Language, Representation and Reasoning
Memorial volume to Isabel Gómez Txurruka

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On innate and specific aspects of human language[1]

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"...my challenge to Wunderlich and other proponents of an innate UG — a challenge that may be directed at anyone in any scientific field who proposes any hypothesis—is simply:What exactly is and is not in UG and what kind of evidence could possibly refute the UG hypothesis?
(Tomasello 2004:644)

Abstract

The claim that human language is largely dependent on innate mechanisms made in the late fifties by Noam Chomsky, though extremely controversial at the time, has become common ground in current language research. Here, I briefly review the history and nature of the *Universal Grammar* hypothesis, and discuss the relevance of some findings from artificial language studies, which provide evidence that innate internal conditions play a crucial role in the representation and processing of human language by the brain. These studies also consider whether those innate mechanisms are shared with other species, or are exclusively human, maybe even language-specific. Briefly put, I present a review of the hypothesis of Universal Grammar as it was born in the late 1950s, in the light of recent studies with artificial languages in both human and non-human organisms.

Keywords: Generativism, innatism, recursion, artificial language, neuroscience.

[1] I am grateful for the opportunity to contribute to this volume in honor of my colleague Isabel Gómez Txurruka; though we knew each other for too brief a time, her untimely death brought it to light that we had several unknown friendship links. It is trough some of those, in particular thanks to Jorge Pintor, that I have learned that she was as beloved as friend as she was liked and admired as a teacher and colleague. I would like to thank Andreu Cabrero, Kepa Erdozia, Aritz Irurtzun, Guillermo Lorenzo, Christophe Pallier, Nuria Sebastián and Juan Uriagereka for valuable comments and feedback on earlier drafts of this paper. However, misrepresentations and shortcomings are solely mine. Research funded by MEC CSD2007-00012, SEJ2007-60751/PSIC, UPV/EHU GIU06/52.

1. Introduction

Linguistics aims at discovering and characterizing the properties of human language(s). Here, I will discuss some results obtained from a variety of sources, mostly in neighboring fields within Cognitive Science, that bear on this central issue. The findings to be reviewed have been obtained from artificial languages, not from natural, existing or documented human languages, which are often thought of, mistakenly, as the only source of evidence in linguistic exploration. The term *artificial language* is understood broadly, encompassing various kinds of language-like input: the set includes (a) mere sequences of sounds or symbols (b) sounds obtained from manipulations of natural language, (c) made-up grammars that either display or do not display some hypothesized property of the human language faculty. These artificial grammars may or may not have meaning associated to its units and combinations. I will focus on what we can learn from them in our search for the innate and specific properties human language, also referred to as *Universal Grammar.*

2. The (contemporary) origin of the Universal Grammar hypothesis

One of the most controversial and influential aspects of Chomsky's legacy is the hypothesis that there is an innate and specific component to language, which he named *Universal Grammar* (Chomsky 1966), in homage to the rationalist thinkers in whose footsteps he was walking. That is why I would like to go back, about half a century, and start with a piece of literature that is crucial for understanding what the research program of generative linguistics is, and also what the current research program is in the interdisciplinary study of human language composed by various fields within Cognitive Sciences. I am referring to the review that Chomsky wrote of B.F. Skinner's account on human language on the basis of behaviorism, entitled *Verbal Behavior* (1957).

The hypothesis that there are innate organism-internal factors that constrain the languages that humans know and use sounded preposterous to most scholars in the Humanities and Social Sciences back in 1959, when Chomsky published it. The universal grammar (UG) hypothesis, as he later named it, has since generated a great amount of research, discussion and argument. In other fields however, such as biology, the claim that human languages are largely shaped by innate conditions not only did not encounter resistance at the time, but was received with sympathy, because it naturally

converged with a general view of living organisms and the importance of genetic factors in behavior. Thus, for instance, the famous Royaumont debate of 1975, where Chomsky and Piaget presented their views and argued their positions with a selected audience of scientists was in fact organized by biologists, not linguists or psychologists: "There was every reason (in our opinion) to expect that these two schools of thought should find a compromise, and that this grand unified metatheory would fit well within modern molecular biology, and the neurosciences. Both systems [Chomsky's and Piaget's] relied heavily on 'deeper' structures, on universals, on precise logico-mathematical schemes, on general biological assumptions. This was music to a biologist's ears." (Piattelli-Palmarini 1994:322).

I think it safe to say that, fifty years later, it is widely accepted that innate mechanisms have a relevant role to play in a full understanding of the human capacity for language. Current disagreements concern the nature and specificity of those mechanisms, both respect to our species and to the cognitive domain(s) where they apply.

So the question I would like to pursue is: what are the contents of UG? That is to say, what has been discovered regarding the hypothesized innate and specific component of human language since it was argued, half a century ago, to constitute a significant part of a human's knowledge and representation of language? In my pursuit for an answer, I will not engage in an exhaustive review of the variety of linguistic arguments and evidences put forward during these years to substantiate the hypothesis within linguistic theory. Rather, I will look at a variety of mechanisms that stand the sharpest tests for innateness, and discuss which ones are good candidates for language specificity (therefore UG membership) and why.

A secondary goal of this talk is to bring to the attention of linguists and philosophers results and findings from neighboring fields within cognitive science that directly bear on the issue of innateness and specificity in language. As a theoretical linguist who has become increasingly engaged in cooperative, experimental research with cognitive psychologists, I believe the benefits of this interdisciplinary way of working largely surpass the frustrations and communication difficulties that are inevitably encountered along the way. I will discuss discoveries related to innateness and specificity relatively well known by language researchers within experimental domains of cognitive psychology, but perhaps not equally well known in theoretical linguistics, and discuss their relevance both to the research program that took off some fifty years ago with the birth of generative grammar, and to our current concepts of grammar and language.

I would like to caution against the temptation to take it for granted that any innate property found in language must necessarily be part of UG. As

we will see, innateness is a necessary condition for a given mechanism to belong in UG, but not a sufficient one: specificity is also required. UG should contain only those properties of language, if any, that cannot be fully accounted for elsewhere, for example in the sensory-motor side of language or in the conceptual-semantic component, both of which seem to largely predate grammar. We must therefore consider which properties appear to stand the test of specificity to language, always considering the possibility of an alternative view such that they were plausibly shown not to be either innate or specific to the language system. This approach, this research strategy, is consistent with recent developments in generative grammar referred to as Minimalism (Chomsky 1995) which necessarily leads us to reflect on what UG is and to try to reduce it, trim it and pare it down to its "bare necessities" (see Piattelli-Palmarini 2002 for a brief characterization of Minimalism in Linguistics).

The term Universal Grammar is not used in the 1959 review, but the hypothesis, though nameless and embryonic, was already there, right at the start. The word "innate" appears three times in the review, once referring to imprinting in animals, and twice referring to human language in the context of language acquisition. One instance of the latter is this:

> "As far as acquisition of language is concerned, it seems clear that reinforcement, casual observation and inquisitiveness (coupled with a strong tendency to imitate) are important factors, as is the remarkable capacity of the child to generalize, hypothesize and process information in a variety of very special and apparently highly complex ways which we cannot yet describe or begin to understand, and which may be largely innate, or may develop through some sort of learning or maturation of the nervous system. "(Chomsky 1959: 43)

We can see that Chomsky is not regarding imitation as irrelevant for the acquisition of language; he is making the point that it will not suffice to tell the whole story. In fact imitation is a crucial, rather distinctive property of humans, and our imitation is highly sophisticated (Meltzoff and Printz 2002). Despite this, language acquisition researchers have found abundant evidence that imitation alone cannot fully account for language learning. The crucial issue in the quote is that it appeals to (then unknown) conditions that determine the process of language acquisition – i.e., hypothetical acquisition mechanisms which were "complex ways which we cannot yet describe or begin to understand". Today, although we still do not fully understand them, we have come a pretty long way. Some of the "special and apparently highly complex ways" in which infants process linguistic input

have been discovered in recent years, both for phonology (Sebastian 2006) and for syntax/morphology (Yang 2002, 2004), and will be discussed later.

The second reference to innatism in language is found when considering acquisition of the lexicon. Chomsky (1959:42) says: "It is possible that ability to select out of the auditory input those features that are phonologically relevant may develop largely independently of reinforcement, through genetically determined maturation. To the extent that this is true, an account of the development and causation of behavior that fails to consider the structure of the organism will provide no understanding of the real processes involved."

Again, though at the time they stirred minds and thoughts, from a contemporary perspective these words do not say anything out of the ordinary; there is widespread agreement that, already at birth, infants do in fact select certain features from the auditory input, some of which we will later discuss (Eimas et al. 1971, Eimas et al. 1987, Mehler et al 1988, Werker & Tees 1984), and that brain maturation is crucially involved in the various stages of early language acquisition. Today, few experts would disagree with the claim that it is crucial to know the structure of the human brain and in order to have a full picture of language acquisition, processing and representation. It is about the nature, specificity and extent of these organism-internal conditions that the debate is taking place nowadays.

In 1959, however, none of this was so clear. In discussing Lashley's work on neurological processes, Chomsky (1959:55) proposed a research program for linguistics: "Although present-day linguistics cannot provide a precise account of these integrative processes, imposed patterns, and selective mechanisms, it can at least set itself the problem of characterizing these completely." This research program should be of relevance to the study of the brain, and vice-versa: "The results of such a study [of the characterization of the mechanisms of language] might, as Lashley suggests, be of independent interest for psychology and neurology (and conversely)." (ibid., p.56)

These statements, which sounded extremely foreign to researchers in linguistics and psychology at the time, paint a landscape that has become the dwelling space of contemporary linguistics and cognitive science (Fisher & Marcus 2006). This expectation of mutual importance and increasing convergence is our present: there is a vast amount of research in human language where linguists listen to what other fields can contribute about human language, and conversely. In sum, the two main conceptual seeds in the *Review of Verbal Behavior* have clearly stood the test of time. The first such seed is that there are innate aspects to our knowledge of language, and the second one is that if we want to understand them, we first need to know

in depth what language is like. Finding this out is the natural research program for linguistics.

To answer the question of what language is like, we turn now to Chomsky's 1957 work, *Syntactic Structures*. This small book, which had a hard time finding a publisher, was very successful. It proposed an approach to the study of language that set up most of the foundational issues still in the background of the discussion today, as I would like to show you.

The goal of linguistics, according to *Syntactic Structures* is to determine "... the fundamental underlying properties of successful grammars. The ultimate outcome of these investigations should be a theory of linguistic structure in which the descriptive devices utilized in particular grammars are presented and studied abstractly, with no specific reference to particular languages." (Chomsky 1957: 11)

Whereas the *Review of Verbal Behavior* is very much concerned with biological aspects of language, *Syntactic Structures* focuses on the formal architecture of grammar and its abstract properties, without mentioning biology or psychology. Years later, in the eighties, both sides of this research program, the biological/psychological side and the formal/abstract side, would appear hand in hand, as in this more recent quote from *Knowledge of Language*:

> "The nature of this faculty is the subject matter of a general theory of linguistic structure that aims to discover the framework of principles and elements common to attainable human languages; this theory is now often called "universal grammar" (UG), adapting a traditional term to a new context of inquiry. UG may be regarded as a characterization of the genetically determined language faculty."(Chomsky 1986: 3)

Given this characterization, UG would therefore include those aspects of language that are not fully determined by experience. However, primitives and mechanisms involved in language that are not specific to language could (and should) be excluded from UG, because they belong to broader or related but independent cognitive domains.

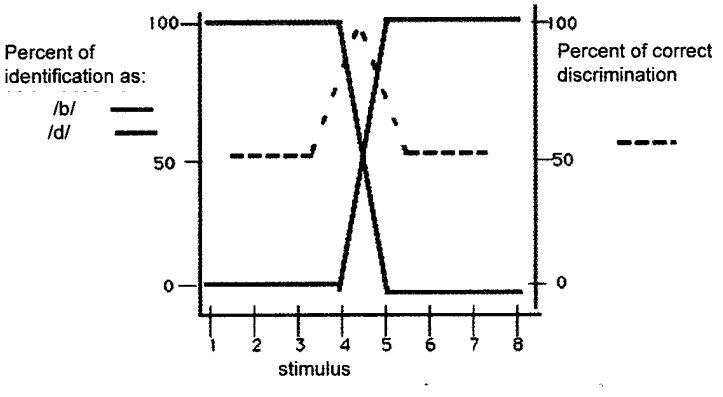
3. Innateness and (but not or) specificity required for UG: two (bad) examples

This naturally brings us to consider innateness and specificity in greater detail. These two properties are not synonymous, for a given trait might be innate in a species, but not specific to it, as is the case with fear of snake-like forms in mammalians. Also, there are increasingly restrictive degrees of

specificity, relative to a species or relative to a cognitive domain. A given property could be human-specific, but not necessarily language-specific. This point was already discussed in the Royaumont debate in 1975, as this remark by Chomsky shows:

> "On this point I agree with Premack. I think he is right in talking about two different problems that enter into this whole innateness controversy. The first is the question of the genetic determination of structures... the second problem concerns specificity." (Piattelli-Palmarini 1980:179)

There are properties that constitute necessary prerequisites for language, which are innate but which are clearly not specific, either to humans or to language. However, in the history of discovery, such mechanisms have often been thought (especially when noticed for the first time) to be specific to both humans and language. A lesson from history, therefore, is that when in our research path we find some innate mechanism or pattern characteristic of human language, we would be wise to check whether it is really specific to humans or language. One example of an innate property present in language and active in the earliest stages of language acquisition, well known to psychologists but perhaps not equally well known among linguists, is categorical perception (CP). The following graph illustrates what CP is:



CATEGORICAL PERCEPTION OF /b/ AND /d/ (after Liberman et al. 1957)

Fig. 1. Categorical Perception of /b/ and /d/ (after Liberman et al. 1957).

This graph (made after Liberman et al. 1957), shows how native speakers of English perceive two distinct phonemes in an acoustic continuum: while the acoustic distance between stimuli is proportionally identical in all relevant parameters, (a) stimuli 1-4 are perceived as similar,

equal, that is, as the phoneme /b/, whereas (b) stimuli 5-8 are perceived as different from all 1-4, and as similar among them, equal, that is, as phoneme /d/. The perceptual change is sharp, as the red and blue lines show. To the person's ear, the sound category "changes" to another category sound at one small area in the acoustic continuum. That is why the lines in the graph goes down sharply, showing a sudden perceptual change.

Language was central in the discovery of this perceptual mechanism, which was originally reported by Liberman et al. (1957), and was taken as evidence that speech is perceived differently from other types of auditory stimuli. At that time it was thought that CP was acquired in life and language-specific. Later, Eimas et al. (1971) found CP in babies (1-4 months), which meant it was an innate mechanism. A few years later, Kuhl and Miller (1975) successfully trained chinchillas to perceive the voicing contrast between /da/ and /ta/ categorically. In short, as a great amount of experimental work has shown, CP is innate, but it is not restricted to speech or speech-like stimuli and occurs with stimuli that bear no resemblance to speech sounds as well (Harnad 1987). In fact, even crickets have been reported to show signs of CP (Wyttenbach et al. 1996).

So here is a perceptual mechanism that is probably essential to understanding and explaining certain architectural properties of language categories such as *discreteness*, a fundamental property of phonemes, morphemes and words (but not of all word-meanings) that turns them into sharp-edged categories, with no fuzzy boundaries of good and not-so good exemplars, with no prototypicality effect of the type we find in concepts (Rosch 1978). But the perceptual mechanism of categorical perception is not specific to language or to our species, though it is innate and critically involved in language development and perception. This does not render it irrelevant or uninteresting for a language researcher, of course, but it clearly makes it a poor candidate for UG because it operates in a broader domain, it lacks specificity.

Another example of an innate mechanism that is very significant for language acquisition is found in the study of the perceptual salience of rhythmic/prosodic properties of speech. Interestingly, the history of its discovery raises a similar point to the one in the previous example. It was originally discovered that newborns are very good at discriminating language groups based on rhythmic information: hours after being born, it can be detected that they can discriminate their mother's language-type using this information (Mehler et al. 1988, Cutler and Mehler 1993, Ramus and Mehler 1999, Nazzi et al. 1998). This capacity is already functioning at the time of birth, and it makes a suitable candidate for a language-specific perceptual mechanism. Recently, however, it was learned that tamarind

monkeys (Ramus et al. 2000) and rats (Toro et al 2003, Toro 2005) can detect rhythmic contrasts too, though not as well as humans. Again, here is a mechanism that appears to be a prerequisite for language, which is not specific to humans; it is a perceptual capacity that non-linguistic beings can display. It is an interesting issue to determine the nature of cross-species differences, but this quest might not provide us with a persuasive candidate for a UG-property.

Accordingly, when we try to determine the fundamental underlying properties of human language, we must first distinguish between prerequisites to language that we share with other species, and those properties, if any, that are specific to language (and therefore to humans). In the words of Hauser, Chomsky and Fitch (2002: 1570), "The empirical challenge is to determine what was inherited unchanged from this common ancestor, what has been subjected to minor modifications, and what (if anything) is qualitatively new."

4. Innateness and developing specificity: an example from phonology

The question of whether there are truly unique linguistic mechanisms is an empirical one, and it is not a conceptual necessity that there exist UG, certainly. It could very well turn out to be empty, if all likely properties were found not to meet both of the required conditions, as we keep on discovering in greater detail the nature and phylogenesis of language processing and representation: "None of this challenges Chomsky's long held conjecture that children are innately endowed with a universal grammar — a set of mental machinery that would lead all human languages to have a similar abstract character. But that shared abstract character may have as much to do with our lineage as vertebrates as with our uniquely human innovations. In Charles Darwin's immortal words, "throughout nature almost every part of each living being has probably served, in a slightly modified condition" in some ancestor or another."(Marcus 2006:1118)

There are undoubtedly important discoveries to be made regarding, phylogenetically ancient and more recent mechanisms that our species might be using and evolving in slightly different ways, in general or particular cognitive domains. Usually, the debate about specificity in language is framed as a yes/no question, whereas what I would like to stress, is that perhaps we will increasingly find that some inherited, pre-linguistic mechanisms have become specialized and combined in humans for mental tasks that our biological relatives have not developed. It is to be expected

also, to find similar computational solutions implemented in evolutionarily and genetically distant species with relevant cortical similarities, as might be the case with singing birds.

Both in the case of categorical perception (CP) and in the case of rhythm detection, humans appear to be particularly good at these capacities and apply them to a novel function (language) in order to select categories that are more abstract than acoustic (or visual) objects, such as phonemes or words. Our task is to find out how this happens, how we push these mechanisms to take a path that other creatures do not tread – the path of language, with categories and representations further and further removed from sensory perception.

Let us review the acquisition of phonemes in more detail as an illustration of what I mean. What crickets and chinchillas are trained to do in categorical perception experiments is acoustic discrimination, but crucially not phoneme perception. Young toddlers are capable of fine-grained phonetic discrimination, so that a child born in a Japanese-speaking community will be able to discriminate between /r/ and /l/ even though this distinction is not phonologically relevant in Japanese, and even though the adults surrounding this baby cannot perceive the distinction.

Werker and Tees (1984) showed that at about ten months of age, children "specialize" for those contrasts that are phonologically distinctive in the language they are acquiring, and become like their parents, in that they no longer discriminate contrasts that are not phonologically relevant in their language. From what we know, this specialization process only happens in humans. Apparently, what we humans do is build a second, higher level of representation on top of a basic, common auditory capacity. Though the extent to which animals have phonetic discrimination capacities similar to those of humans is still unknown, I am assuming it is roughly equivalent but nothing in the argument would change if we were to find out that even auditory perception is not equivalent across chinchillas, monkeys and humans.

This higher order category children represent through development is the phoneme, a language-specific category. We take a mechanism for auditory perceptual discrimination, and build a language category apparently using the same mechanism, in ways that are still not completely understood. In this regard, the peculiar thing about human babies is that they are able very quickly to construct something new, something different, using largely an old perceptual mechanism.

If we go back to *Syntactic Structures* again, one of the central claims made there was that to understand the structure of human language, a first thing to understand is that language involves different levels of

representation. Phonology and syntax, for example, have their own separate primitives and rules, though clearly the different levels are connected. This general picture, is widely agreed in linguistics today, but it was not an agreed property of language in the late fifties. In this light, what human babies do is build a repertoire for a new type of category, the phoneme, apparently using the same perceptual mechanism for acoustic perception, and presumably employing other, perhaps less types of cues for category membership. Accordingly, we are now talking about something that is "qualitatively new" in human language, though the means to develop is an older, more general perceptual mechanism.

5. Innateness and specificity (not necessarily exclusiveness): example from syntax

It is widely accepted today that syntax is the most innovative and specific component of human language, and this aspect of language is the one that generates most controversy in studies on the evolution and specificity of language. The reason is that it is in syntax that we find hierarchical structures, constituents and recursion. As we will see, some recent studies suggest there is a wide gap that seems to set humans apart from other species regarding some aspects of this computational capacity.

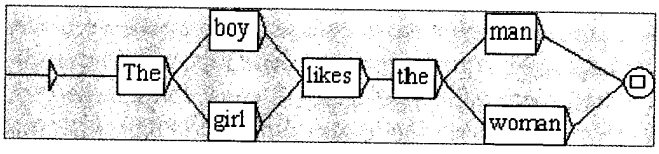
The combinatorial and recursive nature of grammar that *Syntactic Structures* argued for are also common ground in linguistics today, as we can see for instance in this quote from O'Donnell, Hauser and Fitch (2005:285): "There are other universals, which are so basic that they are implicit in every linguistic theory and become most obvious when we compare language with other animal communication systems. These include the fact that language is built up from a set of reusable units, that these units combine hierarchically and recursively, and that there is systematic correspondence between how units combine and what the combination means."

So we move to syntax, the component of language furthest removed from sensory perception. Again, we start by remembering one of the main arguments in *Syntactic Structures* – i.e., that phrase structure, or constituency, is an essential property of human languages that models of language must capture.

Let us remind ourselves of the original argument in *Syntactic Structures*, for it will soon become relevant in our discussion: language cannot be captured by a model with no phrase structure. For instance, language cannot be captured by a finite state grammar (FSG). In a FSG you generate a piece of language by going from one point/state/word to the next along whichever

path you choose among the ones available, until you reach the final state, at the end of the path:

(2)



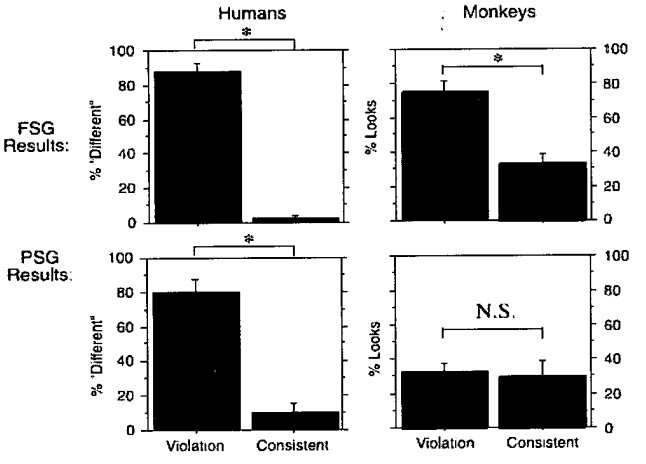
This grammar does not give you any kind of constituency, an important problem if you want to understand and explain how human language is organized. *Syntactic Structures* shows that certain aspects of English cannot be accounted for by a grammar like the one in (2). The reason why this is so is that the syntactic structures of human languages can resemble matriuskas, those Russian wooden dolls you open to find smaller but identical dolls nested inside. Consider for instance the English sentence, for which a rudimentary constituent structure is offered:

(3) [[The girl [the boy saw]] [thinks [the parrot likes cherries]]]

Here, we find sentences nested inside sentences, and there is no grammatical limit to the number of times I can make a bigger doll, a longer sentence, by stacking more and more. Of course, this is not only a property of English, but a property of language, and the fact that all human grammars can build these matriuska-structures tells us that this is a very essential aspect of human language. This property receives the name of *recursion.* Here, I will focus on three recent studies that have asked whether phrase structure is qualitatively new and specific to humans and language. That is to say, whether recursion is a suitable candidate for UG membership.

Fitch and Hauser (2004) have asked this very question regarding species-specificity. They taught two artificial languages to two groups of tamarind monkeys, where the difference between the two languages was precisely phrase structure. Whereas one language could be accounted for by a FSG, the other one had to be accounted for by a phrase structure grammar (PSG), so the FSG could not capture it. Fitch and Hauser found that tamarinds, given time, did quite all right distinguishing grammatical versus ungrammatical sequences for the FSG, but interestingly, they could not manage to learn the PSG.

(4)



In (4), taken from Fitch and Hauser (2004), we can see that whereas the human group could discriminate grammatical vs. ungrammatical sequences for both grammars (results on the left), the monkeys (on the right) seemed to grasp this contrast for the FSG (top right) but not for the PSG (bottom right), where they failed to discriminate between grammatical vs. ungrammatical sequences.

Does this mean that we have found a specific property of human cognition? Have we found a specific property of human language? In order to be able to answer this question, we still need to know more. For instance, we need to know whether it is only we humans who can grasp constituent structure, the unbounded combination of symbols that yields recursion in human language (Chomsky 1995). Recently, Gentner et al. (2006) reported that starlings do in fact grasp recursion. I think the jury is still out on this claim, mainly because it is not sufficiently clear whether what the starlings do is recursion or counting, a doubt expressed in Fitch and Hauser (2004:378): "Because limited output from a PSG can always be approximated by a more complicated FSG (at the limit, a memorized list of exemplars), it is difficult to prove conclusively that subjects have learned the former. This is equally true for human or animal subjects. However, failure to master a grammar (as demonstrated by a failure to distinguish grammatical from ungrammatical strings) can be empirically confirmed. Of course, such a failure could occur for myriad reasons, and it is thus imperative to demonstrate success on a similar task, matched in all extraneous respects, before concluding that particular computational constraints are at work." In any event, songbirds are a good species to investigate, because their songs are long, structured, and in some species

acquisition and cortical representation parallels humans in intriguing respects (Bolhuis and Gahr 2006).

Another way of determining whether phrase structure is a good candidate for UG membership is to try to determine whether our own human brain processes phrase structure in a special way. Two recent neuroimaging studies indicate that this might be so. Musso et al. (2003), and Friederici et al. (2006) taught human subjects human-like, and non-human-like grammars (a similar idea to the previous animal study) to see how the brain reacted to each. The aim was of course to determine whether there is a property of human language that only human language has (specificity in the strongest sense). If this were the case, we could expect to find some evidence of that in the brain.

Musso and co-workers (2003) taught native German speakers three rules/constructions of true Italian and true Japanese, and three unnatural rules of a fake Italian-like language and a fake Japanese-like language. I say Italian-like and Japanese-like because the words employed in these unnatural languages were the same as in the corresponding natural language. For example, one such unnatural rule placed negation always after the third word of the sentence.

(5) Negative construction in *Unreal Italian*: place negation after third word.

Paolo mangia la no pera
Paolo eat the not pear
"Paolo does not eat the pear"

The rule is trivial, but no human language does this, because a rule that counts words necessarily ignores phrase structure. Hence, the rules are easy and consistent, so that difficulty or complexity could not be an obstacle for learning, but they pay no attention whatsoever to a basic organizational principle of language such as phrase structure. What the authors found is that detection of violations of natural rules triggers an activation of Broca's area that is not found when subjects detect violations of unnatural rules.

Friederici and co-workers (2006) entitle their paper "The brain differentiates human and non-human grammars", and they also show that violations of FSG rules activate an area of the brain called the *frontal operculum*. In contrast, when subjects detect violations of the rules of a *recursive* grammar, that is, a grammar with phrase structure, this violation also activates Broca's area, an area that was not recruited in the case of the FSG violation. Friederici et al. (2006: 2460) argue as follows:

"Results indicate a functional differentiation between two cytoarchitectonically and phylogenetically different brain areas in the left frontal cortex. The evaluation of transitional dependencies in sequences generated by an FSG, a type of grammar that was shown to be learnable by non-human primates, activated a phylogenetically older cortex, the frontal operculum. In contrast, the computation of hierarchical dependencies in sequences generated according to a PSG, the type of grammar characterizing human language, additionally recruits a phylogenetically younger cortex, namely Broca's area (BA 44 45)."

The area of the brain that deals with recursive grammars is phylogenetically newer than the part of the brain that deals with FSG, indicating that this might indeed be something that is qualitatively new, and specific to both humans and language. The truth is that we don't yet know whether humans are completely alone among primates in their capacity for recursion, so that the capacity for recursion might be general across great apes, even if it were absent in monkeys. Another possibility (Marcus 2006:1117) is "that the capacity to recognize recursion might be found only in species that can acquire new patterns of vocalization, for example songbirds, humans and perhaps some cetaceans." Suffice to say that these questions have many unknown corners, and that these are very intriguing times indeed for the study of language as a cognitive capacity.

6. Could there be more to UG?

Before finishing, I would like to say something about aspects of language that appear elusive and which may well contain more strongly specific properties yet to be found. We have come a long way in the understanding of basic, universal aspects of language structure, which seemed the impossible challenge in the 1950s, when it was very much in question whether universal properties of languages even existed. However, we still need to understand much more about language mutation/variation and the way in which it emerges. In his book *The Atoms of Language*, Baker (2001) provides a very readable and accessible account of the principles and parameters model developed in the early eighties. This model assumes that language variation is systematic and results from the interaction of a finite numbers of binary parameters – built-in aspects of grammar that must be specified according to the input. The model has been very successful in the discovery of systematic aspects of language variation, and it is largely due to this success that we can now ask certain questions about it. I agree with the Minimalist perspective that we can no longer entertain the view of a rich and

highly elaborate UG, as envisaged in the principles and parameters model. Something makes language extremely malleable, and we know that children rapidly tune into these crucial aspects of language variation, such as basic word order patterns, or prosodic contours. I think we still do not understand this process well enough, despite all the current progress in language acquisition and processing, and many more cross linguistic studies on different types of languages are needed if we will advance in our understanding of what language variation involves and what role it plays in language structure.

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