A Probabilistic View of Language

Rachel Giora
General Studies, Tel Aviv

George Lakoff, *Women, Fire, and Dangerous Things: What Categories Reveal about the Mind*. Chicago: University of Chicago Press, 1987. 614 pp.

Steven Harnad, ed., *Categorical Perception*. Cambridge: Cambridge University Press, 1987. 599 pp.

Teun A. van Dijk, *Communicating Racism: Ethnic Prejudice in Thought and Talk*. Newbury Park: Sage, 1987. 435 pp.

Current research into concepts and categorization presents a real challenge to the hitherto dominant theory about concepts called the classical view. In this view, all instances of a category share a set of common properties on which the concept is defined, that is, which form the necessary and sufficient conditions for category inclusion. This classical view, which dates back to Aristotle, has been criticized lately by proponents of an alternative approach called the probabilistic view (e.g., Smith and Medin 1981). This view holds that instances of a concept vary in the degree to which they both share properties and represent the category. Membership or status is no longer a matter of equivalence, but exhibits gradation relative to the most typical member of the set, called a prototype. The graded internal structure which produces the relative goodness of examples typifies both fuzzy (e.g., tallness) and well-defined categories (e.g., even numbers) (Armstrong, Gleitman, and Gleitman 1983 inter alia). The probabilistic view has been shown to hold for categories of all types, such as general knowledge, social knowledge, and lately, for linguistic knowledge as well. Lakoff's

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Women, Fire, and Dangerous Things, under review here, is a prominent representative of that probabilistic view of language which constitutes a major criticism of generative linguistics.

I. Categorical Perception

Inquiry into visual and auditory perception suggests that colors and voicing are perceived categorically. The phenomenon of categorical perception (CP) found in vision and in audition (reviewed by Bornstein in Harnad [1987: 287–300]) suggests that both visual and auditory categorization involves enhanced intercategory discrimination relative to intracategory discrimination. For example, two greens of different shades look more alike than a green and a shade of yellow, despite the fact that the yellow is no more different in wavelength from any one of the greens. Intracategory differences appear to be much smaller than intercategory differences, which suggests that the effect of category boundary is not merely quantitative but also qualitative.

Intracategory discrimination allows for a graded internal structure which distinguishes between better and poorer examples of the category. The better examples, termed prototypes, represent the central tendencies of the category. They are identified more easily as category members and are shown to hold preferential, attentional, mnemonic, and learning advantages over the poorer examples. Although some cognitive domains might have vague boundaries so that categories gradually fade into each other (e.g., tall/short, cup/bowl), the central tendencies of the categories are clear and thus regulate categorization.

The perception and knowledge of spatial relations could be exemplary with respect to CP. Experientially, space is perceived as continuous and homogeneous. However, this analogous noncategorical information is translated into a set of digital categorical distinctions, such as up/down, in/out, and the like.

The hierarchical structure of categories suggests that categorization is a matter of degree—an approximate rather than an absolute matter. Category membership is thus a matter of probability: an item is either more probably or less probably a member of a certain category.

Aspects of CP in vision and audition have been shown to be universal. For example, Berlin and Kay (1969) showed that bilingual observers from 20 communities could uniformly identify a small set of basic "focal" colors (40 hues out of 320 colors). This uniformity of color identification transcends the issue of linguistic or cultural differences.

II. Semantic Memory

Recent research into categorization of our general knowledge (Rosch 1973; Rosch and Mervis 1975; Rosch, Gray, Johnson, and Boyes-Braem 1976; Mervis and Rosch 1981; Smith and Medin 1981; Medin

and Smith 1984; Armstrong, Gleitman, and Gleitman 1983 inter alia) alludes to the fact that the principles governing categorical perception are not peculiar to sensory perception only. General-knowledge categories also exhibit intracategory similarity, as opposed to low intercategory similarity. Both fuzzy categories and natural categories whose boundaries are unclear (e.g., tallness, bird) as well as clearly defined categories in which membership is all or none (e.g., even numbers) have a graded structure, whereby some members count as better examples (e.g., Goliath, robin, 2), while others are marginal in terms of category representativeness (e.g., Napoleon, chicken, 5396). As similarity is the salient principle of organization, some members enjoy a preferential status. The members sharing the highest number of category features are the best examples: the prototypes.[1] Best representing the category as well as exhibiting its redundancy structure, prototypes enjoy an enhanced accessibility status which makes them function as the point of reference for the category. That is, a decision on category inclusion is made relative to the similarity of a candidate-member to the prototype. Membership is thus a matter of degree. It does not require having a set of necessary and sufficient features. Rather, sharing some feature(s) with the prototype may suffice. The number of common criterial features will determine the probability of category inclusion.

Given the reference-point function of the prototype as the element governing the set, the internal structuring of the set exhibits a hierarchy of accessibility as well. The top governing entry is the most accessible member, while the bottom/marginal constituent is least accessible. Informationally, such grading reflects a hierarchy of informativeness, ranging from the least to the most informative member in the category (see Table 1). The point about these lists is that they reflect storage in memory under the most accessible member, which represents the category set of common and distinctive features.[2] Specifically, the hierarchy reflects the cognitive distance obtaining between the

1. Prototypes are only one principle of organization, says Lakoff (p. 87). Many categories are understood in different terms, such as those of ideals, paragons, generators, etc. For instance, the ideal husband is a good provider, faithful, strong, and attractive. The stereotypical husband, on the other hand, is bumbling, dull, pot-bellied, and the like. Or, take *The Guinness Book of World Records*, which exemplifies categorization in terms of paragons; or, the single-digit numbers, which function as generators in comprehending natural numbers generally.

2. Lakoff views this as a mistaken interpretation of the early writings of Rosch (pp. 44–45). At a later stage, Rosch herself (1978, 1981) argued that goodness of example reflects neither processing nor graded membership. Membership is equal for all members, though there is an internal structure which produces goodness of example. For Lakoff and Rosch, prototypes do not constitute a theory of representation for categories.

Table 1

Fruit	Vegetable	Bird
Apple	Carrot	Robin
Plum	Asparagus	Eagle
Pineapple	Celery	Wren
Strawberry	Onion	Chicken
Fig	Parsley	Ostrich
Olive	Pickle	Bat

Table 2

Superordinate	Animal	Furniture
Basic level	Dog	Chair
Subordinate	Poodle	Rocker

various members and the prototype. This distance accounts for speed of retrieval and, similarly, for ease of processing in terms of the number of features searched when a decision on category inclusion is to be made.

Category coherence is thus achieved through family resemblance (Wittgenstein 1953), whereby adjacent members bear similarity to each other. As opposed to the classical view of well-defined categories in which membership is considered equal, the prototype-oriented concept of classification allows for a graded internal structuring which marks the central tendency of the category and is unclear about the boundaries (e.g., robin, as opposed to chicken, in the set of birds).

However, hierarchical structuring obtains not only horizontally, between members of the same category, but also vertically, between levels of categorization. There is a level of abstraction that seems more basic than the others. It is more basic in that, at this level, things are perceived holistically as a single gestalt. The names for these things are simpler, and people learn, name, and recall them more readily. Psychologically, most basic-level information is in the middle of the taxonomic hierarchy (see Table 2). Our knowledge is mainly organized at the basic level. That is, when asked to list attributes of category members, subjects list very few at the superordinate level (animal, furniture). Most of what they know, they list at the basic level (dog, chair). The subordinate level of categorization hardly exhibits any increase in information (poodle, rocker) (Brown 1958, 1965; Berlin, Breedlove, and Raven 1974; Rosch et al. 1976; Mervis 1987 inter alia). Furthermore, at the basic level, our knowledge is mainly organized around part/whole divisions, which further determines our perception

of events (Tversky and Hemenway 1984; Tversky 1986). Tversky and Hemenway show that we impose part/whole structure on events and perceive event categories in the way that we perceive object categories.

III. Social Knowledge

The principles organizing our knowledge in general apply to the organization of social information as well. The categorization of humans also admits of gradation; some members are prominent and better represent the set than others. Clearly, the member acknowledged as the human prototype is the (white) male. But on what grounds? Does the man represent the human-category set of common features better than the woman? Obviously not. However, he does if we take an ecological view of categorization. Man is our prototype in terms of Lakoff's Idealized Cognitive Model (ICM). For Lakoff, our Idealized Cognitive Models account for prototype effects that do not fit the world as we know it. Fillmore's (1982) example of the category of "bachelor" illustrates the point clearly. When defined solely in terms of an unmarried adult male, the concept "bachelor" takes into account a world in which there is a human society with monogamous marriage and a typical marriageable age. This idealized model ignores the existence of priests, long-term unmarried couples, homosexuals, and the like, who, with respect to this idealized model, become marginal examples. The source of fuzziness here is not within the model, Lakoff contends, but in the model's interaction with other models characterizing other aspects of our knowledge. One such source is our social knowledge of stereotypes. The stereotypical bachelor, for example, is "macho," dates many women, is interested in sexual conquest, hangs out in bars, etcetera.

How are stereotypes formed? How is a cognitive representation of social information formed? A number of cognitive researchers (Cantor and Mischel 1977, 1979, for example) attest to the fact that when we form a concept or an impression of an individual, we organize the list of her/his characteristics in a categorical organization based on semantic networks of association (Anderson and Bower 1973; Collins and Loftus 1975 inter alia). Within these theories, an impression or concept is formed, among other things, along the similarity principle. When similarity applies, features which are most similar (to each other) become the individual's central characteristics (Rosenberg and Sedlak 1972). At the same time, features that do not seem consistent with or similar to the set of central characteristics are deleted in the process of concept formation (Wyer and Gordon 1984).

The similarity constraint is even more compelling when we form impressions of out-group individuals (Tajfel, Sheikh, and Gardner 1964; Malpass and Kravitz 1969; Chance and Goldstein 1975). Secord,

Bevan, and Katz (1956), for example, showed that the identification of an individual's ethnic origin resulted in a deletion of individual traits. When an individual was perceived as a Negro, s/he was taken to represent her/his social group at the cost of individuation. In other words, for the self, the others are all alike (Park and Rothbart 1982; Rothbart, Dawes, and Park 1984; see also van Dijk 1987, reviewed below). In terms of complexity, the concept of the other, as opposed to the concept of the self, is much simpler. Self-image is much more complex because in-group knowledge of individuals is more informative and detailed than knowledge of out-group individuals (Linville and Jones 1980).

The case of literature may well serve as evidence. In Ariel and Giora (1988), a study of Hebrew literature of the 1930s, we found that female characters in the works of male authors were stereotypically formed in terms of the other. That is, in male authors' works, females were homogeneously represented. The variety of female characteristics could all be reduced to one of feebleness. However, in the works of female authors, female characters were conceived of in terms of self, so their portrayal tended toward androgynous representation.

Forming the concept of the other is a process of assimilating the other into her/his group—dehumanizing the other. No wonder, then, that self/other relations are typified by hostility (Forgas 1979). The attitude toward in-group members is much more sympathetic than that toward out-group members (Tajfel 1972; Doise 1976; Dion 1979). As van Dijk's recent research into communicating racism shows, ethnic minorities are perceived by whites as extremely homogeneous groups, if only by some negative characterization which typifies their various evaluations.

Ideology

How are ideologies formed? How are sets of attitudes formed? Van Dijk's *Communicating Racism* is based on conversations, or rather interviews, revolving around the topic(s) of ethnic prejudice. His subsequent analysis shows that the organization of attitudes follows the general principles of cognitive structuring and processes, hierarchical or linear, for example, within categorical organization. Hierarchical relations obtain between general and more specific attitudes, while linear relations obtain between proximate attitudes. Coherent clusters of attitudes form ideologies.

Sets of attitudes consist of central and peripheral opinions (Rokeach 1973). Looking into racist discourse, van Dijk found that a set of prejudiced opinions is governed by a general attitude of negativity, with "threat" and "competition" constituting the central tendencies.

IV. Linguistic Knowledge

The idea that language too allows for categorical organization, whereby grammaticality is a matter of degree, has also emerged recently (e.g., Halliday [forthcoming]). It questions both the adequacy of the classical view of language and the assumption underlying generative linguistics that there is an autonomous faculty of language. That is, findings concerning manifestations of gradation in language suggest that the alternative to the classical view is a probabilistic one, which allows for the use language makes of our general cognitive apparatus.

Lakoff reviews a number of asymmetries within linguistic categories which reveal prototype effects in language. The notion of "markedness," he argues, serves to describe the fact that some categories have a certain "marker," while others are "unmarked." With respect to morphology, for instance, the singular (in most languages) is the "unmarked" member of the morphological number category, and the feminine (in some languages) is the "marked" gender category. Thus, singular and masculine are shorter in form, which reflects their more basic and simpler cognitive status. Generally speaking, markedness is a term used by linguists to describe prototype effect, whereby one member is taken to be more basic than the other.

Markedness or asymmetry occurs in semantics as well. Given the pair tall/short, for instance, tallness is the unmarked concept whose meaning is more basic and general enough to include the concept of shortness as well. "How tall is Cathy?" for instance, does not exclude the possibility of Cathy's being short. Shortness, however, is a more specific notion. "How short is Cathy?" will not include the possibility of Cathy's being tall.

Most insightful is Lakoff's treatment of polysemy: the idea that related meanings of words form categories and that meanings bear family resemblances to one another. Note that polysemy occurs when a single word has more than one meaning and when these meanings are conceptually related. For instance, while the two meanings of "bank" (i.e., where one deposits money, and the river's edge) are not conceptually related—which makes "bank" a case of homonymy—the two meanings of "run," as in "Harry ran into the woods" and "the road ran into the woods," are conceptually related. Cases of polysemy, says Lakoff, occur where there is one lexical item with a family of related senses. Where one lexical item has a family of related meanings, they form a category. However, this category cannot be characterized in terms of a set of necessary and sufficient conditions, as the set does not reflect equal status among members. Instead, it exhibits gradation. For example, Fillmore (1982) observed that between the two senses of "long," the spatial sense is taken to be more central or more prototypical, whereas the temporal sense is only metaphorically related.

The strongest evidence in favor of a prototype effect in language comes from the study of verbs and prepositions. Lakoff concentrates particularly on Brugman's 1981 study of "over" as an instance of a complex category incapable of being represented by a single core meaning that will account for all and only the various senses. Rather, the sense of each expression is shown to form a radially structured category, with a central member and spokes defined by image-schema transformations and metaphors. The noncentral cases are shown to depend for their meaning on the central ones:

> The painting is over the mantel.
> The plane is over the hill.
> Sam is walking over the hill.
> Sam lives over the hill.
> The wall fell over.
> Sam turned the page over.
> He spread the tablecloth over the table.
> The guards were posted all over the hill.
> The play is over.
> Do it over, but don't overdo it.
> Look over my corrections, and don't overlook any of them.
> You made over a hundred errors.

Or, take metaphors: Mostly, research into metaphor-making (Glucksberg and Keysar 1990; Turner 1988; Shen 1989, 1991) has gained tremendously from research into categories, particularly into ad hoc categories (Barsalou 1983). Ad hoc categories (e.g., "things to take on a picnic," "things to save from a fire") have been shown to exhibit graded structure as well. While literal comparisons (e.g., "sparrows are like robins") require that natural/stable categories be constructed (e.g., birds), metaphor-making ("My love is like a red red rose") requires the construction of ad hoc categories in which "my love" and "rose" can both be members.

Givón (1986) argues that it is the fuzzy-edged nature of prototype categories that can best explain metaphoric extensions. Given the right context/purpose/perspective, a less typical member may join the category. If, for example, "George built a wall around himself" is understood metaphorically, that is, taken to mean "isolated himself," it is because the less typical meaning of "build a wall around," that is, "create isolation," resembles the literal prototype meaning and is allowed to join the category.

As Givón further shows, prototypes themselves are allowed to change diachronically. The English words "know" and "can," for instance, come from the same root, with "know" being older. "Can" evolved from "know" through an intermediate, less prototypical stage where "know" meant "know how" or "be able." "Be able," however,

which in addition developed the "power to act" as a property, upgraded the latter meaning into a central characteristic at the cost of downgrading the former.

Syntactic categories show prototype effects as well. In a number of studies, Ross (1972, 1973a, 1973b, 1974, 1981) has shown that such categories as noun, verb, adjective, clause, preposition, noun phrase, verb phrase, syntactic constructions (e.g., passive, relative wh-preposing, wh-preposing, question, topicalization, etc.) exhibit this sort of asymmetry. Consider the noun category for asymmetries. In the examples below, the nouns are hierarchically organized in terms of prototypicality or "nouniness" (toe > breath > way > time), whereby the "nounier" nouns obey the general rule, as expected of nouns, while the less "nouny" nouns do not:

1.
To stub one's toe
To hold one's breath
To lose one's way
To take one's time

2. Modification by a passive particle
A stubbed toe
*Held breath
*A lost way
*Taken time

3. Gapping
I stubbed my toe, and she hers.
I held my breath, and she hers.
*I lost my way, and she hers.
*I took my time, and she hers.

4. Pluralization
Betty and Sue stubbed their toes.
Betty and Sue held their breaths.
*Betty and Sue lost their ways.
*Betty and Sue took their times.

That the clause type shows prototype effect is made manifest by the intuitions behind different theoretical attempts to distinguish between the basic "deep structure" form of a clause and its various "transformations" which mark deviation from the base structure (Harris 1957; Chomsky 1957). The basic clauses show a privileged relationship between meaning and grammar or between form and content, while the less basic forms do not enjoy this relationship.

The relation between meaning and form seems to motivate a gradation in speech acts as well, which also exhibit gradation, that is, a scale of better and poorer examples. Consider Givón's (1986) graded hierarchy of speech acts. The set of imperatives listed below, for in-

stance, exhibits category-ordering in terms of graded prototypicality from the most prototypical imperative to the least; the latter, in fact, is a most prototypical interrogative:

Pass the salt!
Please pass the salt.
Pass the salt, would you please?
Would you please pass the salt?
Could you please pass the salt?
Can you please pass the salt?
Do you see the salt?
Is there any salt around?

In the examples above, we can see that syntax marks the degree of prototypicality. While the most prototypical imperative, at the top of the scale, has the syntactic marking of an imperative, the least prototypical imperative, at the bottom of the scale, has the marking of a different speech act. The two extremes on the scale correspond most closely to their respective speech-act prototypes, both semantically and syntactically. What Givón shows is that, while traditional speech acts are the most clearly coded and most easily identified, the gradation between them, both functionally and syntactically, is also a basic fact of grammars.

The set of speech acts itself can be viewed categorically as comprised of basic and nonbasic speech acts. Kasher (1981) views assertions, commands, and questions as basic speech acts. Indeed, the three are universal (Levinson 1983). Nonbasic speech acts are classified as such, by usage, according to their degree of institutional formality and dependency on basic speech acts.

Consider, now, basic-level effects in language. We have seen that our knowledge at the basic level is mainly organized around part/whole divisions and that we impose part/whole structure on event categories (Tversky and Hemenway 1984; Tversky 1986). In dealing with story understanding, Abbot, Black, and Smith (1985) demonstrate that our knowledge of events, which appears to be sequential, is, indeed, hierarchical. They show that when presented with a detail, subjects tend to infer the more general concept of which the detail is a part. Inferences, thus, correspond to the basic-level abstraction.

Categorical Organization in Texts

Earlier (Giora 1985, 1988), I suggested that the principles of text organization be viewed along the lines of a taxonomical structuring (see Section I, above). I showed that the principles governing a categorical organization as delineated by Rosch (1973) and by Rosch and Mervis (1975), for example, are applicable to non-narrative/informative texts. On this basis, a text is well formed if and only if:

> a. it begins with the least informative message in the given text-segment. This least informative message, termed Discourse Topic (DT), is a generalization that governs the rest of the messages in the text. Cognitively, it functions as the prototypical category member, which represents the redundancy structure of the set; (The Relevance Requirement [Giora 1985: 116–28])

and

> b. it proceeds gradually along the informative axis whereby a given message is more informative or, at least not less informative than the one it precedes. (The Graded Informativeness Requirement [Giora 1988: 559])

Given this Graded Informativeness Requirement, the text must end with its most informative message. Informativeness is defined in terms of class membership and according to classical information theories (Shannon 1951; Attneave 1959 inter alia).

For an illustration, consider the passage below, discussed in Giora (1988):

> It has often occurred in the history of science that an important discovery was come upon by chance. A scientist looking into one matter, unexpectedly came upon another which was far more important than the one he was looking into. Penicillin is a result of such a discovery.

The sequence here obeys categorical constraints. It begins with a generalization, which represents the redundancy structure of the text; that is, it presents the set of properties shared by all the propositions in the text: (1) scientific, (2) chance, (3) discovery ("It has often occurred in the history of science that an important discovery was come upon by chance"). The second proposition shares this set but adds another property, the importance of the chance scientific discovery ("A scientist looking into one matter, unexpectedly came upon another which was far more important than the one he was looking into"). By sharing the paragraph's common properties, the second proposition obeys the Relevance Requirement. By adding another one, it conforms to the Informativeness Requirement. With respect to these two, the proposition concerning the discovery of penicillin ("Penicillin is a result of such a discovery") is both relevant, sharing the set of common properties, and more informative. The idea of important chance discoveries in the history of science—the set of properties suggested by the first and the second propositions—alludes to a number of possibilities. The mention of the discovery of penicillin, which is a specific case of the category "important scientific chance discovery," eliminates the other alternatives that could be included in this category and adds its specific property. In sum, the sequence in the passage above reflects categorical organization, whereby all the propositions are linked by a similarity relation to the generalization appearing at the begin-

ning (the Relevance Requirement), while linearly, the more informative message follows the less informative one, in accordance with the Graded Informativeness Requirement.

Text well-formedness, then, is a hierarchical notion. It requires that the various text constituents be governed by a generalization and develop along an informativeness axis. Reflecting categorical organization, the constraints on text coherence account for both the linear and the hierarchical organization of the text.

Given the grammar of non-narrative texts, it seems plausible to contend that the set of (non-narrative) texts can be perceived as hierarchically organized. Texts obeying the rules can be viewed as prototypes, while texts with transformations can be viewed as somewhat deviant and nonbasic. Elsewhere (Giora 1991), I have shown that texts containing (marked) digressive material, termed "evaluative" by Labov (1972) or "poetic" by Jakobson (1960), are more difficult both to understand and to recall. Earlier work (Giora 1985, 1988) attests to the fact that where the surface structure of the text does not conform to its deep conceptual structure (i.e., where the Graded Informativeness Requirement is violated), the text is considered by subjects to be less appropriate.

In conclusion, formal theories of language (e.g., generative grammar) are not powerful enough to account for the gradational nature of linguistic phenomena. Linguistic performance seems to defy classical categorization. Rather, classical categories are replaced by prototype-dependent (both natural and ad hoc) categories. However, in an era when both formal mathematics and physics present a departure from classical theories and assume a probabilistic approach, such a probabilistic approach to language is no longer completely unthinkable.

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