



Discussion

The nature of the language faculty and its implications for evolution of language (Reply to Fitch, Hauser, and Chomsky)[☆]

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Abstract

In a continuation of the conversation with Fitch, Chomsky, and Hauser on the evolution of language, we examine their defense of the claim that the uniquely human, language-specific part of the language faculty (the “narrow language faculty”) consists only of recursion, and that this part cannot be considered an adaptation to communication. We argue that their characterization of the narrow language faculty is problematic for many reasons, including its dichotomization of cognitive capacities into those that are utterly unique and those that are identical to nonlinguistic or nonhuman capacities, omitting capacities that may have been substantially modified during human evolution. We also question their dichotomy of the current utility versus original function of a trait, which omits traits that are adaptations for current use, and their dichotomy of humans and animals, which conflates similarity due to common function and similarity due to inheritance from a recent common ancestor. We show that recursion, though absent from other animals’ communications systems, is found in visual cognition, hence cannot be the sole evolutionary development that granted language to humans. Finally, we note that despite Fitch et al.’s denial, their view of language evolution is tied to Chomsky’s conception of language itself, which identifies combinatorial productivity with a core of “narrow syntax.” An alternative conception, in which combinatoriality is spread across words and constructions, has both empirical advantages and greater evolutionary plausibility.

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The influential 2002 paper by Hauser, Chomsky, & Fitch (HCF) made three contributions. First, it drew a conceptual distinction between aspects of language that are unique to it (the faculty of language in a narrow sense or FLN) and aspects shared by other faculties or other organisms (the faculty of language in a broad sense or FLB). Second, it proffered the empirical hypothesis that “FLN comprises only the core computational mechanisms of recursion as they appear in narrow syntax and the mappings to the interfaces”—what we called the “recursion-only hypothesis.” Third, it drew an implication for the evolution of language: if it is only recursion that is “recently evolved,” that would “nullify” the argument from design (Pinker & Bloom, 1990; Pinker, 2003; Jackendoff, 1992, 2002), which proposes that many aspects of language have recently evolved by natural selection for enhanced communication. In Pinker & Jackendoff (2005, henceforth PJ), we disputed the second and third suggestions; in Fitch, Hauser, and Chomsky (2005) (FHC), the authors respond to our critique. In the interest of brevity, we will not reply to FHC point by point, but will only try to clarify our major disagreements with FHC’s argument.

We begin by discussing some general issues of evolutionary explanation. Section 2 turns to the FLN/FLB distinction, showing how we interpret it differently from FHC. Section 3 discusses the recursion-only hypothesis, showing that it is either uninterestingly vague or unlikely to be true. Finally, it is important to discuss the evolution of language in the context of an empirically adequate view of the contemporary language faculty. Section 4 outlines reasons to doubt the theory presupposed by FHC and to consider an alternative which both provides a better account of the facts of language and lends itself to a more graceful interaction with evolutionary issues.

1. Evolutionary explanation

We fully agree with FHC’s point that hypotheses about the adaptive function of a trait should be stated in a form that is empirically testable. However, we believe that their analytic framework by its nature excludes certain important alternative hypotheses.

First, they divide questions about adaptations into “current utility” (how an organism puts a trait to use at present) and “functional origins” (what the trait was adapted to in the first organisms that possessed a version of it). Current utility is defined by the history of learning, training, and discovery in the lifetime of the organism. For instance, the current utility of the human leg includes, among other things, kicking a soccer ball and braking a car. Functional origin is relevant when there have been changes in the functions of homologous structures over deep evolutionary time. The functional origin of the leg (depending on how far back you go) is presumably control of swimming in fish.

However, this dichotomy leaves out a crucial third possibility, current *adaptation*: what the trait was selected for in the species being considered. In the case of the human leg, this would be adaptation to bipedal locomotion, where adaptation is defined by shaping of innate structure through its reproduction-relevant consequences in the species’ evolutionary history. Though this is often the most biologically interesting question about a trait, FHC provide no place for it in their dichotomy. And it is only by omitting this third alternative that Chomsky can maintain that nothing distinguishes the use of language

for communication from the use of hair styles for communication, and that nothing distinguishes the utility of language for communication from the utility of language for inner speech.

Second, in order to argue that adaptive function is near-impossible to determine, FHC slice adaptive functions so finely that the functions become evolutionarily indistinguishable. True, we may not know whether bat echolocation is for navigating or for finding food, but we certainly know it is not for oxygenating the blood or nourishing an embryo. Our knowledge about its function simply has to be reframed at a more generic level, something like sensing the location and motion of objects in the dark. Likewise it seems odd to say that, just because we do not know whether primate vision evolved for finding mates or finding food, we cannot say anything about the adaptive function of the visual system at all!

Third, FHC reiterate Chomsky's (2000) assertion that all hypotheses about adaptation are "equally pointless." The argument seems to be, "Adaptive explanations can be done badly, so no one should ever attempt to do them well." Moreover, this stance is controverted by the fact that Hauser and Fitch, in their experimental work, brilliantly test hypotheses about adaptive function. Moreover, FHC themselves say that language (in the broad, though not necessarily the narrow, sense) "shows signs of adaptive design," that it has "been shaped by natural selection for, among other things, communication with other humans," and that "communication must be one of the primary selective forces that influenced the evolution of FLB." Evidently the charge of pointlessness is being wielded selectively.

FHC cite a number of sources of evidence for testing evolutionary hypotheses. These include the fossil record, for which evidence about language is scant, and homologies with related species, which we agree are well worth pursuing. But they fail to mention another source of evidence, namely reverse-engineering or functional analysis, which assesses (perhaps iteratively) the goodness of fit between the design specs required for a system to effectively accomplish a goal in a given environment and the empirically assessed properties of the organism in question. This strategy has been indispensable in understanding the organs of the body.¹ PJ brought such evidence to bear on the question of whether the adaptive function of language is communication or inner speech. We noted, for example, that it makes sense for a system adapted for communication (but not one adapted for internal reasoning) to use a code that is systematically related to the capacities of the vocal tract, and to depend on the use of socially shared sound–meaning pairings. Moreover, the existence of phonological rules that ease articulation, and of syntactic processes with pragmatic communicative functions such as topic and focus, points strongly to language being an adaptation to social communication rather than to internal reasoning (though reasoning may be enhanced by inner speech; see Jackendoff, 1997b, chapter 8).

Moreover, reverse-engineering a trait can shed light on its likely evolutionary history, not just its adaptive function. In the eye, a retina would have been useful in the absence of

¹ In this light, it is ironic that Chomsky has repeatedly argued that the language faculty should be treated like bodily organs yet inveighs against any systematic attempt to characterize its adaptive function.

muscles moving the eyeballs, but the reverse is not the case. This suggests that the retina evolved first and the muscles that move the eyeballs evolved into their current arrangement later. In the case of language (see Jackendoff, 2002), consider the possible orderings in the evolution of the lexicon and syntax. Suppose what evolved first was a capacity to communicate symbolically with words, but without any syntactic connections among words, only concatenation. While not as expressive and efficient as modern language, it would be a major improvement in communication over primate calls (and this is arguably not far from the status of present-day pidgins and the earliest stages of first and second language acquisition, Bickerton, 1990). On this view, it is plausible that the capacity for syntactic structure evolved as an adaptive means of making such communication more informative and efficient (Jackendoff, 1990b, 2002; Newmeyer, 1990; Pinker & Bloom, 1990). In contrast, it would make little sense for syntax to evolve before words, since there would be nothing for it to combine into utterances. Such reasoning can sometimes be heuristic, but it is not thereby pointless, an issue we return to in Section 4.

2. The FLN/FLB distinction

FHC accuse us of misunderstanding their FLN/FLB distinction or failing to apply it properly. However, a conceptual distinction is useful only insofar as it allows competing hypotheses to be framed clearly and their implications to be spelled out perspicuously. We find neither of these criteria to be met by the FLN/FLB distinction as it is now explicated by FHC.

First, the claim that a trait is “unique to language” or “unique to humans” can be interpreted in two ways. It can be interpreted in absolute, categorical, all-or-none terms: a “unique” trait is *sui generis*, with nothing remotely similar in the rest of the mind or the rest of the animal kingdom, and appearing out of the blue in the course of evolution. Or the claim can be interpreted in graded terms: that the trait has been modified in the course of human evolution to such a degree that it is different in significant aspects from its evolutionary precursors (presumably as a result of adaptation to a new function that the trait was selected to serve), though not necessarily different in every respect.

FHC often apply the FLN/FLB distinction in absolute terms, using any similarity between a language function and anything else (speech perception and generic audition, word learning and fact learning, speech acquisition and vocal imitation) to sequester the function in FLB. It is no surprise, then, that they can relegate all the evidence we adduce for linguistic adaptations into FLB, preserving their claim that FLN contains only recursion, and in turn maintaining that FLN fails tests for adaptation.

We instead interpreted FLN in graded terms. The point of the FLN/FLB distinction is to identify those features of language that recently evolved in the human lineage (and which thereby help to answer the key question of why we have language and other apes do not). Evolutionarily speaking, nothing springs forth without a precedent, so if FLN is interpreted as “uniquely human” in the absolute sense, it is hard to imagine that it could contain anything, in which case it no longer defines a useful distinction. The absolute interpretation would, in particular, rule out features of language that arose from extensive

duplications, modifications, expansions, and interconnections of pre-existing primate systems. Yet we consider this to be the most likely source for a “uniquely human” language system. A definition of FLN that rules out such possibilities fails at its assigned task. In contrast, a graded interpretation reserves space in FLN for any subsystem that can be shown to have been adapted for language from some evolutionary precursor. The FLN/FLB distinction is, nonetheless, far from vacuous, because FLB can include components of the language faculty that were almost certainly carried over intact from other faculties (e.g. aspects of vocal tract anatomy, some concepts underlying word meanings, and the low-level mechanisms of sensory processing, motor control, and neural plasticity).

To illustrate: The use of rhythm is common to language, music, dance, and possibly even primate displays, as FHC observe. However, the particular way rhythm is put to use in each of these is different, in the same way that human fingers and toes have similar gross morphology but distinct details and specializations. Therefore a useful taxonomy for components of language must at least allow for the possibility there is something special to language about speech rhythm that goes beyond a general rhythmic capacity. The same might be said of vocal imitation: humans can more or less imitate animal noises and car horns and buzz saws; and people can imitate melodies, with a great deal of inter-individual variance; and all normal children can imitate the speech pattern of the adults around them in extremely fine and accurate detail. At a crude level this is all “vocal imitation”, but there is something particularly fine-grained, adept, and species-ubiquitous about the imitation of the sound pattern of a language.

Similarly for the concept of ownership: FHC are correct that one finds a rough parallel in animals’ territoriality, but the human notion of ownership, involving rights and obligations and the possibility of trade (Jackendoff, 1992, chapter 4), appears unique. Likewise for conceptions of time: just because various animals demonstrate evidence of recognizing the passage of time does not mean they could ever attain something like the human concept of a *week*. Still another example is the perception of connected speech. FHC, pointing to recent demonstrations that monkeys, like infants, are sensitive to regions of low transition probability in nonsense speech, equate humans’ and monkeys’ perceptual abilities. Yet humans past infancy not only segment speech but continuously map the segments onto an enormous lexicon of minimally contrasting yet semantically distinct words. It is far from obvious that this ability should come for free with a sensitivity to transition probabilities.

The same problem is found in FHC’s discussion of the FOXP2 gene. This is one feature which we *know* is uniquely human: the gene has been sequenced, no other species has the human sequence, and statistical analyses show it to have been subjected to selection in the human lineage. True, the gene belongs to a *family* of similar genes found in other mammals, but its exact sequence is uniquely human, and in transcription factors a small sequence difference can radically change the effect of the protein (just as in language, a one-letter substitution can differentiate the meaning of *John appeared to Mary to be brave* and *John appealed to Mary to be brave*). Yet FHC use the similarity between this uniquely human gene and other mammalian genes to assign it to FLB. It is true that when it comes to the separate issue of what it was selected *for*, we can not be certain whether the human version of the gene was selected for language per se or for orofacial praxis. But the

alternatives are empirically distinguishable, and the former seems far more likely. Fine control of the articulators, one aspect of the evolutionary improvements necessary for language, would yield an advantage in orofacial praxis as a by-product, but the reverse is not true: enhancement in oral praxis would not be expected to yield the advantages in grammatical production, comprehension, and judgment documented in the possessors of the normal version of the gene. Moreover, language is a salient difference between humans and chimpanzees in their talents and lifestyles, but (as far as we know) orofacial praxis is not. Thus an FLN/FLB distinction that relegates this uniquely human, language-facilitating feature to the FLB side, with the implication that it did not figure in recent selectional history of human language, does not seem like a perspicuous way to analyze the evolution of language.

Worse, FHC sometimes assign to FLB any trait that is reminiscent of a trait found *anywhere in the animal kingdom*, such as vocal imitation in songbirds (and seals and dolphins), which uncontroversially evolved independently of language in humans. This is problematic. Despite FHC's emphasis on the comparative method, their lumping of close relatives and remote relatives into the category "animals," and their lumping of traits with homologues and traits with analogues into the category "not uniquely human," is antithetical to that method. For instance, the presence of vocal learning in songbirds but not chimpanzees and gorillas has a completely different interpretation than would the presence of vocal learning in the latter two taxa. The former possibility suggests that vocal learning emerged in the evolution of the human lineage (possibly in response to selective pressures that overlap with those that shaped birdsong); the latter would suggest that vocal learning did *not* emerge in the human lineage, but rather in the evolution of a common ancestor of apes and humans, and indeed may be an evolutionary holdover in our species with no new adaptive function at all. An FLB category that collapses analogies to distant relatives and homologues to close relatives is incapable of capturing this key distinction.

In their first paper, the authors acknowledged this issue. In explaining why the FLN/FLB is significant in the first place, HCF suggest that:

most, if not all, of FLB is based on mechanisms shared with nonhuman animals...In contrast, we suggest that FLN—the computational mechanism of recursion—is *recently evolved* and unique to our species' (p. 1573, emphasis ours).

The contrast they draw between "shared with nonhuman animals" and "recently evolved" makes sense only if the animals in question have a recent common ancestor (as is the case with chimpanzees). If the animals are sparrows or dolphins, then a trait (such as vocal learning) could be shared with the animal *and* recently evolved, rendering the "in contrast" a non sequitur.

3. The recursion-only hypothesis

FHC repeatedly claim that we misunderstand their hypothesis about the content of FLN. Yet their statement of the hypothesis is extremely unclear.

Quoting their original paper, FHC assert that FLN comprises "only the core computational mechanisms of recursion as they appear in narrow syntax and the

mappings to the interfaces.” However, this characterization is ambiguous: it could mean either “mechanisms of recursion as they appear in [syntax and the mappings to the interfaces]” or “[mechanisms of recursion as they appear in syntax] and [the mappings to the interfaces].” On the former reading, the hypothesis would seem to be falsified by the evidence presented in PJ to the effect that much besides recursion is specific to the language faculty. On the latter reading, the claim is rather uninteresting, because “mapping to the interfaces” is left vague in both articles. In FHC (and the online appendix) the mappings to the interfaces are said to “include aspects of phonology, formal semantics and the lexicon insofar as they satisfy the uniqueness condition of FLN.” But the “insofar” clause turns this part of the hypothesis into a tautology: other than recursion, the uniquely human/uniquely-linguistic subset of language consists of whatever aspects of phonology, semantics, and the lexicon prove to be uniquely human and uniquely linguistic.

Moreover, FHC equivocate on what the hypothesis actually consists of. They write:

The only “claims” we make regarding FLN are that 1) in order to avoid confusion, it is important to distinguish it from FLB, and 2) comparative data are necessary, for obvious logical reasons, to decide upon its contents.

But they immediately make a third claim regarding FLN, namely the recursion-only hypothesis (reproduced from the original article). They then add: “To be precise, we suggest that a significant piece of the linguistic machinery entails recursive operations...” which actually substitutes a weaker claim: “recursion only” becomes “recursion as a significant piece.” This is soon replaced by a still weaker version, namely, “We hypothesize that ‘at a minimum, then, FLN includes the capacity of recursion’.” Thus in the course of a single paragraph, recursion is said to be the only component of FLN, a significant component of FLN, and merely one component of FLN among others.

Indeed, under the absolute definition of FLN employed in the FHC paper (see Section 2 above), even the weakest version of the recursion-only hypothesis appears to be false. We agree that true recursion, with hierarchical structures of unlimited depth, does not seem to be present in any other known animal communication system. However, FHC assert that “[t]here are no unambiguous demonstrations of recursion in other human cognitive domains, with the only clear exceptions (mathematical formulas, computer programming) being clearly dependent on language.” Yet there does seem to be a clear case in human visual cognition (we do not know about animals). Consider [Fig. 1](#) (next page):

This display is perceived as being built recursively out of discrete elements which combine to form larger discrete constituents: pairs of *xs*, clusters of two pairs, squares of eight clusters, arrays of four squares, arrays of four arrays, and so on. One could further combine four of these super-arrays into a still larger array, and continue the process indefinitely. So, to use Chomsky’s term, we have here a domain of “discrete infinity” in visual perception, with hierarchical structure of unlimited depth, its organization in this case governed by gestalt principles. Presumably the principles that organize [Fig. 1](#) play a role in perceiving objects in terms of larger groupings, and in segregating individual objects into parts, parts of parts, and so on. Similar principles of grouping apply in music ([Lerdahl & Jackendoff, 1983](#)). This shows that recursion per se is not part of FLN under FHC’s definition. (Indeed, in PJ we argued that the main reason that recursive syntax evolved is to express recursive structures in cognition.) Their construal of the FLN/FLB

and psychologists, “language” has much more general and various meanings, roughly captured by “the communication system used by human beings.”

They identify the former sense of “language” roughly with FLN and the latter with FLB. They remark that “[t]he distinction itself is intended as a terminological aid to interdisciplinary discussion, and obviously does not constitute a testable hypothesis.” Actually, this distinction is far from theoretically innocent.

First, note that their characterization of FLN as “an abstract core of computational operations, central to language,” or in HCF, “core computational mechanisms of recursion as they appear in narrow syntax and the mappings to the interfaces,” is more specific than our own taxonomy, which spoke simply of aspects of language that are specific to it (it is this difference that HCF refer to as our “misunderstanding” of their argument). The crucial difference is the phrase “an abstract core of computational operations.” HCF identify this core with recursion, in accord with the Minimalist Program, where the rules of grammar are reduced to the basic recursive operation of Merge. In turn, the recursion-only hypothesis identifies this core with FLN. Crucially, this core of operations excludes the lexicon, since words are not computational operations, but are rather stored associations of phonological, syntactic, and semantic features.

It is important to realize that this entire line of argument presupposes a particular theory of the language faculty. Not only are there alternatives to that theory—with different implications for the evolution of language—but we believe the alternatives are empirically superior. Among the assumptions of mainstream generative grammar of the past 50 years are that entries stored in the lexicon consist of simple words and morphemes, devoid of the combinatorial structure seen in phrases and sentences, and that phrases and sentences are assembled by operations that build, combine, and move syntactic trees. This theory goes well beyond the traditional distinction between productive computational operations and stored memory entries (some version of which is common to all non-connectionist theories of language), because it identifies the former with a general, recursive syntactic tree-processor and the latter with a list of syntactically unstructured words. Thus the clustering of interlinked concepts in HCF and FHC—language as it is understood by linguists, the core of language, abstract computation, narrow syntax, recursion, and the uniquely human part of language—depends on this conception of the division of labor between grammar and lexicon, a conception that goes back to classical generative grammar and traditional grammar before it (e.g. Bloomfield, 1933).

Despite FHC’s assurances, this conception is not terminological: it is an empirically testable hypothesis. Over the past twenty years, it has come into question through research within a variety of frameworks, especially Construction Grammar (Fillmore, 1988; Fillmore, Kay, & O’Connor, 1988; Zwicky, 1994; Goldberg, 1995, to appear), Head-Driven Phrase Structure Grammar (Ginzburg & Sag, 2000; Pollard & Sag, 1987, 1994), Cognitive Grammar (Langacker, 1998), Lexical Functional Grammar (Bresnan, 1982), and Parallel Architecture/Simpler Syntax (Culicover, 1999; Jackendoff, 2002; Culicover & Jackendoff, 2005); see also Williams, 1994. All of these have concluded that the grammar/lexicon distinction must be reframed.

Space precludes our giving more than a taste of the evidence for this substantial rearrangement of the grammatical universe. But the key phenomenon is the ubiquity of idioms and constructions which defy analysis in terms of principles of combinatorial syntactic phrase structure that apply across the language, on the one hand, and lexical items consisting of individual words, on the other. English speakers know, alongside their knowledge of words, an enormous number of idioms. Many idioms have normal syntax conforming to general rules: *kick the bucket* is a VP, *son of a gun* is a NP, *down in the dumps* is a PP, *the jig is up* is a sentence, and so on. But a few have anomalous syntax, e.g. *by and large*, *for the most part*, *all of a sudden*. Many have variables for open argument places, e.g. *take NP for granted*, *give NP a piece of Pronoun's mind*, *put NP in Pronoun's place*, *the cat's got NP's tongue*. And some have both anomalous syntax and variables, such as *Far be it from NP to VP*, *How dare NP VP!* We also find noncanonical utterance types like (1), as well as other noncanonical pieces of syntax with varying degrees of productivity such as (2).

- (1) a. *PP with NP!* Off with his head! Into the trunk with you!
 b. *How about X?* How about a cup of coffee? How about we have a little talk?
 c. *NP+acc Pred?* What, me worry? Him in an accident? [Akmajian 1984]
 d. *NP and S* One more beer and I'm leaving. [Culicover 1972]
 e. *The more S* The more I read, the less I understand.
- (2) a. *Numbers*: three hundred fifty-five million, one hundred twenty-five thousand, six hundred and thirteen
 b. *Focus reduplication* (Horn 1993, Ghomeshi et al. 2004):
 You make the tuna salad, and I'll make the SALAD-salad.
 Would you like some wine? Would you like a DRINK-drink?
 Do you LIKE-her-like her?
 c. *N-P-N construction* (Williams 1994):
 dollar for dollar, face to face, house by house, month after month

Presumably English is not alone in having a sizable number of these “syntactic nuts” (to use the term of Culicover, 1999).

FHC's definition of FLN contains a quiet hedge against such recalcitrant data. The word *core* in “core computational phenomena” adverts to the distinction made by Chomsky (1981) between “core grammar”—the deep regularities of language—and the raffish “periphery”, which includes “phenomena that result from historical accident, dialect mixture, personal idiosyncrasies, and the like” (Chomsky & Lasnik, 1993). Chomsky and Lasnik advocate “putting aside” such phenomena, which include idioms and constructions of the sort in (1)–(2). And since they cannot be identified with a generic recursion operation, FHC would have to place them in FLB. Yet this defense is unsatisfactory.

First, idioms and constructions are as specific to language as any other syntactic phenomenon. That is, they do not come for free with understanding the concepts underlying word meanings, and therefore cannot be relegated to FLB.

Second, idioms and constructions are not “peripheral” to language on any ordinary understanding of that word. We know of no accurate estimates, but the number of idioms

and constructions that speakers know appears to be of comparable magnitude to the number of words. Furthermore, an examination of any stretch of actual language shows that idioms and constructions make up a substantial proportion of speakers' usage.

Third, relegating the syntactic nuts to the periphery is computationally arbitrary, because they use the same mechanisms of phrase structure and argument structure as the “core” phenomena of canonical words and structures. For instance, idioms such as *take NP for granted* require arguments, just like ordinary transitive verbs. More problematic, they can override even the most basic mechanisms of recursive combination that are assumed to be at the heart of the language faculty. For instance, there are VP constructions in which the complement of the VP is not determined by the verb (Jackendoff, 1990a, 1997a; Goldberg, 1995):

- (3) a. He sang/drank/slept/laughed his head off.
(V his head off = ‘V excessively’)
- b. Bill belched/lurched/joked/laughed his way out of the meeting.
(V his way PP = ‘go PP while/by V-ing’)
- c. Sara slept/drank/sang/laughed the whole afternoon away.
(V NP away = ‘spend NP amount of time V-ing’)
- d. The trolley squealed/rumbled around the corner.
(V PP = ‘go PP, inducing V-ing sound’)
- e. Bill drank the pub dry.
(V NP AP = ‘make NP AP by V-ing’)

The underlined complements in these examples are not determined by the verb, as would happen automatically in standard recursive phrase structure operations. Indeed these constructions preclude the verb taking its own object, e.g. *He drank (*scotch) his head off*, *Sara drank (*scotch) the whole afternoon away*, etc. Goldberg and Jackendoff have argued that these constructions are idioms with VP structure in which the verb functions as an argument rather than playing its default role as semantic head. Hence these “peripheral” phenomena commandeer the same computational machinery as the “core” phenomena of phrase structure and argument structure; they are not simple, ad hoc bits that are memorized by some mechanism separate from the combinatorial engine of language. Perhaps not coincidentally, idioms, constructions, and other syntactic nuts have been virtually ignored within the mainstream traditions of Government-Binding Theory and its successor, the Minimalist Program.

The conclusion from these widespread phenomena is that human memory must store linguistic expressions of all sizes, from individual morphemes to full idiomatic sentences (such as *The jig is up*). These expressions furthermore fall along a continuum of generality, defined by the number and range of variables they contain. At one extreme are word-like constants such as *dog* and irregular forms such as *bought*, with no variables to be filled. Moving along the continuum, we find mixtures of idiosyncratic content and open variables in idioms like *How dare NP VP* and *take NP for granted*. Still more general are the argument structures of individual predicates such as *dismantle NP* and *put NP PP*. Finally, at the other extreme are rule-like

expressions consisting only of very general variables such as $V \rightarrow V$ -suffix and $VP \rightarrow V$ (NP).²

The distinction between lexical storage and grammatical computation no longer corresponds to a distinction between simple morphemes and recursive combination of syntactic trees. Rather, grammatical knowledge is embedded in stored entities of various sizes containing various proportions of variables. The combinatoriality of language is achieved by an operation called Unification (Shieber, 1986), a constraint-satisfaction formalism which uses expressions to instantiate the variables of other expressions (a bit like solving simultaneous equations), thereby creating larger data structures containing mutually consistent syntactic, semantic, morphological, and phonological information. Unlike the recursive Merge operation in Chomsky's MP, it combines expressions of any size and composition, not just words and syntactic trees (Culicover & Jackendoff, 2005). Unification may be a fundamental operation throughout perception and cognition; if so, the language-specific part of grammar would reside in the nature of the stored representations (their constants and variables) rather than in the operation that combines them.

The "construction-based" view of language that emerges from these considerations, if correct, has consequences for the study of language processing, acquisition, and, most germane to the present discussion, evolution. If a speaker's knowledge of language embraces all the words, all the constructions, and all the general rules, coded in the same format, then there is no coherent subset of language that "delineate[s] an abstract core of computational operations", i.e. FHC's notion of FLN. Thus this alternative theory, which we believe has considerable empirical support, challenges FHC's program of identifying the language-specific, human-specific part of language with the "core computational operations" and in turn (with the help of MP) with the single operation of recursion.

The larger design of language then looks as follows. A typical word is an association of a piece of phonological structure, a piece of syntactic structure, and a piece of conceptual structure. Conceptual structure, which captures the algebraic aspects of meaning relevant to linguistic expression (e.g. excluding sensory and motor imagery), is a mental representation that supports formal inference and is present in simpler form in nonlinguistic organisms such as apes and babies (Jackendoff, 1983, 1990a, 2002; Pinker, 1989, 1994).³ Most of the semantic information associated with utterances comes from the conceptual structures in the words

² In some ways, this approach suggests a recasting of the traditional distinction between lexicon and grammar, or words and rules, and in particular the notion that irregular forms are stored in the former and regular forms are computed by the latter. As noted by Jackendoff (2002, chapter 6) and Pinker (1999, pp. 22–24), in this view irregular forms are stored as constants; regular forms are built by composing a stem with a regular affix (whose stored form contains a variable for the stem). All the standard arguments for separation of the two mechanisms (Pinker, 1999; Pinker & Ullman, 2002) can be carried over into this interpretation.

³ FHC say of our notion of Conceptual Structure, "Perhaps [PJ] have in mind a "language of thought," which evolved prior to FLB and includes its basic internal computational mechanisms. But that assumption simply transfers the basic questions of evolution from language to a language of thought, and this new problem cannot even be posed until we are told what the language of thought is." We find this criticism disingenuous, in light of the fact that Jackendoff (1983, 1987, 1990a, 2002, and many other works) and Pinker (1989, 1994) have painstakingly characterized Conceptual Structure as a combinatorial and recursive language of thought used in inferential reasoning, explained how it differs from Fodor's (1975) notion of the Language of Thought, and discussed its possible evolutionary antecedents.

themselves. What distinguishes true language from just collections of uttered words is that the semantic relations *among* the words are conveyed by syntactic and morphological structure, which are largely unique to humans and language. Productivity and compositionality are implemented by the instantiation of variables in stored structures through the process of unification, which applies in phonology, syntax, and semantics. Syntactic rules or principles are regarded as general constructions with maximally unrestricted variables, sometimes but not always bleached of meaning.

In this view, syntax is the solution to a basic design problem: semantic relations are recursive and multidimensional but have to be expressed in a linear string. In particular, propositional structure (who did what to whom) is orthogonal to referential dependencies such as scope of quantification, and both are partly orthogonal to information structure (new vs. old information, topic/focus/common ground). Syntax has to multiplex these conflicting dimensions of structure into a single output representation. Within a language, the result can be alternative word orders: *I saw that movie* (*movie* is what is seen, presented as new information) vs. *That movie, I saw* (*movie* still is what is seen, but is now presented as the topic). Crosslinguistically, the different dimensions may be simultaneously conveyed using grammatical devices such as case, intonation, and word order. The online appendix to FHC alludes to such conflicts among semantic dimensions as the motivation for movement in grammar, citing Chomsky, 2000; the identical point was made almost three decades earlier by Jackendoff (1972, 384–386). The upshot is that syntax (and hence syntactic recursion) is not to be regarded as the central generative capacity in language, from which all productivity in expression derives. Rather it is a sophisticated accounting system for marking semantic relations so that they may be conveyed phonologically.

The construction-based view of language was not developed specifically with evolutionary plausibility in mind, but it has a happy consequence: it makes it natural to conceive of syntax as having evolved subsequent to two other important aspects of language: the symbolic use of utterances (as posited by Deacon, 1997; Aitchison, 1998, for example) and the evolution of phonological structure as a way of digitizing words for reliability and massive expansion of the vocabulary (Pinker, 1994; Nowak & Krakauer, 1999). Only after these more basic aspects of linguistic communication are in place could there be any adaptive advantage to the system's developing regimented syntactic means to arrange words into larger utterances, so that semantic relations among words could be expressed in conventionalized fashion. Thus the construction-based theory, in addition to its advantages in accounting for contemporary language, permits a natural integration of evolutionary considerations as well.

5. Conclusion

Despite these disagreements, we agree with FHC's renewed call for multidisciplinary research that compares language to capacities elsewhere in human and animal cognition, and for analyzing language not as a monolith but as a combination of components, some special to language, others rooted in more general capacities in human or animal cognition. Indeed our own work has emphasized the value of such research for many years (e.g. Jackendoff, 1983, 1987, 1992, 2002; Lerdahl & Jackendoff, 1983; Pinker, 1994;

Pinker & Bloom, 1990). We thus applaud the experimental work of Hauser and Fitch and the new efforts by Chomsky to connect his theories of grammar to evolutionary considerations.

We demur, however, from some of their classificatory dichotomies, which prejudice the issues by making some hypotheses—in our view the most plausible ones—impossible to state. These include (1) the Narrow/Broad dichotomy, which makes space only for completely novel capacities and for capacities taken intact from nonlinguistic and nonhuman capacities, omitting capacities that may have been substantially modified in the course of human evolution; (2) the current-utility/original-function dichotomy, which conceals the possibility of capacities that are adaptations for current use; (3) the human/nonhuman dichotomy, which fails to distinguish similarity due to independently evolved analogous functions from similarity due to inheritance from a recent common ancestor; and (4) the core/noncore and syntax/lexicon dichotomies, which omit the vast set of productive linguistic phenomena that cannot be analyzed in terms of narrow syntax, and which thus incorrectly isolate recursion as the only unique development in the evolution of language.

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