Narrow Mind

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I will assume that the vast body of contemporary research, collectively known as 'cognitive science', aims to identify a new aspect of the world—a real 'joint' of nature—that was not open to serious scientific investigation until recently. Call this aspect the 'mental', on a par with other aspects of the world such as the electrical, the chemical, the genetic, and the like (Chomsky, 2000b). More specifically, the task is to give a scientific foundation to the concept of human mind.

I will focus on *biolinguistics* (Jenkins, 2000), which is just one of the many strands of research that fall under the cognitive sciences, to show that there is a sense in which a central part of biolinguistic research, viz the study of the single computational system of human language (C_{HL}), captures a coherent conception of mind *by itself*. In this sense, the mental—a new aspect of the world—has already been identified in terms of the properties of C_{HL}. To emphasise, the claim is not just that C_{HL} constitutes a part of the mental among other things; it is *the* mental. The concept of mind, thus, is assigned to a rather narrow and abstract postulation of science.

In the first two sections, I summarise the basic perspective on language as enunciated in Mukherji (2010: Chapters 1, 2 and 6). In the sections that follow, I outline an approach to the concept of my mind from the perspective attained on human language.

Language and the Mental

I assume that we talk (legitimately) of an aspect of the world *only* in connection with a scientific theory of an advanced character with the usual features of abstract postulation, formalization, depth of explanation, power of prediction, etc. I think this assumption underlies Chomsky's remark that '(t)he study of language tries to develop bodies of doctrine with an eye to eventual unification. Its constructs and principles can properly be "termed mental"' (Chomsky, 2000b, 168).

Contemporary generative linguistics aims to solve "Plato's Problem" for the domain of language: 'how can we know so much given that we have such limited evidence?' (Chomsky, 1986, xxv) From the beginning, research focused on language as a cognitive system in the brain that solves Plato's problem for the child (Chomsky, 1955); hence, the enterprise is also called "Biolinguistics". In just a few decades since its inception, biolinguistics has become a major scientific enterprise across the globe. Jenkins (2000, ix) reports that, apart from research in theoretical linguistics (syntax, semantics, morphology, lexicon, phonology) covering thousands of languages and dialects, the enterprise now actively touches on areas such as articulatory and acoustic phonetics, language acquisition, language change, specific language impairment, language perception, sign-language, neurology of language, language-isolated children, Creole language, split-brain studies, linguistic savants and electrical activity of the brain, among others.

Notwithstanding astonishing growth within a short time, biolinguistics continues to be an enigma which arises as follows. Biological systems are standardly viewed as poor solutions to the design-problems posed by nature. These are, as Chomsky puts it, 'the best solution that evolution could achieve under existing circumstances, but perhaps a clumsy and messy solution' (Chomsky, 2000d, 18).

In contrast, the so-called 'exact sciences', such as physics and parts of chemistry, follow the Galilean intuition that nature is perfect; that is, natural effects are obtained under conditions of 'least effort'. Thus, the search for these conditions in nature had been a guiding theme in these sciences.

The design-problem that the human linguistic system faces is the satisfaction of legibility conditions at the interfaces where language interacts with other cognitive

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systems of the mind: roughly, the sensorimotor systems access representations of sound (PHON), and conceptual-intentional systems access representations of 'meaning' (SEM). As Chomsky phrases the design-problem:

> To be usable, the expressions of the language faculty (at least some of them), have to be legible by the outside systems. So the sensorimotor system and the conceptual-intentional system have to be able to access, to 'read' the expressions; otherwise the system wouldn't even know it's there (Chomsky, 2000d, 17).

Explorations under what is known as the Minimalist Program are beginning to substantiate the view that the system is 'perfect': it solves the design-problem under conditions of least effort. For example, what look like apparent imperfections in the system, such as the existence of (semantically) uninterpretable features in the lexicon, are best explained as optimal mechanisms for meeting legibility conditions imposed by systems external to language (Chomsky, 1995; Chomsky, 2001a). How do we accommodate these discoveries with the idea that biological systems are 'clumsy and messy?'

Note that it is already surprising that the human language system could be subjected to scientific inquiry at all. Natural sciences typically focus on 'outer' domains of the world, called the 'external world' in the philosophical literature; the study of 'inner' domains just does not belong to serious science. This is one source of the classical mind-body problem. The mind (the collection of 'inner' domains) is thought to be so fundamentally different from the body (the collection of 'outer' domains) that the forms of scientific explanation that are available for the latter are not supposed to obtain for the former.[1] When we add the further assumption that the forms of explanation that apply to the 'outer' domains are the only ones in hand, it follows that 'inner' domains fall out of science. Moreover, in the study of 'outer' domains, scientific inquiry typically works for simple problems: 'Even in the hard sciences, when you move beyond the simplest structures, it becomes very descriptive. By the time you get to big molecules, for example, you are mostly describing things' (Chomsky, 2000d, 2).

Setting other 'inner' domains aside, it is already clear that language escapes the suggested divide between what does and does not fall under science. Language not only belongs to the 'inner' domain, it is an extremely complex system even when it is studied under the so-called 'top-down'—rules and representations—approach; at the level of neurones and their connections, the complexity is astronomical. This is where we would least expect genuine scientific understanding. Yet, in just over four decades of research, we not only have substantive solutions to Plato's problem in this domain, the solutions have the form of the most advanced corners of science.

The situation is somewhat aggravated by Chomsky's observation that the problem of unification between 'psychological' studies and biology is as unresolved today as it was two centuries ago (Chomsky, 2000a,b). Commenting on E.O. Wilson's optimism about a 'coming solution to the brain-mind problem', Chomsky remarks that the 'grounds for the general optimism' regarding 'the question of emergence of mental aspects of the world' are at best 'dubious' (Chomsky, 2000b). Yet, from extensive internal research on languages of the world, there is growing evidence that language is a perfect system in the sense indicated.

Some years ago, Chomsky formulated the big puzzle that emerges as follows: 'how can a system such as human language arise in the mind/brain, or for that matter, in the organic world, in which one seems not to find anything like the basic properties of human language?' (Chomsky 1995, 1-2) Chomsky thought that the 'concerns are appropriate, but their locus is misplaced; they are primarily a problem for biology and the brain sciences, which, as currently understood, do not provide any basis for what appear to be fairly well established conclusions about language' (ibid).

There are serious attempts in biology itself to address the tension between the concept of perfection and what is known about biological systems. In recent years, there has been increasing application of considerations from physics (such as symmetry, least energy requirement, and the likes) to try to understand the organisation and function of complex biological systems (Jenkins 2000; Leiber 2001). If this approach is successful in providing an account of some of the complex physical structures and patterns found in the biological domain, then biology will also confirm the intuition about nature's drive for perfection.

Pending such advances in biology, the only option is to make scientific sense of linguistic research *in its own terms*. In other words, we view the basic vocabulary and the constructs of linguistics—its lexical features, clause structures, island constraints, argument structures, landing sites, constraints on derivation, etc.—as theoretical devices to give an account, at least of a part of the organic world, viz the human grammatical mind; perhaps, much more.

In this connection, Chomsky has alluded to an intriguing period in the history of science in recent years. The period at issue concerns the character of chemistry, as viewed by most of its principal practitioners, before its unification with (quantum) physics. According to Chomsky, it was claimed, up until the 1920s by Nobel

laureates, philosophers of science, and everyone else, that *chemistry is just a calculating device*; it can't be real. This is because chemistry couldn't be reduced to physics (Chomsky, 2001b). The gap seemed unbridgeable essentially because the chemists' matter was discrete and discontinuous, the physicist's energy was continuous. Under the assumption that the physicist's view of the world is 'basic' at all times, it is understandable that chemistry was viewed as 'unreal'. However, as Chomsky has repeatedly pointed out in recent years, the gap was bridged 'by unifying a radically changed physics with a largely unchanged chemistry, which had provided important guidelines for the reconstruction of physics' (ibid). Analogically, from what we saw about the current state of biological research on cognition and behaviour, it is possible that a 'radically changed' biology, perhaps on the lines sketched above, will unify with a 'largely unchanged' linguistics. Since the likelihood of such biology is remote, all we have in hand is the body of linguistic research itself.

Biolinguistics is a body of doctrines which is likely to remain isolated, in the sense outlined, from the rest of science for as far as we can see. To emphasise, this conclusion is based on the history of science, viz that the problem of unification between 'psychological' studies and biology is as unresolved today as it was two centuries ago. The crucial recent dimension to this history is that 'psychological' studies now contain a scientific theory; so, there is a genuine partition in science.[2] The twin facts of isolation and scientific character of biolinguistics raise the possibility that biolinguistics may have identified a new aspect of the world.

Recall that we assigned the term 'mental' generally to capture whatever falls under the study of 'inner' domains; more specifically, the term was designed to denote the human mind, if we set aside the 'inner' domains of non-human species for now. What are the prospects of aligning the mental with the new aspect of the world identified by biolinguistics? *Prima facie*, it would seem improper to identify the rather narrow concerns of biolinguistics with the entirety of the human mind. Biolinguistics studies the human language system, which is just one of the many cognitive systems humans are normally endowed with. The identification of the object of biolinguistics with the mental thus implies, counterintuitively, that properties of language exhaust the concept of mind.

Chomsky offers interesting signals on this topic. He does suggest that biolinguistics is an inquiry into the mental: 'The study of language tries to develop bodies of doctrine with an eye to eventual unification. Its constructs and principles can properly be "termed mental"' (Chomsky, 2000b, 168). Notice that, here, Chomsky does not mention anything else apart from language that can properly be 'termed mental'. However, elsewhere in the same book, Chomsky thinks of 'the human mind' more broadly as consisting of 'visual system, reasoning, language, etc.', where he takes 'mind' to 'mean the mental aspects of the world with something like its traditional coverage' (Chomsky, 2000b, 75). Thus, although Chomsky includes the constructs and principles of biolinguistics under the mental, he does not intend to restrict the mental to language.

The key word here is 'coverage'; the mental covers more than just language because it is counterintuitive to *identify* an aspect of nature with the results of just one strand of research, however abstract and ingenious. Restricting the scope of the mental to language would be like identifying aspects of nature solely from the study of tides or pendulums: nature is not likely to have *aspects* such as the tidal or the pendular notwithstanding focused studies on these phenomena for centuries. Hence, Chomsky proposes to extend the scope of the mental to cover at least the 'traditional' domains of language, vision, and reasoning.

Assume that a 'naturalistic approach to linguistic and mental aspects of the world seeks to construct intelligible explanatory theories' (Chomsky, 2000b, 106). The problem is that there is no unified intelligible explanatory theory of the visual system, reasoning, language, etc., put together; the only intelligible explanatory theory, approaching the standards of advanced sciences, pertains to language. In fact, looking at the visual system with this theory in hand, it is implausible that the visual system falls under the same aspect of the world as that of language since the *general properties* of language do not apply to the visual system (Mukherji, 2010, for more). Even if we are not looking for 'sharp boundaries' or 'true criterion or mark of the mental' (Chomsky, 2000b, 75), we expect the notion of the mental to be coherent. To that extent, biolinguistics is all we have in hand.

I will argue that the *impasse* has a solution in that biolinguistics *itself* has a coverage much beyond language, although the coverage does not include the visual system. In particular, we will see that the main burden of biolinguistics, the study of the single computational system of human language (C_{HL}), has an interesting spread. For the purposes of this paper, therefore, the term 'C_{HL}' is taken to be a rigid designator that picks out a certain class of computational principles and operations, notwithstanding the built-in qualification regarding human language. As to whether the coverage approaches the 'traditional' concept of mind, I will suggest that the aspect of the world currently under investigation in

biolinguistics does coincide in interesting ways with Descartes' concept of mind. However, we do not expect a theoretical postulation of science to cover exactly the range of informal traditional concepts.

C_{HL}[3]

As noted, 'C_{HL}' is Noam Chomsky's short for 'Single Computational System of human language'. According to Chomsky, Universal Grammar (UG) postulates the following provisions of the faculty of language (FL) that enter into the acquisition of language (Chomsky, 2000b; Chomsky, 2000c):

A. A set of features
B. Principles for assembling features into lexical items
C. Operations that apply successively to form syntactic objects of greater complexity.

C_{HL} incorporates C in that it integrates lexical information to form linguistic expressions (PHON, SEM) at the interfaces where language interacts with other cognitive systems of the mind. Although there has been significant progress in recent decades on principles of lexical organisation, linguistic theory has been primarily concerned with the properties of C_{HL}. This is where biolinguistic research has attained the high standards that enabled it to isolate a system that seems to be perfect in design. In that sense, the mental aspect of the world uncovered by biolinguistics essentially consists of the properties of C_{HL}.

We saw that a central reason for calling biolinguistics a 'body of doctrines' is that, as Chomsky puts it, current biology and the brain sciences do not provide any basis for what appear to be fairly well established conclusions about language. If these conclusions also extend to some cognitive systems other than language for which also current biology and the brain sciences do not provide any basis, then, *other things being equal*, the concept of mind will have the desired spread.

The established conclusions on language fall broadly into two groups: (a) general properties that characterise the overall nature of the system and (b) specific properties that indicate how the system works. In that sense, the operations and principles of C_{HL} belong to the second category. This distinction suggests the following methodological move. Let us first ask if there is some motivation for thinking that the general properties of language cover some other cognitive systems. If yes, then we ask if the workings of these systems can also be explained in terms of the specific operations and principles that constitute C_{HL}.

An obvious general property of language is that it is a formal, articulated system; that is, it is a system of perceptually distinguishable signs that individually and collectively express information encoded in the representations associated with the signs. Thus, one can either articulate information via the system of signs or extract information from (articulated) signs. This contrasts sharply with the visual system which is a 'passive' system. However, the human systems of arithmetic, logic and music certainly have this property, as do human and non-human systems of signals, calls and gestures.

Another general property of language is that it is a system of discrete infinity. The language system includes a recursive part that generates, in principle, unbounded sequences of expressions; intuitively, there are three-word sentences, five-word sentences, and so on without any upper bound, but there is no 3.5-word sentence. By now it is taken to be an established fact that discrete infinity of human language is an unusual property of organisms in that it is not found anywhere else in the organic world. In humans, however, the property abounds in systems such as arithmetic, music and logical thinking and much else.

Following Jerry Fodor (2000), Chomsky has stressed yet another general property of language: 'language is different from most other biological systems, including some cognitive systems, in that the physical, external constraints that it has to meet are extremely weak' (Chomsky et al., 2001). In contrast, 'the innate system of object recognition... has to be attuned to the outside world; if you had a system that had objects going through barriers and so on, you couldn't get along in the world' (ibid), No doubt, each of the systems of music, arithmetic, and logic (i.e., natural, 'mental' logic) has this property as well; for example, there doesn't seem to be any control from the world on the human musical system.

This suggests that general properties of language belong to cognitive systems other than language. In fact, the cluster of these properties defines the domain of 'language-like' systems.[4] For convenience of exposition, let us introduce the concept of *natural symbol systems* (NSS) to capture the suggestion: 'natural' to distinguish them from artificial symbol systems such as programming languages, musical notations etc.; 'symbol systems' to indicate their formal, articulated nature in contrast to systems such as the visual system, DNA sequences, assembly of particles etc., which are not formal objects themselves (Mukherji, 2003, for a fuller discussion). It is natural to ask: do the combinatorial principles of language, that is the specific properties of language, belong to each member of this class as well? The concept of NSS gives some rough idea as to how the examination

of the spread of C_{HL} might proceed. I am setting technical details aside.

Descartes and the Mental

Returning to the characterisation of the mental, the broad research programme of biolinguistics is often viewed as a revival of the Cartesian tradition in the study of 'inner' domains (Chomsky, 1966; Leiber, 1991). Appealing to the long tradition from René Descartes (1637; 1641) to Wilhelm von Humboldt (1836), Chomsky argued that 'linguistics and cognitive psychology are now turning attention to approaches to the study of language structure and mental processes which in part originated and in part was revitalised in the "century of genius" and which were fruitfully developed until well into the nineteenth century' (Chomsky, 1966, 72). This is because, although 'Descartes himself devoted little attention to language', the Cartesian tradition on the whole offered 'a coherent and fruitful development of a body of ideas and conclusions regarding the nature of language in association with a certain theory of mind' (Chomsky, 1966, 2).

As these remarks suggest, the tradition was invoked essentially for its general programmatic ideas ('approaches'), and *not* for extracting any specific theory of language or of mind. Chomsky did point out some interesting theoretical moves made in the tradition, e.g., the distinction between deep and surface structures and the implicit notion of grammatical transformation (Chomsky, 1966, 97, notes 67, 68). Still, Chomsky's basic concern was to draw attention to the 'internalist perspective' explicitly proposed in the Cartesian tradition: a focus on the inner 'cognoscitive powers' of humans, especially those that underlie the rich expressive capacity of human language (Chomsky, 2000b).

Insofar as the philosophical claims of Descartes are concerned, Chomsky has always rejected what is perhaps the most influential legacy of the Cartesian tradition: the doctrine of mind-body dualism. According to Chomsky, developments in physics rendered untenable the Cartesian conception of body; hence, there is no meaningful contrast between mind and body (Chomsky, 1980; Chomsky, 2000b, 199, note 17). In recent years, Chomsky has been even more emphatic in rejecting any form of dualism in rational inquiry (Chomsky, 2000b, Chapter 4). Science is viewed as a unified enterprise which seeks to develop bodies of doctrines wherever rational inquiry is granted an entry. These bodies of doctrines do not affect the assumption of the fundamental unity of nature: 'Certain phenomena, events, processes, and states are called "chemical" (etc.), but no metaphysical divide is suggested by that usage. These are just various aspects of the world that we select as a focus of attention for the purposes of inquiry and exposition' (Chomsky, 2000b, 75). The Cartesian tradition is credited with the selection of the mental as a focus of attention.

C_{HL}, the object of biolinguistic inquiry under discussion here, is a very specific scientific postulation reached in a theoretical enterprise that has little connection with the past. This object is buried deep down somewhere in the total architecture of human cognoscitive powers such that people do not have introspective access to it in any intelligible sense. Its existence was not even known until some decades ago. Thus, even if the classical Cartesian tradition has motivated contemporary biolinguistics in re-selecting the focus of attention, the actual description of C_{HL} has little historical link with the proposals of that tradition.

Nevertheless, I will suggest that the postulation of C_{HL} meets Descartes' requirements for the concept of human mind in interesting ways. Assuming that Descartes' conception captured some of our central intuitions about the human mind, the postulation of C_{HL} will be viewed as capturing those intuitions as well. However, due to the historical discontinuity between Descartes and Chomsky just noted, the properties of C_{HL} are not likely to meet Descartes' requirements *exactly*, as we will see.

It is interesting that both Chomsky (1966) and Justin Leiber (1991b), authors who vigorously advocate the suggested link between the Cartesian tradition and biolinguistics, begin their discussion with Descartes' interest in explaining some fundamental difference between humans and animals. In that sense, we may take this to be Descartes' basic concern; his specific proposals may then be viewed as attempts to give some conceptual shape to it (Mukherji, 2009, for more).

In his oft-cited letter to Henry More, Descartes formulated his interest as follows: 'now, all men, the most stupid and the most foolish, those even who are deprived of the organs of speech, make use of signs, whereas the brutes never do anything of the kind; which may be taken for the true distinction between man and brute' (cited in Chomsky, 1966, 6). In the same paragraph, Descartes explained the specific notion of sign he had in mind; by 'signs' he meant 'anything which could be referred to thought alone, rather than to a movement of mere nature... the only certain mark of the presence of thought hidden and wrapped up in the body.' Descartes did not miss the fact that some non-human species have the ability to 'make us clearly understand their natural movements of anger, of fear, of hunger, and others of like kind, either by the voice or by other bodily motions.'[5]

Nonetheless, 'it has never yet been observed that any animal has arrived at such a degree of perfection as to make use of a true language.' Although direct citation is difficult to locate in Descartes, these remarks lead to the plausible inference that Descartes was referring to a species-specific capacity—'a unique type of intellectual organization'— such that 'ordinary language use [is] both unbounded in scope and stimulus-free' (Chomsky, 1966, 4-5). Later, von Humboldt explicitly mentioned the capacity that 'involves infinite use of finite means' (Chomsky, 2000b, 6).

The reason I am citing these familiar remarks at length is that they bring out a feature of Descartes' concerns that is not exhausted by his specific mention of human language. Descartes' formulation of 'the true distinction between man and brute' involved unbounded 'use of signs', which are 'the only certain mark of the presence of thought hidden and wrapped up in the body'. Human language, no doubt, is the most ubiquitous—perhaps, the paradigmatic—example of this distinction. But, recall that the general properties of language apply to a variety of cognitive systems other than language: music, arithmetic, logical thinking, among others (Mukherji, 2010). This led to the general picture in which C_{HL} is viewed as centrally involved in all these systems. Descartes' formulation of the 'true distinction' seems to apply to these systems insofar as it draws attention to some of the general properties of language.[6]

In fact, the general picture might well obtain beyond what we have called 'natural symbol systems'. Consider the vast range of representational schemes humans routinely employ to study a variety of things: musical notations, logistic and programming languages, syntactic trees, Feynman diagrams for representing interaction of particles, maps, family trees, combinatorial representations of DNA sequences, varieties of graphical representations and so on, not to mention vast bodies of mathematical symbolism. Typically, these systems are not natural in that we invent them for specific purposes (Mukherji, 2003).

The point of interest is that all of them satisfy Descartes' criterion of signs that mark the presence of thoughts; it goes without saying that each of these is uniquely human. *Prima facie*, a number of them—such as logistic systems, programming languages, syntactic trees and musical notations—certainly satisfy the general properties of language as well; it is an open question if the rest of them do so. Since these are artificial systems in the sense indicated, their phenomenal properties, especially properties of acquisition, will differ from that of language. But then, the phenomenal properties of *natural* systems, like language and music, differ as well. For example, it is known that language acquisition has two peaks around ages 3 and 7; it is doubtful if acquisition of music has similar peaks. Also, language acquisition precedes the acquisition of the number system, while it is quite possible that, other things being equal, music acquisition precedes the onset of language.

Clearly, there are two choices here. Given that each of the systems under discussion requires access to some (or other) computational system as part of their generative capacity, either there is a common computational core in C_{HL}, or there is a (complex) array of domain-specific computational systems. Now, given (a) that (most of) these systems individually satisfy the general properties of language, and (b) that the combinatorial operations and principles of language are not linguistically specific, the second choice looks rather implausible.

Therefore, unless specific counter-evidence is advanced, differences in phenomenal properties do not rule out the possibility that *all* these systems— natural and artificial— have a common core in C_{HL}. This is not to suggest, as noted, that these systems *access* C_{HL} in the same way or to the same extent; system-specific properties are likely to influence the conditions of access to C_{HL}. Even then, the shifting of complexity from an array of computational systems to access-conditions to a single system makes the total architecture much simpler.

We, thus, have a general picture in which a variety of cognitive systems access C_{HL} for their combinatorial part. The specific properties of expressions so generated depend, in part, on the specific features of the representations (lexicon, data base, etc.) stored in a system. Thus, Jackendoff (1992, 18) writes: 'arithmetic comes out of, or is an idealization of, the logic of amounts and individuation, where these are particular primitive elements in conceptual structure... [g]eometry comes out of the logic of the 3D model representation, which encodes our understanding of space', etc.

Narrow and Broad Mental

The preceding picture suggests at least two ways in which the mental may be conceptualised: the *narrow* mental consists just the C_{HL}, the *broad* mental consists all the cognitive systems put together with C_{HL} at the core.[7] Clearly, these options are the farthest apart. So, theoretically, there are various intermediate choices: C_{HL} plus *some* parts of cognitive systems. In what follows, I will ignore them since my interest is to examine whether we can settle for the narrowest–hence, the simplest— conception of the mental. This will give us a definite hold on the concept of mind to which we may progressively add more material later, when needed.

A choice between the two options depends on how Descartes' 'true distinction'-criterion applies. In other words, assuming that C_{HL} marks the true distinction between human and non-human organisms (we return to this), the issue is whether the rest of the parts of the cognitive systems under discussion are human-specific as well. The issue is open to empirical investigation. It seems that, apart from supporting some version of the first (narrow) option, empirical findings also affect the notion of a cognitive system. So far I have been using the notion loosely to designate whatever is involved in the generation of articulated signs of a certain kind. Empirical investigation seems to cast doubt on the theoretical significance of this notion; hence, on the second (broad) option.

Consider the cognitive system of language, the overall system that is responsible for the generation of linguistic signs as they appear in, say, utterance tokens. Notice that even this broad conception of the cognitive system is an idealisation in the sense that the conception excludes social, cultural and other normative factors that are certainly involved in the making and interpretation of utterances. In that sense, the conception of the cognitive system is restricted to organism-internal factors. But even there, the conception excludes other organism-internal systems that are necessary but not sufficient for language (e.g. memory, respiration, digestion, circulation, etc. (Hauser et al., 2002). How does this restricted conception of the cognitive system of language fare with respect to Descartes' criterion?

It is widely believed that the properties of vocalisation that enter into human speech are uniquely human. Almost each aspect of this belief can now be questioned (Hauser, 2001, for review). Consider the structure of the vocal tract and the descended larynx of humans, thought to be unique to the species. There is now evidence that many nonhuman mammalian species that lack speech also possess a descended larynx, suggesting that a descended larynx has non-phonetic functions. As for the rhythmic and prosodic properties of speech, it is already known that the language system shares some of these with the system of musical cognition (Lerdahl and Jackendoff, 1983). Recent experiments suggest that not only human infants but also cotton-top tamarin monkeys can discriminate the rhythmic and prosodic differences between, say, Dutch and Japanese: 'this suggests that the human newborns' tuning to certain properties of speech relies on general processes of the primate auditory system' (Ramus et al., 2000). Furthermore, it is now well attested that chinchillas, macaques, and even birds display categorical perception which was thought to be a unique property for the development of human speech.[8] It follows that 'the perceptual basis for categorical perception is a primitive vertebrate characteristic that evolved for general auditory processing as opposed to specific speech processing' (Hauser et al., 2002; Hauser, 1996, 7.3.2 for details).

These considerations extend to related properties of acquisition of speech. For example, human infants undergo a phase, called 'babbling', when they produce long monologues consisting of speech-like elements. Young songbirds produce 'subsongs' that are structurally different from adult songs, but they contain similar elements (Hauser, 1996, 13). Similarly, just like humans and unlike primates, most songbirds learn their species-specific song by listening to conspecifics, and develop highly aberrant song if deprived of such experience in their infancy.

Descartes might have aimed to control for these possibilities in a general way. Recall that he granted that animals can 'make us clearly understand their natural movements... either by the voice or by other bodily motions'. Also, there is no clear evidence that Descartes wanted to trace the uniqueness of human language to some unique feature of human voice or 'other bodily motions'. Instead, he traced the uniqueness to the fact that 'all men, the most stupid and the most foolish, *those even who are deprived of the organs of speech*, make use of signs' (emphasis added).

Suppose that, in the cited remark, Descartes was just drawing attention to the human use of multiple modalities. Even then the shift is interesting. It is well known that the use of multiple modalities is rare in organic systems. Only humans and dolphins are known to use multiple modalities for imitation, although many species such as parrots and songbirds display widespread ability of vocal imitation; strikingly, vocal imitation, as well as visuomanual imitation, is nearly non-existent in the case of primates. However, only humans have the ability to lose one modality (e.g., hearing) and transfer the competence without loss to another one (e.g. signing). This could suggest that human linguistic competence constructs inner representations that remain invariant across modalities.[9] In other words, in humans, there is a modality-independent 'inner speech' marking the 'presence of thought hidden', as Descartes put it. In abstracting away from the physical/perceptual aspects of vocalisation, Descartes might have been looking for this *underlying* system, without the advantage of discriminating evidence that we can now marshal.

The preceding picture for the sound-part of the cognitive system of language extends to the thought-part—the conceptual-intentional systems—as well, although the evidence for this part is not as rich. From

the little that is known, the most interesting general conclusion is that, as Hauser et al. (2002) point out emphatically, there is little correlation between conceptual abilities and articulatory abilities for nonhuman species.[10] We saw some evidence of this kind of dissociation for the sound-part as well; for example, a descended larynx is found in species which lack speech. The phenomenon is widespread for the conceptual-intentional systems.

As Hauser et al. (2002) report, nonhuman mammals and birds have rich conceptual representations, including abstract concepts such as tool, colour, geometric relationships, food and number. Furthermore, a wide variety of nonhuman primates have knowledge of social hierarchy, relationship of dominance, etc. In an earlier work, David Premack suggested that some primates can distinguish and make use of thematic roles such as agent, object, goal and patient (Premack, 1986). Recent work suggests that chimpanzees have a rudimentary theory of mind (Premack and Premack, 2002). They seem to possess a sense of self and are able to represent the beliefs and desires of others; they can also assign truth and falsity to these beliefs. Yet, this rich conceptual repertoire is not reflected in the rather limited vocalisation abilities of these animals. Thus, 'the best evidence of referential communication in animals comes not from chimpanzees, but from a variety of monkeys and birds, species for which there is little convincing evidence for a theory of mind' (Hauser et al., 2002).

Even for communicating animals it is unclear how much of their conceptual repertoire is, indeed, reflected in their vocalisation abilities: 'Birds sing, chimps grunt, and whales whistle, but those sounds fall far short of expressing the richness of their experiences' (Cromie, 2002). Summarising a large body of research on vervet monkeys, macaques, Diana monkeys, meerkats, prairie dogs, and chickens in varied communicative contexts, Hauser et al. (2002) suggest that the communicative ability of animals is restricted to a limited, fixed, and context-bound set of calls and signals that are typically used non-intentionally, that is without taking into account the beliefs of others: 'The information they provide doesn't go beyond "I'm the dominant animal in this territory", "Here's food", or "I'm a female/male looking for a mate"' (Cromie, 2002), plus 'danger, run'.

Extensive research on communicative ability of non-human species generally ratifies what was held to be a truism in the Cartesian tradition: animal communication is restricted to 'natural movements of anger, of fear, of hunger, and others of like kind'. However, this research also brings out an interesting aspect that is apparently in conflict with the tradition. We saw that, although animals *vocalize* in limited ways, they do have access to many, if not all, *elements* of the human conceptual-intentional systems; the distribution of these elements varies widely across species, though they seem to cluster in primates.[11] Although there are wide differences in the scale and mode of acquisition of conceptual representations between humans and nonhuman species, it is undeniable that these representations are not restricted to humans. Hence, the (alleged) Cartesian view that thought and consciousness *mark* the 'true distinction' looks untenable. So far, the evidence suggests that his desired true distinction is restricted to the C_{HL}-part of language. We return to this.

In any case, insofar as the sound and the thought parts of the (organism-internal) cognitive system of language are concerned, two points stand out: (a) these parts are widely distributed across non-human species, and (b) for non-human species there is a striking dissociation between the two. Somehow, these parts have become associated in humans to form an organization of C_{HL}, sensorimotor systems, and conceptual-intentional systems—acollectively called 'language'. We saw that C_{HL} is not linguistically specific though human-specific; elements of the other systems involved in language are not even human specific. In that sense, language is 'real but as [a] taxonomic artefact—ain the sense in which, say, terrestrial animals are real. It's not a biological category', as Chomsky put it in another context (Chomsky, 2000b).

These remarks extend to other cognitive systems such as music and arithmetic although much less is known about these systems. We suggested that C_{HL} may well be involved in the generative part of music. We also noted that prosodic structures are not only common between language and music, they are also found in non-human species. Although the human tonal system is rich and varied, it is well known that a rudimentary tonal system is widely available in songbirds, dolphins and other animals. As for representations of numbers, Hauser et al. (2002) report interesting evidence that humans and chimpanzees seem to have two mechanisms for representing them. The first, used for object-tracking etc., can accurately discriminate between 1 and 2, 2 and 3, upto 4. The second mechanism gives rise to an approximate number sense in accordance with Weber's law, with greater discriminability among small than large numbers, and between numbers that are further apart. Chimpanzees have been trained to recognise numbers up to 9 to the point that they can understand the meaning of number words, and even Arabic numeral symbols. But as with language, music and everything else, the total repertoire is rather small and fixed, and it takes thousands of trials, spread over years in carefully-controlled

environments, to train human-reared animals to extend this repertoire in small doses.

Recall that we have been considering a choice between narrow mental (C_{HL}) and broad mental (array of cognitive systems). The preceding discussion suggests, in my opinion, that the very notion of a cognitive system (language, music, arithmetic, etc.) is of little theoretical value insofar as understanding aspects of the world is concerned. To that extent, the conception of the mental as an array of cognitive systems is without much interest as well. We are left then with just C_{HL} which constitutes the conception of the narrow mental.

Is C_{HL} enough for Descartes?

As noted, Descartes might have wanted more in his conception of the mental. The received view is that he took the entire categories of thought and consciousness to be unique to humans. Insofar as the category of thought is concerned, the view is certainly untenable, as we saw. I assume that the same holds for the category of consciousness. On the other hand, as hinted throughout, it is also true that the human systems of linguistic sounds, concepts, numbers, tones, geometrical representations, social and emotional categories, and the like, are incomparably richer, in magnitude and complexity, than non-human animals. So, it would seem that restricting the scope of the mental, via Descartes' criterion, just to C_{HL} is untenable as well. Is there a coherent picture between these opposing pulls?

It is interesting that Chomsky supports Descartes' postulation of a 'thinking substance' *only* in the context of 'the creative aspect of language use' that marks 'the fundamental distinction between human language and the purely functional and stimulus-bound animal communication systems' (Chomsky, 1966, 9). Setting the metaphysical implications of Descartes' postulation aside, this could simply mean that thought is unique to humans insofar as it accompanies the generative properties of language. In other words, even if the elements of thought are to be found in non-human species, only humans have the ability to put these elements to generative use. In this reading, Descartes need not hold that thought *per se* is absent in animals, only *generative* thought is. It seems that much of Descartes' interest in the *Cogito*-argument and the related thought experiments concerns just this aspect of thoughts (Mukherji, 2000, Chapter 2; Leiber, 1991b).[12] Assuming this to be the proper interpretation of Descartes, it gives us a hold on the question asked above. We can now envisage a picture in which both humans and non-humans share a variety of cognitive elements. However, when these elements are fed into C_{HL}, the output for each category of elements explodes in scale and complexity.

The number system immediately confirms this picture. We saw that humans and non-humans share some of the basic mechanisms for representation of numbers. However, these mechanisms give rise to just a small set of numbers, as noted. When this small set is coupled to the generative system, it results in a discrete infinity. It is not surprising that the presence of this unique mechanism in humans leads to qualitatively different modes of acquisition. Hauser et al. (2002) observe that while chimpanzees learn each number in the small set of numbers *afresh*, human children just take off after learning the first few. It will be surprising if a very similar picture does not obtain for the human musical system. Furthermore, as the familiar 'nominalizationalization's show, the lexico-morphological system is also tuned to a generative system—(parts of) C_{HL}, under hypothesis—leading to an explosion in the lexical base' (Pinker, 1995, for review). As the generative system offers a large lexical base, humans have many more concepts to symbolise. The massive body of 'thoughts hidden', in turn, puts pressure on the phonetic-part to generate resources for externalisation and so on.

C_{HL} and the elements of cognitive systems, thus, constitute the only building blocks out of which the cognitive architecture of organisms are fashioned; the massive cognitive resources of humans just attests to the unusual fact that these building blocks come in contact with each other. Assuming C_{HL} to be unique to humans, the rest of the impressive and apparently unique features of human cognitive systems are *effects* caused by the building blocks already in hand. In that sense, only C_{HL} is the new aspect in the organic world.

No doubt, the view raises more questions than it answers. For example, how does the rich feature system of the human lexicon, especially the inflectional part of the lexicon, come about? Are the elements of this system distributed in the rest of the organic world as well? Which elements need to be plugged in to C_{HL} to fashion what Chomsky calls the human 'science forming faculty'? More importantly, just how and why did all the building blocks get linked in humans? Hopefully, empirically significant approaches to these and many other questions will be found as our understanding of the structure of C_{HL} advances.

Could it be that even C_{HL} is not unique to humans, making Descartes' criterion infructuous for unearthing aspects of the world? If yes, then Descartes' criterion will still apply to the unique *organization* of the aspects of the world in humans without applying to the individual aspects themselves. Recall the phenomenon of

dissociation between conceptual and articulatory devices in non-human species. Along similar lines, it is not inconceivable that C_{HL} may be dissociatively involved in some non-communicating systems of some organisms: 'Some other organism might, in principle, have the same I-language (= brain state) as Peter, but embedded in performance systems that use it for locomotion' (Chomsky, 2000b, 27). To pursue the idea, Hauser et al. (2002) suggest that 'comparative studies might look for evidence of such computations outside of the domain of communication (e.g. number, navigation, social relations)'. Without denying the plausibility of the idea, as noted, some conceptual clarifications, not to mention focused empirical support, are needed here.

Consider the notion of optimal search implemented by C_{HL}. Following the Galilean assumption that nature is perfect, optimal search could well be a general property of every process in nature, including the functioning of organisms. As such, principles of optimal search ought to be present from collision of particles and flow of water to formation of syntactic structures in humans. However, it requires a giant leap of faith to assume that the *same* principles of optimal search hold everywhere. For example, Hauser et al. (2002) observe that 'elegant studies of insects, birds and primates reveal that individuals often search for food using an optimal strategy, one involving minimal distances, recall of locations searched and kinds of objects retrieved'. Plainly, we do not wish to ascribe 'recall of locations searched' to colliding particles or to the trajectory of a comet. In the reverse direction, there is (currently) no meaningful sense in which principles of optimal water-flow are involved in syntactic structures. In other words, while the Galilean idea is a guide to science, nothing of empirical significance follows from the idea itself; we need to find out, for each specific system, how the idea is implemented there.[13] For example, it has been a ground-breaking discovery that the principles of C_{HL} implement the Galilean idea in the human cognitive architecture.

Turning to the issue of a specific link between human and non-human animals in this regard, can we infer, from the fact of dissociation between vocalisation and conceptual abilities in non-human species, that C_{HL} might be similarly dissociatively located in non-human animals? Hauser et al. (2002) do suggest that investigations in 'the domain of spatial navigation and foraging where problems of optimal search are significant' might reveal the presence of the generative system in non-human species. What does it mean to locate C_{HL} in, say, the system of insect navigation and foraging?[14]

The sole evidence for the existence of C_{HL}, we saw, is the unbounded nature of a variety of articulated symbol-systems used by humans; 'use of a true language', as Descartes put it. In particular, we saw that C_{HL} is likely to be centrally involved in every system that satisfies the three general properties of language: articulation, discrete infinity and weak external control. Outside of humans, there is no system which satisfies these properties at once; hence, the Cartesian intuition that C_{HL} is unique to humans. In other words, we look for C_{HL} when we find *these* properties clustering in the behaviour of some organism: especially, articulated symbol manipulating behaviour. As Hauser et al. note, the system of recursion found in human language provides 'the capacity to generate an infinite range of expressions from a finite set of elements'. It is not at all clear what sense may be made of the possibility that foraging behaviour of animals display this capacity, since other organisms simply do not *exhibit* the required behaviour in any domain.

In contrast, non-human organisms do display properties of vocalisation and conceptual systems in their behaviour, although they are typically dissociated as we saw. These systems contain elements that are also found in the related human systems. As Descartes noted, these systems are also dissociable in humans: one may lose vocalization without losing the conceptual system, and vice versa. Thus, facts of dissociation converge across the human/non-human divide, making it a genuine, empirically discernible phenomenon in nature. No doubt, classic studies on selective impairment of the brain show that the linguistic and the conceptual systems are also dissociable in humans (Yamada, 1990; Marshall, 1990). However, the form of this dissociation cannot extend to the non-human case directly since non-humans just do not have access to the linguistic system. In this sense, the analogy between insects and humans is no more credible, for now, than that between insects and comets (Mukherji, 2010, for more).

In any case, independently of the view one adopts on this issue, everyone needs to explain the unique *organisation* of the variety of aspects involved in the human language and related systems. Other things being equal, it is natural to suppose that the uniqueness of organisation may be traced to at least one unique factor that draws all these aspects together like a magnet. Otherwise, the massive fact of uniqueness will continue to be a mystery. Given the demonstrated distribution of the rest of the elements of human cognitive systems in the non-human world, C_{HL} is the only unique factor currently in hand.

The suggestion has some large-scale consequences. First, our conception of the mental will certainly grow and change directions in time; but any extension to the current idea is likely to proceed from now on, especially

with respect to the form of explanation, from the scientific core already attained, just as Galilean physics formed the heart of all physics that followed. Second, the proposed identification of the mental with C_{HL} implies that much research in cognitive science, pursued outside the biolinguistic framework, currently falls out of the study of the mental. In that sense, biolinguistics is beginning to enforce directions that go against informal expectations around the concept of mind. For example, it now becomes questionable whether current investigations on consciousness, 'theory of mind', concept-formation, object-recognition, problem-solving, and the like, fall under the study of the mental, especially if, as seems likely, these investigations extend to the non-human part of the organic world (Hauser, 1996; Hauser et al., 2002). However, this is not to deny the possibility that non-biolinguistic research in the cognitive sciences may be attempting to unearth other aspects of the world. When that happens, we will face new forms of the unification problem, not only between biolinguistics and the existing sciences (Jenkins, 2000), but also between biolinguistics and the rest of the cognitive sciences.

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Notes

1. Chomsky has dubbed this doctrine 'methodological dualism'; see Chomsky (2000b) for extensive criticism.
2. This needs to be sharply distinguished from the *a priori* claim that, since mental properties are 'nomologically autonomous', their study is 'not part of the rest of science' (cited in Churchland and Sejnowski, 1992, 2).
3. See Mukherji (2003) for more details.
4. Beyond suggesting provisionally that language, music, arithmetic, logic, etc. form a coherent class, I am ignoring the exact constitution of this class. This is not to say that individual cases do not merit further attention. See Mukherji (2003, note 3; 2000, Chapter 4), and Maess et al. (2001) for some discussion and references on structural similarities between language and music.
5. See the interesting distinction between signals and cues on the one hand, and *signs* on the other in Hauser (1996, 9). However, Hauser's notion of signs is still too broad for Descartes since Hauser's notion applies—sometimes in a cross-species manner—to, say, advertisement calls produced by male frogs which are signs from the perspective of a predatory bat (Hauser, Ibid., note 13).
6. See Mukherji (2000, 4.4.3 and references) for some discussion of the sense in which musical notes 'mark the presence of hidden thoughts'. The issue is controversial; some authors (e.g., Scruton, 1983) think that, in a sense, the notion of musical thought is incoherent.
7. Recall that we have already left behind an even broader conception of the mental that includes language, vision, reasoning etc.
8. This refers to categorical perception of *human* speech. Categorical perception in species-typical vocalisations is found in field crickets, swamp sparrows, mice, pygmy marmosets and Japanese macaques (Hauser, 2001).
9. This is empirically controversial; see Hauser (1996, 5.4.3, especially 344-6).
10. The conclusion is interesting because at least in the contemporary philosophy of language initiated by Gottlob Frege (1919), Ludwig Wittgenstein (1921), Bertrand Russell (1918), and others, the study of language is viewed as almost identical to the study of thought. A similar view is held, usually implicitly and in part, by others as well. Fred Lerdahl and Ray Jackendoff suggest that music differs from language in that the former does not have the sense/reference distinction (Lerdahl and Jackendoff, 1983, 5). Thus, the sense/reference distinction, a feature of the thought systems, is taken to be a distinguishing feature of language.
11. It seems that Descartes was generally aware of this obvious fact, but he did not know what to make of it. His worry was that 'there is no reason to believe it of some animals without believing it of all, and many of them such as oysters and sponges are too imperfect for this to be credible' (cited in Leiber, 1991a).
12. It is unclear how this view extends to the category of consciousness.
13. I am not denying that, say, foraging bees execute optimal search, as do singing humans and colliding particles. The problem is to show that there is a fundamental unity in these mechanisms. In other words, there could be an underlying mechanism of optimal search in nature that has 'parametric' implementation across particles, bees and humans. But the unearthing of this mechanism will require the solution of virtually all problems of unification.
14. This problem is different, though related, to the more general problem that we do not know what it means for an insect to have a computational system in the first place (Gallistel, 1997, cited in Chomsky, 2001b). As Chomsky points out, Gallistel's problem is a specific version of the unification problem between biology and psychology. The problem I am raising arises within 'psychology', broadly speaking.