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Linguistic Logic: Evidence of Axiomatized Thought in Language

This paper will explore the structure of linguistic theory, as put forth primarily by Noam Chomsky and elaborated on by others. Also discussed briefly will be the similarities between the linguistic theory and some philosophies of mathematics, as the philosophy of linguistic theory bears certain similarities to Formalism or Logicism. Ideally, linguistic theory would allow linguists to form coherent sentences based solely on syntax, rather than depending on the semantics of words, much as Hilbert and his followers wished to use only mathematical symbols when constructing proofs. In this way, where geometry uses an axiomatic system to understand the nature of space, linguistics uses the theory of syntactical form as an axiomatic study of language.

The study of linguistic theory is divided into two categories: semantics and syntax. Where semantics deals with the meanings and connotations of words, syntax embodies a complex grammatical system governed by an underlying formal structure. Throughout the history of the study of linguistics, scholars had focused on the meanings of words as the more important part of speech and language in general. However, in the second half of the twentieth century, a new syntactical movement led by Chomsky, a professor of linguistics and philosophy at MIT, set out to find a formal system of grammar.

Syntax is actually a way to simplify the seemingly formidable complexity of natural languages. According to Chomsky, that complexity is a result of the repeated application of certain principles of sentence construction which are present in fairly simple grammar. Central

to Chomsky's approach is generative grammar, an ideal example of which is described by Chomsky himself as something that "would describe all and only the grammatical sentences of a particular language, and so could be considered a (highly abstract) description of what a person must know in order to speak and understand that language" (Miller 15).

Since the overreaching goal of linguistic theory is to be able to form comprehensible sentences based on syntax alone; no meaning from semantics would be necessary. In order for this to happen, however, the theory must be highly structured and justified at every step. The logic used to perform these justifications is virtually identical to that used in geometry. When viewed as a whole, geometry is a complex system. The axioms and other proven statements made about it make the system understandable and therefore, make it useful. In much the same way, languages exist as extremely complex systems. The various aspects of the linguistic theory promote understanding of the otherwise enigmatic language system. By using a system of linguistic levels, linguistic theory reduces the complexity of parts of a language to manageable proportions.

Where the geometric axioms provide information about the undefined terms of a certain system of geometry, the various parts of linguistic theory are a collection of explanations toward understanding of the historically ephemeral theory of linguistic form. Where the theory itself has been described in pedantic terms as an abstract theory in which each proposed grammar can be evaluated, in a practical sense, it is still being developed, and in this sense is undefined. The numerous properties of the theory, then, give it shape and meaning.

One of the main questions plaguing linguists (and psychologists as well) involves how children can learn to speak a language correctly, to be able to synthesize an infinite number of new sentences, when they have only been exposed to a very small amount of the language.

When Chomsky was developing his theory, he considered this problem and proceeded to address it by building the answer into the theory. He made two especially relevant points: first, that people can and do project their past linguistic experience to include certain new forms while excluding others. And secondly, that the speaker of a particular language possesses – for a large part unconsciously – in his mind a huge store of knowledge about his language. This way, although children only have limited access to and experience with language, the theory suggests that by analyzing the form of previous experience, children can create correct statements in that language. Of course, as the amount of experience grows, so does the innate store of knowledge about that language. And thus, older children and teenagers can know how to use grammatical rules better than young children.

When discussing this ability to generate a seemingly infinite number of new sentences from prior experience and innate knowledge of structure, Chomsky writes, "We will construct certain linguistic levels with recursive devices so that a description in terms of them generates an infinite set of sentences" (Chomsky 65). The levels that Chomsky defines are arranged hierarchically based on complexity and to a degree, on impact within speech. The hierarchy begins with phonemes and morphemes at the bottom, through words, syntactic categories (parts of speech), and phrase structure (involving sentences and clauses), and finally transformations, which distinguish between sentences like "he is here" and "is he here."

Each level is a sort of system of spelling, and possesses a specific alphabet of symbols, called "primes." The primes, then, can be combined to form strings (for example, in the words level, the primes are the letters of the alphabet, which when strung together, form the words). Among the strings on each level are certain strings representing the utterances of the language. The generative grammar comes into play to distinguish these utterances.

In the same way that propositions and theorems are built upon axioms to form systems of geometry, "every factor relevant to the choice among grammars must be built into linguistic theory" (Chomsky 66). And as axioms apply to a universal range of the undefined terms they demonstrate, grammars are generalized when a set of statements, each concerning a single element, is replaced by one statement involving the entire set of elements. In order for this approach to be significant, however, a fixed set of notations must exist with which to convey the generalized grammar.

As a device for generating sentences (hence, "generative grammar") grammar can be taken as a sequence of statements in the form

$$X_i \rightarrow Y_i \qquad (i = 1, 2, 3, \ldots, N)$$

interpreted as "rewrite X_i as Y_i" where X_i and Y_i are strings. The sequence shown above is a conversion; suppose that X_i is the element *Sentence*. While some conversions must happen and others are merely allowed to happen, running through the different conversion options in a particular sentence an indefinite number of times allows for infinite generation on whatever linguistic level the sequence occupies. Chomsky describes this process as being "roughly analogous to a proof, with *Sentence* playing the role of the single axiom, and the conversions corresponding roughly to the rules of inference" (Chomsky 67). According to James McCawley in his explanation of logic aimed at linguists, the rules of inference are general principles that specify what conclusions may be inferred from what premises.

Following from these points, as well as several others which will not be explored in this essay due to their technical nature, the goal of linguistic theory is to bypass semantics in sentence formation: to be able to make well-formed statements based solely on syntax. However, when put to use, the theory runs into some problems, three especially, which are noteworthy. The first

of the fundamental problems of descriptive linguistics is involved with the construction of grammars for particular languages. The second speaks to the construction of an overall theory of linguistic structure of which each of the previously mentioned grammars is an example. Third and finally, exists the problem of justifying and validating the results of inquiries into the two previous questions, and demonstrating that the constructed grammars are in some sense correct.

While mathematicians are divided amongst the opposing schools of logicism, intuitionism, and formalism, linguists seem to use ideas present in each while building their own theory of form. Logicism attempts to show that mathematics is an extension of classical logic, that the same principles apply to both. Snapper describes a logical proposition within this school as "a proposition which has complete generality and is true in virtue of its form rather than its content" (Snapper 209). This is reminiscent of the linguistic theory of form in a couple of ways. The reference to generality carries over into Chomsky's linguistics when he discusses the generalization of grammars in accordance with the $X_i \rightarrow Y_i$ sequence. More importantly, perhaps, is the reference to the virtue of form over meaning. This triumph of syntax over the historically dominant semantics is the central point in Chomsky's theory.

Mathematic intuitionists believe that the correct way to build a mathematic system is from the ground up. Although it may seem to the inexperienced observer that this is the method employed by children when they learn a language, Chomsky makes it quite clear that intuition has no place in his theory. Both he and his followers within the field of descriptive linguistics want to completely explain the syntactic form of language. However, as the study of generative grammar is still relatively new in the study of linguistics, there is much that it cannot yet understand or ever may be able to understand. Even though Chomsky and others wish to be able to create sentences based on grammar alone, the meanings of words often discourage this

process. In this way, they are fighting against hundreds of years of an intuitionist study of linguistics, trying to find the logical structure and applying formal terms and justifications.

When describing formalization, Snapper writes that "we formalize some given *axiomatized* theory" (Snapper 214). This is the ideal goal of Chomsky's linguistic theory of form. He is convinced that if the process of diagramming and mapping the structure of language could be formalized, then the overreaching goal of linguistic theory (the rule of syntax with semantics in a submissive form) could be realized. However, since the system of a language is so incredibly complex, the formalization of such a system is extremely difficult. While some axioms of language are known and demonstrated by Chomsky within the hierarchy of linguistic levels, many have not yet been identified. In such a case, the study of linguistics proves itself to be a continually developing science.

Though Chomsky's work in linguistics started a new era in the field, in subsequent years the ideas have branched off and evolved. In *The Mathematics of Language* Marcus Kracht, a professor at UCLA, writes "The main characteristic of our approach is that we do not treat languages as sets as strings but as algebras of signs. This is much closer to the linguistic reality" (Kracht *x*). So even though Chomsky believed a formal structure existed in the syntax of language, he was content to continue to study words, and sentences. Kracht, on the other hand, believes that the formal structure of syntax is much more mathematical than Chomsky suggested.

Detailed analysis of the underlying structure of a language's syntactical system by scholars like Noam Chomsky and Marcus Kracht has gone a long way to form a theory of linguistics. However, substantial insight has also come from the perspective of mathematics and the idea to create a language by purely axiomatic methods. Baron Gottfried Wilhelm von Leibniz, the German mathematician and philosopher worked hard to discover a universal

language (which he called Characteristica Universalis) that would allow people to think and communicate the way mathematicians calculate. He sincerely, and somewhat idealistically, believed that such language would make reasoning in metaphysics and morals as simple and efficient as in geometry and analysis. Regarding Leibniz and artificial languages, George Miller, a professor at Princeton University, writes, "Progress in understanding such artificial languages has done much to clarify the logical structure of natural languages and to define what might be meant by a formal theory of language in general" (Miller 215).

When Chomsky wrote his doctoral dissertation on his idea of a syntactical linguistic theory, he initially encountered opposition to its acceptance. The idea that language could be completely understood without semantic influence was so revolutionary at the time that many traditional linguists of the day refused to accept it. However, because Chomsky's argument was so logical, he eventually gained a huge following and is one of the top experts in his field today. His logical justifications not only validated his argument, but also established his linguistic theory as an axiomatic system of language.

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