitive linguistics and an embodied cognitive science beginning in the late 1970s.

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The discoveries coming from this research have provided a very different view of the mind. Here are some of the results I find most interesting.

### **1. The embodiment of mind has been established**

Concepts are shaped by the sensory-motor system, by neural structures, and by bodily experience in the world. Theories of how particular concepts are embodied now exist for spatial relations concepts, action concepts, aspectual concepts, and primary conceptual metaphors.

These results contradict the idea in the formalist nativist paradigm idea that thought is disembodied symbol-manipulation, as in the artificial intelligence views of Newell and Simon, McCarthy, and others. They also contradict the philosophical idea of functionalism, that the mind can be studied independently of the brain and body—an idea central to the formalist nativist paradigm.

### **2. Language is also shaped by embodiment**

Language is constituted by direct links between conceptual and phonological structures, each of which is embodied via the sensory-motor system, the emotional system, and so on. The basic unit of grammar is the construction, a multi-faceted structure consisting of such direct links between conceptual structures (including constraints on context, knowledge, discourse structure, and so on) and the sound structures expressing them. The fundamental properties of linguistic systems arise from the properties of the neural systems constituting the embodied bases of both conceptual and phonological systems, and the circuitry connecting them, which constitutes grammar.

These results contradict the formalist nativist paradigm's view of language taken from the fundamental ideas of Chomskyan linguistics, namely:

- (a) that grammar is a system of meaningless symbols—an autonomous, purely formal structure, independent of meaning, context, world knowledge, memory, attentional mechanisms, and all processing mechanisms;
- (b) that there are “transformations” that operate independent of real time; and
- (c) that we are born with an innate “syntax box” using no general cognitive mechanisms and taking no input from any other aspect of cognition.

### **3. After two decades of intense research, many of the basic conceptual mechanisms underlying thought seem to have been arrived at**

They are: image-schemas, force-dynamic-schemas, X-schemas, frames, conceptual metaphors, conceptual metonymies, mental spaces, conceptual blends, and prototype structures of various kinds (radial categories, stereotypes, typical cases, graded cases, paragons, anti-paragons, salient exemplars, cognitive reference points). There may well be more, but as of now, these appear to be the basics.

Conceptual metaphors are cross-domain mappings that permit abstract concepts to import most of their inference structure from concepts with a direct sensory-motor basis. There are thousands of such metaphoric mappings characterizing modes of abstract inference for speakers of all languages.

These results not only make obsolete the idea that thought is a version of formal logic, but also refute certain central ideas of analytic philosophy: the correspondence theory of truth, the view that all meaning is literal, the classical theory of categories as defined by necessary and sufficient conditions, and so on.

#### **4. A Neural Theory of Language has been outlined and is under development**

It is a first approximation of an answer to the question: *How do concepts and language arise from the physical brain?* The answer combines three elements:

- (A) detailed neural structures,
- (B) basic principles of neural computation,
- (C) detailed conceptual structures and linguistic constructions.

The central idea is that the effects of detailed conceptual structures and constructions as described by cognitive linguists can be computed via principles of neural computation from detailed neural structures of the sort found in the brain. Some of the detailed neural structures are known to exist (e.g., topographic maps of the visual field, orientation-sensitive cells, center-surround receptive fields). Others are hypothesized by reasoning backwards, asking which types of neural structures would have to be there to compute the conceptual structures and constructions that have been discovered.

Within the neural theory of language, Dynamic Simulations characterize how utterances are understood in context in real time using general knowledge and making real-time inferences using both literal and metaphorically-mapped inference patterns. The dynamic simulations are governed by parameterizations—individual factors determining what happens in a simulation. Grammatical constructions link conceptual parameters to phonological parameters. That is, grammar consists of neural circuitry that mediates between, and depends on, what is thought and what is spoken and heard (or signed and seen).

This development is in direct conflict with the formalist nativist paradigm's idea that language is entirely a human innovation—an innate, autonomous, purely formal structure in no way shaped by the sensory-motor system (which animals have) nor by general constraints on neural computation (as opposed to those just found in the processing of language alone).

It also contradicts PDP (parallel distributed processing) connectionism, which argues against the rich kinds of neural structures required to characterize the detailed conceptual structures, phonological structures, and grammatical constructions found natural languages.

### **5. The learning of grammar makes central use of primary experiences and linguistic expressions for them**

Grammatical constructions expressing such experiences and linked to such verbs are learned first. Following extensive empirical findings, current neural models of language acquisition require prior conceptualizations of experience, the learning of basic conceptual structures, and the neural recruitment of circuitry linking phonological modes of expression directly to those conceptual structures.

### **6. Language acquisition makes fundamental use of *the opulence of the substrate***

The *substrate* is the enormously rich neural structure developed by each child for comprehending both physical and interpersonal experience and for correlating produced sounds and heard sounds—all of which precedes the learning of grammar.

This contradicts the formalist nativist paradigm's idea of *the poverty of the stimulus*, the idea that language is learned on the basis of an extremely limited and skewed sample of utterances. Once it is recognized that language pairs richly embodied concepts with richly embodied phonology via neural binding, and that grammar is just that pairing, a theory of an innate, isolated, autonomous “grammar box” does not fit the facts.

### **7. A wide range of grammatical phenomena have now been given sound cognitive linguistic explanations**

Within the cognitive construction grammar tradition, many technical problems in grammatical structure have been shown to make use of the fundamental mechanisms of conceptual systems, i.e., frames, metaphors, conceptual blends, and so on. In addition, functional grammarians have shown how discourse structure enters into grammatical generalizations. At the same time, the range of linguistic phenomena studied by the formalist nativist paradigm has gotten smaller and smaller.

### **8. Applications of these ideas are currently taking central stage in rethinking traditional disciplines**

The neural view of language has been at the core of psycholinguistics for decades, in research concerning spreading activation, priming, and so on. Currently, philosophy and linguistics are being rethought along these lines. But the new theory of mind has also been central in the rethinking of literary theory, law, politics, and mathematics. In each case, what results is a radically new understanding of the discipline.

In short, the formalist nativist paradigm with which cognitive science began in the 1960s and early 1970s has been turned on its head. In place of logic, there are image-schemas, frames, metaphorical mappings, mental spaces, and so on. In place of formal generative grammars, there are embodied cognitive grammars designed to operate probabilistically

in real time, using grammatical constructions that directly link an embodied semantics with an embodied phonology. In place of symbol systems, there are highly structured neural models. In place of the poverty of the stimulus, there is the opulence of the substrate. In place of Anglo-American analytic philosophy with its correspondence theory of truth, there is emerging a new embodied view of philosophy with an embodied account of truth. In place of a mathematics that is an abstract, objectively structured, feature of the universe, there is an embodied cognitive mathematics that makes use of normal cognitive mechanisms, especially image-schemas and conceptual metaphors. In place of categories defined by necessary and sufficient conditions, there are richly structured cognitive categories, with many types of prototypes. In place of the Rationalist/Empiricist dichotomy, there is a third approach, Experientialism, an embodied realism that is neither of those. In place of the symbolic/connectionist dichotomy, there is a neural theory of language and thought that captures the best features of both.

These changes in our view of the mind, language, and philosophy have been wrought by cognitive science and they have been profound. It is indeed an exciting time to be a cognitive scientist.

Unfortunately, you can read virtually nothing about all these exciting developments in cognitive science from reading *The MIT Encyclopedia of the Cognitive Sciences*. It is, as advertised, the *MIT* version of cognitive science, *MIT* being the center of the formalist nativist paradigm. Despite its 471 articles and six introductory essays, one finds only the barest hint of these developments, scattered here and there in obscure places. The six major articles that supposedly provide an overview to the field make no mention of them.

However, if you read really carefully, you can find a hint of some of these developments here and there. When the publisher first announced the volume and the tentative contents, I sent an e-mail suggesting that they discuss these developments seriously. The result: They asked Karen van Hoek to write a one-page discussion of all of Cognitive Linguistics, which would be like writing a one-page discussion of Linguistics. Van Hoek, dutifully wrote a page worth, which could not cover much. But even that was misdescribed by Gennaro Chierchia as a mere “disagreement . . . over the choice of primitives” rather than as a whole field looking at language and thought from the perspective of embodied cognition and reaching diametrically opposed conclusions. Another brief glimpse comes in a fine but brief and hidden entry by Raymond Gibbs on figurative language.

If you want to know about linguistics and the study of concepts and reasoning from the perspective of the formalist nativist paradigm, this is a fine place to go. Unfortunately, much of the most exciting work in linguistics and cognitive science is not covered here. The best I can do to help is to give the readers of this journal some of what *MITECS* leaves out—a brief introductory guide to readings in embodied cognitive science.

## References

This is a topic-oriented list of references. It includes both works cited and other works that are either of an introductory or supplementary nature. It is intended to allow the reader entry to the literature, rather than to be exhaustive.

*Reference list organization*

- A. Cognitive linguistics and related literature.
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**The reference list**

*Cognitive Linguistics* is a journal devoted to the whole gamut of cognitive approaches to linguistics.

*A.1. Metaphor theory*

Conceptual metaphor is the mechanism by which abstract concepts are understood and reasoned about in terms of physically-based concepts. The most popular introduction to the field is *Metaphors We Live By*, by Lakoff and Johnson (1980). It's now two decades old. *Philosophy in the Flesh* by Lakoff and Johnson (1999) is up-to-date, but longer. Johnson (1981) is a survey of previous approaches to the study of metaphor.

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## B. The neural theory of language and structured connectionism

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## C. Applications

### C.1. Philosophy

Lakoff and Johnson (1999) is the best overall account. Johnson's *The Body in the Mind* is a classic. Lakoff's *Women, Fire, and Dangerous Things* lays out an earlier version of the position.

Lakoff, G. and M. Johnson, 1999. *Philosophy in the Flesh: The Embodied Mind and Its Challenge to Western Thought*. New York: Basic Books.

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### C.2. Literary studies

Cognitive Literary Theory is an established approach to the study of literature. The foundational texts are Lakoff and Turner's *More Than Cool Reason* and Turner's *The Literary Mind*.

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### C.3. Politics

Lakoff (1996) is the first full scale application of cognitive science to American politics.

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### C.4. Law

Winter is the major figure here, with nearly two dozen law review papers setting out a framework for cognitive legal theory. Winter (2001), even in pre-publication form, has become the central text in cognitive legal theory.

Winter, S., 1989. Transcendental Nonsense, Metaphoric Reasoning and the Cognitive Stakes for Law. *University of Pennsylvania Law Review* 137.

Winter, S., 2001. *A Clearing in the Forest: How the Study of the Mind Changes Our Understanding of Life and Law*. Chicago: University of Chicago Press.

### C.5. Mathematics

Lakoff and Núñez (2000) is a cognitive theory of mathematical ideas and presents a new approach via cognitive science to the philosophy of mathematics.

Lakoff, G. and R. Núñez, 1997. The Metaphorical Structure of Mathematics: Sketching out Cognitive Foundations for a Mind-Based Mathematics. In L. English (ed.), *Mathematical Reasoning: Analogies, Metaphors, and Images*. Hillsdale, NJ: Erlbaum.

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