In summary, Jackendoff's book is one of several recent manifestations in linguistics of the equivalent of the Prague Spring of 1968, when calls for putting a human face on Soviet-style "socialism" began to be heard (cf. the longing for "linguistics with a human face" expressed by Werth [1999, p. 18]). Jackendoff's stance, according to which the "mistakes" that were made do not invalidate the TGG framework, amounts to a bid to change the system from within. In a totalitarian political system, this may only work if the prime mover behind the change is at the very top of the power pyramid: Czechoslovakia's Dubcek in 1968 merely brought the Russian tanks to the streets of Prague, whereas Russia's Gorbachev in 1987 succeeded in dismantling the tyranny that had sent in the tanks. In generative linguistics, it may be too late for any further attempts to change the system from within, seeing that previous rounds of management-initiated reforms did little more than lead the field in circles (Edelman & Christiansen 2003). If so, transformational generative grammar, whose foundations Jackendoff ventures to repair, may have to follow the fate of the Communist Bloc to clear the way for real progress in understanding language and the brain.

Complexity underestimated?

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Abstract: Instead of commenting directly on *Foundations of Language: Brain, Meaning, Grammar, Evolution,* I provide some remarks from an interdisciplinary view. Language theory is examined from the perspective of the theory of complex systems. The gestural-vocal dichotomy, network theory, evolutionary mechanisms/algorithms, chaos theory, and constructive approach are briefly mentioned.

1. The perspective. I do not have a background in generative linguistics, and read the book *Foundations of Language* (Jackendoff 2002) from the perspective of how the author managed to embed linguistics into an interdisciplinary framework. I remain slightly disappointed. The author clearly abandoned Chomsky's grand isolation decades ago, but the real integrative approach is missing. For example, the title of the first chapter is "The Complexity of Linguistic Structure," but the author gives only a few references from the community of complex-system researchers. Still, though the book seems to be primarily a text written by a linguist for linguists, I have learned very much from it. My comments here are directed not so much at the book itself as at articulating the potential ingredients for a more interdisciplinary approach.

2. The gestural-vocal dichotomy. Jackendoff assumes that language arose in the vocal-auditory modality, and states (in my view, surprisingly) that "a gesture-visual origin would not materially change my story" (p. 236). Based on the fascinating findings of mirror neurons (for reviews, see Rizzolati & Arbib 1998), the mirror system hypothesis of language evolution has been suggested (e.g., Arbib 2002a). Mirror neurons in monkeys are active both in order to execute motor actions and to observe similar actions of other monkeys or humans. The neural region involved in these operations is considered to be the homologue of Broca's area, the crucial speech area of humans. Language in humans evolved from a basic mechanism that was originally not related to communication, namely, the "capacity to recognize actions" (Rizzolatti & Arbib 1998). Should we believe now, in light of these newer results, that the gestural-visual systems implemented in the action-perception cycle might have a more important role in language evolution than was earlier thought? While I might see the difficulties in explaining the transfer from gestural to vocal modality, I don't see why we should not consider these findings as a big step toward a new Neurolinguistics.

3. Network theory: Static and (statistical) characterization; self-organizing algorithms. Real world systems in many cases can be represented by networks, and complex networks can be seen everywhere. The organization of biological, technological, and social structures might be better understood by using network theoretical approaches (Albert & Barabasi 2002; Newmann 2003). "Small-world" graph properties (highly clustered and small average length between nodes) and power-law distributions are the key properties of the networks. Complex networks are neither purely ordered nor purely random.

Motivated by the big success of network theory, several works have shown that certain networks assigned to human language have the characteristic patterns of complex organization. Cancho and Solé (2001) analyzed the British National Corpus, and a network of interacting words has been constructed by taking into account only short-distance correlations. The authors don't deny that their algorithm is based on the analysis of the surface structures of sentences. Another network of words was constructed from a thesaurus by Motter et al. (2002). Roughly speaking, words are connected if they express "similar" concepts. In any case, both networks showed statistical properties very similar to those of other complex networks.

Dorogovtsev and Mendes (2001) gave a self-organizing algorithm for the development of word networks based on elementary interactions between words. This algorithm might be the basis of a mechanism to produce a kernel lexicon of the language.

4. Evolutionary mechanisms/algorithms. Jackendoff certainly gives some credit to recent work "on mathematical and computational modeling of communities of communicating organisms" (p. 81). At least from the perspective of integrative approaches, it is interesting to see how model frameworks of population dynamics and evolutionary game theory can be extended to describe language evolution (e.g., Nowak & Krakauer 1999), and specifically grammar acquisition (Komarova et al. 2001), which offers a model framework for describing signal-object association, word formation, and the emergence of syntax with coherent concepts.

5. Chaos theory. Chaos theory might have some role in linguistics. It certainly contributed to the explanation of the occurrence of the celebrated Zipf's law (Nicolis & Tsuda 1989). (I understand that statistical-empirical laws might have nothing to do with architectures, so Zipf's law should not necessarily be mentioned in the book.) The population-dynamical/game-theoretical models elaborated for the acquisition and evolution of language might lead to chaotic behavior under certain conditions. Mitchener and Nowak (2003) recently argued that small learning errors may lead to unpredictable language changes.

6. Constructive approach. While there are different strategies to simulate language evolution, the constructive approach seems to be particularly interesting (e.g., Hashimoto 2001). Language, as a complex dynamical system, can be studied at different hierarchical levels. The origin of the first linguistic systems, the evolution of various languages and language structures, the normal development and acquisition of language in children and adults, and the sense-making process of giving meanings to words during communication take place in different levels of language organization. The constructive approach takes into account both the subjective language-users and the communication among them. The prerequisites of simulating language evolution are language-users, that is, communicative individuals with an established communication system.

Recent efforts to understand emergent biological and social structures adopt the constructive approach. Accordingly, structures and processes emerge as a result of the interaction between the components of complex systems. Specifically, one can understand the emergence of linguistic structures and behaviors. These components consist of interacting autonomous agents, their neural, sensorimotor, cognitive, and communication abilities, and their physical and social environment.

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Jackendoff might be right: "Linguistics alone cannot sustain the weight of the inquiry. We need all the help we can get from every possible quarter" (p. 429).

7. Afterthought. Jackendoff's *Foundations* is a result of an incredible intellectual effort. I am very curious to see how the author reacts to remarks coming from an external world.

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Imaginary mistakes versus real problems in generative grammar

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Abstract: Jackendoff claims that current theories of generative grammar commit a "scientific mistake" by assuming that syntax is the sole source of linguistic organization ("syntactocentrism"). The claim is false, and furthermore, Jackendoff's solution to the alleged problem, the parallel architecture, creates a real problem that exists in no other theory of generative grammar.

Jackendoff's *Foundations of Language* (Jackendoff 2002) begins with a polemic about a perceived "scientific mistake" in standard generative grammar, which is corrected in his new proposal for the architecture of grammatical theory. The mistake, dubbed "syntactocentricism," concerns theories in which the only formation rules (i.e., mechanisms that create linguistic representations) are those of the syntactic component. "In short, syntax is the source of all linguistic organization." In contrast, Jackendoff proposes a model in which there are three independent sets of formation rules (for phonology, syntax, and semantics), a model he calls the parallel architecture. The three independent representations thereby generated must then be related by interface (or correspondence) rules, including rules that relate phonological representations directly to semantic representations.

Before discussing the parallel architecture proposed as a solution to the purportedly flawed standard theory, it is useful to consider exactly how current theories of generative grammar are syntactocentric, given Jackendoff's characterization. Let us consider the case of the minimalist program (cf., Chomsky 1995; 2000; 2001), which is inaccurately represented in Figure 1.[1]

Within a minimalist derivation (e.g., Chomsky 1995, Ch. 4), the first step is the selection from the lexicon of a lexical array, a set of lexical items designated *the numeration.* This lexical array is then used to build linguistic structures via the iterated application of the concatenation operation Merge. Merge builds syntactic structures bottom-up by concatenating two syntactic objects (lexical items from the numeration, or phrases constructed from previous applications of Merge) and labeling the concatenation with the syntactic category label of one of the two concatenated objects, thus creating a new syntactic object.[2] The syntactic object generated eventually produces a Phonetic Form (PF) that is interpreted at the sensory-motor interface and a Logical Form (LF) that is interpreted at the conceptual-intensional interface.[3] Within the derivation of a linguistic expression, there is a point called "Spell-Out" (S/O) where the phonetic features of the expression are sent to the phonological component for further processing, and the rest of the structure moves on to the LF interface. Any changes to the structure of the expression after S/O are covert, because their effects cannot be seen in PF.

Even if Merge is the only formation rule available in the derivation, it does not follow that syntax is the sole source of linguistic organization. The charge of "syntactocentrism" ignores the contribution of the lexicon. Given that the lexicon specifies the phonological, morphological, syntactic, and semantic structure of lexical items, it too constitutes a major source of "linguistic organization." If lexical items enter the syntactic derivation with a specification of their syllable structure, then there is no need to independently generate a syllable structure for the whole linguistic expression generated.[4] The charge of syntactocentrism is simply false for this theory, and as far as I can tell, for any previous theory of generative grammar that has ever been proposed. The notion is little more than a phantom.

Given that lexical entries contain phonological and semantic information, as well as syntactic information – the standard model since Chomsky 1965 – Jackendoff's parallel architecture creates a serious dilemma. Presumably, the parallel architecture lexicon that feeds the syntactic component contains no phonological or semantic information. Otherwise, the parallel derivations of phonological and semantic representations would redundantly specify information that is already part of the syntactic derivation, thereby undermining the need for parallel derivations in the first place. Ironically, the syntactic derivation under the parallel architecture must be "syntactocentric" – in just the same way that the phonological derivation is "phonocentric" and the semantic derivation is "semantocentric."

The parallel architecture puts an enormous burden on the interface/correspondence rules, one that they must surely fail to carry in even the simplest cases. If, as Jackendoff seems to be claiming, phonological representations contain no syntactic information, then there must be a correspondence rule that links the phonological representation of *persuade* to the lexical category V, rather than some other lexical category. However, the phonetic labels of words in a language are fundamentally arbitrary – what Chomsky (1993) calls "Sausseurian arbitrariness" – so there is no systematic way (i.e., via rules) to correlate phonetic labels and lexical categories. The same point applies to the connections between phonological and semantic representations. Given the parallel architecture, nothing in the phonological representation of *persuade* tells us that it corresponds to the semantic representation of *persuade* rather than the semantic representation of *try.* The standard solution to the problem of Sausseurian arbitrariness is to list the correspondences in the lexicon, traditionally the repository for idiosyncratic properties of a language. But once we do this, the motivation for the parallel architecture evaporates.

NOTES

1. It is important to note that the minimalist program is a program for research investigating very general questions concerning the optimality (in some interesting sense) of the computational system for human language and more generally the possible "perfection" of language design. (See Chomsky 1995; Freidin 1997 for discussion.) These questions by themselves do not provide a theoretical framework or a particular model, let alone a specific theory. At present, the minimalist program is being investigated in a variety of ways, where specific proposals are often mutually exclusive, as is normally the case in linguistics, and rational inquiry more generally.

2. Thus phrase structure is constructed via transformation and therefore there is no phrase structure rule component. Movement transformations in this theory also involve a form of merger, where the syntactic object moved is concatenated with the root of the phrase containing it. When two independent objects are merged, this is called external Merge; whereas when a syntactic object is displaced to an edge of the constituent containing it, this is called internal Merge. The two types of Merge correspond to the distinction between generalized versus singulary [*sic,* technical term] transformations in Chomsky (1957 and earlier).

3. There is no further conversion of LF to "semantic representation" as indicated in Figure 1. Furthermore, following up on Note 1, recent proposals have questioned the existence of any level of representation like LF (see Chomsky 2002).

4. The same argument can be made regarding semantic representation. Assuming that the structures Jackendoff proposes for the semantic representation of verbs are on the right track, these structures could just as easily be part of the semantic specification of the lexical entry for predicates where the elements labeled "Object" in Jackendoff's lexical representations are variables to be replaced with constant terms from the actual sentence in which the predicate occurs. Again, there is no need to generate