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Chomsky, Cognitive Science, Naturalism and Internalism

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The present paper is about Noam Chomsky's contribution to cognitive science. The

reason this topic interests me is that Chomsky's relation to cognitive science is puzzling. On the one hand, Chomsky is, I think, unquestionably the most important contemporary linguist. Arguably, his work is still today the single most important contribution to our current understanding of human language and the human mind. On the other hand, Chomsky's work is either widely neglected or regarded as very controversial by philosophers of mind and language. Philosophers of the natural sciences try to draw general conclusions about the acquisition of scientific knowledge from their examination of the actual reasoning of scientists in physics, chemistry or the life sciences. In the philosophy of mind and language, little if any attention is paid to linguistic theorizing as it has developed under Chomsky's influence over the past forty-five years.

For the present purpose, philosophers of mind and language can be usefully divided into two groups: the methodological dualists and the methodological monists (in the sense of the great dispute between partisans and opponents of the methodological dualism between the Naturwissenschaften and the Geisteswissenschaften). To a first approximation, the latter assert and the former deny that mental phenomena can be studied according to the same standards of rationality as any other natural phenomena. Chomsky is a methodological naturalist (i.e., a methodological monist): he is a vigorous advocate of the view that the standards of rationality which are prevalent in the natural sciences should also prevail in the study of language and mind. It is not surprising therefore that much of his work should be controversial among methodological dualists. What is more surprising is that philosophers of mind and language who are methodological naturalists do not pay much attention to his achievements. This is my puzzle.

In the present paper, I want first to justify my claim that Chomsky's work on language and mind is of crucial importance for cognitive science. Despite my not being a linguist, I will try to provide a sense of Chomsky's revolution in linguistics. Then, I will explain why Chomsky's approach to language acquisition played a crucial role in other areas of cognitive

science — particularly, in the study of human cognitive development. Finally, I will discuss some of his views that stand in sharp contrast with the views of most philosophers with naturalistic proclivities. One such view is Chomsky's thesis that normal language use is a mystery, not a problem that we can solve. Another one is his internalism in semantics. Finally, I shall argue that Chomsky's internalism is related to his scepticism about evolutionary explanations based on natural selection.

1. What is a generative grammar?

Arguably, the contemporary scientific study of human languages started in 1957, the year Chomsky published his slim monograph, Syntactic Structures. His work in the 1950's opened up an entirely new approach to the study of the human ability to use language, i.e., generative grammar. The goal of generative grammar is to provide an explicit characterization of the computational properties of the human language faculty. Explicitness and testability are the two scientific features of linguistic theorizing made possible by generative linguistics. As repeatedly noted by Chomsky, this project could not have been carried out until the 1940's when the concepts became available to allow a precise account of the computational principles required to generate expressions of natural languages. Hence, generative grammar rests on the formal scientific work of mathematicians such as Turing and Church.

Not only does generative grammar constitute a revolution in linguistic studies. It was also a major factor in the "cognitive revolution" of the early 1960's. It is, I think, fair to say that Chomsky's (1959) review of B.F. Skinner's (1957) book, Verbal Behavior, made a decisive contribution to the overthrow of the behaviorist methodology in psychology: Chomsky "killed" behaviorism in the sense in which Karl Popper (1974: 69) claims credit for having killed logical positivism. Chomsky's major input to the cognitive revolution lies in his criticism of the behaviorist confusion between evidence and subject-matter:

I think that there is some significance in the ease and willingness with which modern thinking about man and society accepts the designation “behavioral science”. No sane person has ever doubted that behavior provides much of the evidence for this study — all of the evidence, if we interpret “behavior” in a sufficiently loose sense. But the term “behavioral science” suggests a not-so-subtle shift of emphasis toward the evidence itself and away from the deeper underlying principles and abstract mental structures that might be illuminated by the evidence of behavior. It is as if natural science were to be designated “the science of meter readings”. What in fact would we expect of natural science in a culture that was satisfied to accept this designation for its activities? (Chomsky, 1968, 1972: 65)

The advent of the cognitive revolution was in turn responsible for the shift away from the study of human behavior towards the study of internal mental states and processes that may or not give rise to observable behavior. Hence, my first claim is that generative grammar was a major component of the scientific revolution that made cognitive science possible at all. My second claim is that, within cognitive science, generative grammar paved the way for a particular research program whose goal is to spell out in scientific terms the uniqueness of human cognition: What is distinctive of human cognition in contrast with non-human kinds of cognition? But, in order to substantiate these two claims, and despite my not being a linguist, I need to provide a sense of Chomsky’s accomplishments in linguistic theory.

Ever since his earliest presentations of the task of a linguistic theory, Chomsky has noted that a person’s ability to understand and produce sentences of her native tongue can give rise to three distinct basic questions:

(Q1) What is the system of knowledge that allows a native speaker to use and understand sentences of her language?

(Q2) How did this knowledge arise in her mind?

(Q3) How is it put to use in actual speech (both in production and in comprehension)?

In response to (Q1), the linguist is expected to provide an explicit characterization of

the grammar of the language. As Chomsky (1986: 6) writes,

a good traditional or pedagogical grammar provides a full list of exceptions (irregular verbs, etc.), paradigms and examples of regular constructions [...]. But it does not examine the question of how the reader of the grammar uses such information to attain knowledge that is used to form and interpret new expressions, or the question of the nature and elements of this knowledge [...] Generative grammar, in contrast, is concerned primarily with the intelligence of the reader, the principles and procedures brought to bear to attain full knowledge of a language.

The goal of a “generative” grammar is to be explicit: an “explicit” characterization of the grammatical knowledge of a speaker of a natural language will be exhaustive, it will not leave any aspect of the speaker’s knowledge implicit. Of course, this investigation makes both the concept of grammar and the concept of knowledge central to generative linguistics. I turn to the former first.

A natural language \underline{L} is a set of sentences. A sentence of \underline{L} is a sequence of words belonging to the lexicon of \underline{L} . Of course, not any sequence of words of the lexicon of \underline{L} counts as a sentence of \underline{L} . To see why not, consider the contrast between (1) and (2):

(1) The black cat drinks her milk.

(2) *black her drinks milk cat the

Although (2) contains the same English words as (1), unlike (1), (2) is not a sentence of English because the order between the words in (2) is not grammatical. Since a sentence is a string of words in a grammatical order, and since words have both phonological and semantic properties, a sentence too has phonological and semantic properties. In fact, a grammar of language \underline{L} — \underline{L} ’s syntax — is a finite device that systematically connects the former properties of sentences with their latter properties. Notice that we are presently talking of what philosophers call sentence-types, not sentence-tokens: many different utterances (or

inscriptions) can be tokens of one and the same abstract sentence-type. The grammar (or syntax) of a language characterizes the properties of sentence-types, not tokens. A generative grammar describes sentences, not utterances.

As is shown by the existence of dictionaries, the lexicon of any natural language is a finite set: a dictionary is just a list of words.¹ The cardinality of any set whose members can be listed has to be finite. In his early work, Chomsky provided a convincing argument for the thesis that, although the lexicon of any natural language is finite, the set of grammatical sentences of a natural language is an infinite set. Thus, human languages exhibit the property which Chomsky calls “discrete infinity”. This can be shown informally by means of the following English examples (3) and (4):

(3a) This flower is pretty.

(3b) This flower is very pretty.

(3c) This flower is very very pretty, etc.²

Assuming the existence of a rule of insertion of the adverbial modifier ‘very’ in sentence (3a), there is no grammatical limit to the number of such iterated insertions. If (3a) is a sentence of

¹ Arguably, there is a purely linguistic sense in which the lexicon of a natural language is itself generative and hence not a finite list. This sense can be illustrated by the following example from Pinker (1994):

missile
anti-missile
anti-missile missile
anti-anti-missile missile, etc.

From a psychological or ontogenetic point of view, however, it makes sense to assume that for the language to be learnable, there must exist a finite list of lexical units to keep in a finite memory. This is the sense emphasized in the paper.

² Arguably, the insertion of an adverbial modifier does not seem to work for all lexical items. If, e.g., ‘very’ is replaced by ‘quite’ as in (3*) the result seems unacceptable:

(3a*) This flower is quite pretty.
(3b*)*This flower is quite quite pretty.

Perhaps the reason is not purely syntactic but pragmatic: perhaps on a scale of prettiness you can always go one step further and find one more possible pretty thing (just as you can add one more natural number). But you cannot indefinitely find one more approximately (or average) pretty thing (as if on the middle of the scale). For those who would argue that (3*) is a grammatical counterexample to the basic claim about recursivity, consider (3**):

(3a**) Simon’s mother was Italian.
(3b**) Simon’s mother’s mother was Italian.

English, so are (3b), (3c) and so on. In other words, there is no grammatical limit on the size of a sentence formed by iterated insertions of ‘very’. If an infinitely long string of words can belong to the set of sentences of a language, then presumably this set must be infinite.

(4a) Colorless green ideas sleep furiously.

(4b) Chomsky wrote ‘Colorless green ideas sleep furiously’.

(4c) Fodor believes that Chomsky wrote ‘Colorless green ideas sleep furiously’.

(4d) Pinker says that Fodor believes that Chomsky wrote ‘Colorless green ideas sleep furiously’, etc.

There is no grammatical limit to the number of embeddings of (4a) under an appropriate matrix clause in English.

If this is correct, then it follows that the set of sentences of any natural language is infinite. If so, then a grammar of a natural language must be a finite device (or mechanism) capable of generating (or enumerating) all of the infinite sentences of the language. It must be finite if it is to be mastered by a human brain or mind which is a finite device. Granted, life is finite, energetic resources are limited and so are human attentional powers. So processing a infinite grammatical sequence of words belonging to whatever language is simply out of the question. But if the previous reasoning is correct, then, by virtue of knowing the grammar of a language, a person must have the ability to produce and understand an infinite set of sentences. The person’s grammatical competence extends over an infinite set of sentences.³ This reasoning is the source of the claim that language is productive: knowing a language is knowing a potentially infinite set of sentences. On Fodor’s (1987) assumption that sentences express thoughts, thoughts too form a productive set.

In order to generate a potentially infinite set of sentences formed out of a finite set of

(3c**) Simon’s mother’s mother’s mother was Italian.

words, a grammar must presumably contain recursive rules, where a recursive rule is a rule that may re-apply to its own output. Consider e.g., the two phrase-structure rules (a) and (b):

(a) $S \rightarrow NP VP$

(b) $VP \rightarrow V S$

Rule (a) says that a sentence can be analyzed into a sequence of a noun phrase followed by a verb phrase. Rule (b) says that a verb phrase can be analyzed into a sequence of a verb followed by a sentence (as illustrated by the sentence ‘John believes that London is pretty’). Rules (a) and (b) form a recursive pair in the following sense: let (a) apply to a sequence of words. If (b) can apply to the output of (a), then (a) can re-apply to the output of (b), and so on.

An adequate generative grammar of English must e.g., have the means of representing the fact that, although superficially similar, the two following English sentences differ in crucial grammatical respects:

(5) John is easy to please.

(6) John is eager to please.

Superficially both (5) and (6) involve the infinitival ‘to please’ which is a complement of the main predicate of the sentence. However, any English speaker understands that in (5) ‘John’ is the object of ‘to please’, whereas in (6) ‘John’ is the subject of ‘to please’. In order to capture the relevant sorts of information, linguists posit different levels of grammatical representation (so-called “deep structures” and “surface structures”).

In the early years of generative grammar the computations performed by a grammar of

³ Strictly speaking, all that follows from the previous argument is that for any sentence containing n words

a natural language were basically assumed to be of two broad kinds:

— *phrase structure*-rules (e.g., (a) and (b) above) that form larger syntactic units from lexical items, and

— *transformational* rules that move one syntactic constituent from one position to another as in (7) and (8):

(7a) John seems to be intelligent.

(7b) [_S [_{NP} e][_{VP} seems [_S [_{NP} John][_{VP} to be intelligent]]]]

(7c) [_S [_{NP} John][_{VP} seems [_S [_{NP} e][_{VP} to be intelligent]]]]

Sentence (7a) has the so-called S-structure (or surface structure) as in (7c) which provides some grammatical information about it. Its so-called D-structure (or deep structure) is as in (7b) which provides complementary grammatical information about (7a). For example, whereas (7c) indicates that ‘John’ is understood to be the subject of the matrix verb ‘seems’ in (7a), (7b) represents the fact that ‘John’ is also understood to be the subject of the embedded infinitival clause. Both (7b) and (7c) represent the fact that (7a) has an embedded infinitival clause which requires a noun phrase in subject position. Since this noun phrase does not have phonological properties (i.e., the speaker does not pronounce it), it occurs as an “empty category”. (7b) is generated by phrase structure rules. Then a transformational rule moves the NP ‘John’ from its embedded position to its initial position. The movement of the constituent leaves a “trace” (i.e., the empty category) so that while the S-structure represents the fact that the moved NP is the subject of the matrix verb ‘seems’, it also keeps a memory of the grammatical information that the NP is also understood as the subject of the embedded infinitive.

(where \underline{n} is any natural number), there exists a sentence with \underline{n}^* words such that $n^* > n$.

(8a) Who did Mary kiss?

(8b) [S' [COMP] [S [NP Mary] [VP kissed [NP who]]]]

(8c) [S' [COMP who] [S [NP Mary] [VP kissed [NP e]]]]

(8b), the D-structure of (6a), which results from the application of a phrase structure rule to lexical items, represents the fact that the NP 'who' (an interrogative pronoun) is understood as the object of the verb 'kiss'. (8c), the S-structure of (8a), results from the application of a transformation that moves 'who' from its object position in (8b) into the complementizer position. The movement rule leaves a trace so that (8c) contains both the information about what the surface position of the interrogative pronoun is and about its grammatical function in (8a).

Figure 1 then is a simplified model of the typical form of a grammar of a natural language according to the generative grammatical literature of the late 1970's-early 1980's:

PF

LF

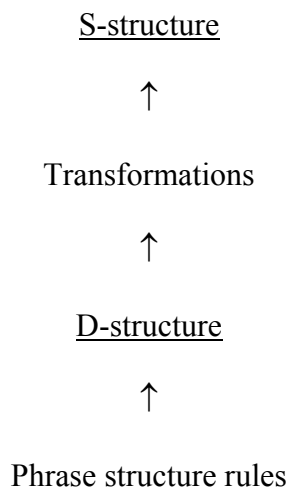


Figure 1

Both D- and S-structures are representations, while phrase structure rules and

transformational rules are operations that apply to representations. Phrase structure rules generate D-structures from properties of lexical items. Then transformations take D-structures as input and produce S-structures as output. S-structures are then “interpreted” by two kinds of interpretive rules: phonological rules assign phonological interpretation (PF for phonological form) to S-structures. Grammatical proto-semantic interpretive rules (essentially quantifier rules) map S-structures onto their logical forms (LF) of which I give a few simple examples. In fact, LFs are really syntactic structures, not genuine semantic representations in the sense that they fall short of providing truth-conditions for the utterances of the sentences. Nor are rules mapping S-structures onto LFs really semantic rules: they are transformational rules (or a natural extension thereof). Just as the rule of WH-motion displaces an interrogative pronoun into COMP, QR moves a quantifier thereby indicating its logical scope. Unlike a rule moving one element from its D-structure position to its S-structure position, however, the result of moving a constituent from S-structure to LF (by hypothesis) is of no consequence on the phonology of the sentence since what matters to phonology is the position occupied by a constituent at S-structure. Consider the S-structure (8c) of sentence (8). A proto-semantic rule interprets the interrogative pronoun ‘who’ in COMP as a quasi-quantifier in the sense of the predicate calculus to yield the logical form (8d):

(8c) [_S [_{COMP} who] [_S [_{NP} Mary] [_{VP} kissed [_{NP} e]]]]

(8d) [for which x] [Mary kissed x]

It is not hard to recognize the similarity between formula (8d) and an existential quantified formula of the predicate calculus such as (8e):

(8e) $(\exists x)(\text{Mary kissed } x)$

Within the semantic framework of generative grammar, the logical form of sentence (9a), for instance, is represented by (9c):

(9a) John invited every student.

(9b) [_S' [_{COMP} [_S [_{NP} John][_{VP} invited [_{NP} every student]]]]

(9c) [_S' [_{COMP} every student][_S _{NP} John [_{VP} invited [_{NP} e]]]]

A rule of Quantifier-Raising (QR) moves the quantified NP 'every student' from its object position in the VP in (9b), the S-structure of (9a), to COMP to yield (9c), the logical form of (9a). QR is clearly at work in the structural disambiguation of the meaning of sentences involving two or more quantifiers as in (9a*) that can be assigned two distinct LFs:

(9a*) Every boy likes a girl.

(9b*) [_S [every boy_i] [a girl_j][e_i likes e_j]]

(9c*) [_S [a girl_j][every boy_i][e_i likes e_j]]

In (9b*) 'every boy' has wide scope over 'a girl' and the sentence means that every boy (in some group of boys) likes some member of a set of girls: different boys like different girls. In (9c*), 'a girl' has wide scope over 'every boy' and the sentence means that there exists a unique girl such that every member of the set of boys likes her.

Clearly, on this view, the linguistic meaning of a sentence determined by the grammar (i.e., LF) is a sharply restricted part of the content conveyed by an utterance of the sentence. The content of an utterance is widely under-determined by the grammatically determined meaning of the sentence. For example, presumably the speaker of (9a) did not mean that John invited every student in the world. Hence, part of the content of an utterance of (9a) is that John invited every student in some restricted set of students. In other words, the universal

quantifier ‘every’ must be restricted to some universe of discourse. However, this restriction is not provided at the grammatical level of representation which Chomsky calls “logical form”. Presumably, this restriction operates at some post-grammatical level. Notice also that, on this view, in so far as they are both parts of grammar, semantics and phonology perform symmetrical operations — an assumption that I will come back to later.

2. Knowledge of grammar

I now turn my attention to the second concept of which I said earlier that question (Q1) made it central to generative linguistics, the concept of knowledge (of grammar). Ever since he reviewed Skinner’s (1957) book, Chomsky has claimed that what allows a person to use and understand sentences of her language is her knowledge of the grammar of her language. He has forcefully (and I think convincingly) argued over the years that any construal of what allows a speaker to use and understand sentences of her language in terms of mere dispositions to verbal behavior is bound to fail. What is present in a speaker’s mind is a cognitive structure, not a set of behavioral dispositions.

In Chomsky’s program, linguistic theory is primarily a theory of a cognitive structure — the language faculty — for which speakers’ linguistic behavior is one relevant source of evidence among others. Chomsky’s revolutionary contribution to the study of language was to show that speakers of natural languages know a great deal of facts about the syntactic, phonological and semantic structures of the expressions of their language. Some of this knowledge is consciously accessible. Some is not. For example, English speakers consciously know that, unlike (1), (2) is not a sentence of English. They consciously know that in (5) ‘John’ is the object of ‘to please’ and in (6) ‘John’ is the subject of ‘to please’. Much of speakers’ grammatical knowledge, however, is not consciously available. It is only available to theoretical linguists. Speakers can form judgments about these grammatical facts about which they have intuitions. One major methodological contribution of generative grammar to

cognitive science was both to find a cognitive domain — syntax — about which human beings have a rich explicit and implicit knowledge and to demonstrate that speakers' grammatical intuitions are a legitimate source of data for linguistics.

Within the paradigm of generative grammar, linguistics is both an empirical science and a formal science. It is empirical because grammatical hypotheses can be tested in a number of ways (one of which is by checking speakers' intuitions). It is a formal science because the linguist is trying to provide a systematic axiomatic representation of speakers' grammatical knowledge. The empirical status of linguistic theories within the paradigm of generative grammar raises an important epistemological issue for cognitive science. It is customary to contrast the kinds of data used by generative linguists to construct grammatical hypotheses with other kinds of empirical evidence such as chronometric reaction times (used by psycholinguists), electrophysiological evidence (event-related potentials or ERP) gathered by neuropsychologists on the electrical activity of the brain or more recently data obtained by using brain imaging technology. There are interesting phenomenological differences between speakers' intuitions, chronometric reaction times, electrophysiological data and images of the brain. However, speaker's intuitions are genuine empirical facts relevant to the empirical task of testing hypotheses about the human language faculty, i.e., a particular structure in the human brain.

The claim that an ordinary speaker of a language knows the grammar of her language has given rise to some philosophical discussion in the late 1960's and early 1970's. Philosophers raised two major issues. One issue is that of whether a speaker can truly be ascribed knowledge of grammatical rules of which, unless she becomes a professional linguist, she is not even aware and which she could not at all formulate.

The question is complex for it is not clear that the English verb 'to know' has a well-defined and clear-cut meaning or expresses a single well-defined concept. Certainly, there is a sense in which knowledge ascriptions differ from mere belief ascriptions. In this sense,

knowledge is ascribed to a single individual and its ascription requires some epistemic conditions. Traditional epistemologists have tried to spell out necessary and sufficient conditions on this epistemological reading of the English word 'to know'. Two such necessary though not sufficient conditions for a person to be ascribed knowledge in this epistemological restricted sense is that the person believes that a proposition is true and that the proposition be true. That these two conditions are not sufficient is made evident by reflection on the fact that true belief may be arrived at by mere chance. If so, then it will not qualify as knowledge in this restricted epistemological sense. Notorious Gettier cases show that, contrary to the assumption of traditional epistemology, knowledge in the relevant sense cannot be justified true belief and how hard it is to spell out the necessary condition that must be added to turn true belief into knowledge.⁴ Reliabilists (who are epistemological "externalists") argue that, in order to qualify as genuine knowledge, a true belief must arise from a reliable process of belief formation. Epistemological internalists argue that a person cannot know that p unless she has a justified higher-order belief that her lower-order belief that p is justified.

Mere intuition not shaped by years of philosophical training and standard scholarly uses of the English word 'knowledge' by historians of ideas and social scientists as well suggest that knowledge can be ascribed to communities and not merely to individuals, as in 'the knowledge of Greek astronomy' meant to refer to the astronomical knowledge distributed among ancient Greeks. In such cases, what is required is that a set of technical beliefs be widespread among members of a community. Such communal knowledge ascriptions do not relevantly contrast with mere belief ascriptions and the requirement that the propositions believed be true (or held to be true by the ascriber) simply vanishes.

⁴ Gettier (1963) invented famous cases in which we feel entitled to say of a person that she has a justified true belief that p although we would be reluctant to say that she knows that p . One example in a schematic form would be: suppose that X has good justifications for believing that p . Suppose, however, that p is false. Suppose further that from her justified false belief that p , X correctly infers the true belief that $p \vee _q$ (which is true in virtue of the truth of q). Now, X has a justified true belief that $p \vee _q$. But would be reluctant to say that she

Certainly, it is true that a speaker of a natural language does not entertain beliefs, let alone justified true beliefs, about the grammatical rules of her language. She does not unless she is a professional linguist. Nor does it make much sense even to ascribe truth to the rules in question. Still Chomsky wants to claim that a person able to use and understand sentences of her language knows the grammar of her language because her ability is not a set of behavioral dispositions. Chomsky's consistent response to the worry expressed by philosophers concerned with the epistemological sense of 'knowledge' has been that this sense is of marginal interest for cognitive science and the study of human cognition. It is mostly of relevance in specialized cultural and institutional contexts — either scientific or legal — in which the weight of the evidence in favor of a conclusion must be assessed with particular caution. Given that a speaker does not hold justified true beliefs about the grammar of her language, she can be said to tacitly know or cognize the grammar of her language. As Chomsky (1980: 99) puts it, the relevant concept of knowledge should be analyzed as the "possession of mental structures". This response strikes me as reasonable.

Another important issue raised by question (Q1) about the explicit characterization of a speaker's knowledge of the grammar of her language has to do with Chomsky's realist view that there are facts of the matter as to which is the correct hypothesis about which grammar a speaker knows. In fact, there are two distinct issues here: one is whether it makes sense to assume that a speaker of a language tacitly knows one particular grammar as opposed to some extensionally equivalent different grammars. Like any other scientific hypothesis, a grammatical hypothesis can give rise to a philosophical dispute between a realist and anti-realist (i.e., an instrumentalist) interpretation. According to the latter, a scientific hypothesis is merely a convenient device that allows empirical predictions. It does not purport to describe some real though unobservable features of the world. As with any scientific hypothesis, it is a legitimate question what part of the theory is supposed to be interpreted realistically and what

knows that $p \vee \neg q$ (since her grounds for reaching the true proposition that $p \vee \neg q$ was the false proposition that

part belongs to the notational system. For example, one does not expect to find in an English speaker's brain little symbols standing for syntactic categories like S, NP, VP anymore than one expects to observe a geometrical circle standing for the Equator.

The other issue is: What kind of evidence is relevant to choosing among extensionally equivalent grammatical descriptions? This question should itself be divided into two questions: one question is what kind of linguistic evidence is relevant to a grammatical hypothesis? In particular, the question arises whether facts in one language (e.g., Japanese) can be relevant to the grammar of another language (e.g., English). The other question is whether non-linguistic evidence can be relevant to a grammatical hypothesis. For example, is the electrical activity of the brain or brain imaging relevant to deciding between rival grammatical hypotheses?

Ever since Aspects (1965), Chomsky has distinguished what he calls the weak from the strong generative capacity of a grammar of a natural language. The former is measured by the set of sentences that the grammar is able to generate. The latter is measured by the set of structural descriptions which a grammar associates with the sentences it generates.

Quine's (1960) famous thesis of the indeterminacy of radical translation can be seen as a sophisticated version of a methodological dualistic thesis in linguistics. The thesis asserts that there are no empirical facts of the matter that will allow a linguist to choose between two or more competing systems of translation of one utterance from one language into another language. Although I do not go into this topic here, Quine's (1960) view amounts to the claim that hypotheses about the meaning of a word in one language are not and cannot be, for principled reasons, scientific hypotheses: unlike scientific hypotheses, they cannot be either confirmed or disconfirmed by empirical evidence.

Now, on the basis of an analogy between natural and formal languages, Quine (1972) has in effect questioned Chomsky's distinction between the strong and the weak generative

capacity of a grammar. He has argued that it would be mysterious to claim that of two extensionally equivalent grammatical systems — capable of generating the same set of sentences — one were true and the other false. As Quine (1972) sees it, the problem is that indefinitely many different grammatical hypotheses (about e.g., phrase boundaries) may be compatible with the observable linguistic behavior (or dispositions to linguistic behavior) of speakers of the language. On Quine's (1972) view, given that two extensionally equivalent grammatical hypotheses are consistent with a speaker's behavioral dispositions, one may say that both hypotheses "fit" the speaker's behavior. But one should resist the claim that the speaker's behavior is "guided" by an "unconscious preference" for one of two rival grammatical hypotheses. Crucially, Quine (1972) assumes that the observable behavior of a speaker of language L is the only evidence relevant to hypotheses about the structure of the grammar of L. It seems like an innocuous assumption, but, as we shall see, it is not.

There are two bones of contention between Chomsky and Quine here. One is that Quine denies the validity of Chomsky's distinction between the weak and the strong generative capacity of a grammar of a natural language on the basis of the analogy between the study of formal languages and the study of natural languages. In some sense, it is obvious that the analogy is misleading since, unlike natural languages, formal languages are created by logicians, mathematicians and computer scientists for particular scientific purposes. Knowledge of formal languages requires teaching and special training and, unlike knowledge of natural languages, it is not acquired on the basis of mere exposition to linguistic evidence.

The other disagreement between Quine and Chomsky is that Chomsky rejects Quine's restriction of the empirical evidence relevant to establishing the truth of grammatical hypotheses about language L to the examination of the dispositions to linguistic behavior on the part of speakers of L. Quine's view comes out clearly in one passage of his (1990) Pursuit of Truth: 37) :

In psychology one may or not be a behaviorist, but in linguistics one has no choice. Each of us learns his language by observing other people's verbal behavior and having his own faltering verbal behavior observed and reinforced or corrected by others. We depend strictly on overt behavior in observable situations.

On Chomsky's view, evidence from the grammars of many different languages and evidence from the study of the brain might be relevant to the selection of a description of the grammatical knowledge of a speaker of L. Clarification of Chomsky's position must await, however, examination of question (Q2) to which I presently turn.

3. Language acquisition and the poverty of the stimulus argument

The second question (Q2) that confronts linguistic theory is: How did knowledge of the grammar of a particular language arise in the mind of a speaker? Investigation of the first question is guided by the search for what Chomsky calls "descriptive adequacy". Speakers of various languages know different things because languages differ. A grammar of a particular language must satisfy the condition of descriptive adequacy in that it must faithfully reflect the properties of what speakers of that particular language know. In response to the second question, linguistic theory must satisfy conditions of "explanatory adequacy": it must contribute to explaining how a human child — any child — is able to acquire knowledge of her language given her exposure to linguistic data. It is quite clear that normal children acquire knowledge of whichever language they are exposed to. Children brought up respectively in Japan and in Brazil will end up speaking different languages. The search for descriptive adequacy and the search for explanatory adequacy pull in opposite directions. The former seems to lead to a variety of rule systems. The latter leads to uniformity of the human initial endowment that allows normal human children to acquire knowledge of the grammar of whatever language is spoken around them.

Ever since he published Aspects (1965) and Cartesian Linguistics (1966), Chomsky

has persistently argued that there are two main lines of response to question (Q2) about the acquisition of grammatical knowledge: a rationalist and an empiricist approach. As he put it in Aspects (p. 58), the problem of acquisition is “that of developing a hypothesis about initial structure that is sufficiently rich to account for acquisition of language, yet not so rich as to be inconsistent with the known diversity of language”. The issue between empiricists and rationalists is not whether language acquisition can proceed without any initial innate structure. As Quine (1969), a leading empiricist, readily acknowledges, any kind of learning presupposes the existence of a set of innate unlearned dispositions to learn. What empiricists and rationalists disagree about is the modularity or task-specificity of the initial state that allows a human child to acquire her knowledge of the grammar of her language. On Chomsky’s rationalist view, human children acquire knowledge of the grammar of their language because they have prior knowledge of what he calls “Universal Grammar” (UG for short). UG is taken to be species-specific in the sense that it is a unique property of the human brain (or mind). It is supposed to be innately known to the human child. Finally it is supposed to be task-specific: its task is to enable language acquisition.

Notice that if a speaker’s knowledge of the grammar of her language is a first-order cognitive structure, then knowledge of UG is a higher-order cognitive system. UG is the faculty of the human mind that, in combination with early linguistic experience, allows a human child to construct her knowledge of the grammar of her language. Presumably, whereas a speaker’s knowledge of the grammar of her language derives from an ontogenetic process, knowledge of UG — the initial state of the language faculty — results from the phylogenetic evolution of the human species. UG is a higher-order cognitive structure present in the human brain as a result of evolution by natural selection.

In favor of his rationalist approach to the problem of language acquisition, Chomsky has consistently used versions of the argument by “the poverty of the stimulus”. Knowledge of grammar is widely under-determined by all available evidence. First of all, as Chomsky has

emphasized many times, unlike e.g., knowledge of historical facts, knowledge of geographical facts or knowledge of chemical theory, knowledge of language is not taught: it “grows” in children’s minds. To see what is at issue, consider the following pairs of examples:

(10a) Mary said that she would come.

(10b) She said that Mary would come.

(11a) Mary expects to feed herself.

(11b) John wonders who Mary expects to feed herself.

Anyone who understands sentences in (10) knows that in (10a), ‘Mary’ and ‘she’ may be coreferential, but not so easily, if at all, in (10b). In (11a) ‘herself’ refers to what ‘Mary’ refers to, but not so in (11b) in which ‘herself’ refers to some female person other than Mary. Surely, no child has been taught those facts. Secondly, the actual linguistic evidence available to a child consists of a fragmentary and degenerate sample of her language: many actual utterances are incomplete sentences, for example. On the basis of such limited data, the child is nonetheless capable of attaining a state of knowledge that allows her to understand and produce novel sentences. Finally, children end up knowing structures of their language for which there simply was no evidence available in the set of utterances to which they have been exposed. This is the problem of “negative evidence”: crucial evidence for some grammatical knowledge consists in contrasts between well-formed sentences which the child might have heard and ungrammatical sequences which must have been unavailable to the child precisely because they are ungrammatical. Briefly, the notion of negative evidence amounts to the claim that in her linguistic sample a child will only find evidence of well-formed sequences of the language. She will not find instances of ill-formed sequences (which the linguist can construct on a theoretical basis).

I shall present one typical example of the argument by the poverty of the stimulus (first advanced by Chomsky at the 1975 Royaumont Conference at which Chomsky met Piaget). Consider pairs of simple English Yes-No questions and their declarative counterparts (12):

(12a) The man is tall \Rightarrow Is the man tall?

(12b) The book is on the table \Rightarrow Is the book on the table?

Now, consider a child learning English. On the basis of the evidence presented in (12), she might consider the simplest hypothesis first: in order to form a Yes-No question in English, process the corresponding declarative sentence word by word from left to right until you reach the first occurrence of the auxiliary. Then, move it to the front of the sentence. Now, consider the declarative sentence involving a relative clause (13a):

(13a) The man who is here is tall

If the child were to use the simplest hypothesis under consideration, she would turn (13a) into (13b) which is not a grammatical question of English:

(13b) *Is the man who here is tall?

The correct English question corresponding to the declarative (13a) is (13c):

(13c) Is the man who is here tall?

Consider now a more complex hypothesis that can account for both questions in (12) and

(13): process the declarative sentence from left to right by analyzing it into abstract phrases (such as NP, VP, etc.) until you reach the first auxiliary. Then, move it in front of the first NP of the sentence. Application of this rule to (13a) correctly yields (13c). Unlike the first hypothesis, the second hypothesis is what Chomsky calls a “structure-dependent” rule: it takes as input an abstract analysis of the sentence into grammatical constituents, not words. And it modifies the structure by moving a constituent. Now, Chomsky makes the empirical claim that in the course of acquiring knowledge of English, children never produce ill-formed questions such as (13b). Since structure-dependence is not a property of utterances that is directly observable, he concludes quite rationally that human children have innate knowledge of the fact that the rule for forming Yes-No questions in English is a structure-dependent rule. Hence, structure-dependence is part of UG.

In Chomsky’s construal, the dispute between rationalists and empiricists raised by question (Q2) is not about innateness. It is about the task-specificity of UG, the initial state of the language faculty that, according to the rationalist story, allows a human child to acquire knowledge of her language on the basis of her access to linguistic evidence. Chomsky’s argument based on the formation of simple Yes-No questions in English is a typical “poverty of the stimulus” argument. It was intended as a challenge to any claim that “general intelligence” is all that is required to acquire knowledge of the grammar of a language. For a defense of the claim that general intelligence can account for language acquisition, see e.g., Putnam (1980).

At the Royaumont Conference, after Chomsky offered his “poverty of the stimulus” argument, one interesting exchange took place between the Piagetian developmental psychologist Bärbel Inhelder and the molecular biologist Jacques Monod. At the Conference, Jean Piaget and the Piagetians were arguing that the development of sensorimotor schemata can account for language acquisition. Monod pointed out that Piagetian theory should predict that children with a severe deficit in motor control (e.g., quadriplegics) should be severely

retarded in language acquisition, if not prevented from acquiring language. Inhelder replied that the required motor ability may be restricted to e.g., eye motion. In effect, as was immediately pointed out by Jerry Fodor, Inhelder was implicitly conceding that all that is required by Piaget's view is that some motoric experience play a "triggering" role in language acquisition. Presumably, to recognize that some motoric experience plays a triggering role in language acquisition is consistent with Chomsky's conclusion from the poverty of the stimulus argument that UG is necessary for language acquisition. In retrospect, some twenty-five years after the debate, it appears that offering the argument by the poverty of the stimulus in favor of the rationalist claim that UG is an innate and task-specific part of the initial state of the language faculty was, I think, the correct strategy for Chomsky to adopt. Furthermore, in the particular case of the Yes-No questions in English, since it depends on the empirical claim that English speaking children never come up with ill-formed questions such as (12b), the conclusion is testable and, as far as I know, it has not been refuted.

As I said above, questions (Q1) and (Q2) must satisfy different kinds of adequacy: the former must satisfy descriptive adequacy; the latter must satisfy explanatory adequacy. The search for descriptive adequacy and the search for explanatory adequacy pull in opposite directions: the former towards multiplicity of rule systems for different languages, the latter towards uniformity of the initial state of the language faculty. As Chomsky (2000: 7) puts it, "this tension [...] has largely set the guidelines of research". Early work in generative grammar emphasized the multiplicity of different rule systems specific to particular languages. Further elaboration and a great deal of empirical study of many different languages led to an approach labelled the "Principles and Parameters" framework that has dominated generative linguistics since the 1980's. On this approach, all languages turn out to be "cast to the same mold". As Chomsky (2000: 8) puts it:

we can think of the initial state of the language faculty as a fixed network connected to a switch

box; the network is constituted of the principles of language, while the switches are the options to be determined by experience. When the switches are set one way, we have Swahili; when they are set another way we have Japanese. Each possible human language is identified as a particular setting of the switches — a setting of parameters, in technical terminology.

The ingenuity of generative linguists consists in sorting out the parameters from the general principles of the language faculty. On this view, human children do not have to learn the general principles of the language faculty. They know the general principles and their task is to fix the parameters of the particular language spoken by members of their community. Although as a non-linguist, I cannot truly judge, it seems to me that the Principles and Parameters framework has led to an enormous amount of discoveries about how languages around the world, though different from one another, are nonetheless “variations on a single theme”.

Now, on the assumption that the language faculty — a higher-order cognitive system that, in combination with linguistic experience, gives rise to grammatical knowledge of particular languages — is a specialized (i.e., modular) system within the human mind, the question arises of how it interacts with other systems of the human mind. In particular, the computations performed by the language faculty must be accessible to various systems of the mind required for the use of language, both for producing and understanding speech. At the very end of the 1990’s, within the so-called “Minimalist” program, Chomsky has entertained the idea that the computations performed by the language faculty must meet “legibility conditions” imposed by e.g., the human sensorimotor system and the human conceptual system. The former must be able to read the phonetic representations generated by the language faculty in order to produce sounds. The latter must be able to take into account the semantic representations generated by the language faculty in order to derive inferences from linguistically coded information. So these “external” (i.e., non-linguistic) systems must be able to read the instructions delivered by the language faculty. In the last few years, within the

Minimalist program, the highly speculative question has arisen whether the language faculty can be seen as an “optimal” solution to the engineering problem of designing legibility conditions accessible to the external systems. I will return to this question at the very end of this paper.

At this stage, we can, I think, go back and clarify one important point of contention between Quine and Chomsky, namely Chomsky’s rejection of Quine’s assumption that in the study of a person’s grammatical competence, only evidence related to the speaker’s behavior (or to the behavior of people speaking the same language) can be a relevant source of evidence. Suppose we want to characterize the grammatical knowledge of an English speaker. Assuming the correctness of Chomsky’s rationalist framework, there exists an initial state of the language faculty that allowed the English speaker to acquire knowledge of her language. The initial state is not “tuned” to the acquisition of English rather than any other particular language. Examination of a feature of Japanese grammar might compel us to attribute knowledge of some principle P to the initial state of the language faculty if e.g., it turns out that a Japanese child could not have extracted her knowledge of P from being exposed to samples of Japanese sentences (a typical instance of negative evidence in Japanese). If so, then knowledge of principle P by an English speaker should be attributed to the initial state of her language faculty as well, not to her particular knowledge of English.

4. Domain-specificity and cognitive development

Chomsky’s application of the argument by the poverty of the stimulus to language acquisition has had, I think, a twofold impact on one area of cognitive science: the study of the cognitive development of human infants. In fact, I think it is fair to say that the contemporary study of the cognitive development of human babies owes its existence to Chomsky’s repeated use of the argument by the poverty of the stimulus. On the one hand, this argument strongly suggests that while human infants do not yet speak any natural languages,

they do not have to learn the basic principles underlying the grammars of all possible human languages. They only need to set the parameters of particular languages. In this sense, the argument by the poverty of the stimulus reveals that much of what a human being knows about language depends on the phylogenetic evolution of the species rather than on some ontogenetic process of learning. At least, the latter strongly supervenes on the former. On the other hand, it strongly suggests that basic cognitive structures are acquired on the basis of sharp innate constraints. In other words, a rich cognitive structure can only be acquired on the basis of a sharply modular (or task-specific) and presumably species-specific initial state (or genetically based cognitive endowment).

As noticed by Chomsky (1975: 17-20), unlike humans, rats cannot acquire knowledge of human languages. Nor for that matter can chimpanzees. Rats and human college students seem to be roughly comparable in maze running capacities. Humans, however, surpass rats in running mazes with numerical properties (where the rule is e.g., to select every prime numbered turn). Indeed, according to Chomsky's (1975, 1980, 1982, 2000) speculations, the language faculty and the capacity to deal with properties of natural numbers share some interesting features and are both distinctive of human cognition. They share the property of "discrete infinity" — a property which is "biologically isolated" in the sense that not many biological creatures acquire cognitive structures that exemplify it. As Chomsky (1997) recently wrote:

Human language is based on an elementary property that also seems to be biologically isolated: the property of discrete infinity, which is exhibited in its purest form by the natural numbers 1, 2, 3, ... Children do not learn this property of the number system. Unless the mind already possesses the basic principles, no amount of evidence could provide them; and they are completely beyond the intellectual range of other organisms. Similarly, no child has to learn that there are three word sentences and four word sentences, but no three-and-a-half word sentences, and that it is always possible to construct a more complex one, with a definite form and meaning. Such knowledge must come to us from "the original hand of nature", in David Hume's phrase, as part of our biological endowment.

As Chomsky (1975, 1980, 1982, 2000) likes to put it, there are “problems” that some creatures can solve in virtue of their cognitive capacities and others that they cannot: language acquisition and properties of natural numbers are such “problems” for human cognition. Problems for human cognition may be what Chomsky (*ibid.*) calls “mysteries” for rat cognition: they fall outside the reach of rats’ cognitive capacities. The latter allow rats to solve maze-running problems. Now, Chomsky (*ibid.*) speculates that there must be “mysteries” for humans that fall outside the human “science forming” cognitive capacity just as language acquisition lies beyond the reach of rat cognition.

At this point, I would like to distinguish Chomsky’s claim that there may be problems which members of any biological species are not equipped to raise and/or to solve from his additional hypothesis that there may exist in the human brain a “science forming capacity”. I think that Chomsky’s distinction between problems and mysteries is in fact the basis of an important research program into the uniqueness of human cognition. But I do not think that it is very plausible to assume that there exists in the human brain a “science forming” cognitive capacity — not if UG is taken to be the model of such a cognitive capacity and UG is supposed to be species-specific, task specific and innate in the human brain. My reasons for scepticism about there being such a science forming cognitive capacity in the human brain stems from three related observations: first, unlike language acquisition, scientific theorizing is slow and difficult. It does not extend merely over a human individual’s personal life but over generations of such personal lives. Second, unlike language acquisition, it requires explicit learning and teaching and also a special institutional and cultural setting. Finally, unlike language learning, scientific theorizing involves important differences among different individuals.

In the last twenty-five years, the Chomskyan distinction between problems and mysteries has given rise to much fruitful research into the study of infants’ cognitive

development. Much has been learnt about human infants' knowledge and reasoning in four basic domains other than language: naive physics, naive psychology (or mindreading), naive arithmetic and naive geometry. The main methodology used in these studies is the habituation paradigm whereby an infant is habituated to e.g. a visual stimulus until her perceptual attention declines. Then the infant is presented with a new stimulus and her looking time on the new stimulus is measured. On the assumption that an infant will look longer at an unexpected event than at an expected one, the measure of looking time provides a measure of infants' assumptions about what is going on around them. I will not review here the discoveries made by developmental psychologists about human infants' knowledge and reasoning in the areas of naive physics, naive psychology, naive arithmetic and naive geometry (see e.g., the work of Renée Baillargeon, Susan Carey, Alan Leslie, Elizabeth Spelke and others).

What I do want to emphasize though is that this research program is very much in line with Chomsky's view that the initial state of the human language faculty is a species-specific modular (or task-specific) higher-order innate cognitive structure. It is a higher-order cognitive structure because, in combination with linguistic experience, it gives rise to knowledge of the grammar of particular languages — a lower-order cognitive structure. Central to Chomsky's influence on the research into the cognitive capacities of human infants in cognitive domains other than language is Chomsky's assumption that the language faculty is modular or task-specific.

Chomsky's notion of modularity is interestingly different from Jerry Fodor's (1983) concept of modularity. First of all, Chomsky uses this notion to solve the "inductive" problem of language acquisition: how can a human child learn her language given the "poverty" of the stimulus? Fodor's notion of modularity is geared towards the solution of a different problem: the problem of providing in computational terms a principled distinction between belief-formation and/or considered judgments (i.e., conceptual processes) and perceptual processes.

Unlike conceptual “central” processes, perceptual processes or “input systems” are modular in Fodor’s sense.

Secondly, a computational mechanism is a system that converts inputs into outputs. Such a mechanism can be limited in two sorts of ways: it can be limited in the kinds of inputs it can process or analyze and it can be limited in the type of computations it can perform on the inputs. The language faculty (UG) in Chomsky’s sense is domain-specific: it processes only linguistic stimuli. The visual system is domain-specific in this sense: it processes visual stimuli, not auditory or tactile stimuli. The paradigm of Fodor’s perceptual input systems is the visual processing of an illusory display such as the Müller-Lyer illusion. Even though you know that the two line segments are equal, they look unequal: the segment whose arrows are converging looks longer than the segment whose arrows are diverging. The computational mechanism that gives rise to the visual illusion is encapsulated because it does not make use of the available information that the two segments are equal. Conversely, even though the two segments look unequal, your considered judgment will be that they are equal: central processes are “Quinean” (holistic) and “isotropic”. The output of the processing of informationally encapsulated input systems is only one of the factors on the basis of which the central processes reach their considered judgment. The Fodorian paradigm of central processes is scientific hypothesis formation where any available information can be used as relevant evidence.

Informational encapsulation and domain-specificity, though related, are nonetheless different properties of a cognitive structure or computational mechanism. In the tradition of generative grammar of the past twenty-five years, core knowledge of grammatical facts gives rise to intricate judgments illustrated by English sentences (14) and (10)-(11) (already discussed), which involve anaphoric dependence between a pronoun and its antecedent (‘she’ and ‘Mary’ in (10), ‘herself’ and ‘Mary’ in (11), ‘each other’ and ‘we’ in (14)):

(10a) Mary said that she would come.

(10b) She said that Mary would come.

(11a) Mary expects to feed herself.

(11b) John wonders who Mary expects to feed herself.

(14a) We like each other.

(14b) We expect each other to win.

(14c) *We expect John to like each other.

(14a) means that each of us likes the other. (14b) means that each of us expects the other to win. But (14c) is not a grammatical sentence with the meaning that each of us expects John to like the other. The point is that no mature English speaker has been taught such facts. Nonetheless, he or she knows them. Given the poverty of the stimulus argument, Chomsky's view is that an English speaker comes to know these facts and make the corresponding judgments in virtue of a task-specific, i.e., a domain-specific, not an informationally encapsulated, cognitive capacity (UG). Grammatical knowledge that underlies judgments of anaphoric dependency presumably cuts across the Fodorian distinction between central processes and input systems. So does presumably human infants' core knowledge of naive physics, naive psychology, naive arithmetic and naive geometry investigated by developmental psychologists. It is a domain-specific, not an informationally encapsulated, cognitive capacity.

On the assumption that I have provided evidence for my claim that Chomsky's work can legitimately be regarded as the single most important contribution to our current understanding of human language and the human mind, I now want to turn my attention to some of his views that stand in sharp contrast with the views of most philosophers of mind

and language who reject methodological dualism.

5. The creative aspect of language use and naturalism

Most of Chomsky's polemics with philosophers of mind and language in the 1970's and the 1980's has been devoted to a criticism of what Chomsky (1980) calls "the bifurcation thesis", i.e., the idea that there is a boundary between the natural sciences and the study of human language and the human mind. Importantly, cognitive science roughly sits at the boundary in question. Therefore, it is primarily concerned by the bifurcation thesis (or methodological dualism). As I mentioned earlier, Quine's thesis of the indeterminacy of radical translation is a sophisticated version of the bifurcation thesis. Another version is Searle's (1992) Connection Principle, according to which, unlike merely neurophysiological states and processes, genuinely mental states and processes must be "potentially accessible to consciousness". If he were right, then most of the computational processes posited by cognitive science would fail to qualify as mental processes: cognitive science might be about the human brain, but not the human mind. The essence of methodological dualism lies in the assumption that, unlike the study of other natural phenomena, the study of language and mind is liable to a priori constraints to which the genuine natural sciences are not subject. As Chomsky (2000: 112) writes:

[...] the natural sciences — whether the topic is the motion of the planets, the growth of an organism [...] — are "first philosophy". The idea is by now a commonplace with regard to physics [...]. But this standpoint is commonly regarded as inapplicable to cognitive science, linguistics in particular. Somewhere in-between, there is a boundary. Within that boundary, science is self-justifying; the critical analyst seeks to learn about the criteria for rationality and justification from the study of scientific success. Beyond that boundary, everything changes; the critic applies independent criteria to sit in judgment over the theories advanced and the entities they postulate. This seems to be nothing more than a kind of "methodological dualism", far more pernicious than the traditional metaphysical dualism, which was a scientific hypothesis, naturalistic in spirit.

Evidently, Chomsky abhors the stance of methodological dualism: since he contributed so much to the contemporary scientific study of the human language faculty that in turn made cognitive science possible, this is quite understandable. Furthermore, I find his persistent arguments against “double standards” quite convincing. From the standpoint of a naturalistic inquiry, however, the question that arises is: What to make of his view that methodological dualism is “far more pernicious than the traditional metaphysical dualism, which was a scientific hypothesis, naturalistic in spirit”? In what sense was metaphysical dualism a scientific hypothesis, naturalistic in spirit?

Recall first Chomsky’s question (Q3): How is a speaker’s knowledge of the grammar of her language put to use in actual speech (both in production and in comprehension)? Chomsky would no doubt concede that some scientific progress has been made in the understanding of the processes whereby a person uses various performance systems to produce and/or process linguistic sounds. He would, however, sharply distinguish these “problems” from the “mystery” of “the creative aspect of language use”. With regard to both speakers’ knowledge of the grammar of their language and the computational properties of the language faculty, intelligible explanatory theories are available. But with respect to normal language use, we “are still in the dark”. The reason normal language use is a deep mystery is that it is: “unbounded; not determined by external stimuli or internal state; not random but coherent and appropriate to situations, though not caused by them; evoking thoughts that the hearer might have expressed the same way” (Chomsky, 1994: 156). This characterization of normal language use as a deep mystery sounds very Cartesian indeed: in fact, it is the root of Chomsky’s claim that metaphysical (or ontological) substance dualism of the Cartesian variety was “a scientific hypothesis, naturalistic in spirit”. In particular, one may be legitimately puzzled by the claim that normal language use is not caused.

Normal language use is quite typical of human intentional behavior: it exemplifies the cluster of properties characteristic of human intentional action. Chomsky accepts the

Cartesian view that human intentional behavior differs from the behavior of anything else in the physical world because humans have minds. On his view as on Descartes', there is a fundamental divide between minds and machines: "no artefact could exhibit the normal properties of language use". On Chomsky's view, unlike what people know, what they do may not fall within the cognitive reach of the human "science forming capacity". As we saw above, like Descartes, Chomsky takes "discrete infinity" to be a fundamental property of human minds. Remarkably, Chomsky also accepts the Cartesian view that human intentional action is radically unlike any machine's behavior. Chomsky (1980: 79) says of human intentional action that it is "indeterminate" because it involves "questions of will and choice that will remain shrouded in mystery". Although there are available explanatory theories of what humans know in some areas (e.g., language), an account of people's grammatical knowledge still leaves the question of "how they talk" wide open. On Chomsky's (1988: 5-6) Cartesian view, humans are merely "incited and inclined" to act:

their behavior may be predictable, in that they will tend to do what they are incited and inclined to do, but they are nonetheless free, and uniquely so, in that they need not do what they are incited and inclined to do. If, for example, I were to take out a machine gun, point it menacingly at you and command you to shout 'Heil Hitler', you might do it if you had reason to believe I was a homicidal maniac, but you would have a choice in the matter, even if that choice is not exercised [...] A machine, in contrast, acts in accordance with its internal configuration and external environment, with no choice. The creative aspect of language use was often referred as the most striking example of this fundamental aspect of human nature.

Although it is true that Chomsky is more sympathetic than most contemporary physicalist writers to the motivations of Cartesian dualism, I do not mean to suggest that Chomsky subscribes to ontological dualism. In fact, Chomsky expresses scepticism about any claim that anything might be "the mark of the mental". He uses "mental" on a par with the "optical", the "electrical" or the "chemical" to demarcate some natural physical phenomena

for which one wants to uncover some deep empirical generalizations. It would make no more sense to look for a criterion of the mental than to look for a criterion of the optical, the electrical or the chemical. Nor should one seek any metaphysical boundary between mental phenomena and other physical phenomena.

One can, I think, go along with Chomsky when he emphasizes the gap between what people know and what they do or how they act. The question is whether the gap is ontological or epistemological. It is one thing to say that an account of what people know will fall short of what they do. It is another to say that human beings' actions is "indeterminate". When Chomsky says of human intentional action that it is "indeterminate", it is not absolutely clear whether he means that it is uncaused — whether it lacks any cause — or whether the causal chain leading to human intentional action is bound to fall outside the human science forming cognitive capacity. Whatever Chomsky's exact position is in this respect, we have located one basic point of disagreement between him and naturalistically inclined philosophers. They assume and he denies that the problem of "mental causation" is a legitimate problem, not a "mystery" — where the problem of mental causation is the problem of how an individual's thought (or mental representation) can cause her to produce a physical motion in virtue of its content.

The Cartesian assumption that human intentional action — particularly, normal language use — is a mystery (not a problem) led Descartes to embrace ontological dualism. According to Cartesian substance dualism, human intentional actions are unlike the behavior of anything else in the physical universe and human minds are unlike bodies. Whereas the essential property of minds is thought, bodies are extended in space and they obey physical laws, i.e., the principles of mechanics. According to the mechanical philosophy, no causal interactions between physical bodies can occur at a distance. According to Chomsky, given the assumption that human intentional action is unlike the behavior of anything else in the physical world, ontological or metaphysical dualism was, unlike contemporary

methodological dualism, a rational (if not a scientific) conclusion.

In many of his recent writings, Chomsky (1994, 2000) has capitalized on this interpretation of Cartesian ontological dualism to draw a picture of the mind/body problem that is radically at odds with most contemporary physicalist discussions of the problem. Most contemporary physicalists ask the question: How can a purely physical system exemplify intentionality and/or consciousness? How can intentionality and/or consciousness arise in a purely physical system? According to Chomsky (2000), the success of Newtonian physics destroyed the Cartesian mechanical philosophy. By acknowledging gravitational action at a distance between physical particles, Newtonian physics showed that the physical universe — and hence, physical bodies — were beyond the explanatory power of the mechanical philosophy. In the process, “the Cartesian theory of mind [...] was unaffected [...], but the theory of body was demonstrated to be untenable. To put it differently, Newton eliminated the problem of [what the philosopher Gilbert Ryle called] ‘the ghost in the machine’ by exorcising the machine; the ghost was unaffected” (Chomsky, 2000: 84). In fact, according to Chomsky, not only did the advent of Newtonian action at a distance destroy the physical view presupposed by the Cartesian ontological dualistic picture, but it also deprived the mind/body problem of its basic presupposition, i.e., that it makes any sense to try to reduce the mind to some well-defined concept of the physical, since no such concept is available.

Since Brentano, many philosophers have taken intentionality to be the mark of the mental. Whether they take intentionality or consciousness (like Searle, 1992 and Strawson, 1994) to be constitutive features of the mental, most physicalists think that the mind/body problem is a deep but genuine metaphysical issue because of the “explanatory gap” between the mental and the physical. If one takes intentionality as a crucial feature of mental representations, then one will be led to ask how physical structures in the brain can have intentionality or content. Physicalists assume that mental states (and/or representations) are brain states. But they divide over whether the fact that a brain state possesses content or

intentionality can play a causal role. Can content be “causally efficacious”? Intentional realists say “Yes”. Intentional irrealists say “No”. In other words, once the gap between intentionality and things devoid of intentionality has been appreciated, one faces a basic choice: one can assume that current physics (together with the rest of the natural sciences) provides the basic outline of the physical. Or one can deny it. If one takes the former option, then one can endorse physicalism and deny various features of the mental. This is what several physicalist writers do to varying degrees. The eliminative materialists who are intentional irrealists (e.g., Churchland) claim that no mental property has ever been instantiated. Other intentional irrealists, who (like Quine, Davidson or Dennett) subscribe to an instrumentalist and/or an interpretationist doctrine of the mental, put into question the reality of various mental phenomena and properties. The other way to go would be to embrace idealism.

Chomsky claims that since the demise of the mechanical philosophy, the mind/body problem cannot even be meaningfully raised. He points out that our concept of the physical is constantly evolving with the development of the physical sciences. On his view, since the Newtonian demolition of the mechanical philosophy, we do not know how to define the physical. So much so that no meaningful question of the reduction of the mental to the physical can arise. What a naturalistic inquiry into the mental should lead us to expect, on his view, is a “unification” of the cognitive science with the core natural sciences, not a reduction of the former to the latter. Perhaps unification will not occur until major changes affect the core natural sciences themselves.

Chomsky is no doubt right to draw our attention to the fact that we have come to accept whatever entities and processes the physical sciences posit however commonsense might find them offensive. Until or unless basic physics completes its job of providing a full and final characterization of the ultimate constituents of the universe, we do not possess a final concept of the physical. Nonetheless, physicalist philosophers of mind might still have

reasons to assume that minds raise special metaphysical issues with respect to anything else the physical sciences have so far found reasons to postulate. Consciousness notwithstanding, intentionality is puzzling. Assuming that what some philosophers call “primitive” intentionality — as opposed to the “derived” intentionality of artefacts — requires the evolution of such complex biological structures as nervous systems, still the question how brains could be minds remains a mystery above the physical mysteries derived from the Newtonian introduction of action at a distance. The mystery of how brains could be minds is — again, consciousness notwithstanding — the mystery of how anything biological, chemical and physical could give rise to representations. The naturalism of physicalist philosophers of mind drives them to ask the question: in virtue of which of its non-semantic properties could a brain construct mental representations? Assuming that a mental representation is a brain state, the question is: Which of the non-semantic properties of a brain state could account for the fact that it can also exemplify content or a semantic property?

The reason, I take it, Chomsky thinks this question is not meaningful is that no “scientific” sense can be made of the notion of content or the semantic property of a mental representation. Although Chomsky has more than anybody else contributed to the construction of “computational representational” (C-R) theories of the mind, he seems to think that we should refrain from asking the question: What do mental representations stand for? What do they represent? I now turn to this question.

6. Internalism in semantics and evolution

As Figure 1 made clear, on Chomsky’s view of grammar, the syntax of a natural language generates linguistic structures step by step until these structures can be interpreted respectively by phonology and the semantic part of grammar. Hence, on this view, meanings and sounds are symmetrical: the former provide instructions for pronunciation, the latter provide instructions for drawing inferences.

In many of his recent writings, Chomsky calls “I-language” (as opposed to E-language) a speaker’s knowledge of the internal computational procedure that allows her to produce and interpret expressions of her language. “I-language” contrasts with “E-language” as both internal contrasts with external and intensional contrasts with extensional. In the following, the internal vs. external contrast will be most relevant. An I-language is internal in the sense that it is a procedure represented in a speaker’s (and/or a hearer’s) brain for generating well-formed expressions. By contrast, an E-language is external in the sense that it is a set of expressions generated by an internal procedure. An I-language is intensional in the sense that, among several extensionally equivalent characterizations of the procedure that generates an E-language, it corresponds to one particular procedure represented in a speaker’s brain.

Thanks to the development of generative grammar, rich testable theories of syntax and phonology are presently available. Insofar as such theories are computational theories, they are internalist theories. They are internalist in the sense that all of the relevant computations go on within a speaker’s mind or brain. Phonological and syntactic computations supervene on a speaker’s brain, not on the relations between the speaker’s brain and his or her environment. The former supervene on the latter in the sense that Chomskyan linguists assume that no phonological and/or syntactic information would be computed unless some physical, chemical and physiological processes would take place in the speaker’s brain and if and when such physical processes do take place, then the phonological and/or syntactic information is being computed by the speaker.⁵ The debate between internalism and externalism is about whether only brain processes (or processes internal to an individual’s brain) underlie a given cognitive achievement or whether properties instantiated in the speaker’s environment too are relevant. According to computationalism, the environment may be relevant to fixing the phonological and syntactic parameters of the language spoken around

⁵ On supervenience, see Kim (1993).

a child. But once fixed, the syntactic and phonological computations operate within the speaker's brain alone.

The success of internalist phonology and syntax raises the question whether all of the scientific study of language and mind is or ought to be similarly internalist. In particular, the question arises whether semantics can or should be internalist. Although Chomsky (2000: 156) recognizes that internalism is not "entailed" by methodological naturalism, he nonetheless thinks that internalism is without a "realistic alternative". What Chomsky calls "I-linguistics" is predicated on the assumption that the study of I-meanings ought to proceed in parallel with the study of I-sounds.

Most externalist philosophers of mind and language disagree with Chomsky about semantics. On the face of it, semantic properties and phonological properties seem to be very different properties of sounds. Much contemporary philosophy of mind can be said to stem from some of the crucial differences between meanings and the acoustic properties of sounds.

Consider an example of Fred Dretske's (1988): a soprano produces an upper sound in the course of singing an Opera and the sound shatters glass. Suppose the sound had both a meaning and an acoustic property. Surely, the sound shattered the glass in virtue of its acoustic property, not in virtue of its meaning. Unlike the acoustic property, the meaning is not an intrinsic property of the sound. Arguably, the sound could have had a different meaning or no meaning at all and still be the same sound. Presumably, the event of the producing of the sound would not have been the same event had the sound lacked its meaning. However, the sound could be the same sound if it lacked its semantic property, not if it lacked its acoustic property. So the sound's acoustic property is an intrinsic property of the sound. And it may be causally efficacious in the process whereby the production of the sound shattered the glass. Indeed, it is presumably because its acoustic property is one of its intrinsic property that it was a causally efficacious property of the sound in the process whereby it shattered the glass. Conversely, it is because the meaning is one of the sound's

extrinsic property that the meaning seems devoid of causal efficacy in the shattering of the glass. On the view of most externalist philosophers of mind and language, the meaning of a symbol (whether linguistic or mental) is not one of its intrinsic property: it is both relational and historical. As Putnam (1974) famously said, “meanings are not in the head”.

No doubt, phonological properties are not acoustic properties. Unlike the latter, the former are not intrinsic properties of speech sounds: the former are extracted from the latter. Neither LFs nor phonological properties are intrinsic properties of speech sounds. As I pointed out earlier, on Chomsky’s view, rules yielding LFs and phonological rules (yielding PFs) are really syntactic rules; they operate in parallel upon S-structures, which are delivered by the transformational component of a grammar. As I argued above, however, LFs are not genuinely semantic representations: rather, they are the output of such syntactic rules as Quantifier Raising (QR), which (I claimed) are extended transformations.

Phonological properties, therefore, are like syntactic properties, not like acoustic properties. Unlike physical (or geometrical) properties, syntactic properties are higher-order properties of symbols. Arguably, unlike the syntactic property of a symbol, and like the acoustic property of a sound, its shape is one of its intrinsic physical or geometrical properties. For example, in propositional calculus, the truth-functional connective for conjunction may assume three different shapes: “&”, “.” and “^”. Thus, three distinct physical symbols with different geometrical shapes have one and the same syntactic property that can be stated by the following rule: if “p” and “q” are well-formed formulae, then so is “p & q”. What this suggests is that the syntactic property of a symbol is one of its higher-order (functional) properties. A symbol can be said to instantiate the above syntactic property just in case it instantiates one of the three mentioned geometrical properties. In general, something exemplifies a given functional (higher-order) property in virtue of the fact that it exemplifies one within a disjunctive class of basic physical properties. Hence, I submit that a symbol exemplifies either a syntactic or a phonological property in virtue of the fact that it

exemplifies one of a disjunctive class of basic physical (either geometrical or acoustic) properties.

Granted, syntactic and phonological properties are functional, hence not basic physical, properties of speech sounds. Still, there is an important difference between syntactic or phonological properties and meaning (or semantic) properties. To say that syntactic and phonological properties of a symbol are functional properties is to say that they supervene on basic intrinsic physical (geometrical or acoustic) properties of symbols. Arguably, although they are not basic physical properties of a symbol, syntactic and phonological properties are internal properties of a symbol. According to externalism, however, meaning (or semantic) properties of symbols do not supervene upon their basic intrinsic properties. Meaning (or semantic) properties of symbols are not internal properties: they are both extrinsic and historical. They are extrinsic because they supervene on properties instantiated in the symbol's environment. According to externalists, nothing can be a symbol and have a meaning unless it results from some historical process or other. The meaning of a symbol is like the authenticity of a work of art or like the economic value of a 100 French francs bill: the latter do not supervene on the intrinsic properties of either a canvas or a piece of paper. They depend on the historical relations between the canvas and an artist or between the piece of paper and agents working for some governmental agency.

On the one hand, Chomsky himself has not expressed views on the metaphysical issue of the extrinsic nature of meaning. On the other hand, unlike Chomsky, most philosophers of mind and language take truth and reference to be central semantic notions. Chomsky often points out that much more is known and understood about referential dependence than about reference. Speakers of natural languages have subtle and intricate intuitions about the relations between an anaphoric pronoun and its antecedent (as illustrated by (10), (11) and (14)). Consider some of Chomsky's examples of such complex referential dependencies in (15):

(15a) The bank burned down and then it moved across the street.

(15b) The bank, which had raised the interest rate, was destroyed by fire.

(16) The book that he is planning will weigh at least five pounds.

In one clause of (15), ‘the bank’ refers to a concrete building. In the other clause, the pronoun coreferential with ‘the bank’ refers to an abstract institution. In (16), the pronoun ‘that’ corefers with ‘the book’. The pronoun refers to some content and its antecedent refers to a physical object that is the vehicle of the content referred to by the pronoun. In such cases, the anaphoric dependency of the pronoun on its antecedent is preserved in spite of the shift from the concrete to the abstract entity being referred to. Chomsky (2000: 62) also points out that there are rich internal semantic relations between some lexical items. So, for example, (17a) cannot be true unless (17b) is:

(17a) John persuaded Bob to leave.

(17b) Bob decided to leave.

Any English speaker knows these facts. The connection between the meanings of the verbs persuade and decide seems “analytic” in the sense that the inferential relations between (17a) and (17b) seem to hold in virtue of the meanings of the words, not in virtue of anything in the world. A speaker who knows that if (17a) is true, then so is (17b), seems to know this fact in virtue of knowing the grammar of English, not in virtue of any of his beliefs about the world. It seems so unless one heroically tries to argue that persuasions and decisions are events or properties in the world such that it is a necessary (metaphysical) truth that if (17a) is true, then so is (17b) — not in virtue of what ‘persuade’ and ‘decide’ mean but in virtue of what persuasions and decisions are. I would tend to agree with Chomsky that it sounds more

plausible to assume that the inference from (17a) to (17b) holds in virtue of the concepts expressed by the English words ‘persuade’ and ‘decide’ than in virtue of a metaphysical dependency of instances of persuasions upon instances of decisions in the world.

As Chomsky (2000: 39) notes, referential dependency of the sort exemplified in (14) and (15) and analytic connections of the sort exemplified in (17) are internalist for they can be thought of as a kind of “logical syntax” for natural languages (as Carnap would have said). Unlike referential dependence and analytic inferential patterns, which involve a relation between two lexical items and are therefore internal to language, truth and reference are semantic properties of sentences and words that depend or supervene on their relations to things in the world. In fact, the truth (or falsity) of a sentence depends on the way some of the words contained in the sentence refer to things in the world.

Much of Chomsky’s scepticism about externalist semantics is a scepticism about the possibility of making any scientific use of truth and reference in linguistic semantics. His scepticism about truth and reference in turns seems to stem from some deep metaphysical puzzles that he likes to raise about the existence of things in the world for words to refer to. In several places, Chomsky (2000: 37, 126) argues that names of cities, e.g., ‘London’ can refer both to something concrete and abstract, animate and inanimate as in (18):

(18) London is so unhappy, ugly and polluted that it should be destroyed and rebuilt 100 miles away.

Chomsky (2000: 126) is surely right that the identity of the thing referred to by simple words (e.g. proper names of cities) depends on a “highly intricate space of human interests and concerns [and that] judgments can be rather delicate, involving factors that have barely been explored” (Chomsky 2000: 126). As example (18) shows, cities have the strange property that they can be destroyed and rebuilt elsewhere. The question is whether from the fact that it is

very hard if not impossible to provide necessary and sufficient conditions of individuation for things in the world to be referred to by linguistic expressions, one ought to conclude that there are no things in the world (e.g., cities) for linguistic expressions to refer to and be true of? If so, then it might follow that semantic relations between words and things in the world are not suitable for scientific linguistic purposes.

The argument from the lack of necessary and sufficient conditions of individuation for things in the world to be referred to by linguistic expressions to the conclusion that truth and reference are dispensable for scientific linguistic purposes does not seem to me like a convincing argument. First of all, Chomsky's internalist tendencies push him in the direction of dropping truth and reference (which are externalist semantic properties and relations of words) in favor of purely internal relations between linguistic expressions such as referential dependency and inferential relations. Referential dependency, however, seems to presuppose that the antecedent of an anaphoric expression possesses a reference. Otherwise, it is hard to see what the anaphoric expression would inherit its reference from. Inferential relations or entailments seem to presuppose some notion of truth. The sentence 'London is pretty' presumably entails the sentence 'A city is pretty' or 'There is a pretty city'. But the inference will not go through unless the sentence 'London is a city' is true (or expresses a truth). Similarly, to say of the entailment from (17a) to (17b) that it is analytic is to say that if (17a) is true, so is (17b) and that the conditional holds in virtue of the rules of language. Entailment is a relation between truths (or true propositions). Secondly, Chomsky would certainly not want to give up the semantic concepts of truth and reference in general. He certainly would be appalled at the idea that reference and truth are inapplicable to e.g., scientific theories in linguistics and cognitive science. But he would probably want to distinguish the fact that they are applicable to any scientific theory from their suitability for linguistic semantics.

From the fact that it is hard if not impossible to provide necessary and sufficient conditions for the individuation of most things in the world that are referred to by linguistic

expressions (e.g., cities), I would not conclude that truth and reference are dispensable from linguistic semantics. Nor would I conclude that there are no things in the world for linguistic expressions to refer to. I would rather conclude that most things in the world which are referred to by ordinary linguistic expressions are not suited for a scientific ontology. In other words, cities might not be the kinds of things about which we could expect deep scientific generalizations.

Furthermore, Chomsky's commitment to internalism is not restricted to the study of language. It extends to psychology in general. In particular, Chomsky (2000: 160-2) subscribes to an internalist interpretation of computational theories of vision such as Marr's theories. According to the internalist interpretation, computational-representational (C-R) theories of visual perception posit various levels of representation related by computational operations. As Chomsky (2000: 23) puts it, "in the study of determination of structure from motion, it is immaterial whether the external event is successive arrays of flashes on a tachistoscope that yield the visual experience of a cube rotating in space, or an actual rotating cube, or stimulation of the retina, or optic nerve, or visual cortex". By examining Chomsky's internalist views of visual perception, we come to understand both the gap between his naturalism and the naturalism of most philosophers of mind who are externalists and the roots of his disagreement with most evolutionary psychologists (such as Cosmides & Tooby, Gigerenzer, Pinker or Sperber).

Some externalist philosophers of visual perception (e.g., McDowell 1982, 1994, Putnam, 1994), who subscribe to a view they call "disjunctivism", claim that, unlike veridical visual perceptions, visual hallucinations are not genuine visual experiences, for in a hallucination, the mind is not presented with a mind-independent fact involving a mind-independent object. Disjunctivism is an extreme version of an externalist account of visual experience. Less extreme (and to my view, less controversial) externalist accounts of visual experience (such as Dretske's 1995 and Tye's 1995) would argue first that visual experience

depends on the function of the visual system and second that the function of the visual system has itself arisen as a result of the historical process of phylogenetic evolution by natural selection. On this externalist view, it is the function of the visual system to detect or pick out the visual attributes of objects (e.g., shape, size, texture, motion, and so on) that have been instantiated in the “normal environment” in which the human visual system has evolved. Natural selection favored animals with such visual abilities. On this view then, although a visual hallucination may be a genuine visual experience, still it is a case of misperception. On this view, it is not the function of the visual system to hallucinate. The function of the visual system is to detect properties that are and were instantiated by real physical objects in a “normal” environment. Hallucinations, however, may nonetheless be visual experiences because the visual system may fail to fulfill its function.

According to most naturalistic so-called ‘teleosemantic’ theories of mental content (see Dretske, 1988, Jacob, 1997, Millikan, 1993, Neander 1995) — not merely naturalistic theories of perceptual content —, a mental representation derives its content from the evolutionary function of the mechanism that produces the representation. The mechanism in turn derives its function from its evolutionary history: it possesses a function because it results from the process of natural selection. I say ‘most’ naturalistic theories of mental content because one prominent naturalistic account — namely Fodor’s (1987, 1990, 1994) — is not a teleosemantic account: it is a purely informational or correlational account. However, unlike Chomsky and like teleosemanticists, Fodor’s purely informational account takes the problem of misrepresentation seriously enough so that his “Asymmetrical Nomic Dependency Condition” is precisely designed to solve it.

It is, I think, important to understand why Chomsky disagrees with externalist accounts of content — in particular, with evolutionary teleosemantic externalist accounts. On Chomsky’s view, talk of ‘misperception’, ‘failure to represent’ an object and biological functions are mere metaphors or façons de parler. On his view, most evolutionary

assumptions according to which it may be the evolutionary function of a sensory or a cognitive mechanism to process information and/or to perform computations are part of common sense, not science. Evolutionary considerations of this sort belong to the “informal presentation” of the computational theory, not to the theory proper. They can play no genuine theoretical role.

As Chomsky (2000: 162) writes, “the critique of internalism [...] gains no force from the observation that, in normal environments, internal processes are reliably correlated with distal properties (objects boundaries, and so on)”. According to externalist philosophers of mind, the problem of misperception or misrepresentation is a genuine problem. On their view, there is a fact of the matter as to whether a visual experience is a case of misperception and whether a mental representation is a misrepresentation or whether it is veridical. According to most externalist philosophers, sensory and cognitive mechanisms can deliver misrepresentations because they can malfunction. They could not malfunction unless they had a function which they derive from their evolutionary history. According to externalist philosophers, there is a fact of the matter as to whether a representation is veridical or a misrepresentation because a representation derives its content from its function. And a mechanism that delivers a representation in turn derives its function from a selectional process. In Chomsky’s (2000: 45, 162) view, there are no such facts of the matter: “failure” to represent objects and properties in an individual’s environment is merely our commonsense “way of describing some human end that we impose for reasons unrelated to naturalistic inquiry, much as in the case of the failure of a comet to hit Jupiter”. There are no more facts of the matter as to whether a mental representation is a case of misrepresentation than there is to the question of whether machines think or airplanes and people fly. Much of the disagreement between Chomsky’s internalism and externalist philosophers of mind, therefore, depends upon what Chomsky takes to be a genuine scientific explanation. Crucial to Chomsky’s internalism is the distinction between the computational theory (of either

language or visual perception) and the evolutionary adaptationist considerations that the theorist might add to the theory. Unlike the theory proper, the latter is part of common sense.

It is at least controversial whether instances of misrepresentation on the part of a biological system having “primitive” intentionality ought to be treated on a par either with the case of the motion of a comet that lacks any function or with the case of an artefact that lacks primitive intentionality and whose function has been ascribed by an engineer with primitive intentionality. One can agree with Chomsky that it is a mere convenience to describe the lack of collision between a comet and Jupiter as a ‘failure’. One can also perhaps agree with Chomsky that there is no clear fact of the matter whether people fly or machines think. But from these concessions, it does not, it seems to me, follow that there is no fact of the matter as to whether a mental representation is veridical or not. Nor should one conclude that whether a cognitive mechanism possesses a biological function is a mere convenience relative to human concerns and interests. It is also surprising that Chomsky should describe evolutionary assumptions based on natural selection as part of common sense or as the informal part of a theory (of either vision or language). One can indeed distinguish the purely computational component of a theory of either vision or language from any evolutionary assumption. But the latter, it seems to me, are not really part of common sense. Neither the concept of natural selection nor the concept of adaptation are common sense biological concepts. They are theoretical concepts and are part of biological evolutionary science.

Here, we reach, I think, a pair of assumptions that are crucial to Chomsky’s overall picture of science, the first of which I shall call the Galilean assumption. Chomsky has always thought that the goal of cognitive science is to adopt what borrowing Husserl’s expression, Steven Weinberg has called the “Galilean style”, i.e., to construct “abstract mathematical models of the universe to which at least the physicists give a higher degree of reality than they accord the ordinary world of sensation” (see Chomsky, 1980: 8). There is little doubt that Chomsky’s model for linguistics and cognitive science is theoretical physics. Of course,

Chomsky is well aware that the study of human cognitive structure cannot have the same generality as physical laws that are true of anything physical in the universe. However, linguistics and cognitive science should aim, in the Galilean style, for the same explanatory depth as theoretical physics: the goal of linguistics and cognitive science should be to make the appropriate idealizations that will lead to the discovery of unexpected principles that will be as removed from the empirical evidence, as are physical laws.

This Galilean assumption leads Chomsky (1997), I believe, to downplay the role of natural selection in evolution. In several places, Chomsky has recognized the tremendous evolutionary advantages provided by the language faculty. However, he seems quite sceptical of the explanatory power of evolutionary arguments based on natural selection. Arguably, “from the Big Bang to the evolution of large molecules, design results from the operation of physical law”. According to Darwinian assumptions, the evolution of complex biological systems involves in addition the action of natural selection. On Chomsky’s picture, the evolution of complex biological systems must arise from a complex interplay between natural selection and the framework or constraints imposed by physical laws. As Chomsky (1999) puts it, “natural selection can’t work in a vacuum; it has to work within a range of options [...] and those options are given by physical law and historical contingency”. In fact, Chomsky wants to maximize the contribution of physical law and minimize the role of historical contingency, adaptation and natural selection in his account of the evolution of complex biological systems. Arguably, Chomsky (1999) belongs to a distinguished tradition including notably the theoretical biologist D’Arcy Thompson whose aim was to emphasize the role of biophysical and topological constraints in evolution. In fact Chomsky (1999: 18) links the underestimation of the role of physical constraints in evolution to a return to Skinner’s behaviorism:

He (Skinner) thought it was an argument for his radical behaviorism, that it works like unstructured

natural selection: so the pigeon carries out any possible behavior and you reinforce the one you want, and you get pigeons playing ping-pong, etc. He argued this is the same logic as natural selection, which is true, but what he missed is the fact that natural selection requires a structured environment, structured entities, and the conditions imposed by natural law, and the same is true of the pigeon. So, it is the same logic and the same mistake for both.

Chomsky (1997, 1999) is urging us to think of the evolution of complex biological systems not so much on the model of the distribution of dark and light moths or the neck of the giraffe as on the model of the sphericity of breaking cells in mitosis or the polyhedral shape of the shells of viruses. Unlike the former, the latter clearly depends on deep physical laws, not so much on opportunistic responses of natural selection. One can, I think, accept Chomsky's point that natural selection cannot work in a vacuum without deriving the conclusion that natural selection lacks explanatory force. It is one thing to point out that natural selection cannot begin to explain why the behavior of human beings falls under the law of universal gravitation. It is something else to argue that natural selection works in tandem with constraints provided by physical and chemical laws. The latter of course recognizes that some biological traits are being exemplified as a result of natural selection. And it is an empirical issue which do and which do not.

As Chomsky (1980a) has written,

consider the human ability to handle fairly deep properties of the number system. I suppose that this ability is genetically determined for humans, though it is hard to imagine that it contributed to differential reproduction. But we need not suppose that this is a miracle, if true. These skills may well have arisen as a concomitant of structural properties of the brain that developed for other reasons. Suppose that there was a selection for bigger brains, more cortical surface, hemispheric specialization for analytic processing, or many other structural properties that may be imagined. The brain that evolved might well have all sorts of special properties that are not individually selected; there would be no miracle in this, but only the normal workings of evolution. We have no idea, at present, how physical laws apply when 10^{10} neurons are placed in an object the size of a basketball, under the special conditions that arose during human evolution.

Here, Chomsky argues that it is conceivable that human numerical abilities might have arisen without being directly selected. Similarly, he might want to maintain that the language faculty might not be the direct result of natural selection. It is presumably easier to imagine that the language faculty “contributed to differential reproduction” among members of a species as social as human beings than the ability to handle deep properties of the number system. Arguably, Chomsky is thereby endorsing a modest version of what is called by evolutionary biologists “exaptation”, or a modest “exaptive” explanation of the evolution of human numerical abilities and, by extension, of the language faculty. Chomsky’s view is a modest version of exaptation in the sense that, by pointing out that we lack insight into the physical constraints under which natural selection must have operated, he makes a case for the view that it is consistent with the Darwinian theory of evolution by natural selection to assume that human numerical abilities have arisen through some evolutionary process without being the direct target of natural selection. In other words, the alternative is not: either human numerical abilities were directly the result of natural selection; or they arose out of a miracle. It is modest in the sense that commitment to full-blown exaptation would commit him to the claim that some piece of brain machinery (e.g., Broca’s area) was selected for some function (e.g., the control of hand motions) and then later was recruited for some different function (i.e., the language faculty).⁶ Of course, the issue of whether a cognitive capacity is or not the direct result of natural selection is an entirely empirical issue, not a conceptual one. In any case, it seems clear that Chomsky wants to distance himself from the empirical claim that human numerical abilities and presumably the language faculty as well could have been directly selected in the course of evolution. He might be right (or wrong) in one or both of the cases. It seems also clear that Chomsky thinks that the explanatory power of natural selection depends on further insight into physical constraints.

In summary, Chomsky’s semantic internalism sharply contrasts with the externalism

⁶ Feathers were first selected because they contributed to thermal regulation. With the increase of the size of

of most naturalistically inclined philosophers of mind and language. It in turn reflects, I think, Chomsky's Galilean assumption according to which theoretical physics is the appropriate model of cognitive science. The naturalism of most externalist philosophers of mind and evolutionary psychologists is based on the assumption that evolution is mainly driven by the mechanism of natural selection. At least, they typically try to provide psychological and/or semantic explanations based on the mechanism of natural selection. Chomsky's naturalism is based on the Galilean assumption that we ought to look for deep physical explanations, which in turn leads him to maximize the contribution of physical laws and downplay the role of natural selection in the evolution of complex biological systems. He seems to assume that time is not ripe yet for providing explanations of cognitive phenomena based on natural selection for we still miss basic insights into the physical constraints under which natural selection must operate. I certainly am in no position to judge whether he is right. Still, what is not always clear from Chomsky's writings is whether he thinks that naturalistically inclined externalist philosophers and evolutionary psychologists are merely guilty of neglecting the role of physical constraints in evolution or whether they are more seriously mistaken in assuming that natural selection is involved in explaining why the behavior of human beings exemplifies the law of universal gravitation.

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wings, feathers later were recruited for their role in flying.

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