BEING REALISTIC, BEING SCIENTIFIC

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THIS PAPER ARGUES IN FAVOR of being realistic and proposes that concern for reality will lead to a scientific linguistics.

It may be thought that linguists hardly need to be urged to be realistic, as they are **10** already concerned with reality. But observation of common practice in linguistics reveals the contrary. Being concerned with reality requires paying attention to things that we have been accustomed to take for granted. Consider, for example, the common supposition that linguistics is the science of language. This statement depends upon the assumption that there are such things as languages. Is it a realistic assumption? I have argued elsewhere that **15** it is not (Lamb 2004a). If it is not, this is an unrealistic belief. The concept LANGUAGE is at best a very abstract one. Language is several steps removed from reality (Lamb 2004a). You cannot touch, see, or feel a language. Yes, you can hear speech, but that is something different. Should we assume that because we have the word *language*, there must be such things as languages? *Language* is just a term of English. It may be interesting to take note of the **20** fact that many 'languages' don't even have a term equivalent to the English term *language*.

Likewise, many linguists suppose that words, morphemes, lexemes have meanings. In what sense of *have* can this notion be viewed as realistic? Even more unrealistic is the commonly encountered belief that a given morpheme, for example a case ending, has a single core meaning, from which all others can be derived. The fact that exercises of deriving one **25** meaning from another can be successfully conducted does not constitute evidence. As I have had students demonstrate in my cognitive linguistics class, it is possible to derive *any* meaning (of any word chosen at random) from any other meaning (of another word chosen at random by another student).

It seems that we can identify two major ways to avoid being realistic: (1) Accept words **30** from ordinary language as valid technical terms (e.g. *language, word, meaning*); (2) Adopt assumptions without questioning them. Likewise, it seems that we can identify two simple principles for being realistic: (1) Start from concrete observable phenomena; (2) Observe.

Being realistic requires not only that we be suspicious of fashions and fads but also that we try to avoid talking metaphorically about linguistic matters. We cannot suppose that **35** metaphors will provide realistic descriptions of phenomena. By definition a metaphor describes something as if it were something else that it is not. Michael Reddy (1979), in correctly challenging the conduit metaphor of communication, proposed that we consider, as an alternative, the tool-maker metaphor. But this is just another metaphor. Is it not possible to observe what really is the basis of our notions of meaning and communication, as a **40** physical basis? The present paper argues that this question has a positive answer.

Concern for reality and careful observation will automatically render linguistic investigation more scientific. This, it can be argued, is the first basic principle of a scientific linguistics. The second, which follows from it, is that linguistics and its findings must be relatable to other sciences, including the physical sciences. If this requirement is followed,
5   linguistics will be able to draw upon the findings of physical (including biological) science as well as to contribute to them.

I say above that we can't be realistic if we attempt to use vague or abstract traditional terms as technical terms. In addition to *language*, there are several other relevant terms that invite suspicion: *thought*, *culture*, *mind*. All these terms are vague, ambiguous, and abstract.
10 To be abstract means to be removed from observable reality. They may even be based on illusion. Terms that are vague and ambiguous mean different things to different people. These are just traditional terms of English, handed down through generations of folk tradition. How can such terms be used as a basis for scientific endeavor?

Let us look more closely at this elusive (and illusory?) term 'language'. First, to say that
15 it is ambiguous is an understatement. It has at least four different meanings (Lamb 2004b): (1) a set of sentences (Chomsky) or utterances (Bloomfield); (2) the system that underlies such productions; (3) processes of speaking and comprehending; (4) the propensity and ability of children to learn languages (in sense 2) (Pinker 1994). All four of these meanings are abstract and therefore suspect. Also, a term with multiple meanings lends itself to what
20 Hockett has called 'Tarzan reasoning', in which one swings from one meaning to another like Tarzan swinging from one tree to another using a vine. Hardly a type of reasoning to be used in scientific discourse. Pinker (1994:18) has provided a good example (cf. Lamb 2004b), with a line of argument which concludes that language is an instinct, conveying 'the idea that people know how to talk in more or less the sense that spiders know how to
25 spin webs'.

However, for the sake of linguistics and in recognition that this field is certainly concerned with languages in some sense of that vague term, we should try to look behind the term and find some tangible and observable reality. There is indeed a readily observable reality behind the term: human beings speaking to one another. On observing such speak-
30 ing, we can readily see (or hypothesize, if we are being especially careful) that (1) such speaking is organized and systematic, and that (2) communication is generally more or less effective.

Victor Yngve has presented arguments similar to these in a series of LACUS papers and in his book *From Grammar to Science* (1996). He proposes what he calls the *linkage,* which
35 models an *assemblage* (of communicating persons) as a basic concept to be used in building a scientific linguistics. He defines an assemblage as 'a group of people together with their linguistically relevant surroundings involved in particular communicative behavior' (Yngve 1996:86). I find two problems with this approach. First, the linkage is an abstraction from people, and any abstraction must be considered questionable. One question, for example:
40 why choose this particular abstraction (the linkage) rather than some other, from among all the phenomena involved in communication? Second, the research that has appeared based on the linkage, in various writings of Yngve and others (again, see recent issues of the LACUS Forum), does not relate well to linguistics as we have known it. Rather than

linguistics, it might better be called the sociology of communication. This is not to criticize sociology of communication. Surely it is a worthy pursuit. On the other hand, it should be added that Yngve also allows for a focus on the properties of the communicating individual. That focus is much more compatible with what is advocated in the present paper.

What I propose as a starting point for further investigation is *the system used by people for their linguistic activity*. In this last sentence, the term *system* is intended to be a neutral term, free of preconceptions. What we are interested in is whatever it is that makes it possible for a person to engage in linguistic activities. The nature of whatever that is is what needs to be investigated. Of course, we need to ask whether this system is a concrete observable object/phenomenon. But first, we need to be clear about what is meant by the term lin- 10 guistic activity.

Linguistic activity includes, of course, speaking and comprehending. It seems reasonable also to include writing and reading. In addition, since we are attempting to be realistic, we should include thinking; not all thinking, but all that which is linguistically based, that which uses inner speech, the internal monologue. Most people probably engage in this 15 activity more than in either speaking or comprehending speech. We should also add the processes of learning how to engage in these activities and expanding our capabilities, for example by the learning of new lexemes.

Since people do indeed engage in such activities, we can realistically conclude that they have the means to do so. That is what I am referring to as a system. Our job, then, is to 20 examine the nature of this system. Such considerations will bring us into direct relationship with neuroscience, one of the biological sciences.

To recap, what we have so far is, first, the observation that people talk to one another. Therefore, they have some means for doing so. To proceed, we need to give a name to this means. It can be called their *linguistic system*. Now, the preceding sentence is ambiguous: it 25 could be interpreted as suggesting that different communicating individuals have the same system. Of course, we do not want to suppose any such thing. And in fact the frequent occurrence of misunderstanding suggests quite the contrary. A more careful wording of that sentence would therefore be: for each such individual, the means may be called his/her *linguistic system*. Based on observation of people's linguistic activity, it seems to be safe to 30 conclude (1) that a person's linguistic system operates (e.g. for speaking and understanding), and (2) that it has been acquired and is further expandable, adaptable, and otherwise changeable.

In keeping with the reservations mentioned above about terminology, we may note that the term linguistic system is not an ordinary term of English. Therefore (unlike language, 35 word, meaning), it is not associated with various concepts from tradition, most of which may be irrelevant and misleading. Rather it is adopted without preconceptions for application to concrete phenomena. And so we do not assume that different people have the same linguistic system, nor that a person's linguistic system consists of rules, nor that it has a form prescribed by some pre-existing linguistic theory, and certainly not that it is geneti- 40 cally determined by a language gene.

Based on readily observable facts about people, I take it as beyond question that a linguistic system, whatever form it has, has to be usable for speaking and understanding

and must be able to acquired and modified. Moreover, there has to be a place where it is located.

This brings us to the next point: what is that place where this system is located? The answer is already available, thanks to generations of work by neurologists and neuroscientists, including neurolinguists. This system is in the brain, mostly in the cerebral cortex. Recognition of this fact, an established scientific finding, brings linguistics into direct relationship with the biological sciences.

In keeping with the cautions mentioned at the outset of this paper, we may next consider two questions:

(1)   Is the linguistic system a real physical object?
(2)   Is the linguistic system observable?

To the first question we can give a clear affirmative answer. The brain, including the cerebral cortex, is a real physical object. For the second question, the answer is not so simple. Observation is indeed possible, although it is indirect. But that indirectness does not disqualify the investigation as unscientific. A large amount of scientific observation is indirect, for example in astronomy and in particle physics.

There are several methods of observation that provide information for a scientific linguistics. Let us begin with neuroanatomy, as it provides the basis for all the others. Neuroanatomy may be considered at a macroscopic scale and a microscopic scale. The macroscopic scale is concerned with the two hemispheres, the four lobes of each hemisphere (frontal, temporal, parietal, occipital), and the subdivisions of the lobes, with their sulci and gyri (see www.rice.edu/langbrain/cglidden/telen.html). At the microscopic level we have the six layers of the cortex and the neurons and their components such as axons and dendrites as well as both smaller (e.g. ion channels) and larger units. A larger unit of basic importance is the cortical column, a bundle of neurons (Mountcastle 1998).

An area of indirect observation that is well over a hundred years old is aphasiology, the study of damage to the linguistic system resulting from strokes, injuries, etc. (Benson and Ardila 1996). In recent decades a number of additional techniques of observation have been developing. Perhaps most important is brain imaging, which has three main varieties based on different technologies: positron emission tomography (PET), magnetic resonance imaging (MRI), and the most recent and potentially most useful for linguistics, magnetoencephalography (MEG) (cf. Papanicolaou 1998). Additional techniques of observation include transcortical magnetic stimulation (TMS), which induces temporary local dysfunction, and the use of microelectronic probes during neurosurgery. In addition, many inferences can be drawn from observing the linguistic behavior of people.

Based on abundant research that has been undertaken using these various types of evidence, we have important findings about the linguistic system for which the evidence is by now quite clear. First, we know that a person's linguistic system is largely represented in his/her cerebral cortex. Further, we know that the cerebral cortex is a network. It is easy to suppose that the nodes of the network are neurons and that the connections are nerve fibers, axons and dendrites. And ultimately it is so. But there is now a large amount of evi-

dence indicating that a better understanding of the function of the cortex in processing information is provided by a conception in which the nodes are columns of interconnected neurons (Mountcastle 1998).

In either case, whether the network is viewed as a network of neurons or a network of cortical columns (and of course it is both, since the column is a network of neurons), we have now arrived at a very important conclusion: **the linguistic system is a network**. From now on I will use the term node to refer to either neuron or column.

The observation that a linguistic system is a network leads directly to others and forces us to reject a number of hypotheses that have been proposed in linguistics over the years. Most rejectable perhaps is this: the brain, hence the linguistic system, operates by means of symbols. Related to this false notion is the corollary that neurons or columns of neurons store symbolic information. But the symbolic information that seems to be so characteristic of language is not directly represented in the cortex at all. Neurons and cortical columns operate by emitting electrical activation to other nodes. This activation typically goes to multiple other nodes in parallel, and it varies in amount, depending on the amount of activation being received. A node accomplishes what it does by virtue of what other nodes it is connected to, not by virtue of any symbolic information it contains.

A great deal is known about the various kinds of connections among nodes. The most basic distinction is perhaps that between local and long-distance connections. The well-known distinction between gray matter and white matter relates to this point. The gray matter consists mainly of columns of neurons. It also includes local connections among adjacent columns. The white matter is composed of long-distance connections (axons), from one part of the cortex to another. (A schematic depiction of a linguistically important bundle of long-distance fibers may be seen at http://www.rice.edu/langbrain.) Connections come in varying degrees of strength, and they become stronger with successful use. This dynamic property enables the networks to increase the amount of information they can handle and to adapt to new situations and changing circumstances. Also important is the distinction between excitatory and inhibitory connections. Excitatory connections are both local and long-distance, while inhibitory connections are local only.

Another well-established fact from neuroscience is the correlation between perceptual functions and cortical areas. The primary visual area is in the occipital lobe of both hemispheres, and higher-level visual integration takes place in successive stages in areas progressively anterior to the primary visual area, extending into the temporal lobe (the **what** pathway) and into the parietal lobe (the **where** pathway). The auditory and somatosensory areas are similarly stratified, in that each has a primary area, most closely connected to the sensory input, and successive stages of higher-level integration in areas spreading out from these primary areas. The auditory area is in the temporal lobe and the somatosensory area is in the parietal lobe.

As might be expected from this brief account, speech recognition is likewise in the temporal lobe, since it is based on auditory information. The evidence indicates that nodes for phonological forms that have been learned by an individual, such as syllables and phonological words, are in the posterior portion of the upper temporal lobe, just posterior to the primary auditory area. This is the area known as Wernicke's area.

Control of motor activity resides in the frontal lobe, and it is here that we, accordingly, find control of speech production, in Broca's area, just anterior to the portion of the primary motor cortex that controls the operation of the speech organs.

Of course, these two areas of basic linguistic importance, Wernicke's area and Broca's
5 area, have to be connected. And indeed they are, by what is perhaps the linguistically most important fiber bundle of the cortex, the arcuate fasciculus (see depiction at www.rice.edu/langbrain or in Lamb 1999:368).

Let us now consider, as a simple example, the form *dog* of English. What gets activated in the cortex by hearing such a form is a network comprising an auditory image in the audi-
10 tory area of the temporal lobe connected to a node in Wernicke's area that can activate this image and be activated by it. This node is connected by the arcuate fasciculus to a node in Broca's area (frontal lobe) that is further connected to nodes controlling the articulatory gestures that will produce the spoken form that we label *dog*. Now, what about the meaning of this word? The meaning of even such a simple word as *dog* is rather complex. It includes,
15 among other things,

(1)   what a dog looks like – a visual network of hundreds or thousands of nodes
(2)   what a dog sounds like (barking and whining) – an auditory network
(3)   what a dog feels like to the touch – a somatosensory network

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Moreover, these networks must be connected, directly or indirectly, to the phonological form for *dog*. At this point, the evidence from neurolinguistics remains a bit hazy, but it is likely that there is a lemma (lexical) node in the angular gyrus, in the lower part of the parietal lobe close to Wernicke's area, that has connections to the phonological node (in
25 Wernicke's area) and to these three sensory-perceptual networks as well as to various items of abstract information associated with dogs and their behavior. This abstract information is of course quite variable across individuals, depending as it does upon their various experiences with dogs and with the varying amounts of abstract knowledge they have acquired about these animals—some of it from direct experience, some from hearsay, some from
30 reading, etc.

And so what we have, for this one simple word, is a vast and complex network. But it is formed entirely of nodes and their interconnections. It is important to realize that many, indeed most, of the nodes of this network are shared by other networks, for example those for cats and bears; and on the phonological side, those for *dawn, hog, log*, etc. What
35 keeps all of these various networks distinct from one another is the non-shared convergence nodes that are dedicated to their unique functions, such as the phonological node for *dog* and the lemma node for *dog*. These convergence nodes also make possible the reactivation of the networks under appropriate circumstances. For example, when you hear the word *dog*, the phonological node is activated, and activation spreads on to the lemma node
40 and from there to the various sensory-perceptual networks for DOG. (Clearly, it's no good to have a lot of information represented if it can't be appropriately reactivated, while not being inappropriately activated.)

One of the beautiful properties of our neurocognitive systems is that such reactivation of acquired information operates in different directions. Upon seeing a dog, for example, activation proceeds from the retinas to the primary visual cortex to higher level visual strata, ultimately (in about 150–200 milliseconds) activating the high level visual nodes dedicated to DOG, from where it can continue to the lemma node and on to the phonological node, and further to the articulatory node in Broca's area, from which activation can further spread to the muscles which allow the person in question to say 'I see a dog', or whatever else is appropriate to the situation. Alternatively, a person can hear the spoken word, which sets up activation from the cochlea to the primary auditory area, from where it spreads to Wernicke's area, from there to the lemma node, and on to the sensory-perceptual networks. The end result is that upon hearing the spoken representation of the word *dog*, one is able, for example, to visualize a dog.

What makes such bidirectional processing possible is the existence throughout the cortex of reciprocal connections between cortical areas (Lamb 2004c). That is, most cortico-cortical connections are bidirectional. This is an established finding of neuroanatomy. It is not that the connecting nerve fibers are in themselves bidirectional. Rather, it is that we find different but roughly parallel fibers going in opposite directions.

For those who may be skeptical about the existence of uniquely dedicated convergence nodes at higher levels, it may be mentioned that we have abundant evidence for such highly specific local representations of high-level information from detailed studies of auditory, somatosensory, and visual perception in various mammals (Mountcastle 1998).

In case it is not by now apparent, let me state outright that we now have the answer to the elusive question of meaning that has perplexed linguists and philosophers and that has led Yngve (1996) to reject much of linguistics because of its preoccupation with meaning as fundamental in the study of language. As mentioned at the outset, it is commonly supposed that words have meanings. As Yngve and others have correctly pointed out, this notion makes no sense. But lurking behind it we can see, through the scientific approach advocated here, making use of observation and the findings of the neurosciences, that there is a reality. It is not the case that words have meanings. Rather, it is the case that, *in the cerebral cortex of an individual, the network activated by the spoken form of a word is connected (in multiple steps) to a cortical network representing information pertaining to that word*. Speaking more loosely, we may say that cortical representations of spoken words *are connected to* cortical representations of their meanings. In keeping with the approach advocated above and followed throughout this paper we must also recognize that no two people can be expected to have exactly the same meaning for a word.

What, then, are we to make of all the work that has been done in linguistics based on previous conceptions of meaning? Must it be thrown out because of these basic misconceptions? An alternative is to make the necessary adjustments to allow some of this work to be accepted as scientifically useful. Consider, for example, the so-called cognitive linguistics of Langacker and others. Langacker (e.g. 2000) proposes that a language consists of symbolic units, and that each symbolic unit is a pairing of a form with a meaning. Symbolic units include not only fixed forms like words and phrases but also constructions. It appears that the large amount of work that has been done using this conception can easily be accommo-

dated as scientifically valid if we use just a little flexibility in our thinking, for Langacker's conception can easily be given an interpretation in terms of relational networks as outlined above. The first accommodation is achieved by changing *language* in the above statement to *linguistic system* (that is, of an individual). The second accommodation is to see that a symbolic unit is a network, in which two portions can be distinguished, one of which represents the form while the remainder represents the meaning. And since the form activates the meaning while the meaning activates the form, the relationship between the form and the meaning of a symbolic unit is that they are connected. Moreover, as mentioned above, the connection is bidirectional, because of the existence in the cortex of reciprocal connections between cortical areas.

The principle just illustrated may be called **accommodation**. Any prescientific work in linguistics may be said to be accommodated by scientific linguistics if its underlying conceptions can be reinterpreted in terms of networks as implemented in the brain.

What other work can be accommodated? Since it has been shown (Lamb 1999) that relational networks can be viewed as abstract representations of cortical networks, it would appear that, in general, research done using the relational network model, by Bennett, Lockwood, Makkai, Reich, Sullivan, and others, can be accommodated as scientifically valid. This appraisal must be qualified, however, by the consideration that the neurocognitive basis of language has not one but two phonologies, both articulatory and auditory, relating to Broca's area and Wernicke's area, respectively. Therefore, all earlier work in phonology, including that done using the relational network model, must be reappraised. Most of it appears to represent articulatory phonology and may therefore be valid for that side of phonology.

It is likely also that much additional work in prescientific linguistics can be accepted as scientifically valid, as it reflects a concern for reality and is based on conceptions that can be accommodated into the neurocognitive conception. Here I can mention the work on discourse analysis of Halliday, Longacre, Shin Ja Hwang and others.

But all such accommodation must include recognition that every individual has his/her own linguistic system. To be sure the different systems of people said to speak the same language have greater or lesser amounts of overlap, and to the extent that there is overlap we tend to communicate successfully. But a unified linguistic system for a community exists only in the realm of illusion.

IN CONCLUSION, THE INDIVIDUAL LINGUISTIC SYSTEM is a concrete observable physical object and therefore a valid object of scientific investigation. Examination of that system reveals that it is a network represented in the cerebral cortex having many features in common with the networks of relational network linguistics (Lamb 1999). It appears that some of the intuitions of prescientific linguistics, along with the findings resulting from research based on these intuitions, can be given scientific interpretations. A prime example is the notion of meaning: The meaning of a form is represented in the linguistic system as a cortical network, and the form is likewise represented as a cortical network; and the relationship between the representations of the form and the meaning is simply that they are bidirectionally connected.

In summary, I suggest the following:

(1)　　To be realistic we must start not with words like *language*, but with observable phenomena.

(2)　　For linguistics, an appropriate first observation is that people talk to one another.

(3)　　They must therefore have some means that allows such talking and understanding to occur.

(4)　　That means can be called a linguistic system

(5)　　A person's linguistic system is largely in that person's cerebral cortex.

(6)　　It has the form of a large dynamic network.

(7)　　Many of the findings of prescientific linguistics can be given scientific interpretation in these terms.

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