The Minimalist Program: A Bridge Principle in Biolinguistics

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The most radical reformulation of transformational generative grammar since its inception has been the Minimalist Program (Chomsky, 1995), in which all but the most essential syntactic principles are discarded. The claims of the Minimalist Program have generated much controversy and confusion, especially with regard to its scientific status in theoretical linguistics, psycholinguistics, and cognitive neuroscience. In the following discussion, I will clarify the claims of the Minimalist Program, define its proper scientific status, and show how the Program is, in essence, an attempt to find reductive bridge principles between linguistics and the biological sciences.

1. The Minimalist Program in Generative Grammar and Cognitive Science

Transformational generative grammar has evolved through several stages from its foundational principles more than half a century ago (Chomsky, 1957; 1965). This evolution has been marked by the exposition of ever more general principles of syntactic combination and syntax-semantics interfacing, with the fundamental goal of elucidating the computational system within the mind/brain of the language user (*I*-language) as opposed to the rules of specific natural languages (the *E*-language approach). The phrase-structure rules of the syntactic component were generalized in X-bar theory (Chomsky, 1972; 1975) and phonological form (PF) and logical form (LF) and their roles as interfaces with other cognitive systems were introduced in Government and Binding theory (Chomsky, 1981). The Principles and Parameters (P&P) approach was a key development toward showing how natural language variation could be traced to a more fundamental linguistic capacity via the setting of parameters (Chomsky & Lasnik, 1993). The goal of uncovering the most general, and indeed the only indispensable aspects of phrase-structure rules is manifested in Chomsky's Minimalist Program. According to this approach, syntactic structure is built from the bottom up via a single operation, Merge. At the most fundamental level of syntactic processing, lexical items are combined recursively by this operator to generate new lexical items. These new lexical items can then be Merged with other lexical items to generate yet another lexical item, and so forth during the build-up of the complete syntactic structure. Importantly, many

of the earlier syntactic operations in transformational generative grammar have been subsumed under the Merge operation. Rather than positing separate operations for particular stages in syntactic build-up, these operations can instead be conceived as different hierarchical applications of Merge. In the standard theory of generative syntax, up to and including Government and Binding theory, a sentence's D-structure undergoes transformation rules such as phrase movement to provide input to the S-structure. Within the S-structure, several more rules must be satisfied (e.g. theta criterion and case filter) in order to make the sentence a kind of "common currency" for PF and LF. In the Minimalist Program, D-structure and S-structure are removed, along with the rules applying to their construction, and are instantiated in the Merge operation (fig. 1). As Chomsky (2002, p. 134) notes, for example, "the whole notion of complement and specifier disappears except as a terminological convenience; you have the things that you merge first, the things that you merge second, and so on."

One of the central guiding principles in the Minimalist Program, and the one that has caused the greatest uproar, is that language may be an optimal solution to map sound to meaning given constraints set by the sensorimotor (SM) system and the conceptual-intentional (CI) system, what has often been called the *strong minimalist thesis* (SMT) (Chomsky, 2000). The notion of optimality, however, is not a functionalist one, such as "optimal for communication." Instead, the minimalist notion of optimality is a mind-internal one, in which the structure of natural language is optimal for interaction with cognitive systems already in place (i.e. those included in the SM system and CI system). The term "language" as it is used in SMT refers to the uniquely human component of the language faculty, the faculty of language in the narrow sense (FLN), and the cognitive systems with which it interacts are conceived as the faculty of language in the broad sense (FLB) (Hauser et al., 2002). The uniquely human FLN is considered to have the property of recursive combination (Hauser et al., 2002), the central syntactic operation in the Minimalist Program. Under SMT, recursive combination, as accomplished by the Merge operation, is an optimal solution for language to be accessible to the SM and CI systems with which it must interface.

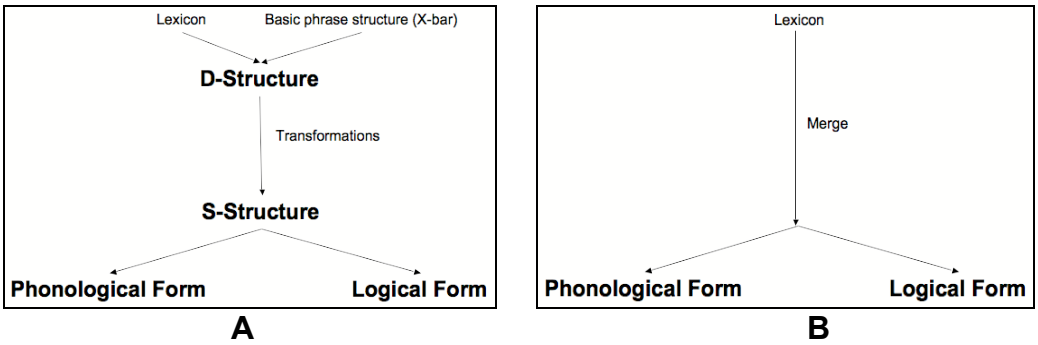

Figure 1. Comparison of Government and Binding Theory (A) with the Minmalist Program (B).

2. What the Minimalist Program Is Not

Before showing how the Minimalist Program can be construed as a bridge principle between linguistics and biology, it is first necessary to clarify the scientific status of the Program. Perhaps the most important clarification required is that the Program is not a theory or a hypothesis, but an approach to *I*-language with the goal of demonstrating how variations in natural languages and the apparent plurality of operations in syntactic theory are actually instantiations of more general principles. This approach can and will likely consist of many theories and hypotheses, but all will involve the fundamental assumption of minimalism.

Another concern about the Minimalist Program is its place in cognitive science. That is, what types of cognitive operations are relevant targets of a minimalist approach? It must be vigorously emphasized, as it has been in earlier generative grammar, that Merge and the interfaces of PF and LF with the SM and CI systems are not approaches to processing of language, but approaches to representation of language. It has, for instance, been argued that the transformations done by a series of Merge operations to arrive at PF and LF are implausible based upon standard psycholinguistic evidence, such as reaction times and eye movements, and therefore that syntactic operations be postulated that are consistent with these data (Edelman & Christiansen, 2003; Culicover & Jackendoff, 2006). This argument is based on the premise that transformations in minimalist syntax are processes carried out in the mind/brain that compute sentence structure. To the contrary, the operations of minimalist syntax, as well as its predecessor transformational generative grammars, are to be understood the level of representation. Framing this notion in terms of Marr's (1982) levels of analysis in cognitive science is

helpful. According to this framework, cognitive phenomena are investigated at three different levels of analysis: the computational level (or representational level, indicating what structures are to be computed), the algorithmic level (or processing level, in which the steps carried out to execute the computation are specified), and the implementational level (or neural level, in which the steps that are carried out are understood in terms of what neurons are doing). Minimalist syntax, the associated Merge operations, and the interfacing components LF and PF all exist at the computational level of Marr's levels of analysis. Thus, the goal of any psycholinguistic or neurolinguistic experiment concerned with the cognitive bases of generative grammar should be not to vindicate the syntactic transformations themselves, but to combine what is known about what kinds of processing various experimental task manipulate (grammaticality judgments, reaction times, BOLD signal changes, etc.) to reach a conclusion about the nature of syntactic representation (Philips & Lasnik, 2003; Marantz, 2005).

3. A Bridge Principle Between Linguistics and Biology

Chomsky's so-called "biolinguistic" ontology (i.e. that language should be studied as a natural object rather than an abstract one) was articulated decades before the introduction of the Minimalist Program (Chomsky, 2007). A key development in biolinguistics was the P&P approach (Chomsky & Lasnik, 1993), in which there are fundamental principles of linguistic operation that are necessary components of all natural languages and that natural languages differ by variations in parameters that contribute to syntactic variability. This approach profoundly lessened the gap between linguistics and natural science by showing that knowledge of natural language can be understood analogously to how biological structures, such as the antibody constitution of an immune system, develop through parameter-setting (Piattelli-Palmarini, 1989). The Minimalist Program represents the most significant, perhaps the paramount, feature of biolinguistics, showing how the hierarchical build-up of linguistic structure is an instance of operations of a uniquely human component of the language faculty (FLN) that must interface with pre-existing systems of sensation, perception, cognition, and motor control.

I suggest that the Minimalist Program can serve as a bridge principle between linguistics and biology in the sense of the account of theory reduction given by Nagel

(1961): Reduction of a higher-level theory *T* to a lower-level theory *t* is accomplished if the statements and kinds that exist in *T* can be defined as the statements and kinds that exist in *t*. To clarify the position of this idea within wider reductionism, theory reduction is a form of epistemic reduction, in which the body of knowledge in one discipline is a logical consequent of the body of knowledge in another discipline. Theory reduction is not a form of ontological reduction or eliminativism, in which case a certain higher-level discipline merely *is* a certain lower-level discipline. In the present context, *T* is taken as generative linguistics and *t* is taken as biology.

The notion of some kind of unifying principles between linguistics and biology is not new. Indeed, it has always been in the background in the biolinguistic approach, even if not overtly stated as a goal (see, for instance, Jenkins (2000), pp. 15-56). Furthermore, the notion that there is an unbridgeable gap between linguistics and biology has been discussed with regard to the ontology and granularity in each discipline (Poeppel & Embick, 2005) and, perhaps most vociferously in Postal (2004), with regard to the fundamental nature of linguistics as an abstract discipline like mathematical logic. Given the approach of the Minimalist Program, however, this supposed gap does not seem as wide as it is often claimed. If it is the case that the structures and transformations studied in generative linguistics are instantiations of the general Merge operation that proceeds according to constraints imposed by the SM and CI interfaces, it would seem as if bridge principles in the sense of Nagel (1961) are at least *conceivably* possible. That is, given the general operation Merge and the constraints imposed by systems making up the broad language faculty (FLB), it should be possible to deduce the structures and transformations posited in generative linguistics.

It is important to note that the account of theory reduction given by Nagel (1961) is deceptively simple: start off with statements and kinds from a more fundamental theory and logically deduce the statements and kinds of the higher-level theory. It is likely that such a deductive-nomological approach will depend on the validity of the Strong Minimalist Thesis (SMT), which holds that FLN is the optimal solution, in the sense of computational efficiency, for mapping sound to meaning given the constraints imposed on this mapping via systems in FLB. If this is the case, then all of the structures of generative linguistics are obtained "for free" given the core generative component of the

language faculty (FLN) and the systems with which it interfaces.

4. Conclusion

Chomsky's Minimalist Program marks the most important development in his biolinguistic approach. It is not only a high point of the evolution of transformational generative grammar, which has been characterized by a systematic elimination of many syntactic entities and principles with the goal of arriving at the most general rules of natural language, but also, as I have argued, a prime candidate as a bridge principle between linguistics and biology. If the generative component of the language faculty is indeed the optimal solution for linking sound to meaning given the constraints of the non-linguistic interfaces, then it should be possible to deduce the syntactic entities and principles posited by generative linguistics from Merge operations proceeding according to these constraints.

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