Grammar and meaning

Essays in honour of
SIR JOHN LYONS

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Fields, networks and vectors

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The traditions of semantics in linguistics and philosophy have overlapped somewhat in recent decades, but earlier trends and treatments in each discipline have dealt with rather different aspects of meaning. In this essay we hope to unite some of these different threads. It is a special pleasure to contribute to a volume in honour of Sir John Lyons, who has made major contributions to a theory of meaning.

In Lyons' early work (1963, 1968) the meaning of a word was conceived of as its place in the lexical network of the semantic field to which it belonged. A theory of reference – to hook up language and the world – is also a necessary part of the semantic enterprise. We wish to explore how theories of sense and reference can be related.

1 A word on terminology

The word meaning is used in many different ways, in both philosophy and linguistics. It has been used to describe extralinguistic relationships, that is, between an expression and something in the external world, and intralinguistic relationships – between expressions within a language or between those in different languages. Given the ambiguity of the word meaning, we shall try to avoid using this word, instead employing reference or denotation for word–world connection, and sense, which Lyons has defined as the 'place in a system of relationships which it contracts with other words in the vocabulary' (Lyons, 1968: 427).1

2 Sense and reference

An adequate semantic theory of reference and sense must explain how reference is determined by a variety of factors which include sense as a central determinant. Such a theory must account for widely recognised features of vagueness and indeterminacy. It must explicate the role of pragmatic determinants. It must accommodate the fact of semantic change. It must include an analysis of the influence of experts and the limits of their influence on reference and sense. It must contain as a salient feature an account of the connection between sense, the network relationships between words, and reference, the relationship between the word and the world. Finally, the theory should clarify how sense and reference combine to yield the interpretation of a word in idiolects and languages. We shall present a semantic theory which combines these various factors, a theory of the aggregation of vectors, to account for reference and sense.

3 Representing meaning

Some semantic theories, especially those offered by philosophers, have described the sense and/or reference of an expression by quoting and disquoting the same expression with minor grammatical amendments. Examples are the following: dog means 'dog', or dog refers to dogs, Rover is a dog is true if and only if Rover is a dog. Such descriptions of sense or reference leave the reader with the impression that they are uninformative. The problem is not that language must be used to explain the relationship between language and the world, though this feature may lead to paradox or linguistic provincialism. There is no escape from the need to use language to account for the relationship between language and the world. The triviality is, we suggest, the result of the fact that the disquoted use of the expression is one that exhibits a certain linguistic role (Sellars, 1963). Merely exhibiting an item that plays a linguistic role does not yield an informative account of that role. An informative scientific account of the linguistic role must go beyond merely exhibiting the item that plays a linguistic role to an explanation of the character of that role. A description of the network relationships of the word along with a variety of pragmatic features provides an essential part of the explanation.

4 Vectors

The metaphor of vectors and its application to language originated with Ziff (1972: 32) and was developed by K. Lehrer (1984). Ziff writes:

The factors that serve to determine what is said have something of the character of vectors and what is said can be thought of as something of a vector sum. To suggest that the factors that serve to determine what is said can be thought of as vectors is, of
course, at once to suggest that they can be represented by directed line segments, that they can sensibly be thought of as forces having a magnitude, a direction in some sort of linguistic space and a sense in which the direction is proceeding. It is also to suggest that one factor can, as it were, serve to deflect another. And more importantly, it is also to suggest that these factors may be active and operative even though owing to the interactions of other factors their action and operation may not be readily apparent.

We feel that the metaphor of vectors is useful in our understanding of reference, since indeed many forces, including forces of different kinds, occur and interact in a complex way. Some of these vectors have been widely discussed, for example, indirect and non-literal uses of language (Bach & Harnish, 1979) and indexicals; others have been discussed in some of the linguistics literature but less so in the philosophical writings on language, such as indeterminacy and semantic change.

5 Expressions where pragmatics is required for reference

It has been acknowledged that pragmatic principles are required to determine the truth value of sentences that contain indexicals (deictics) of all sorts, and this includes practically all sentences with the possible exception of eternal sentences like Two plus two equals four, where the present tense is analysed not as a deictic but as semantically tenseless.

Deictic expressions include pronouns, tense, determiners, adverbials like here, there, now, then, yesterday, today and verbs like come, go, bring and take (see Fillmore, 1971). Even the interpretation of deictics is not straightforward. Consider a personal pronoun like we, which is usually analysed as referring to the speaker and one or more additional individuals. Such an analysis is correct in (1):

(1) We went to the store.

But consider (2) and (3):

(2) Twenty thousand years ago we lived in caves, but now we live in houses.

(3) We Americans — not you and I personally — consume too much energy.

In (2), the second instance of we could, but need not, include the speaker, but the first instance certainly does not. In (3) we refers to some vague subset of Americans, and the sentence explicitly excludes the speaker without contradiction (see Kitagawa & Lehrer, 1990).

Place deictics like here can also be problematically vague, and can refer to a small precise area, a city, country, planet, universe and anything in between. Similar examples can be constructed with other indexicals. Those discussed by Saka (1991) include use of kin terms, as in:

(4) Where is Daddy?

(5) Mother called yesterday.

One has to know who the speaker is to determine the reference of Daddy or Mother.

Pragmatic factors are also required for vague predicates, like bald, and for the many scalar expressions that refer to norms (which shift with context). The reference for a heavy wine will depend on the class of wine, the norms for the class, the experience of the speaker and/or hearer and the other wines being compared. A similar list of conditions is applicable to cool evening, tall tree, large animal, etc. An interpretation will require indexing the relevant norms, contexts, participants, etc.

6 Value vectors

The truth conditions for sentences like BV Cabernet Sauvignon 1989 is good involve not only the specifications listed above but also preference of unspecified individuals (either the speaker or the wine connoisseur community or both). In the case of interpretation of many, possibly most, vague terms the unspecified and often controversial norms lead to variation from speaker to speaker and place to place (see A. Lehrer, 1983). Even words that are normally considered to be purely descriptive have values as a part of their sense, for example, sour: a person who liked a highly acidic wine would describe it as tart, whereas someone who disliked it would use sour.

Many words incorporate an evaluative element as a part of their sense. Consider the sentences in (6) and (7):

(6) a. Oliver North was a hero.

b. Oliver North was a villain.

c. Oliver North was a fool.

(7) a. The Contras were freedom fighters.

b. The Contras were terrorists.

The statements in (6) and (7) were hotly debated in the 1980s, reflecting the political beliefs and ideologies of the speakers. An analysis like ‘Contras were freedom fighters’ is true if and only if Contras were freedom fighters does not help us at all with the truth conditions because it leaves the matter of the reference of freedom fighter unsettled.
However much people may disagree on the truth of the sentences in (6) and (7), there is much greater agreement on the sense of hero and villain or freedom fighter and terrorist.

7 Indeterminacy

Closely connected to the topic of vagueness is that of indeterminacy – the fact that word senses often have fuzzy boundaries. As a result, it is often not clear how to apply a word to a thing, event, property, etc. Prototype theory was constructed to avoid this problem by concentrating on paradigm cases, not borderline ones. A. Lehrer explored this topic (1970, 1974), and many working lexical semanticists have in fact used something like optional features or components (Wierzbicka, 1985; Lipka, 1985) to handle this phenomenon. For example, a glass is a usually cylindrical container without a handle, intended for drinking from, and it is usually made of glass, but it can be made of other vitreous material and it can be of another shape, and it can be used for other purposes. In evaluating the truth of a sentence like X is a glass, where X is non-prototypical, we must make some decision on whether to extend the expression glass to a non-prototypical instance.

Colour terms have notoriously indeterminate borders, and a sentence like (8) provides an interesting case:

(8) Bing cherries are red.

People say things like (8), or at least they might infer this, because they say things like cherries are red. But it is more accurate to say:

(9) Bing cherries are maroon.

Sentences (8) and (9) are apparently incompatible, so either one of the sentences is incorrect, probably (8), or the use of red is contextually sensitive. If people disagree about (8) and (9), we do not assume it to be a factual dispute about the colour of cherries but about the applicability of predicates.

8 Fixing reference by appealing to experts

One suggestion for fixing reference has been proposed by Putnam (1970, 1975). A part of Putnam’s theory includes a sociological feature, whereby there is a division of labour that delegates to experts in a scientific field the authority to determine the reference of terms like water, gold, lemon, tiger and cat, not only in this world but in other possible worlds, like Twin Earth. Putnam (1975) is correct to emphasise the social factor, but the role he assigns to experts is oversimplified. Consider arm (the body part), which physicians define as the part of the body between the shoulder and elbow. This contrasts with the forearm, the part from the elbow to the wrist. Although our consultants (mostly students and colleagues) are willing to delegate the correct use of some technical terms, like arthritis (an example from Burge, 1979), they are adamant in rejecting expert advice on arm. Their reaction is that physicians might have their own good reasons for such a lexical distinction, but it is irrelevant to the word’s sense and use for others. If the majority of speakers reject the authority of experts for some cases, authority is not delegated to them. The influence of expertise depends on how much weight we give to their usage, and this is variable.

9 Fixing reference by appealing to possible worlds

Appeal to possible worlds has been used by Putnam and others to determine sense and reference beyond the actual world. The sense (intension) in such accounts is a function or rule that determines the reference or extension of a term in possible worlds beyond the actual world. The need for considering the extension in possible worlds results from the fact that it is obviously incorrect to identify the sense (intension) merely in the actual world. Such methods presuppose, however, that we can readily determine which worlds are possible. But can we? How weird can possible worlds be? The kinds of possible worlds that philosophers construct might just be too ordinary. We normally define die as an irreversible biological process, but we can imagine a world in which death is a reversible process. Is this difference a linguistic one involving the sense of die or a reflection of death in our world? Imagine a world in which it is normal to be schizophrenic and paranoid and where people believe that some inanimate objects, like chairs, want to kill them. For such a population, chair would have semantic and pragmatic components lacking in the sense of this word for us. In Kurt Vonnegut’s world there are seven sexes, and so the sense of sex in his world must be considerably different from our sense. Or imagine a world where things change so rapidly that the inhabitants lack a concept of things and speak like Quine’s (1960) natives of stages instead. The pragmatic factors of fact and context in the actual world influence sense and reference in a way that transcends possible-world cogitation.
10 Semantic change

The causal theory of meaning, also referred to as the historical theory, holds that there is a baptismal event in which a name is given to a thing or class of things, and then transmitted to others via a causal or historical chain (Kripke, 1980). As a general theory of the origin of word meanings, this is rather fanciful. A language is transmitted from one generation to the next, of course, but not in the simple, linear way that the causal theory suggests.

One of the facts of language, however distressing to some language conservatives, is that language, including meaning (sense and reference), is constantly changing. Language change, including semantic change, is a traditional part of linguistics. Moreover, the relationship between linguistic variation (including sense variation) and change is taken for granted. Some changes involve radical shifts, which at the time are considered errors, such as the application of Madagascarian, the shift of sense of bead from 'prayer' to 'small round ball', and the shift of sofa from 'camel saddle' to 'furniture for sitting' (see Mercier, 1992a). Most shifts are more gradual, involving a widening or narrowing of sense or reference. Examples widely found in books of semantic change include the narrowing of deer from 'animal' to its current sense and the widening of the verb sail from 'go by sailing vessel' to 'go by any sea-going vessel' to 'transport through media other than water'.

Other semantic shifts create not only an extension or restriction of sense or reference, but more commonly, additional senses, sometimes metaphorical, sometimes not. One of the problems with the causal theory is that it cannot account for these natural processes in a natural way (Mercier, 1992b). All such shifts are treated as deviations from the norm or mistakes.

Sometimes changes in sense or reference come about because of new discoveries or belief shifts, but there is no routine way in which these shifts occur. In the case of atom, where the word originally included the sense 'indivisible', physicists continued to refer to the same objects as atoms after the atom was split, but the sense of atom changed so as not to include 'indivisible'. If a synchronic account were to completely capture a speaker's understanding of the sense of an expression, a conjecture made in 1875 like Someday the atom may be split would have been completely unintelligible to a scientist who took indivisibility as a defining characteristic of atoms. In fact, a synchronic sense is pregnant with the potentiality of diachronic change, and the conjecture would have been understood.

Putnam (1975) has constructed a famous example in which cats turn out to be Martian spy robots, and he has predicted that a similar thing would happen: we would continue calling these furry creatures cats, but the sense of cat would change. A rather different outcome occurred in the case of witch. In the scientific and legal domains, the theory of witchcraft was rejected, and so the sense of witch ceased to have any reference. Some religious fundamentalists retain the belief that witches exist, but presumably the disagreement between such fundamentalists and scientists is not a matter of the sense of witch but of their existence. (Witch also has a metaphorical sense of 'wicked woman'.) Other outcomes might have been possible. It could have turned out that witch remained in the language for referring to individuals with certain personalities. In that case, the reference of witch might have remained, but the sense would have changed (similar to Putnam's Martian cats).

A still different outcome occurred in the case of Indian. European explorers who landed in the New World at first thought they had found India, and called the New World inhabitants Indians (or the equivalent in their native languages). Even when they discovered their mistake, they continued to use Indian for the New World inhabitants. But the word also continued to be used (in English, at least) with its old sense and reference as well, creating an ambiguity in the term. (A counterpart to Putnam's example would be a case in which only some cats, striped ones, turned out to be Martian spy robots.)

Another case would be where the sense and reference both change. For example, the noun ship at an earlier period of time referred only to sailing vessels and had that sense; but when steam ships were invented, ship was applied to them as well. The shift of sense needed to include steamships in the reference of ship depends on defining ship as 'large vessel for travelling across water'. Such changes in sense and reference are, we propose, most intelligible if sense and reference are matters of degree that change and shift in response to experience and discovery. The potentiality for change and indeterminacy are connected. If there were no potential for change, it would make more sense to look at synchronic relationships as fixed and fully determinate.

11 Semantic networks

One of Lyons' many contributions to semantics is that words and their senses do not exist as isolated elements - they are embedded in a set of rich lexical relationships of various sorts, and it is this set that constitutes the sense. One of these relationships is entailment, a relationship that both philosophical and linguistic traditions of semantics have investigated.
Examples from the literature include sentences like those in (10) and (11):

(10) X is a bachelor \(\rightarrow\) X is an unmarried, adult, male.
(11) X is kissing Y \(\rightarrow\) X is touching Y.

Cases of indeterminacy provide problems for analyticity, as do the objections raised by Quine, whose challenge of the analytic–synthetic distinction is well known. Putnam's example (1975), discussed above, has challenged the distinction by his popular example in (12):

(12) Cats are animals.

Also controversial are cases like (13):

(13) a. Tomatoes are vegetables.
    b. Tomatoes are fruits.

The examples in (13) illustrate a slightly different problem: namely, that classification is done for a variety of purposes. If edible plants are grouped for botanical taxonomic purposes, then (13a) is true; if for culinary purposes, then (13a) is true.\(^{11}\) This means that there is a pragmatic factor that decides between botanical and culinary interests. Of course, one can simply assert that botanical interests are 'correct' and others are not, but this assertion is a bias and needs to be justified.\(^{12}\)

A slightly different problem exists in (14), which most speakers would take to be true by definition. After all, something like (14) is likely to be used as part of a definition of *potato*:

(14) Potatoes are vegetables.

The problem with (14) is that *vegetable* (the relevant sense) is not a natural kind term like *animal*, but more akin to a culinary–functional class. Potatoes are usually considered vegetables, but they are nutritionally like grains in being starchy and relatively higher in calories than other vegetables, such as green beans and broccoli, and in this respect can be classified with rice and pasta. This makes the truth of (14) more complicated than an all-or-nothing matter.

Interestingly, the closest German equivalent to *vegetable* is *Gemüse*, and *Kartoffel* 'potato' is not categorised in its domain. Therefore, the translation of (14) as (15) would be rejected by German speakers (Lyons, 1963):

(15) Kartoffeln sind Gemüse.

Appealing to experts in these cases begs an important question: which experts—botanists or chefs? It is surely a philistine prejudice to insist that botanists should be given greater weight!

**Fields, networks and vectors**

Although there is some indeterminacy and vagueness in these sense relations, mirroring that of reference, we hold that the sense relationships are in general more stable over time and from person to person than the reference relations. The following kinds of semantic entailments would not seem to be falsifiable by new discoveries; only a change of meaning (application and/or sense) would defeat them:

(16) If X is big in size, X is large (where the norm and context are indexed, as discussed above).
(17) If X is big in size, X is not small (also indexed).
(18) If X is scarlet, X is red.
(19) If X is a cannon, X is a weapon.
(20) If X kills Y, Y is dead.
(21) If X drops Y, Y falls.
(22) If X buys Z from Y, Y sells Z to X.
(23) Yellow is a colour.

In general, the relationship of antonymy, and entailments involving nominal kinds (e.g. artefacts, words like *bachelor*) and primary kinds (words like *yellow*, *sweet*, and similar perception expressions) have more stable network associations than (some) natural kind terms. It is hard to see how (23) could be falsified without a sense change of some sort, although it may be easy enough to construct scenarios involving such change.

Domains that are less stable, more subject to indeterminacy, individual variation and change, are found in many semantic fields, where there might be disagreements both on the reference and on the network relationships. Consider the various English words for the field of *streets*: *street*, *avenue*, *boulevard*, *lane*, *path*, *alley*, *road*, *freeway*, *highway* (*expressway* plus others). A plausible analysis would postulate *street* as a superordinate for the set, but also allow it to contrast with the other words. (That is, the polysemy of *street* involves a general and a specific sense.) There would be partial overlap and partial synonymy for *street*, *avenue* and *boulevard*, and this set would contrast with *lane*, *path* and *alley*, which would also exhibit partial overlap and partial contrast. A third subset would include *road* as a superordinate for *highway*, *expressway* and *freeway*, terms that contrast in some localities and are synonymous in other places. However, other plausible analyses are possible, and we would expect speakers to disagree among themselves and change their minds, depending on what kinds of sentences, images and memories come to mind at the time they are making their judgments. However, even disagreements and inconsistencies are limited, and they can be pinpointed.
Change may come about as the individuals who name streets in new developments apply these terms in arbitrary and idiosyncratic ways, as they often do (Algeo, 1978; Lehrer, 1992). Or a change may come about as a result of a conversion from an ordinary term to a technical one. For example, city planners may draw up codes for traffic and parking that would involve precise definitions of road, street, boulevard, avenue, lane and alley.

12 Semantic fields

The semantic field is an important concept that Lyons introduced into the English-speaking linguistics community and a concept to which he made major contributions. In principle, we can invoke semantic networks without appealing to semantic fields; however, semantic fields play an important role in semantic analysis. Firstly, since most words are ambiguous, it is often simpler to deal with each of their senses in its own semantic domain. Secondly, fields provide an intermediate unit between the atomicity of single words and the whole of a vocabulary. Although a change in the sense of one word may have implications for other words, usually the effects are found only in that word's semantic field. (Kittay, 1992 develops this point.) A Putnam-like change in cat would affect feline, other hyponyms of feline, animal, and possibly other words, but it would not affect the sense or reference of tulip, neutrino or avenue. Thirdly, many words that have overlapping reference are embedded in different lexical networks, that is, in different semantic fields. One example would be port and harbour. Although these words can refer to the same object, port is embedded in a word field of entrances to a place, whereas harbour is embedded in a network of protection. Womb and uterus provide another example where the reference is the same but the networks are not coextensive. Emotive meaning, association and connotation have been reluctantly acknowledged as existing, but then ignored or relegated to pragmatics or literary studies. None the less, these factors play an important role in language sense and language use.

13 (How) Do we ever manage to communicate?

Given the indeterminacies and other problems that have been outlined above, it would seem that communication should be much more difficult than it apparently is. At any time for a speech community there are conventions that fix reference, at least for prototypes, and there are network relations, many of which are highly stable. But even in cases of vagueness and indeterminacy there are conventions that permit mutual understanding.

14 A vector model of interpretation

Communication, which appears to occur with remarkable ease, depends on the shared interpretation of an expression by an articulate speaker and his or her engaged listener. We shall now attempt to offer a theory of the interpretation of an expression, though we restrict our account to single words to start with the simplest case. There is a multiplicity of vectors that influence the interpretation of an expression. One of these is the place of the terms in a semantic network. A psychologically realistic account of the role of this factor in the interpretation of the expression must limit the extent of the network relations which contribute to the interpretation. The field theory of semantic relations specifies that limit: for example, anything referred to by the word red must be referred to by the word coloured. Within the framework of the computational theory of mind the position of an expression within a semantic network articulates the conceptual role of the expression. We are not necessarily advocating the computational theory of mind or conceptual role semantics; we simply observe that conceptual role semantics is based on intralinguistic relationships of the sort that the network theory articulates. Any such conceptual role semantics is going to have to limit the extent of such relationships determining the conceptual role, and field theory suggests the needed principle of localisation.

Another factor is the application of the word by previous speakers, as the causal theorists have insisted, but the ubiquity of linguistic change, the flux of usage which we have illustrated above, will undermine any simplistic theory of reference in terms of causality, however elegantly formulated in terms of ancestral relations. The present reference of an expression is influenced by more factors than an ancestral relationship to the original use of it. There is the importance of expertise in the use of some parts of the language, technical terms of science or art, as Reid (1785) and Putnam (1975) have insisted, but there are limits to our deference. We defer to lawyers and judges concerning the reference of the term felony, to philosophers concerning the term epiphany and, perhaps, to no one concerning the term arm. So, network relationships, causal relations and deferential relations are all factors in determining the reference of a term. That is part of our reason for claiming that pragmatics plays a large part in the determination of reference.
There is another part already suggested by the influence of a multiplicity of vectors: namely, that the various factors may all have some degree of influence, and the outcome must be the result of an aggregation of various degrees of influence. This suggests, therefore, that the factors are input vectors which interact to yield the output of reference. The output of reference is a vector that combines with an output vector of sense to yield interpretation.

15 Reference and vector aggregation: an informal account

We suggest a model of sense, reference and interpretation of a word as an aggregation of input vectors. There are various factors that influence sense and reference. These become the input vectors determining the sense or reference function of a word for an individual. The resulting sense or reference functions of individuals will then be regarded as vectors to be aggregated to determine a social or communal sense or reference function for the language. One typical form of aggregation is averaging a set of values to yield a significant average, for example, when one averages the heights of members of a population to determine the average height of a person in that population. Vector aggregation is in fact a form of averaging in which different weights are assigned to different vectors. Our proposal is that sense and reference, whether individual or social, are the result of assigning weights to various vectors of sense and reference and averaging.

Sense and reference, thus conceived, are averages of the relevant vectors in such a way that the average height of a person in a population is the average of the vectors constituting the heights of members of the population. The latter average is a simple average in which the height of each person is given the same weight, \(1/n\), where \(n\) is the number of members of the population. A weighted average would be an average in which the heights of some people, adults perhaps, are given greater weight than the heights of others in computing the average height. The aggregation which yields sense and reference is a weighted average in which some vectors may be given greater weight than others to obtain the sense and reference functions of individuals. Moreover, some individual functions may be given greater weight than others, perhaps reflecting the relevance of expertise, to obtain the social or communal function.

When reference is the theoretical construct that interests us, the values of the construct should be quantitative, a matter of degree, to represent the widely accepted fact of the indeterminacy of reference (Quine, 1951; A. Lehrer, 1970, 1974; Zadeh, 1971). In fact, both semantic and referential relations are to some extent indeterminate, and, therefore, a quantitative account of sense and reference as matters of degree is adopted. (A formal account of the aggregation model of sense, reference and interpretation is contained in the appendix.)

The model leaves us with some residual theoretical problems in addition to the practical ones of specifying methods for ascertaining the values of various vectors and the weights for an individual to assign to those vectors. (Some suggestions are to be found in K. Lehrer and Wagner, 1980.) The primary problem concerns the acceptance of an account of reference specified in degrees rather than a simple yes or no format. Traditionally, an assignment function yielded a yes or no answer to the question of whether any object belonged to the reference of a term, indeed, any object in any possible world. We do not apologise for differing. The data suggest considerable indeterminacy. In some instances, it will be fully determinate that a term applies to a specific object, but there will be many indeterminate cases for most terms. We do not have a rule in our minds for determining whether or not every object in every possible world is part of the reference of every term, even when fully informed about the object. A satisfactory scientific account of the reference of words, should, moreover, explain why the word refers to the objects it does, or has the degree of determinacy of referring to those objects, rather than simply positing the result without explanation.

A secondary objection might be that the aggregation is psychologically unrealistic. We do not, it might be objected, compute averages to determine the reference of a word. Indeed, we can perfectly well decide whether or not a word refers to an object without doing any arithmetic. Our reply to the objection begins by noticing that there is a great deal more indeterminacy about whether an object is referred to by a word than the objection suggests. The crux of our reply, however, is that the mathematical representation of a process within an individual does not imply that the individual reflectively carries out the computation. First of all, there are many unreflective and unconscious computations of the mind. Syntactic parsing is an example. Secondly, even if the process is not computational at all, the mathematical representation may be correct. The earth and moon do not compute the values of the laws of physics in order to conform to equations concerning gravitational attraction. Moreover, there is an argument based on neuropsychology to support vector aggregation as a model of human functioning (Churchland & Sejnowski, 1992). When you extend your arm to touch an object, the neurons conform to a model of vector aggregation to yield the resulting contact. We do not, of course, insist that our model of vector aggregation corresponds to neural aggregation, though it may, but suggest
that anyone interested in a unified model of mind and language should be cheered by a model that tells us that the model of linguistic functioning recapitulates a plausible model of neural functioning.

15.1 Reference, networks and interpretation

How can we combine the theory of the vectors of reference with the theory of network roles in a unified explanation of interpretation? If communication occurs, then there must be some consensus or agreement in the way in which people use words. Were there none, my interpretation of what you say would be mistaken, and communication would fail. It is, however, notorious that people apply the same words differently, even among those living together, as domestic linguistic disputes reveal. Even such words as sweet and dry applied to wines are applied very differently by different speakers (A. Lehrer, 1983). Such disagreement is, of course, compatible with agreement in central cases, so that all might agree that sugar is sweet and pepper is not. One key to understanding communication is the greater agreement among speakers concerning the sense or semantic role of an expression in a linguistic network. The very people who disagree about whether a wine with zero sugar content and a marked fruity bouquet is sweet or dry will agree that if the wine is sweet, then it is not dry. Thus, our suggestion is that network role is a marked area of agreement. This may be, in part, due to an innate understanding of abstract linguistic structures, as work concerning semantic universals (Talmy, 1980; Jackendoff, 1990) suggests. These structures, for example, antonymy structure (Lehrer and Lehrer, 1982), may be innately understood and interpreted by the assignment of lexical items to the abstract positions in the structure.

15.2 A paradox of reference

Vectors of reference are influenced by the circumstances of an individual. These vectors include how a word is introduced to a person initially, which may be individualistic and perhaps idiosyncratic. The outcomes of individual aggregations of reference must be expected to differ. However, communication must incorporate interpretation of the referential intentions of the speaker, for understanding without such interpretation would be reduced to the understanding of linguistic relations between tokens without any understanding of what the tokens refer to. Communication would fail. We arrive at what might be considered a paradox of reference. The vectors of reference vary from individual to individual and yet they are essential to the understanding of expressions. By contrast, network relations appear to be less variable, but an understanding of them is insufficient for an understanding of a linguistic expression. What is required, therefore, is an account of interpretation of expressions combining an understanding of reference and network relations.

15.3 The individual and society: a dynamic duo

The solution to the paradox depends, first of all, on recognizing the dynamic processes, aggregation processes, whereby individuals come to assign reference the way they do. The aggregation process described above occurs over time, and one feature, the most heavily weighted factor for some words, is the conviction of the individual concerning the way others apply the word. The reason, therefore, that reading an expression into a network carries a social determinant of reference with it is that the aggregation of the individuals often gives dominant weight to what they take to be the social assignment of reference. Of course, the soundness of the conviction about how others apply the term will depend on the information that an individual has about the linguistic behaviour and intentions of others.

The social reference assignment is, on our account, an average of the individual reference assignment and is, in this way, a fiction like the average child born in 1991. One should not conclude, however, that there is no fact of the matter concerning the social reference assignment. There is a fact of the matter about the weight of the average baby born in 1991, for that is the average weight of such babies. This means that an individual can have a more or less correct view about the social reference assignment of members of the group. Thus, an individual reference assignment can be more or less idiosyncratic depending on the correctness of his or her conviction about the social reference assignment and the weight that he or she gives to that reference assignment in aggregating the vectors of reference.

The moral of the story is that there is a dynamic interaction between the individuals and the linguistic community to which they belong. The individuals aggregate what they take to be the social reference assignment. The social reference assignment is itself an aggregate of individual reference assignments. The dynamics of this interaction and aggregation generate similarity between individual reference assignments and the social assignment. Given this similarity, interpretation of an expression in terms of the position of the expression in a semantic network carries an understanding of reference along with it. It is, however, important to notice that this
account of the interpretation of an expression allows for wide variation among different individuals in how they apply a single word and wide variation within individuals as well. On the theory we are offering, interpretation and communication vary greatly in the degree of mutual understanding among individuals concerning the reference of a word. They vary from almost exact coincidence to wide disagreement. That, we suggest, is the reality of our use and understanding of the language of others.

The underlying agreement in linguistic networks, though allowing of some variation as well, allows us to draw inferences up on which we agree and to resolve our referential disagreements as they become manifest. We need only re-adjust our convictions about the reference assignments of others and aggregate our improved information. The method of aggregation does not guarantee that we shall agree in our reference assignment, but, being an average of our assignments and those of others, it does provide a method for improving our agreement. That is all we need to carry on the business of linguistic communication and the various other businesses it serves. When we need exact referential agreement we know how to get it. Keep exchanging information and aggregating until the point of convergence clarifies. When we do not need exact referential agreement, communication proceeds comfortably without it.

What is most impressive about our language ability is that we can use and exploit the dynamics of meaning by negotiation and decision. We can stipulate a precise technical definition whenever we consider this necessary, a process that is always dynamic; we can talk about our disagreements in sense and reference and either adopt one usage or understand the usage of the others in a conversation. But successful negotiation is only possible if there is stability elsewhere in the system, since we use other words to define the words in question. We may rebuild the ship of language at sea, but we need a stable working place within the ship for our constructive efforts.

**APPENDIX**

**Reference and vector aggregation**

We shall propose a formal model which represents the various factors of reference as vectors and their resulting influence as the aggregation of the vectors. The simplest model of vector aggregation is the weighted averaging of vectors. Weighted averaging is a form of averaging in which the various factors averaged are given different weights, whereas simple averaging gives equal weight to the factors averaged. Notice immediately that the role of experts and the division of labour theory of reference, where not all people are equal in their influence on reference, is naturally amenable to weighted averaging. Different people might be assigned different weight depending on their expertise or our willingness to defer to their expertise concerning reference.

To give us a formal model, suppose that each member of a group assigned a degree of determinacy to the application of the term *felony* to a crime described in as much detail as one wished. Let there be one hundred people in a reference-determining group. We have values $r_i(\mathbf{f},c) = n$ for each of the individuals, where $r_i$ is a reference function for person $i$ who assigns value $n$ as his or her degree of determinacy that the term $\mathbf{f}$, *felony*, refers to the crime $c$. We can aggregate the values by assigning weights, $w_i$, to the various members of the group and multiplying to find a weighted average. For the sake of mathematical simplicity, suppose that the weights assigned to members of the group are in the interval of $0$ and $1$, that they sum to $1$, and that the values of $n$ assigned by individuals as their degree of determinacy are also in the interval of $0$ and $1$. (We assume nothing about the sum of the $n$ values assigned by members of the group.)

We then obtain the value of reference determined by aggregating expertise, $r_a$, as follows:

$$
E. r_a(\mathbf{f},c) = w_1r_1(\mathbf{f},c) + w_2r_2(\mathbf{f},c) + \ldots + w_mr_m(\mathbf{f},c).
$$

The value of $r_a(\mathbf{f},c)$ is an average and can be expected to fall between the extreme values of $0$ and $1$ but not coincide with those extreme values whenever the reference values of individuals differ. Thus, in many cases some degree of indeterminacy about the reference of a term should be expected, and that outcome seems empirically warranted.

The equation, $E$, which aggregates the reference functions of various individuals, can be re-interpreted and used to aggregate various factors influencing an individual instead of the influence of diverse individuals. We may think of the various functions $r_1, r_2$ and so forth to $r_a$ as the results of determining the degree of determinacy of reference an individual would assign on the basis of various factors mentioned above. The various weights would be those that the individual assigns to those factors, and the resulting function, $r_a$, would be a reference function for an individual. The individual reference function is then renamed and used in the social aggregation, $E$. This aggregates the individual functions to extend the analysis beyond the individual or idiologic reference function to the social or communal reference function.

**Combining sense and reference**

Our formal account combines an interpretation function for a person consisting of a network component, the position, $p$, in a semantic field, $f$, and a reference function consisting of a range of application, $\mathit{a}$. Thus, we have two functions for interpreting a word, $w$. The first represents the position of the word in a semantic field and gives us the sense of the word.

$$s(w',p)$$
and the second represents the reference of the word
\[ r('w',a) \]

Each of these functions is a quantitative value reflecting the degree of determinacy of the respective assignments. The greater determinacy of network relations will be reflected in higher values in some cases than the values of the reference function. In other cases, this order will be reversed. In the case of wine words, for example, we may be quite uncertain about the reference of wine descriptors while very certain of the semantic relations between them, but in the case of road descriptors we might be more certain of the reference of the descriptors than of the semantic relations between the words.

Empirically, there seems to be greater determinacy about sense than reference in languages and idiolects, but both have some degree of indeterminacy. We may expect the central role of sense in interpretation to be reflected in a higher degree of determinacy about the place of a word in a semantic field and the greater weight given to the sense function than the reference function in our interpretation function for a word. The central role of sense in interpretation is the result of the fact that the sense function is more stable and less sensitive to the shifting influence of pragmatic factors. Aggregation of reference plays itself out on the background of semantic fields of sense.

How can we combine the functions of sense and reference to obtain a unified interpretation of a word? There is, of course, the simple pair of functions,
\[ \langle s('w',p), r('w',a) \rangle \]

to which we could assign some degree of determinacy, perhaps a simple average of the values of sense and reference functions. That is, however, too simple a view. These two functions are themselves vectors of interpretation and might be given different weight. We may, in fact, explicate our claim about the greater determinacy of sense functions over reference functions in terms of the greater weight given to the sense function than the reference function in ascertaining the values of the interpretation function. Again, assuming that the weights applied to each are non-negative and together sum to 1, we compute the value of the interpretation function as a weighted average. We use the weights \( w_s \) and \( w_r \) to average the values of sense \( s \) and reference \( r \), to obtain the value of the interpretation function, \( i \), as follows:
\[ i('w',s,r) = s('w',p)w_s + r('w',a)w_r \]

The resulting function gives us the degree of determinacy of the interpretation of the word \( 'w' \) based on the degree of determinacy of the sense function and reference function for a word. The interpretation is an aggregation of the vectors of function and sense. The communal interpretation of a word is an aggregation of the individual interpretations. These in turn are influenced by the vectors of individual convictions about the communal interpretation. Sense and reference, personal and communal, interact as vectors that are activated by new information about language, the world and each other. Reference is the flux of pragmatic aggregation organised within a field of sense.

NOTES

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1 In some recent philosophical work, intralinguistic relationships (such as those among synonyms, antonyms, etc.) have been considered syntax (following Morris, 1946).

2 The spatial interpretation of vector theory suggested by Ziff is, however, inessential to mathematical representation of a subject matter in terms of vector theory. We shall employ vector theory in a more abstract way as the weighted average of initial values to compute an outcome rather than adopting the spatial representation of vectors suggested by Ziff.

3 Vagueness is one kind of indeterminacy. Predicates like bald are vague, but indeterminacy can result from other factors, such as the referential expressions discussed above.

4 For us maroon is a shade of purple, not red. However, if some speakers classify maroon as a shade of red, that is evidence for the indeterminacy we discuss.

5 Putnam claims that scientists would decide that twin Earth's XYZ, which is perceptually and functionally equivalent to water, but atomically different, was not water. This is an interesting empirical prediction that could be false.

6 We came upon this example because a doctor friend chided us (and everyone else) for using arm incorrectly. Marga Reiner raises the question of whether arm is a natural kind term. The term 'natural kind' is somewhat vague, but law-cluster concepts appear to be natural kind terms. The medical use of arm is a law-cluster concept, according to our medical expert.

7 Vonnegut never explains how reproduction works: he says it is too complicated for humans to understand.

8 For example, see the paper by Lewandowska-Tomaszczuk (1985). Classic works on semantic change include Ullmann (1962), Stern (1931) and Williams (1975). Mercier (1992a, 1992b) has discussed semantic change in the context of philosophical semantics.

9 Saka (1992) points out the difficulties that truth-conditional semantics has in dealing with lexical ambiguity. Since ambiguity is the normal case of word sense, not a rare exception, this is indeed a serious problem. Metaphor, too, is a common linguistic phenomenon which truth-conditional semantics has so far had little to contribute to (see Goodman, 1968; A. Lehrer, 1974, 1983; Kittay, 1987). Nunberg (1979) discusses polysemy and the extension of referring expressions, but he does not deal with sense relationships.

10 Kripke (1980) and Putnam (1970) accept a position of essentialism with respect to rigid designators, which include natural kinds. So that if something is a cat, it must have certain biological properties (e.g. genetic material). Therefore, a cat must be an animal, where animal is also defined in terms of some biological properties. Whether the things we call cats are this (i.e. a natural kind) is an empirical matter.
11 Vegetable as a botanical term is used for the kingdom.
12 If tomatoes were always and only served with other fruits, for instance, only in fruit salads, or as a dessert, then (13b) would be accepted without question.
13 In fact, how well we do communicate is an empirical question. A. Lehrer's research (1983), as well as that of many others, suggests that miscommunication may be frequent.

REFERENCES
