



Book Review

As advertised: A review of *The MIT Encyclopedia of the Cognitive Sciences* [☆]

George Lakoff

*Department of Linguistics, University of California at Berkeley, 608 Barrows Hall,
Berkeley, CA 94720-2650, USA*

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.

[☆] MIT Press, Cambridge, MA, 1999. 1312 pages. Price US\$ 149.95 (Cloth). ISBN 0-262-23200-6. CD-ROM. Price US\$ 149.95. ISBN 0-262-73124-X.

E-mail address: Lakoff@cogsci.Berkeley.EDU (G. Lakoff).

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.
 - A.1. Metaphor theory linguistics.
 - A.2. Experimental studies in metaphor.
 - A.3. Metaphor in gesture and American sign language.
 - A.4. Categorization.
 - A.5. Framing.
 - A.6. Mental spaces and conceptual blending.
 - A.7. Cognitive grammar and image-schemas.
- B. The neural theory of language.
- C. Applications.
 - C.1. Philosophy.
 - C.2. Literary studies.
 - C.3. Politics.
 - C.4. Law.
 - C.5. Mathematics.

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.

Fernandez-Duque, D. and M. Johnson, 19xx. Attention Metaphors: How Metaphors Guide the Cognitive Psychology of Attention. *Cognitive Science*.

Gibbs, R. and G. Steen (eds.), 1999. *Metaphor in Cognitive Linguistics*. Amsterdam: John Benjamins.

Johnson, C., 1997. Metaphor vs. conflation in the acquisition of polysemy: The case of SEE. In M.K. Hiraga, C. Sinha and S. Wilcox (eds.), *Cultural, Typological and Psychological Issues in Cognitive Linguistics*. Current Issues in Linguistic Theory, 152. Amsterdam: John Benjamins.

Grady, J., 1997. *Foundations of Meaning: Primary Metaphors and Primary Scenes*. Ph.D. Dissertation. University of California at Berkeley.

Grady, J., 2000. THEORIES ARE BUILDINGS Revisited. *Cognitive Linguistics*.

Grady, J., S. Taub and P. Morgan, 1996. Primitive and Compound Metaphors. In A. Goldberg (ed.), *Conceptual Structure, Discoursen, and Language*. Stanford: CSLI.

- Grady, J. and C. Johnson, to appear. Converging Evidence for the Notion of *Subscene*. In J. Moxley and M. Juge (eds.), *Proceedings of the Twenty-Third Annual Meeting of the Berkeley Linguistics Society*. Berkeley: Berkeley Linguistics Society.
- Johnson, C., 1997a. Metaphor vs. Conflation in the Acquisition of Polysemy: The Case of SEE. In M.K. Hiraga, C. Sinha and S. Wilcox (eds.), *Cultural, Typological and Psychological Issues in Cognitive Linguistics*. Current Issues in Linguistic Theory, 152. Amsterdam: John Benjamins.
- Johnson, C., 1997b. Learnability in the Acquisition of Multiple Senses: SOURCE Reconsidered. In J. Moxley and M. Juge (eds.), *Proceedings of the 22nd Annual Meeting of the Berkeley Linguistics Society*. Berkeley: Berkeley Linguistics Society.
- Johnson, M., 1993. Conceptual Metaphor and Embodied Structures of Meaning. *Philosophical Psychology* 6 (4), 413–422.
- Johnson, M., 1997. Embodied Meaning and Cognitive Science. In D. Levin (ed.), *Language beyond Postmodernism: Saying and Thinking in Gendlin's Philosophy*, 148–175. Evanston: Northwestern University Press.
- Johnson, M. (ed.), 1981. *Philosophical Perspectives on Metaphor*. Minneapolis: University of Minnesota Press.
- Kövecses, Z., 1990. *Emotion Concepts*. Berlin: Springer-Verlag.
- Kövecses, Z., 1986. *Metaphors of Anger, Pride, and Love: A Lexical Approach to the Structure of Concepts*. Philadelphia: John Benjamins.
- Kövecses, Z., 1988. *The Language of Love: The Semantics of Passion in Conversational English*. Lewisburg, Penn.: Bucknell University.
- Kövecses, Z., 2000. *Metaphor and Emotion*. Cambridge, England: Cambridge University Press.
- Lakoff, G., 1993. The contemporary theory of metaphor. In A. Ortony (ed.), *Metaphor and Thought*, 2nd ed., 202–251. Cambridge: Cambridge University Press.
- Lakoff, G. and M. Johnson, 1980. *Metaphors We Live By*. Chicago and London: University of Chicago Press.
- Lakoff, G. and M. Johnson, 1999. *Philosophy in the Flesh: The Embodied Mind and Its Challenge to Western Thought*. New York: Basic Books.
- Reddy, M., 1979. The conduit metaphor. In A. Ortony (ed.), *Metaphor and Thought*, 284–324. Cambridge: Cambridge University Press.
- Sweetser, E., 1990. *From Etymology to Pragmatics: Metaphorical and Cultural Aspects of Semantic Structure*. Cambridge: Cambridge University Press.

A.2. Experimental studies of metaphor

The journal *Metaphor and Symbol* is devoted primarily to empirical psychological research on metaphor. Gibbs, 1994 is an excellent overview of that research.

- Albritton, D., 1992. The Use of Metaphor to Structure Text Representations: Evidence for Metaphor-Based Schemas. Ph.D. Dissertation, Yale University.
- Boroditsky, L., 1997. Evidence for Metaphoric Representation: Perspective in Space and Time. In M.G. Shafto and P. Langley (eds.), *Proceedings of the Nineteenth Annual Conference of the Cognitive Science Society*. Mahwah, NJ: Lawrence Erlbaum Associates.

- Gentner, D. and D.R. Gentner, 1982. Flowing Waters or Teeming Crowds: Mental Models of Electricity. In D. Gentner and A.L. Stevens (eds.), *Mental Models*. Hillsdale, NJ: Erlbaum.
- Gibbs, R., 1994. *The Poetics of Mind: Figurative Thought, Language, and Understanding*. Cambridge: Cambridge University Press.
- Gibbs, R. and J. O'Brien, 1990. Idioms and Mental Imagery: The Metaphorical Motivation for Idiomatic Meaning. *Cognition* 36, 35–68.
- Kemper, S., 1989. Priming the Comprehension of Metaphors. *Metaphor and Symbolic Activity* 4, 1–18.
- Nayak, N. and R.W. Gibbs, 1990. Conceptual Knowledge in Idiom Interpretation. *Journal of Experimental Psychology: General* 116, 315–330.

A.3. *Metaphor in gesture and American sign language*

McNeill is a classic book on the nature of spontaneous gesture and the first study of metaphoric gesture. Taub is the best major source on iconicity and metaphor in American Sign Language.

- McNeill, D., 1992. *Hand and Mind: What Gestures Reveal about Thought*. Chicago: University of Chicago Press.
- Taub, S., 2001. *Language in the Body: Iconicity and Metaphor in American Sign Language*. New York: Cambridge University Press.
- Wilbur, R.B., 1987. *American Sign Language: Linguistic and Applied Dimensions*. Boston: Little, Brown and Co.
- Wilcox, P., 1993. *Metaphorical Mapping in American Sign Language*. Ph.D. Dissertation, University of New Mexico.

A.4. *Categorization*

Lakoff (1987) is the best overall survey of relevant results and the best introduction to radial categories. The works by Rosch are classics.

- Barsalou, L.W., 1983. Ad-Hoc Categories. *Memory and Cognition* 11, 211–227.
- Barsalou, L.W., 1984. Determination of Graded Structures in Categories. Psychology Department, Emory University, Atlanta, GA.
- Berlin, B., D. Breedlove and P. Raven, 1974. *Principles of Tzeltal Plant Classification*. New York: Academic Press.
- Craig, C. (ed.), 1986. *Categorization and Noun Classification*. Philadelphia: John Benjamins.
- Hunn, E., 1977. *Tzeltal Folk Zoology: The Classification of Discontinuities in Nature*. New York: Academic Press.
- Lakoff, G., 1987. *Women, Fire, and Dangerous Things: What Categories Reveal about the Mind*. Chicago and London: University of Chicago Press.
- Mervis, C., 1984. Early Lexical Development: The Contributions of Mother and Child. In C. Sophian (ed.), *Origins of Cognitive Skills*, Hillsdale, NJ: Lawrence Erlbaum.

- Mervis, C., 1986. Child-Basic Object Categories and Early Lexical Development. In U. Neisser (ed.), *Concepts and Conceptual Development: Ecological and Intellectual Factors in Categorization*, Cambridge: Cambridge University Press, 201–233.
- Mervis, C. and E. Rosch, 1981. Categorization of Natural Objects. *Annual Review of Psychology* 32, 89–115.
- Rosch, E. (E. Heider), 1973. Natural Categories. *Cognitive Psychology* 4, 328–350.
- Rosch, E., 1975a. Cognitive Reference Points. *Cognitive Psychology* 7, 532–547.
- Rosch, E., 1975b. Cognitive Representations of Semantic Categories. *Journal of Experimental Psychology: General* 104, 192–233.
- Rosch, E., 1977. Human Categorization. In N. Warren (ed.), *Studies in Cross-Cultural Psychology*. London: Academic Press.
- Rosch, E., 1978. Principles of Categorization. In E. Rosch and B.B. Lloyd (eds.), *Cognition and Categorization*, 27–48. Hillsdale, NJ: Erlbaum.
- Rosch, E., 1981. Prototype Classification and Logical Classification: The Two Systems. In E. Scholnick (ed.), *New Trends in Cognitive Representation: Challenges to Piaget's Theory*, 73–86. Hillsdale, NJ: Erlbaum.
- Rosch, E. and B.B. Lloyd, 1978. *Cognition and Categorization*. Hillsdale, NJ: Erlbaum.
- Rosch, E., C. Mervis, W. Gray, D. Johnson and P. Boyes-Braem, 1976. Basic Objects in Natural Categories. *Cognitive Psychology* 8, 382–439.
- Schwartz, A., 1992. *Contested Concepts in Cognitive Social Science*. Honors Thesis, University of California, Berkeley.
- Smith, E.E. and D.L. Medin, 1981. *Categories and Concepts*. Cambridge, MA: Harvard University Press.
- Taylor, J., 1989. *Linguistic Categorization: Prototypes in Linguistic Theory*. Oxford: Clarendon Press.
- Tversky, B. and K. Hemenway, 1984. Object, Parts, and Categories. *Journal of Experimental Psychology: General* 113, 169–193.
- Wittgenstein, L. 1953. *Philosophical Investigations*. New York: Macmillan.

A.6. Frame semantics and the lexicon

Fillmore is the major source for empirical linguistic research on frames and the syntax and semantics of lexical items (see the website: www.icsi.berkeley.edu/Framenet). Holland and Quinn introduced the techniques to anthropology.

- Fillmore, C., 1975. An Alternative to Checklist Theories of Meaning. In *Proceedings of the First Annual Meeting of the Berkeley Linguistics Society*, 123–131. Berkeley: Berkeley Linguistics Society.
- Fillmore, C., 1978. The Organization of Semantic Information in the Lexicon. In *Papers from the Parasession on the Lexicon*, 1–11. Chicago: Chicago Linguistic Society.
- Fillmore, C., 1982a. Towards a Descriptive Framework for Spatial Deixis. In R.J. Jarvella and W. Klein (eds.), *Speech, Place, and Action*, 31–59. London: Wiley.
- Fillmore, C., 1982b. Frame Semantics. In Linguistic Society of Korea (ed.), *Linguistics in the Morning Calm*, 111–138. Seoul: Hanshin.
- Fillmore, C., 1985. Frames and the Semantics of Understanding. *Quaderni di Semantica* 6, 222–253.

- Fillmore, C., 1997. *Lectures on Deixis*. Stanford: CSLI/Cambridge.
- Fillmore, C.J., 1977. Scenes-and-frames semantics, Linguistic Structures Processing. In Zampolli, A. (ed.), *Fundamental Studies in Computer Science*, No. 59, North Holland Publishing.
- Fillmore, C.J., 1977. The need for a frame semantics in linguistics. In Karlgren, H. (ed.), *Statistical Methods in Linguistics*.
- Fillmore, C.J., 1976. Frame semantics and the nature of language. In *Annals of the New York Academy of Sciences*, Conference on the Origin and Development of Language and Speech, Vol. 280, 20–32.
- Johnson, C. and C.J. Fillmore, 2000. The FrameNet tagset for frame-semantic and syntactic coding of predicate-argument structure. In *Proceedings of the 1st Meeting of the North American Chapter of the Association for Computational Linguistics (ANLP-NAACL 2000)*, April 29–May 4, 2000, Seattle, WA, 56–62.
- Holland, D.C. and N. Quinn (eds.), 1987. *Cultural Models in Language and Thought*. Cambridge: Cambridge University Press.

A.7. Mental spaces and conceptual blending

- Fauconnier 1985 is the classic introductory work on mental spaces. Works by Fauconnier and Turner are definitive for conceptual blending research. (See website: www.wam.umd.edu/~mturn/WWW/blending.html.)
- Coulson, S., 2001. *Semantic Leaps: The Role of Frame-Shifting and Conceptual Blending in Meaning Construction*. New York: Cambridge University Press.
- Fauconnier, G., 1985. *Mental Spaces: Aspects of Meaning Construction in Natural Language*. Cambridge, MA: MIT Press.
- Fauconnier, G., 1997. *Mappings in Thought and Language*. Cambridge: Cambridge University Press.
- Fauconnier, G. and E. Sweetser (eds.), *Spaces, Worlds, and Grammar*. Chicago: University of Chicago Press.
- Fauconnier, G. and M. Turner, In preparation. *How the Mind Thinks*.
- Fauconnier, G. and M. Turner, 1996. Blending as a Central Process of Grammar. In A. Goldberg (ed.), *Conceptual Structure, Discourse, and Language*. Stanford: CSLI/Cambridge.
- Mandelblit, N., 1997. *Grammatical Blending: Creative and Schematic Aspects in Sentence Processing and Translation*. Ph.D. Dissertation, UC San Diego.
- Sweetser, E., 1997. Mental Spaces and Cognitive Linguistics: A Cognitively Realistic Approach to Compositionality. Fifth International Cognitive Linguistics Conference. 1997.
- Turner, M., 1996. Conceptual Blending and Counterfactual Argument in the Social and Behavioral Sciences. In P. Tetlock and A. Belkin (eds.), *Counterfactual Thought Experiments in World Politics*. Princeton, NJ: Princeton University Press.
- Turner, M., In preparation. Backstage Cognition in Reason and Choice. In A. Lupia, M. McCubbins and S. Popkin (eds.), *Elements of Political Reasoning*.

- Turner, M. and Fauconnier, G., In press. Conceptual Integration in counterfactuals. In J.P. Koenig (ed.), *Conceptual Structure, Discourse, and Language 2*. Stanford: CSLI/Cambridge.
- Turner, M. and Fauconnier, G., 1995. Conceptual Integration and Formal Expression. *Metaphor and Symbolic Activity* 10 (3), 183–204.

A.8. Cognitive grammar and image-schemas

Langacker's two volume *Foundations of Cognitive Grammar*, his shorter *Concept, Image, and Symbol* and Goldberg's *Constructions* are classics of the cognitive approach to grammar. Lakoff's Case Study 3 in *Women, Fire, and Dangerous Things* is the most detailed case study.

Talmy's 2 volume work *Toward a Cognitive Semantics* is a foundational work for spatial relations and image-schemas. Case Study 2 in Lakoff's *Women, Fire and Dangerous Things* is a good introduction to many issues. M. Johnson's *The Body in the Mind* has an excellent introduction to image-schemas.

- Brugman, C., 1981. *Story of Over: Polysemy, Semantics, and the Structure of the Lexicon*. New York and London: Garland.
- Casad, E., 1982. *Cora Locationals and Structured Imagery*. Ph.D. Dissertation, University of California, San Diego.
- Casad, E. and R.W. Langacker, 1985. 'Inside' and 'Outside' in Cora Grammar. *International Journal of American Linguistics* 51, 247–281.
- Goldberg, A., 1995. *Constructions: A Construction Grammar Approach to Argument Structure*. Chicago and London: University of Chicago Press.
- Johnson, M., 1991. The Imaginative Basis of Meaning and Cognition. In S. Kuchler and W. Melion (eds.), *Images of Memory: On Remembering and Representation*, 74–86. Washington: Smithsonian Institution Press.
- Johnson, M., 1989. Image-schematic Bases of Meaning. *RSSI (Recherches Semiotique, Semiotic Inquiry)* 9 (1–3), 109–118.
- Lakoff, G., 1996. Reflections on Metaphors and Grammar. In S. Thompson and M. Shibatani (eds.), *Festschrift for Charles Fillmore*. Philadelphia: Benjamins.
- Langacker, R., 1983. Remarks on English Aspect. In P. Hopper (ed.), *Tense and Aspect: between Semantics and Pragmatics*, 265–304. Amsterdam: John Benjamins.
- Langacker, R.W., 1986, 1991. *Foundations of Cognitive Grammar*. 2 vols. Stanford: Stanford University Press.
- Langacker, R.W., 1990. *Concept, Image, and Symbol: The Cognitive Basis of Grammar*. Berlin and New York: Mouton de Gruyter.
- Lindner, S., 1981. *A Lexico-Semantic Analysis of Verb-Particle Constructions with Up and Out*. Ph.D. Dissertation, University of California at San Diego.
- Slobin, D., 1970. Universals of Grammatical Development in Children. In G.B. Flores d'Arcais and W.J.M. Levelt (eds.), *Advances in Psycholinguistics: Research Papers Presented at the Bressanone Conference on Psycholinguistics, 1969*. Amsterdam: North-Holland.

Slobin, D., 1985. Crosslinguistic Evidence for the Language-Making Capacity. In D. Slobin (ed.), *A Crosslinguistic Study of Language Acquisition*, Vol. 2: *Theoretical Issues*. Hillsdale, NJ: Lawrence Erlbaum.

Talmy, L., 2000. *Toward a Cognitive Semantics*. Cambridge: MIT Press. Two volumes.

B. The neural theory of language and structured connectionism

Regier's *The Human Semantic Potential* is a magnificent study of how neural structures in the visual system can compute image schemas and more complex spatial relations. Narayanan's *Embodiment in Language Understanding* is required reading. Shastri and Ajjanagadde (1993) is a thorough overview of Shastri's work on neural binding models. (See website: www.icsi.berkeley.edu/NTL.)

Ajjanagadde, V. and L. Shastri, 1991. Rules and Variables in Neural Nets, *Neural Computation* 3, 121–134.

Bailey, D., 1997. *A Computational Model of Embodiment in the Acquisition of Action Verbs*. Ph.D. Dissertation. Computer Science Division, EECS Department, University of California, Berkeley.

Bailey, D., J. Feldman, S. Narayanan and G. Lakoff, 1997. Modeling Embodied Lexical Development. In M.G. Shafto and P. Langley (eds.), *Proceedings of the Nineteenth Annual Conference of the Cognitive Science Society*. Mahwah, NJ: Lawrence Erlbaum Associates.

Ballard, D., 1997. *An Introduction to Natural Computation*. Cambridge, MA: Bradford Books/MIT Press.

Feldman, J., 1982. Dynamic Connections in Neural Networks. *Biological Cybernetics* 46, 27–39.

Feldman, J., 1985. Four Frames Suffice: A Provisional Model of Vision and Space. *Behavioral and Brain Sciences* 8, 265–289.

Feldman, J., 1988. Computational Constraints on Higher Neural Representations. In E. Schwartz (ed.), *Proceedings of the System Development Foundation Symposium on Computational Neuroscience*, Cambridge, MA: Bradford Books/MIT Press.

Feldman, J. and D.H. Ballard, 1982. Connectionist Models and Their Properties. *Cognitive Science* 6, 205–254.

Feldman, J. and L. Shastri, 1985. Evidential Reasoning in Semantic Networks. In *Proceedings of the Ninth International Joint Conference on Artificial Intelligence*. 465–474.

Feldman, J., G. Lakoff, A. Stolcke and S. Weber, 1990. Miniature Language Acquisition: A Touchstone for Cognitive Science. In *Proceedings of the 12th Annual Conference of the Cognitive Science Society*, Cambridge, MA: MIT Press. 686–693.

Hummel, J. and I. Biederman, 1990. *Dynamic Binding in a Neural Network for Shape Recognition*. Technical Report 90-5, Department of Psychology, University of Minnesota.

Lange, T.E. and M.G. Dyer, 1989. High-Level Inferencing in a Connectionist Network, *Connection Science* 1 (2), 181–217.

- Narayanan, S., 1997a. *Embodiment in Language Understanding: Sensory-Motor Representations for Metaphoric Reasoning About Event Descriptions*. Ph.D. Dissertation, Department of Computer Science, University of California, Berkeley.
- Narayanan, S., 1997b. Talking the Talk Is Like Walking the Walk: A Computational Model of Verbal Aspect. In *Proceedings of the Nineteenth Annual Conference of the Cognitive Science Society*.
- Nenov, V., 1991. Perceptually Grounded Language Acquisition: A Neural/Procedural Hybrid Model. Ph.D. Dissertation, University of California, Los Angeles.
- Omohundro, S., 1992. *Best-First Model Merging for Dynamic Learning and Recognition*. Technical Report TR-92-004, International Computer Science Institute, Berkeley.
- Regier, T., 1995. A Model of the Human Capacity for Categorizing Spatial Relations. *Cognitive Linguistics* 6 (1), 63–88.
- Regier, T., 1996. *The Human Semantic Potential: Spatial Language and Constrained Connectionism*. Cambridge MA: MIT Press.
- Shastri, L., 1988a. A Connectionist Approach to Knowledge Representation and Limited Inference, *Cognitive Science* 12 (3), 331–392.
- Shastri, L., 1988b. *Semantic Networks: An Evidential Formalization and Its Connectionist Realization*. Los Altos: Morgan Kaufmann/London: Pitman.
- Shastri, L., 1995. Structured Connectionist Models. In M. Arbib (ed.), *The Handbook of Brain Theory and Neural Networks*, 949–952. Cambridge, MA: MIT Press.
- Shastri, L., 1996. Temporal Synchrony, Dynamic Bindings, and SHRUTI, A Representational but Non-Classical Model of Reflexive Reasoning, *Behavioral and Brain Sciences* 19 (2), 331–337.
- Shastri, L., 1997a. A Model of Rapid Memory Formation in the Hippocampal System. In M.G. Shafto and P. Langley (eds.), *Proceedings of the Nineteenth Annual Conference of the Cognitive Science Society*. Mahwah, NJ: Erlbaum.
- Shastri, L., 1997b. Recent Advances in SHRUTI. In F. Maire, R. Hayward and J. Diederich (eds.), *Connectionist Systems for Knowledge Representation and Deduction*. Queensland University of Technology, Neurocomputing Research Center.
- Shastri, L. and V. Ajjanagadde, 1993. From Simple Associations to Systematic Reasoning. *Behavioral and Brain Sciences* 16 (3), 417–494.

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.

Johnson, M., 1987. *The Body in the Mind: The Bodily Basis of Meaning, Imagination, and Reason*. Chicago: University of Chicago Press.

- Johnson, M., 1999. Cognitive Science and Morality. In W. Bechtel and G. Graham (eds.), *A Companion to Cognitive Science*. Oxford: Blackwell Publishers.
- Johnson, M., 1996. How Moral Psychology Changes Moral Philosophy. In L. May, A. Clarke and M. Friedman (eds.), *Mind and Morals: Essays on Ethics and Cognitive Science*, 45–68. Cambridge, MA: MIT Press.
- Johnson, M., 1993. *Moral Imagination: Implications of Cognitive Science for Ethics*.

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*.

- Freeman, M., 1997. Grounded Spaces: Deictic-Self Anaphors in the Poetry of Emily Dickinson, *Language and Literature* 6 (1), 7–28.
- Lakoff, G. and M. Turner, 1989. *More Than Cool Reason: A Field Guide to Poetic Metaphor*. Chicago and London: University of Chicago Press.
- Oakley, T., 1995. Ghost-brother. In *Presence: The Conceptual Basis of Rhetorical Effect* Ph.D. Dissertation, University of Maryland.
- Turner, M., 1987. *Death Is the Mother of Beauty*. Chicago: University of Chicago Press.
- Turner, M., 1991. *Reading Minds: The Study of English in the Age of Cognitive Science*. Princeton: Princeton University Press.
- Turner, M., 1996. *The Literary Mind*. New York: Oxford University Press.

C.3. Politics

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

- Lakoff, G., 1990. Metaphor and War: The Metaphor System Used to Justify War in the Gulf. Distributed by electronic mail, December, 1990. Reprinted in H. Kreisler (ed.), *Confrontation in the Gulf: University of California Professors Talk about the War*. Berkeley, CA: Institute of International Studies, 1992; also in B. Hallet (ed.), *Engulfed in War: Just War and the Persian Gulf*, Honolulu: Matsunaga Institute for Peace, 1991. Also in: *Journal of Urban and Cultural Studies* 2 (1) (1991). Also in: *Vietnam Generation Newsletter* 3 (2) (1991). Also in: *The East Bay Express*, February, 1991.
- Lakoff, G., 1995. Metaphor, Morality, and Politics, or, Why Conservatives Have Left Liberals in the Dust. In *Social Research* 62 (2), 177–214.
- Lakoff, G., 1996. *Moral Politics*: Chicago: University of Chicago Press.
- Morgan, P., 1998. Beyond the Issues: A Linguistic and Conceptual Study of American Public Discourse. Ph.D. Dissertation, University California, Berkeley.

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.

Lakoff, G. and R. Núñez, 2000. *Where Mathematics Comes from: How the Embodied Mind Brings Mathematics into Being*. New York: Basic Books.

