

study in this way languages of Indians, Africans, and other aborigines as it is to study the English dialects of Brooklyn, Boston, Richmond, or London.

While informants are the basic apparatus, the linguist can improve and speed up his work with the aid of mechanical tools, just as the biologist studies his animals and plants with the aid of microscopes, X-ray machines, and other costly instruments. The linguist is aided by judicious use of good phonographic reproducing devices. Much could also be done with the help of business machines.

Although linguistics is a very old science, its modern experimental phase, which stresses the analysis of unwritten speech, could be called one of the newest. So far as our knowledge goes, the science of linguistics was founded, or put on its present basis, by one Panini in India several centuries before Christ. Its earliest form anticipated its most recent one. Panini was highly algebraic, i.e., pattern-symbolic, in his treatment; he used formulas in a very modern way for expressing the obligatory patterns of Sanskrit. It was the Greeks who debased the science. They showed how infinitely inferior they were to the Hindus as scientific thinkers, and the effect of their muddling lasted two thousand years. Modern scientific linguistics dates from the rediscovery of Panini by the Western world in the early nineteenth century.

Yet linguistics is still in its infancy so far as concerns wherewithal for its needed equipment, its supply of informants, and the minimum of tools, books, and the like. Money for mechanical aids, such as I referred to above, is at present only a happy dream. Perhaps this condition results from lack of the publicity the other sciences receive and, after all, fairly earn. We all know now that the forces studied by physics, chemistry, and biology are powerful and important. People generally do not yet know that the forces studied by linguistics are powerful and important, that its principles control every sort of agreement and understanding among human beings, and that sooner or later it will have to sit as judge while the other sciences bring their results to its court to inquire into what they mean. When this time comes, there will be great and well-equipped laboratories of linguistics as there are of other exact sciences.

Whorf, B.L. (1956)

## LANGUAGES AND LOGIC\*

In English, the sentences 'I pull the branch aside' and 'I have an extra toe on my foot' have little similarity. Leaving out the subject pronoun and the sign of the present tense, which are common features from requirements of English syntax, we may say that no similarity exists. Common, and even scientific, parlance would say that the sentences are unlike because they are talking about things which are intrinsically unlike. So Mr. Everyman, the natural logician, would be inclined to argue. Formal logic of an older type would perhaps agree with him.

If, moreover, we appeal to an impartial scientific English-speaking observer, asking him to make direct observations upon cases of the two phenomena to see if they may not have some element of similarity which we have overlooked, he will be more than likely to confirm the dicta of Mr. Everyman and the logician. The observer whom we have asked to make the test may not see quite eye to eye with the old-school logician and would not be disappointed to find him wrong. Still he is compelled sadly to confess failure. "I wish I could oblige you," he says, "but try as I may, I cannot detect any similarity between these phenomena."

By this time our stubborn streak is aroused; we wonder if a being from Mars would also see no resemblance. But now a linguist points out that it is not necessary to go as far as Mars. We have not yet scouted around this earth to see if its many languages all classify these phenomena as disparately as our speech does. We find that in Shawnee

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these two statements are, respectively, *ni-l'θawa-ko-n-a* and *ni-l'θawa-ko-θite* (the *θ* here denotes *th* as in 'thin' and the apostrophe denotes a breath-catch). The sentences are closely similar; in fact, they differ only at the tail end. In Shawnee, moreover, the beginning of a construction is generally the important and emphatic part. Both sentences start with *ni-* ('I'), which is a mere prefix. Then comes the really im-

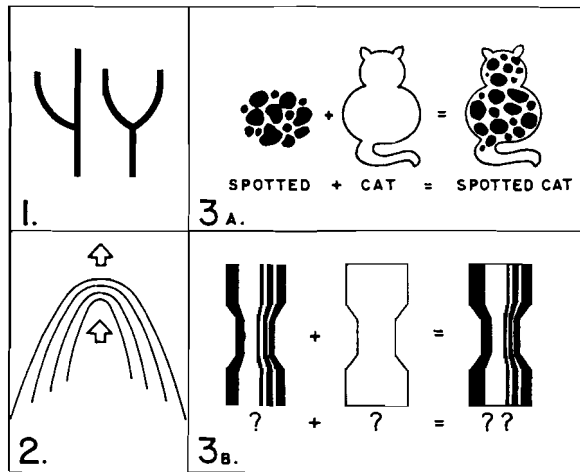


Figure 15. Suggested above are certain linguistic concepts which, as explained in the text, are not easily definable.

portant key word, *l'θawa*, a common Shawnee term, denoting a forked outline, like Fig. 15, no. 1. The next element, *-ko*, we cannot be sure of, but it agrees in form with a variant of the suffix *-a'kw* or *-a'ko*, denoting tree, bush, tree part, branch, or anything of that general shape. In the first sentence, *-n-* means 'by hand action' and may be either a causation of the basic condition (forked outline) manually, an increase of it, or both. The final *-a* means that the subject ('I') does this action to an appropriate object. Hence the first sentence means 'I pull it (something like branch of tree) more open or apart where it forks.' In the other sentence, the suffix *-θite* means 'pertaining to the toes,' and the absence of further suffixes means that the subject manifests the condition in his own person. Therefore the sentence can mean only 'I have an extra toe forking out like a branch from a normal toe.'

Shawnee logicians and observers would class the two phenomena as intrinsically similar. Our own observer, to whom we tell all this, focuses his instruments again upon the two phenomena and to his joy sees at once a manifest resemblance. Figure 16 illustrates a similar situation: 'I push his head back' and 'I drop it in water and it floats,' though very dissimilar sentences in English, are similar in Shawnee. The point of

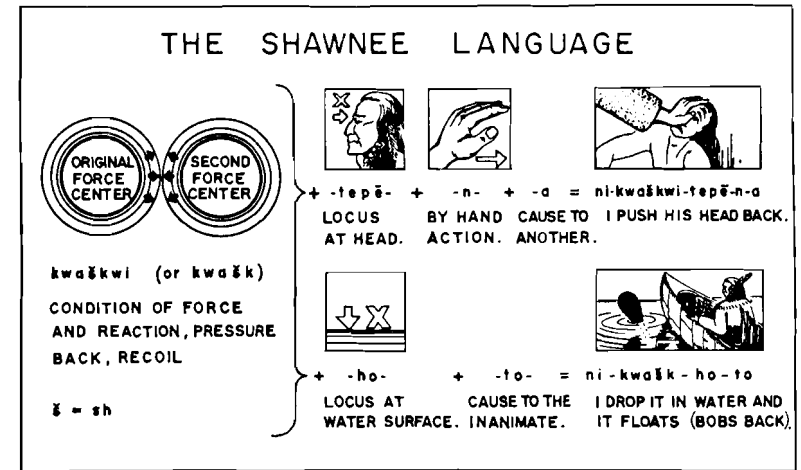


Figure 16. The English sentences 'I push his head back' and 'I drop it in water and it floats' are unlike. But in Shawnee the corresponding statements are closely similar, emphasizing the fact that analysis of nature and classification of events as like or in the same category (logic) are governed by grammar.

view of linguistic relativity changes Mr. Everyman's dictum: Instead of saying, "Sentences are unlike because they tell about unlike facts," he now reasons: "Facts are unlike to speakers whose language background provides for unlike formulation of them."

Conversely, the English sentences, 'The boat is grounded on the beach' and 'The boat is manned by picked men,' seem to us to be rather similar. Each is about a boat; each tells the relation of the boat to other objects—or that's our story. The linguist would point out the parallelism in grammatical pattern thus: "The boat is xed preposition y." The logician might turn the linguist's analysis into "A is in the state x in relation to y," and then perhaps into  $fA = xRy$ . Such symbolic methods lead to fruitful techniques of rational ordering, stimulate our

thinking, and bring valuable insight. Yet we should realize that the similarities and contrasts in the original sentences, subsumed under the foregoing formula, are dependent on the choice of mother tongue and that the properties of the tongue are eventually reflected as peculiarities of structure in the fabric of logic or mathematics which we rear.

In the Nootka language of Vancouver Island, the first "boat" statement is *tlih-is-ma*; the second, *lash-tskwiq-ista-ma*. The first is thus I-II-*ma*; the second, III-IV-V-*ma*; and they are quite unlike, for the final -*ma* is only the sign of the third-person indicative. Neither sentence contains any unit of meaning akin to our word 'boat' or even 'canoe.' Part I, in the first sentence, means 'moving pointwise,' or moving in a way like the suggestion of the outline in Fig. 15, no. 2; hence 'traveling in or as a canoe,' or an event like one position of such motion. It is not a name for what we should call a "thing," but is more like a vector in physics. Part II means 'on the beach'; hence I-II-*ma* means 'it is on the beach pointwise as an event of canoe motion,' and would normally refer to a boat that has come to land. In the other sentence, part III means 'select, pick,' and IV means 'remainder, result,' so that III-IV means 'selected.' Part V means 'in a canoe (boat) as crew.' The whole, III-IV-V-*ma*, means either 'they are in the boat as a crew of picked men' or 'the boat has a crew of picked men.' It means that the whole event involving picked ones and boat's crew is in process.

As a hang-over from my education in chemical engineering, I relish an occasional chemical simile. Perhaps readers will catch what I mean when I say that the way the constituents are put together in these sentences of Shawnee and Nootka suggests a chemical compound, whereas their combination in English is more like a mechanical mixture. A mixture, like the mountaineer's potlicker, can be assembled out of almost anything and does not make any sweeping transformation of the overt appearance of the material. A chemical compound, on the other hand, can be put together only out of mutually suited ingredients, and the result may be not merely soup but a crop of crystals or a cloud of smoke. Likewise the typical Shawnee or Nootka combinations appear to work with a vocabulary of terms chosen with a view not so much to the utility of their immediate references as to the ability of the terms to combine suggestively with each other in manifold ways that elicit novel and useful images. This principle of terminology and way of analyzing events would seem to be unknown to the tongues with which we are familiar.

It is the analysis of nature down to a basic vocabulary capable of this sort of evocative recombination which is most distinctive of polysynthetic languages, like Nootka and Shawnee. Their characteristic quality is not, as some linguists have thought, a matter of the tightness or indissolubility of the combinations. The Shawnee term *l'θawa* could probably be said alone but would then mean 'it (or something) is forked,' a statement which gives little hint of the novel meanings that arise out of its combinations—at least to our minds or our type of logic. Shawnee and Nootka do not use the chemical type of synthesis exclusively. They make large use of a more external kind of syntax, which, however, has no basic structural priority. Even our own Indo-European tongues are not wholly devoid of the chemical method, but they seldom make sentences by it, afford little inkling of its possibilities, and give structural priority to another method. It was quite natural, then, that Aristotle should found our traditional logic wholly on this other method.

Let me make another analogy, not with chemistry but with art—art of the pictorial sort. We look at a good still-life painting and seem to see a lustrous porcelain bowl and a downy peach. Yet an analysis that screened out the totality of the picture—as if we were to go over it carefully, looking through a hole cut in a card—would reveal only oddly shaped patches of paint and would not evoke the bowl and fruit. The synthesis presented by the painting is perhaps akin to the chemical type of syntax, and it may point to psychological fundamentals that enter into both art and language. Now the mechanical method in art and language might be typified by no. 3A in Fig. 15. The first element, a field of spots, corresponds to the adjective 'spotted,' the second corresponds to the noun 'cat.' By putting them together, we get 'spotted cat.' Contrast the technique in Fig. 15, no. 3B. Here the figure corresponding to 'cat' has only vague meaning by itself—"chevron-like," we might say—while the first element is even vaguer. But, combined, these evoke a cylindrical object, like a shaft casting.

The thing common to both techniques is a systematic synthetic use of pattern, and this is also common to all language techniques. I have put question marks below the elements in Fig. 15, no. 3B, to point out the difficulty of a parallel in English speech and the fact that the method probably has no standing in traditional logic. Yet examination of other languages and the possibility of new types of logic that has been advanced by modern logicians themselves suggest that this matter may

be significant for modern science. New types of logic may help us eventually to understand how it is that electrons, the velocity of light, and other components of the subject matter of physics appear to behave illogically, or that phenomena which flout the sturdy common sense of yesteryear can nevertheless be true. Modern thinkers have long since pointed out that the so-called mechanistic way of thinking has come to an impasse before the great frontier problems of science. To rid ourselves of this way of thinking is exceedingly difficult when we have no linguistic experience of any other and when even our most advanced logicians and mathematicians do not provide any other—and obviously they cannot without the linguistic experience. For the mechanistic way of thinking is perhaps just a type of syntax natural to Mr. Everyman's daily use of the western Indo-European languages, rigidified and intensified by Aristotle and the latter's medieval and modern followers.

As I said in an article, "Science and linguistics," in the *Review* for April 1940, the effortlessness of speech and the subconscious way we picked up that activity in early childhood lead us to regard talking and thinking as wholly straightforward and transparent. We naturally feel that they embody self-evident laws of thought, the same for all men. We know all the answers! But, when scrutinized, they become dusty answers. We use speech for reaching agreements about subject matter: I say, "Please shut the door," and my hearer and I agree that 'the door' refers to a certain part of our environment and that I want a certain result produced. Our explanations of how we reached this understanding, though quite satisfactory on the everyday social plane, are merely more agreements (statements) about the same subject matter (door, and so on), more and more amplified by statements about the social and personal needs that impel us to communicate. There are here no laws of thought. Yet the structural regularities of our sentences enable us to sense that laws are SOMEWHERE in the background. Clearly, explanations of understanding such as "And so I ups and says to him, says I; see here, why don't you . . . !" evade the true process by which 'he' and 'I' are in communication. Likewise psychological-social descriptions of the social and emotional needs that impel people to communicate with their fellows tend to be learned versions of the same method and, while interesting, still evade the question. In similar case is evasion of the question by skipping from the speech sentence, via physiology and "stimuli" to the social situation.

The WHY of understanding may remain for a long time mysterious; but the HOW or logic of understanding—its background of laws or regularities—is discoverable. It is the grammatical background of our mother tongue, which includes not only our way of constructing propositions but the way we dissect nature and break up the flux of experience into objects and entities to construct propositions about. This fact is important for science, because it means that science CAN have a rational or logical basis even though it be a relativistic one and not Mr. Everyman's natural logic. Although it may vary with each tongue, and a planetary mapping of the dimensions of such variation may be necessitated, it is, nevertheless, a basis of logic with discoverable laws. Science is not compelled to see its thinking and reasoning procedures turned into processes merely subservient to social adjustments and emotional drives.

Moreover, the tremendous importance of language cannot, in my opinion, be taken to mean necessarily that nothing is back of it of the nature of what has traditionally been called "mind." My own studies suggest, to me, that language, for all its kingly role, is in some sense a superficial embroidery upon deeper processes of consciousness, which are necessary before any communication, signaling, or symbolism whatsoever can occur, and which also can, at a pinch, effect communication (though not true AGREEMENT) without language's and without symbolism's aid. I mean "superficial" in the sense that all processes of chemistry, for example, can be said to be superficial upon the deeper layer of physical existence, which we know variously as intra-atomic, electronic, or subelectronic. No one would take this statement to mean that chemistry is UNIMPORTANT—indeed the whole point is that the more superficial can mean the more important, in a definite operative sense. It may even be in the cards that there is no such thing as "Language" (with a capital L) at all! The statement that "thinking is a matter of LANGUAGE" is an incorrect generalization of the more nearly correct idea that "thinking is a matter of different tongues." The different tongues are the real phenomena and may generalize down not to any such universal as "Language," but to something better—called "sub-linguistic" or "superlinguistic"—and NOT ALTOGETHER unlike, even if much unlike, what we now call "mental." This generalization would not diminish, but would rather increase, the importance of intertongue study for investigation of this realm of truth.

Botanists and zoologists, in order to understand the world of living species, found it necessary to describe the species in every part of the globe and to add a time perspective by including the fossils. Then they found it necessary to compare and contrast the species, to work out families and classes, evolutionary descent, morphology, and taxonomy. In linguistic science a similar attempt is under way. The far-off event toward which this attempt moves is a new technology of language and thought. Much progress has been made in classifying the languages of earth into genetic families, each having descent from a single precursor, and in tracing such developments through time. The result is called "comparative linguistics." Of even greater importance for the future technology of thought is what might be called "contrastive linguistics." This plots the outstanding differences among tongues—in grammar, logic, and general analysis of experience.

As I said in the April 1940 *Review*, segmentation of nature is an aspect of grammar—one as yet little studied by grammarians. We cut up and organize the spread and flow of events as we do, largely because, through our mother tongue, we are parties to an agreement to do so, not because nature itself is segmented in exactly that way for all to see. Languages differ not only in how they build their sentences but also in how they break down nature to secure the elements to put in those sentences. This breakdown gives units of the lexicon. "Word" is not a very good "word" for them; "lexeme" has been suggested, and "term" will do for the present. By these more or less distinct terms we ascribe a semifictitious isolation to parts of experience. English terms, like 'sky, hill, swamp,' persuade us to regard some elusive aspect of nature's endless variety as a distinct THING, almost like a table or chair. Thus English and similar tongues lead us to think of the universe as a collection of rather distinct objects and events corresponding to words. Indeed this is the implicit picture of classical physics and astronomy—that the universe is essentially a collection of detached objects of different sizes.

The examples used by older logicians in dealing with this point are usually unfortunately chosen. They tend to pick out tables and chairs and apples on tables as test objects to demonstrate the object-like nature of reality and its one-to-one correspondence with logic. Man's artifacts and the agricultural products he severs from living plants have a unique degree of isolation; we may expect that languages will have fairly isolated terms for them. The real question is: What do different languages do,

not with these artificially isolated objects but with the flowing face of nature in its motion, color, and changing form; with clouds, beaches, and yonder flight of birds? For, as goes our segmentation of the face of nature, so goes our physics of the Cosmos.

Here we find differences in segmentation and selection of basic terms. We might isolate something in nature by saying 'It is a dripping spring.' Apache erects the statement on a verb *ga*: 'be white (including clear, uncolored, and so on).' With a prefix *nō*- the meaning of downward motion enters: 'whiteness moves downward.' Then *tó*, meaning both 'water' and 'spring' is prefixed. The result corresponds to our 'dripping spring,' but synthetically it is 'as water, or springs, whiteness moves downward.' How utterly unlike our way of thinking! The same verb, *ga*, with a prefix that means 'a place manifests the condition' becomes *gohlga*: 'the place is white, clear; a clearing, a plain.' These examples show that some languages have means of expression—chemical combination, as I called it—in which the separate terms are not so separate as in English but flow together into plastic synthetic creations. Hence such languages, which do not paint the separate-object picture of the universe to the same degree as English and its sister tongues, point toward possible new types of logic and possible new cosmical pictures.

The Indo-European languages and many others give great prominence to a type of sentence having two parts, each part built around a class of word—substantives and verbs—which those languages treat differently in grammar. As I showed in the April 1940 *Review*, this distinction is not drawn from nature; it is just a result of the fact that every tongue must have some kind of structure, and those tongues have made a go of exploiting this kind. The Greeks, especially Aristotle, built up this contrast and made it a law of reason. Since then, the contrast has been stated in logic in many different ways: subject and predicate, actor and action, things and relations between things, objects and their attributes, quantities and operations. And, pursuant again to grammar, the notion became ingrained that one of these classes of entities can exist in its own right but that the verb class cannot exist without an entity of the other class, the "thing" class, as a peg to hang on. "Embodiment is necessary," the watchword of this ideology, is seldom STRONGLY questioned. Yet the whole trend of modern physics, with its emphasis on "the field," is an implicit questioning of the ideology. This contrast crops out in our mathematics as two kinds of symbols—the kind like 1,

2, 3,  $x$ ,  $y$ ,  $z$  and the kind like  $+$ ,  $-$ ,  $\div$ ,  $\sqrt{\quad}$ ,  $\log$  —, though, in view of  $0$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$ ,  $\pi$ , and others, perhaps no strict two-group classification holds. The two-group notion, however, is always present at the back of the thinking, although often not overtly expressed.

Our Indian languages show that with a suitable grammar we may have intelligent sentences that cannot be broken into subjects and predicates. Any attempted breakup is a breakup of some English translation or paraphrase of the sentence, not of the Indian sentence itself. We might as well try to decompose a certain synthetic resin into Celluloid and whiting because the resin can be imitated with Celluloid and whiting. The Algonkian language family, to which Shawnee belongs, does use a type of sentence like our subject and predicate but also gives prominence to the type shown by our examples in the text and in Fig. 15. To be sure, *ni-* is represented by a subject in the translation but means 'my' as well as 'I,' and the sentence could be translated thus: 'My hand is pulling the branch aside.' Or *ni-* might be absent; if so, we should be apt to manufacture a subject, like 'he, it, somebody,' or we could pick out for our English subject an idea corresponding to any one of the Shawnee elements.

When we come to Nootka, the sentence without subject or predicate is the only type. The term "predication" is used, but it means "sentence." Nootka has no parts of speech; the simplest utterance is a sentence, treating of some event or event-complex. Long sentences are sentences of sentences (complex sentences), not just sentences of words. In Fig. 17 we have a simple, not a complex, Nootka sentence. The translation, 'he invites people to a feast,' splits into subject and predicate. Not so the native sentence. It begins with the event of 'boiling or cooking,' *tl'imsh*; then comes *-ya* ('result') = 'cooked'; then *-is* 'eating' = 'eating cooked food'; then *-ita* ('those who do') = 'eaters of cooked food'; then *-itl* ('going for'); then *-ma*, sign of third-person indicative, giving *tl'imshya'isita'itlma*, which answers to the crude paraphrase, 'he, or somebody, goes for (invites) eaters of cooked food.'

The English technique of talking depends on the contrast of two artificial classes, substantives and verbs, and on the bipartitioned ideology of nature, already discussed. Our normal sentence, unless imperative, must have some substantive before its verb, a requirement that corresponds to the philosophical and also naïve notion of an actor who produces an action. This last might not have been so if English had

had thousands of verbs like 'hold,' denoting positions. But most of our verbs follow a type of segmentation that isolates from nature what we call "actions," that is, moving outlines.

Following majority rule, we therefore read action into every sentence, even into 'I hold it.' A moment's reflection will show that 'hold' is no action but a state of relative positions. Yet we think of it and even see it as an action because language formulates it in the same way as it

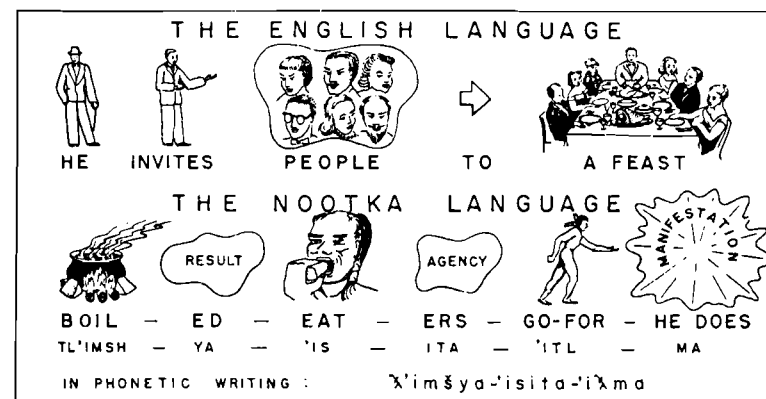


Figure 17. Here are shown the different ways in which English and Nootka formulate the same event. The English sentence is divisible into subject and predicate; the Nootka sentence is not, yet it is complete and logical. Furthermore, the Nootka sentence is just one word, consisting of the root *tl'imsh* with five suffixes.

formulates more numerous expressions, like 'I strike it,' which deal with movements and changes.

We are constantly reading into nature fictional acting entities, simply because our verbs must have substantives in front of them. We have to say 'It flashed' or 'A light flashed,' setting up an actor, 'it' or 'light,' to perform what we call an action, "to flash." Yet the flashing and the light are one and the same! The Hopi language reports the flash with a simple verb, *rehpi*: 'flash (occurred).' There is no division into subject and predicate, not even a suffix like *-t* of Latin *tona-t* 'it thunders.' Hopi can and does have verbs without subjects, a fact which may give that tongue potentialities, probably never to be developed, as a logical system for understanding some aspects of the universe. Undoubtedly modern science, strongly reflecting western Indo-Euro-

pean tongues, often does as we all do, sees actions and forces where it sometimes might be better to see states. On the other hand, 'state' is a noun, and as such it enjoys the superior prestige traditionally attaching to the subject or thing class; therefore science is exceedingly ready to speak of states if permitted to manipulate the concept like a noun. Perhaps, in place of the 'states' of an atom or a dividing cell, it would be better if we could manipulate as readily a more verblike concept but without the concealed premises of actor and action.

I can sympathize with those who say, "Put it into plain, simple English," especially when they protest against the empty formalism of loading discourse with pseudolearned words. But to restrict thinking to the patterns merely of English, and especially to those patterns which represent the acme of plainness in English, is to lose a power of thought which, once lost, can never be regained. It is the "plainest" English which contains the greatest number of unconscious assumptions about nature. This is the trouble with schemes like Basic English, in which an eviscerated British English, with its concealed premises working harder than ever, is to be fobbed off on an unsuspecting world as the substance of pure Reason itself. We handle even our plain English with much greater effect if we direct it from the vantage point of a multilingual awareness. For this reason I believe that those who envision a future world speaking only one tongue, whether English, German, Russian, or any other, hold a misguided ideal and would do the evolution of the human mind the greatest disservice. Western culture has made, through language, a provisional analysis of reality and, without correctives, holds resolutely to that analysis as final. The only correctives lie in all those other tongues which by aeons of independent evolution have arrived at different, but equally logical, provisional analyses.

In a valuable paper, "Modern logic and the task of the natural sciences," Harold N. Lee says: "Those sciences whose data are subject to quantitative measurement have been most successfully developed because we know so little about order systems other than those exemplified in mathematics. We can say with certainty, however, that there are other kinds, for the advance of logic in the last half century has clearly indicated it. We may look for advances in many lines in sciences at present well founded if the advance of logic furnishes adequate knowledge of other order types. We may also look for many subjects of in-

quiry whose methods are not strictly scientific at the present time to become so when new order systems are available."<sup>1</sup> To which may be added that an important field for the working out of new order systems, akin to, yet not identical with, present mathematics, lies in more penetrating investigation than has yet been made of languages remote in type from our own.

<sup>1</sup> *Sigma Xi Quart.*, 28:125 (Autumn 1940).