the pragmatic component. The stated principle of this component is for the program to accommodate its remarks to the hearer's presumed state of knowledge. If this description seems vague, it is because the authors once again present a potentially interesting idea without a detailed description. In addition to the syntactic and pragmatic components, the program must also have a semantic component for communicating meaning and a lexical component for translating meaning into words. When one realizes how many potentially distinct games of tic-tac-toe are possible (about 20,000 according to the authors), the ability of the program becomes more impressive.

In Chapter 18, Power and Longuet-Higgins (published originally in 1978) describe a computational model of language acquisition. However, lest the reader be misled, the model is really a description of how an adult might learn the numeral system of a foreign language. The model is provided with an internal grammar consisting of three components: a semantic component, a syntactic component, and a lexicon. Each component plays a crucial role in the processing of numerical information. According to the authors, "reference to the lexicon enables the [model] to decide whether any number occurring in the [numeral] structure is to be realized directly, by a single word, or is to be further elaborated by the semantic component" (p. 252). The semantic component translates the numerical structures into arithmetic expressions. For example, *five hundred and thirteen* would be translated into $((100\times5)+13)$. Finally, the syntactic component comprises a set of rules for expressing syntactic forms. In English, for example, there is a "rule that any expression of the type $(20+n)$ where n lies in the range 1–9 can be realized by the syntactic form $<p><n>$" (p. 253), where p is considered a major term. Another noteworthy feature of the model is that both language production and comprehension are performed with reference to the same lexical, syntactic, and semantic components.

The authors also describe a system for learning how to count. Like natural language acquisition, the model is provided with strings (in this case, numerals) and their meanings (in this case, numbers) and attempts to induce rules for mapping the two together. Also, like natural language acquisition, the model is able to generalize across a number of specific instances. For example, it can recognize that *twenty-one* and *twenty-five* are similar instances of conjunction and can be expressed in the abstract form $<p><n>$. The model does this through reasoning by analogy to forms learned earlier. In addition, the authors argue that the notion of the major term indicating the formula for computing a number "corresponds with the way in which grammatical rules are actually stored in a person's memory" (p. 261). This form of structural organization seems to have presaged current head-driven lexical theories of processing (Bresnan, 1982; Pollard, 1984). However, unlike first language acquisition, the model also provided ordered input and explicit feedback. This is by far the most detailed model of language processing provided. Not only are the learning principles clearly stated but there are appendices providing detailed examples of how the program learns to count.

In the final chapter concerning language, Longuet-Higgins (published originally in 1985) discusses the role of intonation in computer speech understanding. The chapter covers three topics: the encoding of intonational information, empirical facts concerning the functions of intonation, and how a speech-understanding system might use this information. Although the coverage of encoding procedures is rather cursory, Longuet-Higgins does provide the reader with a list of some interesting facts concerning the functions of intonation. These uses include "identifying the actual words of an utterance and establishing the syntactic relations between them and its use in decoding that part of the speaker's message which is only implicit" (p. 289). More specifically, he notes that people use intonation to distinguish declaratives from interrogatives, to distinguish various meanings for compound nouns, and to contrast new with old information with the new information often carrying more stress. In discussing how a speech-understanding system might benefit from intonational information, Longuet-Higgins notes that if the words with the most conspicuous pitch changes are assumed to be the most important, they may be used as the "nuclei" for an "inside-out" recognition system. Such a recognition system could be deemed intelligent precisely because it utilizes these empirical facts. This is extremely important as the need for knowledge-based computer modeling is well documented by the recent generation of artificial-intelligence researchers.

Longuet-Higgins and his coworkers have assembled a collection of articles, which, while impressive in their breadth, are lacking in depth. There are solutions to lots of microproblems; however, there is no attempt at integration. Since the authors have demonstrated a keen ability to uncover difficult problems, the book is most suitable to readers who are interested in learning a little about a lot of linguistic processes. Finally, the reader should expect the discussion to cover computational properties of mental processes that are abstracted away from the limited resources of the human processor.

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Women, fire, and dangerous things: What categories reveal about the mind. George Lakoff. Chicago: University of Chicago Press, 1987. Pp. xvii + 614.

What do categories and the language we use to express them reveal about the workings of the human mind? This fundamental, yet elusive question has engaged philosophers, linguists, and psychologists for more than 2,000 years. After centuries of scholarly attention, there remains considerable controversy concerning the structure and representation of human concepts.

In his provocative new book, *Women, fire, and dangerous things*, Lakoff takes this controversy head on, illuminates it with fresh instructions, and renders it widely accessible. His insights sharpen our appreciation of the intricate relations linking linguistic and conceptual organization and challenge prevailing notions in cognitive science. For all their depth, originality, and clarity, however, Lakoff's claims cannot take the place of a clearly articulated theoretical position.

Women, fire, and dangerous things is divided into two books; in Book I, entitled *The mind behind the machine*, Lakoff proves himself strongly committed to the idea that cognitive models based on parallels between minds and machines are essentially misguided. Drawing on evidence from cognitive psychology, cognitive linguistics, and cognitive anthropology to introduce his new theory of conceptual structure and representation, Lakoff asserts that our existing theories fail to acknowledge two critical aspects of human concepts: first, that all human concepts have richly textured underlying models (*idealized cognitive models*), and second, that the structure of these models depends crucially on our own bodily experience (*embodiment*). In Book II, entitled *Case studies*, Lakoff claims to establish their scope and power.

Book I is itself divided into two parts. Part I (Categories and Cognitive Models) begins with the now-familiar argument that the classical view of concepts (where concepts are defined logically by necessary and sufficient objective criteria) fails to capture the richness and diversity of human conceptual organization. Lakoff then presents a selective history of alternative models, focusing on prototype theory and embracing Rosch's classic finding that object concepts, whatever their underlying structure and representation may be, give rise to robust prototype effects. That is, for any given category (e.g., *Bird*), some members (e.g., *robins*) seem to be better examples than others (e.g., *ostriches*). Lakoff is at pains to clarify what he takes to be a crucial misunderstanding regarding prototype theory. Prototype effects are not veridical reflections of either the structure or the representation of human concepts; instead, they are superficial byproducts of an underlying, and as yet unexplained, conceptual organization. His goal in *Women, fire, and dangerous things* is to construct a cognitive model that will both capture this underlying conceptual organization and give rise to prototype effects.

Lakoff devotes the remainder of Part I to outlining the first cornerstone of his theory: that underlying all human categories is a family of structures, called Idealized Cognitive Models (ICMs). Here, his most detailed and elegant example is an analysis of the common, yet complex, concept *mother*. According to Lakoff, this concept illustrates two of the most ubiquitous types of ICM – radial and metonymic models. First, *mother* has a radial structure comprised of a cluster of distinct models. These include the birth model (the person giving birth is the mother), the genetic model (the female who contributes the genetic material is the mother), the nurturance model (the person who raises and nurtures the child is the mother), and the marital model (the wife of the father is the mother). According to Lakoff, our

notion of a *real mother* is an ideal case, located at the intersection of these models. In addition, *mother* serves to illustrate another type of ICM – the metonymic model – in which a salient instance can stand for the entire category, usually for the purposes of quick judgments and identifications. In North American culture, for example, we often use the stereotype of the housewife as a reference point for the entire category *mother*. Lakoff suggests that radial and metonymic models underlie the vast majority of our concepts, generate metaphors, and yield prototype effects.

In Part II (Philosophical Implications), Lakoff addresses the second cornerstone of his theory, the problem of *conceptual embodiment*. Rejecting the "objectivist" approach in which concepts are taken as logical entities, as separate from the self, and as internal representations reflecting an external world, he argues instead for an "experientialist" approach. Here, concepts are taken to be inseparable from both ourselves and from the world as we experience it. Because concepts are brought into existence via our physical interaction with the world, they are "embodied." Consequently, human mental life is inextricably bound to bodily experience.

Within Lakoff's experientialist framework, "preconceptual bodily experiences" become the new conceptual primitives, the foundation upon which we construct abstract conceptual and symbolic systems. He identifies two kinds of preconceptual experiences: basic level categories (which are reflected in the structure of language and evident in our interactions) and *kinesthetic image-schemas*. In this view, because both language and cognitive models (the ICMs) make use of the same preconceptual structures, there can be no principled distinction between language and thought, and, hence, no dilemma concerning the relation between the two. Consequently, linguistic analysis assumes a central position in the study of human concepts.

Women, fire, and dangerous things can be read in two very different ways: as an elegant illustration of the depth and diversity of human concepts, or as a theoretical statement of Lakoff's new cognitive model. On the first reading, Lakoff does the field of cognitive science a great service, for he is a gifted interpreter of linguistic phenomena. He outlines the Whorfian hypothesis, its philosophical and psychological commitments, and the research surrounding it in brilliant detail. His liberal use of examples magnifies his argument for deep commonalities between ourselves and those from other cultures and linguistic communities, despite superficial differences in categorization.

Lakoff recounts, for example, that in traditional Dyirbal, an aboriginal language of Australia, the classifier *balan* is used to refer to women, anything connected with water or fire, sun and stars, and a host of dangerous animals. This is not a collection that most Westerners would consider to be a natural kind. Yet, the application of *balan* represents more than a serendipitous list, as we discover from the summary Lakoff provides of the detailed work of R. M. W. Dixon, whose linguistic analyses of Dyirbal reveal the implicit rules and motivations for applying the classifier system correctly. From Dixon's analysis, Lakoff argues that like the concept *mother*, the Dyirbal classifiers are generated by deep, underlying ICMs. This claim is

fortified by the work of A. Schmidt, in her study of language death in Dyirbal, and by numerous other examples detailed by several linguists and anthropologists. Lakoff's close analysis of diverse concepts highlights the shortcomings of current theories of human conceptual organization.

Lakoff's attempt to supplant existing theories with his own is, however, less successful. His examples offer a flavor of the theoretical position he wishes to advance, but cannot themselves support the weight of his claims. This unfortunately compromises the strength of his theory, diminishing its predictive and explanatory power. Although his arguments against current cognitive theories (Part I) and against objectivism (Part II) are strong, he does not explain fully how the two cornerstones of his theory – ICM's and conceptual embodiment – can be forged to create a new foundation. His speculations regarding conceptual development are, as yet, too lightly sketched to be put to empirical test. In addition, Lakoff fails to specify how many different types of ICMs he would attribute to the human mind, precisely how these ICMs are constructed, and whether they interact according to identifiable principles. Moreover, an inevitable casualty of Lakoff's efforts to compress several decades of experimental work is the sacrifice of the depth and sophistication of several researchers' positions.

At times, Lakoff's conclusions would also benefit from more logical development. For example, he locates prototype effects within both our linguistic and conceptual categories and uses this observation to support the view that language and cognition share the same general cognitive mechanisms. Although Lakoff defends this controversial view strenuously, the argument that the linguistic and conceptual systems are independent has also been eloquently made (e.g., Chomsky, 1965; Fodor, 1983). Further, it is well known that observations of superficial similarities (here, prototype effects) do not necessarily constitute evidence of a common underlying structure. Although they share superficial characteristics, prototype effects in different domains, like wings from different species (e.g., birds and bats), need not spring from the same source.

The case study on *anger* illustrates both the promise and the problems inherent in Lakoff's approach. Lakoff's decision to discuss this complex emotional concept reveals his conviction that (a) a single, coherent set of ICMs underlies all human concepts, and that (b) the content of such concepts is correlated with our physical experience (they are embodied). Lakoff opens with the observation that the several seemingly unrelated linguistic expressions of anger (e.g., "He lost his cool"; "I almost burst a blood vessel"; "He was foaming at the mouth") are, in fact, related to one another and also to anger via a coherent underlying conceptual organization, much of which is metaphorical. He argues convincingly that these diverse expressions stem from a shared folk theory that is based on the physiological effects of anger (increased body heat, blood flow, muscle tension, and the like).

This intriguing intuition is pressed almost beyond the bounds of plausibility, however, through Lakoff's claim that our conceptualization of emotions contributes to the high incidence of rape in America. Speculating that the overlap between our concepts of violence and anger on one hand, and

sexuality and lust on the other, constitutes a source of confusion in the Western mind. But by providing nothing more than anecdote and conjecture in support of this position, Lakoff renders his position virtually untenable, for if both anger and sexuality are embodied (and therefore universal), failure to describe how these can be conflated in one culture and not in others represents a crucial omission.

In conclusion, *Women, fire, and dangerous things* enriches the study of human linguistic and conceptual organization. Yet at the same time, it runs the risk of claiming more than it can support. In an author with less insight, creativity, and breadth, this could be taken as naive. But Lakoff is by no means naive. And simply because his position lacks consistency and force as a theory does not warrant its premature dismissal. *Women, fire, and dangerous things* offers psychologists and psycholinguists a unique challenge: an invitation to specify Lakoff's fine intuitions, to derive principled predictions, and to put the central ideas to test. This book may not be the new gold standard of cognitive theories. It does, however, provide a gold mine to which scholars will often return for its bold, fresh approach and illuminating examples.

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Cognition and language growth. S. W. Felix. Dordrecht: Foris. 1987. Pp. 199.

In his recent book, *Cognition and language growth*, S. W. Felix presents three different, but theoretically consistent essays devoted mostly to "a clarification and justification" (p. 4) of the nativist generative approach in the study of language acquisition. The author, however, goes beyond a mere defense and justification of the generative perspective and, with elegant logic, postulates some fascinating distinctions and hypotheses in an attempt to answer important questions in first- and second-language acquisition. The book is successful in convincing even the most skeptical reader that the generative enterprise is not only alive and well but also producing new and promising insights in response to old-time questions in developmental psycholinguistics.

The author's forceful and elegant defense of the generative perspective is motivated mostly by his perception of current suspicion, if not "outright hostility" (p. 4) towards Chomskian hypotheses. Felix believes that researchers' negative attitudes stem from two major sources: our empiricist legacy and our seldom-recognized ignorance of linguistics and of the vast complexity of adult language competence. Indeed, the author makes a strong argument that while interactionist perspectives might account for the relatively