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A Finite Image of the Universe of Language

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Abstract

The innatist, or generativist, view of language is based on the connected notions of linguistic 'infiniteness' and 'creativity'. These notions have—in some way—been stirred up by Plato's thought on acquisition of knowledge, which later was theorized as 'Plato's Problem' or 'Poverty of Stimulus'. The view of the form of grammar—and consequently that of the process of language acquisition—has been shaped by these notions in modern linguistics. Here we are intended to cast a different light on human language. We propose that the universe of language can validly be viewed as finite. We also argue that the so-called linguistic infinity should not be a crucial consideration in theorizing the process of language acquisition, because it can be validly argued that linguistic creativity is not a true one. Instead, grammar is invariably mechanical and strikingly simple. Following that path of reasoning, we consider that language is not necessarily innate to human, and acquisition of grammar should be a task much easier than assumed in generative and structural linguistics. Thus, we reach a solution to Plato's Problem very different from, and more plausible than, which is held by the innatists.

Keywords *: Finite, Infiniteness, Creativity, Grammar, Grammatical, Recursion, Mechanical, Acquisition.*

1. Introduction

The concepts of 'infiniteness' and 'creativity' in natural language use are at the very centre of the origin and development of the *Generative* school of linguistics. Formally and rigorously theorized by Noam Chomsky (Chomsky: 1957, Chomsky: 1964, Chomsky: 1965, Chomsky: 1966, Chomsky: 1968, Chomsky: 1975, Chomsky: 1986, Chomsky: 1995, Chomsky: 2002, Chomsky: 2009), these concepts have been evoked and examined in the writings of seventeenth century rationalist philosophers like Rene Descartes (Descartes: 1984-85, Descartes: 1991), Jeraud De Cordemoy (Cordemoy: 1668), G. W. Leibniz (Leibniz: 1949), the Port-Royal school (Lancelot and Arnauld: 1660, cited in Chomsky: 2009), the nineteenth century German philosopher William Von Humboldt (Humboldt: 1988) and others, though they have their deepest roots in the question raised by Plato (Plato: 1924) about how human knowledge is acquired. And they have influenced the next generation linguistics so overwhelmingly that they have almost swept out the possibilities of any other point of view to emerge. The more moderate thinkers like Steven Pinker (Pinker: 1994) and Ray Jackendoff (Jackendoff: 1997, also in Pinker and Jackendoff: 2005) have also taken the view advocated by Chomsky in respect of these concepts. We elaborate and illustrate the concepts of 'infiniteness' and 'creativity' later in this essay. At this initial point, we are rather willing to seek help from John Searle (Searle, 1972:2) to summarize the central ideas of generative theorizing:

> The description of a natural language would be a formal deductive theory which would contain a set of grammatical rules that could generate the infinite set of sentences of the language, would not generate anything that was not a sentence, and would provide a description of the grammatical structure of each sentence. Such a theory came to be called a "generative grammar" because of its aim of constructing a device that would generate all and only the sentences of a language.

2. The Origin of the Ideas: Plato's Problem

The central ideas of 'creativity' and 'infiniteness' theorized in the innatist school of linguistics have, in some way, to do with the question raised by Plato in his Dialogue *Meno* in 380 BC. The question was: how does human child acquire much knowledge in a very short time from scant data? Chomsky called it 'Plato's Problem' or 'Poverty of Stimulus'. The perfect knowledge of language was theorized as the faculty capable of creating infinite number of well-formed sentences of a language. The concepts of linguistic creativity and infiniteness were needed to be developed in order to establish the need of the existence of an innate language faculty. Plato claimed that even the knowledge of mathematics was not needed to be learned; what humans only needed was to recall the knowledge that they had acquired in their previous births. Similarly, the knowledge of language, which is *infinitely creative*, and available so scantily and fragmentarily in the ambience of human child, should not be a faculty capable of being acquired through learning, beacause human life is far too short for such learning or memorizing. So it is deduced that there is an innate faculty of language.

With this background behind the ideas we are dealing with, we are now intended to explore them in more detail.

3. On the notion of infiniteness

3.1 Structural observation about infiniteness

Here we shall go through some of the core structuralist observations about linguistic infiniteness without any need of further explanation or interpretation:

> "...it is obvious that most speech-forms are regular, in the sense that the speaker who knows the constituents and the grammatical pattern, can utter them without ever having heard them; moreover, the observer cannot hope to list them, since the possibilities of combination are practically infinite. ..." (Bloomfield, 1935:275)

> "Language is limited by nothing in the choice of means, for apparently nothing would prevent the associating of any idea whatsoever with just any sequence of sounds." (Saussure, 1959:76).

> "A workable system of signals, such as a language, can contain only a small number of signaling-units, but the things signaled about—in our case, the entire content of the practical world—may be infinitely varied." (Bloomfield, 1935:162)

But their suggestions, directly or indirectly, emphasize on arbitrarily limited or space-time-bound use of the system. For, language is, as they held, essentially and strictly a social phenomenon:

> "...in no other respect are the activities of a group as rigidly standardized as in the forms of language. Large groups of people make up all their utterances out of the same stock of lexical forms and grammatical constructions." (Bloomfield, 1935:37)

3.2 Generative view of infiniteness

In their article appeared in *Science*, Marc D. Hauser, Noam Chomsky and W. Tecumseh Fitch (Hauser, Chomsky and Fitch: 2002, HCF hereafter) assert:

> FLN takes a finite set of elements and yields a potentially infinite array of discrete expressions. This capacity of FLN yields discrete infinity (a property that also characterizes the natural numbers (2002:1571).

According to Chomsky (Chomsky: 1957), language is a 'discrete infinity' in the sense that it is "a set (finite or infinite) of sentences, each finite in length and constructed out of a finite set of elements"(1957:13), and also in the sense that "each natural language has a finite number of phonemes (or letters in its alphabet) and each sentence is representable as a finite sequence of these phonemes (or letters), though there are infinitely many sentences(1957:13)." The notion of discreteness once again appears in the third chapter in *Syntactic Structures* (1957), where the author thinks of a sentence "as a sequence of phonemes of finite length (1957:18)."

Now, we should look at the following paragraph:

> The core property of discrete infinity is intuitively familiar to every language user.... There is no longest sentence (any candidate sentence can be trumped by, for example, embedding it in "Mary thinks that..."), and there is no non-arbitrary upper bound to sentence length. In these respects, language is directly analogous to the natural numbers." (HCF, 2002:1571)

Then, the definition of the so-called 'infiniteness' is both in the sense that sentences are potentially infinite in length, and in the sense that the number of sentences in a language is infinite. Now the question is, how the sentences of a language can be infinite in length, and at the same time, discrete; in other words—finite? Obviously, this is logically impossible. And, recursive rules, if applied freely on natural languages, would literally produce infinitely long sentences, like the following one:

$$X \rightarrow Y + X$$
$$\rightarrow Y + Y + X$$
$$\rightarrow Y + Y + Y + X...$$

3.3 The proposition to answer the question about infiniteness

It can be a logical observation that every sentence is potentially infinite, in the mathematical sense, but has an arbitrary upper bound to its length as long as natural language is concerned. That is why sentences of a natural language are necessarily finite in length. We can call this constraint *Convention Boundary* which, like grammaticality, is determined by the acceptance of the language user, and fulfills the conditions of grammaticality. And obviously, sentences of a natural language are embodied by this convention boundary, without which a word sequence would be necessarily infinite; in other words, incomplete, and therefore a non-sentence. Any theoretical or imagined infinite string of words, or that without any convention boundary would be ungrammatical, or a non-sentence because of its incompleteness. A grammatical sentence of a language must be finite in length, and should not go beyond convention

boundary. Convention boundary makes sure that a sentence be of any length, but finite in length. This is not, as Chomsky claims (Chomsky: 1965), because of non-grammatical issues like "memory limitations, intonational and stylistic factors" (1965:11) etc. On the contrary, it is because of grammaticality considerations. This finiteness is an obvious aspect of the language universe.

4. Language-internal factors of finiteness

In his *The Language Instinct* Steven Pinker (Pinker: 1994), gives an account of the infiniteness of language. Taking an average of 10 different words that probably can be inserted "in a grammatical and meaningful way" (1994:77) at one random point of a 20-word sentence, one gets 10^{20} (a hundred million trillion) sentences. Going further, Pinker quotes as example a 110-word sentence from George Bernard Shaw, which gives us 10^{110} sentences. Even further, he mentions a sentence from William Faulkner's novel *Absalom, Absalom!*, containing 1300 words, the longest in English according to the *Guinness Book of World Records*, which will give us 10^{1300} sentences. Yet this is not the limit. Pinker shows that, that record can easily be broken by adding just one phrase to the sentence, and then another, and then another. "And so on, ad infinitum."

But this procedure cannot continue infinitely in any natural language for some obvious language-internal (grammatical) reasons:

1. The first problem in applying infinite recursion to natural language is that, it would produce strings of infinite length, as well as infinite number of strings. So we can have 20-word long strings, then 110-word long strings, then 1300-word long sentences, and so on, up to infinity. But, this is a contradiction. In fact, we have to choose one of the two options. Luckily, we do not have to make a blind decision, because with a finite set of lexical elements (i.e. words or phrases), and with recursion operating, we can have neither an infinite set of sentences, nor a single string of infinite length. It would produce a finite set of strings. For an explicit account, let us assume that, the language L has only 5 lexical and grammatical items: Bird, -s/-es, fly, I, watch. Grammar can produce out of these items only the following longest grammatical strings:

(2) Birds fly.

(3) Bird flies.

(4) I watch.

(5) I fly.

(6) Birds watch.

(7) Bird watches.

Now, we add to the lexicon of L one word—'that', which will introduce *recursion operators*[1]. Then we will get the following longest possible strings:

(8) I watch that birds fly.

(9) Birds watch that I fly.

(10) Bird watches that I fly.

(11) I watch that bird flies.

(12) I watch that I fly.

(13) Birds watch that birds fly.

(14) Bird watches that birds fly.

(15) Bird watches that bird flies.

(16) Birds watch that bird flies.

(17) I fly that I watch.

(18) Bird flies that bird watches.

(19) Birds fly that I watch.

(20) Bird flies that I watch.

(21) Birds fly that birds watch.

(22) Bird flies that birds watch.

(23) I fly that birds watch.

(24) I fly that bird watches.

(25) Bird flies that I watch.

Though several strings like (12), (13), (21) are practically impossible, because in this particular and finite language world, there are no concepts—and so, no such corresponding words—like video recording, and the same bird/birds cannot watches/watch itself/themselves as it/they is/are flying, just like I cannot watch myself when I am flying, still we consider them grammatical sentences.

Note that, though recursion is operating, the finite number of words is exhausted constructing the finite number of strings of finite length (only 5-word). Therefore, there should be, at least theoretically, a "non-arbitrary upper bound to sentence length." And the additional fact is that, recursion can and will generate a number of ungrammatical strings. The following strings should not be recognized as grammatical:

(26) *I watches that bird fly.

(27) *Birds flyes that I watches. etc.

2. With 'finite media' (words, phrases), producing an infinite number of sentences is impossible. For, doing so we have to

(a) make infinite use of finite media, which is not possible. As we have seen in the example of language L, a finite set of elements would be exhausted constructing its optimal sentences, and we cannot use the same words or phrases repeatedly like in the following strings:

(26) *I I watch that birds fly fly.

(27) *I watch that birds fly that I watch that bird flies...[2]

or

(b) insert finite words (we can take an average of 10, following Pinker) into an string of infinite length. Beacuse

if a sentence is 20-word long, the number of sentences a person can deal with is 10^{20}, which is finite, and

if a sentence is 110-word long, the number of sentences a person can deal with is 10^{110}, which is also finite, and

if a sentence is 1300-word long, the number of sentences a person can deal with is 10^{1300}, which is also finite.

So with finite words in hand, we need an infinite string to insert words into to produce infinite number of sentences. But again, this is not possible. Because, as we have just seen above, we cannot use infinite use of finite words of a natural language.

So, in principle, we can have only a finite number of sentences of finite length, given the number of lexical and grammatical items is finite. In other words, the universe of natural language is, in theory at least, finite in scope.

To be even more explicit, we will now examine the claim made by HCF (HCF: 2000) that in terms of recursion "language is directly analogous to the natural numbers."

5. Natural language vs. natural number

Here we need to consider the difference between the two recursive systems: natural language and natural number. This difference will show us that language has its distinct grammatical constraints in applying free recursion to produce infinite number of strings. Natural languages are fundamentally different from natural numbers in significant ways:

1. We do not have an infinite number of nouns or verbs or adjectives etc. So,

   1, 2, 3, 4, 5,...,... ∞ but

   table, fast, run...,... n when at any given time n is finite.

2. Number-strings containing any number of digits are possible. Thus,

   1 is a valid number.

   12 is a valid number.

   123 is a valid number.

   And so on. But in the case of natural language, this is not necessarily true. For example, the following strings are invalid or ungrammatical as sentences:

(28) *Table

(29) *The table

(30) *The table is

3. Numbers have no grammar constraints. Any digit can be embedded in a number-string, and in any place in any number (in this sense also, contrary to natural numbers, natural languages again are not infinitely recursive). To illustrate, let us take five digits arbitrarily: 1, 3, 6, 9, 0.

Now, all of the following strings are valid natural numbers:

(i) 13690

(ii) 13609

(iii) 13096

(iv) 13069

(v) 01369

thus, 5! = all 120 numbers.

On the other hand, natural languages have very strict grammar constraints. For example, contrary to the number-strings (i)-(v), in the following language-strings only one (or, at best, two) can be considered valid (grammatical), and all of the other permuted variations are invalid (ungrammatical):

(a) They have done a job.

(b) Have they done a job? (If question mark is introduced)

(c) *Done they have a job.

(d) *A job have they done.

(e) *A job have done they.

And so on. Thus, 120-2=118 permuted 'language-strings' out of 120 are in fact *not* language-strings at all, for they are ungrammatical.

4. As mentioned above, unlike natural numbers, natural languages are unable to bear indefinite or infinite recursion. For

example, taking once again the five digits: 0, 1, 3, 6, 9, the following strings are valid natural numbers:

(vi) 9113333660,...,...and all of their permuted variations.

(vii) 9910036003,...,...and all of their permuted variations.

And so on. Thus, in any string from (i) to (vii), any digit could be inserted for any times in any place of the string validly, and every such string produced in this way would be a valid natural number. In short, this procedure can be operated validly infinitely. In fact, only one digit is enough to produce valid integers of infinite number and of infinite length.

1

11

111...

On the other hand, as we have seen in the examples (26)-(27), natural languages cannot be infinitely recursive. The above accounts suggest that, the principles of mathematics are not directly and fully applicable in linguistic theorizing.

6. On 'creativity'

6.1 'Creativity' within generative framework

The result of the operation of recursion on natural language is termed 'creativity' in generative thought of language use. In the nativist view, language underlies "...abstract principles that govern its structure and use, principles that are universal by biological necessity and not mere historical accident, that derive from the mental characteristics of the species." (Chomsky, 1975:3). The recursive productivity in language use is theorized as 'creativity' in generative thought.

6.2 Origin of creativity: predictability considerations

But the concept of creativity can be approached from a different point of view: something creative should not be necessarily predictable. But grammar and the mechanism of recursion in language both make sentences necessarily predictable—that a noun will be followed by a

verb in English, usually a noun is preceded by an adjective in Bangla and so on. Any novel sentence representing any novel situation is bound to be grammatical in terms of pre-set grammaticality.

> And the 'new' sentences will satisfy the same operational test of acceptability to other native speakers as 'old' sentences, which might have been produced simply from memory. They will exhibit the same regularities and can be accounted for by the same rules. In other words, it the class of potential utterances which we must identify as the sentences of the language." (Lyons, 1968:139)

This procedure makes language faculty a mere automaton and, at the same time, gives language-world a guise of infinite creativity. In fact, creativity in language use lies in assigning new meaning arbitrarily to structures—arbitrariness is the origin of creation, the rest is nothing but routine.

7. The form and acquisition of grammar

With this position developed above, and with the awareness that though the universe of language is theoretically finite in scope, it is so vast that it gives an impression of infiniteness, we are now intended to explore the following sentence quoted from a Salman Rushdie novel, *The Ground Beneath Her Feet*. This 112-word long sentence contains a number of *recursion operator*s.

> [The open mouth of the plumed serpent surrounded a dark hollow [scooped out of the stone, [and although her own mouth was stretched wide by her screams [the only noise she could hear was the popping of flashbulbs; [but before they could slit her throat, [before her lifeblood could bubble into that terrible cup, [she awoke at noon in the city of Guadalajara, Mexico in an unfamiliar bed with a half-dead stranger by her side, a naked mestizo male in his early twenties, [identified in the interminable press coverage that followed the catastrophe as Raul Paramo, the playboy heir of a well-known local construction baron, [one of whose corporations owned the hotel]. (2000:1)

Note that, the structures of the recursion operators are quite simple familiar sentences (some of them could be broken into even simpler ones) and other elements, embedded in a longer sentence. Reasonably, the propositions made bellow may follow from the above example:

1. Grammar is simple: All languages have structurally a few kinds of sentences (i.e. declarative, interrogative, passive etc.). In fact, the traditional structural classification of sentences can be adapted in terms of recursion for the sake of meaningful definition of sentence. Simple, compound and complex sentences have the same structural patterns considering recursion; the latter two are only declarative, interrogative or passive sentences constructed by embedding. So, now we have a simple grammar that includes

A. rules for the structurally few kinds of sentences, and

B. recursion operators and their application rules.

These rules would tell a learner/speaker how to form the few kinds of sentences or phrases, and how to join them as recursion operators to form larger sentences. In this view, the number or length of the sentences of a language has no significance in the form of its grammar, and so in acquisition and use of that language. According to the classical Indian view of language, "...sentences are virtually countless and we certainly cannot learn a language by learning these countless sentences and their meanings. It is only by learning a few (a finite number of) words and seeing how that language works that we gain the linguistic competence..." (Miṃānsā sub-school held by Bhāṭṭa Kumārila, c. AD 650, 1898 edn, cited in Matilal, 2001:107) and Prābhākara (Prābhākara, c. AD 670, 1932 edn, cited in Matilal: 2001).

2. Grammar is mechanical: It is accepted in generative theorizing that grammar is nothing but a mechanical device for generating grammatical sentences, and that the core mechanism of this device is recursion. So, the rules of sentence construction and recursion would work mechanically and mathematically, to produce, in principle, any number of sentences of any length.

8. Grammar as a machine

> The mechanism of language, which consists of the interplay of successive terms, resembles the operation of a machine in which the parts have a reciprocating function even though they are arranged in a single dimension. (Saussure, 1959:128)

Saussure's emphasis on the 'arbitrary nature of sign' and his view of language as a 'social institution' or 'human institution' do not contradict with his treating language as a machine.

So, in Saussure's view, language is a system which has originated from arbitrariness, but has been made usable imposing restrictions [which are the rules of grammar]:

> In fact, the whole system of language is based on the irrational principle of the arbitrariness of the sign, which would lead to the worst sort of complication if applied without restriction. (Saussure, 1959:133)

As we have seen before, Bloomfield also recognized the infinite scope of language, but at the same time, he, like Saussure, defined this scope within a restricted set of constructions. And, the child's acquiring of language 'in the first years of his life' "...is doubtless the greatest intellectual feat any one of us is ever required to perform." (Bloomfield, 1935:29). In this view, acquisition of language needs no innate grammar (UG), it is only 'an inherited trait' for 'repetition' or 'imitation' what is needed (1935:29-31).

The structuralists (except for Saussure), like the generativists have made no direct claim that language (or grammar) is a sentence-producing machine. But formulating any grammar—whether normative or descriptive—in some way means that sentences produced in terms of that grammar will be the only sentences of the language concerned. When one talks about grammar, he talks about a machine.

In these respects, there is no genuine 'creativity' in language use, because every novel construction is just mechanical and surely predictable combination done by using the recursion operators, and is based on and combination (which is also done by the same

mechanism—recursion, or grammar) of existing grammatical experiences. And again, we are to keep in mind that, recursion cannot produce qualitatively infinite number of sentences of natural language, given that the number of words at a particular space[4]-time is limited, and given that grammaticality must be present in sentences.

Now, it can be argued logically that, one does not need a great period of time to acquire a simple grammar with the existing brain capacity of humans. Furthermore, an individual or a speech community does not use the whole repository of items contained in the dictionary of his/its language, and during the acquisition period the volume of the lexicon of a child remains considerably small. So, at that time the number of grammatical strings to be acquired is radically reduced.

9. Final remarks

It appears that too much has been attributed to human language as an independent property of human mind. It has been overlooked that language is just an instrument or tool for man's expression of his Conceptual-Intentional properties, and not the only one. The supra-segmentals, the bodily expressions supplementing language, making language really live and 'human' are there, and sometimes a mere bodily expression, or even only silence in many cases, is enough—sometimes the most efficient—for expressing thought. It has been unspoken that humans laugh, play, pray, dance, create music (a highly recursive and 'creative' 'language' that can be compared with the language we are talking about) to express thoughts. None of these can be found in any other species and all of these have something to do, in some way, with the Conceptual/Intentional system of man.

And finally, the so-called creativity in language use appears as mechanically manipulating the symbols in a limited universe of elements. It seems to us novel and creative, and doesn't bore us because of its continuous mapping with the conceptual/intentional properties. If someone would start to notice the repetitive formation of grammar apart from its interface with novel things, ideas, situations etc., he would be immediately bored of its monotony.

Notes

1 Every embedded string of word(s) can be considered as a *recursion operator* (a loop in the Markov Chain). The absence of any of them does not affect grammaticality of the rest of the sentence. Recursion operators include words like adjectives, adverbs, phrases, sentences etc.

2 Contrary to Chomsky's argument that a sentence like "$a + S_1 + b$" "comes nowhere near exhausting" the possibilities for uncertain embedding (Chomsky, 1957:22), (27) does exhaust the finite elements of the language L. Otherwise the sentence under question will repeat itself infinitely, and this process cannot account for a real, or in Pinker's words, 'meaningful' infiniteness. Here, Chomsky arises a logical or methodological problem that to "arbitrarily decree" that the process of embedding "cannot be carried out more than n times, for some fixed n" is not possible, for "This would of course make English a finite state language, as for example, would a limitation of English sentences to length of less than a million words." And if so, "it will be possible to list the sentences, and a list is essentially a trivial finite state grammar. But this grammar will be so complex that it will be of little use or interest. In general, the assumption that languages are infinite is made in order to simplify the description of these languages. If a grammar does not have recursive devices (closed loops...) it will be prohibitively complex." (1957:23-24) We already have the answer to this problem, that embedding is finite for natural languages, so we do not need to "arbitrarily decree" its finiteness. And finiteness does not necessarily invoke complexity of grammar, or discard of recursion. Rather, natural languages only operate this process in a finite way, for they have finite elements and grammar constraints.

3 Here the term *space* will refer to a particular version of a particular language.

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