Neo-Cartesianism in Generative Grammar

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1 Introduction

A conceptual barrier preventing a natural science of the mind was first posed as a by-product of Descartes's metaphysical mind-body dualism, but it was later eliminated by Newton. However, at the same time, the unbounded creativity in human cognition (externalized via human speech) essentially remains as much a mystery as Descartes observed with puzzlement, and the serious naturalistic inquiry into the mind is presumably only possible when the issues surrounding unbounded creativity are circumvented, in much the same way as Descartes did in his construction of mechanical philosophy. Thus, natural sciences of the mind, if any, would be both *methodologically un-Cartesian*[1] and *epistemologically Cartesian*, in that they must reject Descartes's mind-body dualism as a conceptual barrier for cognitive sciences, while nevertheless respecting Descartes's advice to avoid insurmountable complexities of unbounded creativity. Among such inquiries, the minimalist program for linguistic theory is further *metaphysically trans-Cartesian*, too, in that it aims at discovering so-called "third-factor" principles, i.e., domain-general laws of nature that are not specific to language and cross-cut physical as well as mental aspects of the world. In this squib, I will briefly argue that generative grammar couched in the minimalist-biolinguistic program is essentially such a *neo-Cartesian* project.

2 Methodological un-Cartesianism

2.1 *Departing from Descartes's mind-body dualism* The astounding progress made in natural science over the past few centuries is arguably one of the noblest achievements in the whole history of humankind. Ever since the "Scientific Revolution" in the 17th century, when this human-made enterprise came to take its modern shape, there have been a growing number of intriguing discoveries regarding the deep nature of the universe that had previously been otherwise inaccessible to human cognition. The progress in this scientific inquiry has been made primarily in the domain of what is termed the *physical*, subsuming the chemical and atomic structure of matter, motion of objects through space-time, electrical and magnetic forces causing motion at a distance, functions and structures of cells of different organisms, and so on. These achievements are so impressive and appealing that many scientists and philosophers have been inclined to *scientific realism*, the belief that the theoretical postulates of successful scientific research reflect the theory-independent reality in the universe, even when the relevant postulates are not themselves observable.

One may wonder whether similar progress is ever possible in the study of the *mental*, what is going on "inside the head." Science is a particular human enterprise that can attain a special sort of understanding when the problems can be simplified enough. Descartes, the father of modern science, first put forward his metaphysical mind-body dualism essentially as a naturalistic hypothesis, which posits that the physical realm, or the first substance that Descartes called *res extensa*, is causally closed in terms of the principles of contact mechanics (mechanical philosophy). He conjectured that we can pursue a rigorous mechanical understanding of the physical with appropriate simplifying assumptions. At the same time, he clearly saw the limitations of his mechanical scientific inquiry, most notably in his observation of the uncaused and unbounded creativity of normal language use by ordinary people. He was led to postulate a second substance called *res cogitans* (the mental) as the source of the boundless creativity of human linguistic behaviors, and he supposed that in order to investigate this domain, we have to seek some metaphysical and methodological alternatives to

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[1] For a different usage of the term *un-Cartesian* by Hinzen & Sheehan (2013) and Hinzen (2014), see note 4.

the principles and methodology that he proposed to adopt for the science of *res extensa*. Then, prospects for the science of the mental are, for Descartes, contingent upon how we can suitably develop such alternative principles and methodology, which was never achieved within the classical Cartesian framework.

Descartes's metaphysical mind-body dualism was quite congenial to our common-sense understanding of the world, but it was nevertheless effectively dissolved by Newton. Newton's finding of universal gravity was essentially an acknowledgment that there exists a deep physical force that affects physical objects without the medium of contact, hence not closed by contact mechanics. Therefore, Newton's work was, much to his dismay, a death sentence for the then-beloved Cartesian science of the material world. In Hume's (1756:542) words, "While Newton seemed to draw the veil from some of the mysteries of nature, he showed at the same time the imperfections of the mechanical philosophy; and thereby restored [Natures] ultimate secrets to that obscurity, in which they ever did and ever will remain."

This effectively eliminated a conceptual barrier for the natural science of the mind (Chomsky, 1995a, 2000b), which, in retrospect, formed the basis for the 20th century "second cognitive revolution" (Jenkins 2000:2; cf. Chomsky 1994:35), during which what we now call the *cognitive sciences* emerged. The progress was most notably made in the study of the *mechanisms* (but not *use*) of human language and of vision (see in particular Marr 1982 for the study of vision). The essential finding in these endeavors was that there are substantive computational mechanisms in the mental aspects of the world that can be studied using the same principles and methodologies as for the physical sciences.

Contemporary cognitive scientists are, in this sense, *methodologically un-Cartesian*, in that they reject Descartes's mind-body dualism as a methodological barrier preventing such naturalistic inquiry.

Specifically for language, contemporary generative linguists have come to terms with the idea that language should be studied using the same methods and criteria as other natural sciences. Chomsky (1995a, 2000b) proposes to call this attitude *methodological naturalism*, which just amounts to avoiding any stereotypes and preconceptions regarding how we proceed in studying the object in question.

It is hardly necessary to add that methodological naturalism is not always shared by cognitive scientists and philosophers outside of the generative camp. In fact, many researchers of the mind still adhere to the idea that what is going on inside the head should be approached differently from other physical objects in the world. To highlight the contrast, Chomsky proposes to call this dominant stance *methodological dualism*. It is thus commonplace to adopt certain presumptions about language and mind, e.g., that any mental-cognitive objects should be in principle accessible to consciousness, or that mental computations should be such that they can be modeled and simulated by particular computer models (such as neural networks). Methodological un-Cartesianism is an attempt to refrain from any such dualist preconceptions, and rather to seek the "best" theories of the object of inquiry in neutral terms. See Chomsky (1995a, 2000b) for discussion.

2.2 *Semantic naturalism as methodological dualism* One prominent example of methodological dualism has been discussed in the philosophical literature. This case concerns the "naturalization" of semantics, often referred to as "semantic naturalism" (see Dretske 1981; Fodor 1990, 1991, 1994, 2008,[2] Loewer & Rey 1991; Boghossian 1991; Loewer 1997, to name just a few). To take a formulation given by Loewer's (1997) "A guide to naturalizing semantics," semantic naturalism concerns the question in virtue of what natural language expressions are associated with relations to mind-external entities like truth-conditional contents and reference, and seeks to provide some answer to this question in some non-mentalistic terms. Those philosophers whom Loewer (1997) calls "semantic naturalizers" regard it as a serious philosophical problem that the linguistic (for them primarily semantic) properties they postulate, be they truth-conditions, reference, intentionality, etc., are *prima facie* not conceivable as something that physical entities can possess, and they hope that the ontology of these semantic postulates somehow bottoms out in the 'safer' ontology of the "physical," i.e., materials discernible by our common-sense perspective on the world, or better yet, by contemporary physics. Most of the traditional semantic naturalizers accept the position that is usually called "physicalism," a philosophical doctrine holding that everything that exists in the world is "physical" in this sense, and conceive of their problem of semantic naturalism as an attempt to reformulate, or in fact reduce, postulated semantic entities to physical ones. Thus, for example, Fodor (1994) notes,

> [N]aturalizability ... is a general constraint upon the ontology of all the special sciences. It's a

[2] See also Rønning (2008) for overview of Fodor's naturalization program. But see also McGilvray (2002) for a serious criticism of the Fodorian representational theory of mind.

> methodological consequence of our conviction—contingent, no doubt, but inductively extremely well confirmed—that everything the sciences talk about is physical. If that is so, then the properties that appear in scientific laws must be ones that it is possible for physical things to have, and there must be an intelligible story to tell about how physical things can have them. (Fodor, 1994:5)

Traditional semantic naturalizers share with Fodor the view that special sciences such as linguistics (for them primarily semantics, understood as the study of language-world relations), or cognitive sciences in general, should meet the condition of naturalizability in this sense.

The course of naturalization of linguistics/semantics envisaged by these semantic naturalizers can be summarized as follows:

(1) Traditional approach to the naturalization of linguistics/semantics:
   a. Assume what is "semantic" (i.e., entities and relations required by one's prior conception of linguistic semantics)
   b. Assume the ontology of the "physical"
   c. Provide re-characterizations of (a) in terms of either reduction to or supervenience on (b)

If we interpret Fodor and other semantic naturalizers' position moderately as just expressing a wish to find a way to bridge the gap between (the ontology of) what their linguistic-semantic theories posit and what other core natural sciences do, then this wish would be more or less a concern for the problem of unification of these yet divergent disciplines. Under this weak interpretation, methodological naturalists would be sympathetic to this wish for eventual unification, with the proviso that the course of naturalization need not take the form of *reduction* as in (1-c) (see Chomsky 1995a, 2000b; we will return to this point later).

One may naturally ask the following question: is the traditional semantic naturalism (1) the only possible course of unification of the study of natural language semantics and other 'core' natural sciences? It should be noted that over the years, Chomsky and other generative biolinguists have been arguing for the view that there exists a promising alternative, namely a purely *internalist* approach to the unification problem, a perspective which will be articulated below.

Note that traditional semantic naturalism requires a prior definition of what counts as "physical" as its starting hypothesis (step (b) in (1)). Indeed, for there to even be an issue of naturalization of linguistics/semantics like (1) in the first place, some explicit criteria of "being physical" should be given, so that the physical, so defined, can then serve as the "reduction base" for the course of naturalization as sketched in (1). Providing an adequate definition of the physical is, however, anything but a trivial task, as amply discussed by, e.g., Stoljar (2000, 2001, 2006). And it seems that past semantic naturalizers have not confronted, much less resolved, this difficulty.

Loewer (1997) notes that most past semantic naturalizers take what is usually called "physicalism" as their working hypothesis, which is also reflected by Fodor's passage above. Physicalism is usually understood as a philosophical doctrine which says that everything that exists is physical. Advocates of this doctrine typically regard the physical as things and entities that can be identified with, or appropriately defined in terms of, laws and entities postulated in contemporary physics. That is, they take ordinary scientific naturalism more or less at face value, and this version of semantic naturalism is, then, aiming at physicalization of semantics.

At the time of Descartes, at least, there was in fact a naturalistic definition of the physical based on mechanical philosophy. The physical (body, matter, etc.), as conceived in mechanical philosophy, is defined as any material substance with three-dimensional spatial extension. Such material, and only such material, can move and participate in contact mechanics. In Descartes's view, "the extension in length, breadth, and depth which constitutes the space occupied by a body, is exactly the same as that which constitutes the body," (*Principles of Philosophy*, II 10) and consequently, there cannot exist a space separate from a body, since all spatial extension simply is the body (*ibid*, II 16). In pushing this hypothesis, Descartes was primarily objecting to the then-dominant Scholastic and Aristotelian views of the world, in which mystical forces and powers, "occult qualities" of sympathy, antipathy, and so on, affect all sorts of phenomena in the world. As a consequence of his categorical rejection of the relevance of any such "occult" forces to physics, Descartes hypothesized that all phenomena of motion are to be explained strictly in terms of immediate contact of contiguous materials. Motion was defined as "the transfer of one piece of matter or of one body, from the neighborhood of those bodies immediately contiguous to it and considered at rest, into the neighborhood of

others" (*ibid*, II 25). Thus, he hypothesized that the causality of material phenomena is strictly closed, and bodies can be affected only by other bodies through contact. The material world, according to this mechanical view, is essentially conceived of as a machine, or a very grand automaton.

Mechanical philosophy is firmly grounded in our common-sense understanding of the nature and interactions of objects, presumably genetically determined in large part (Chomsky, 2009). It has a number of features that strongly appeal to our intuitive folk physics: persistence of objects through time and space, causality through contact, bodies only being able to affect bodies, motion being able to produce nothing but motion, and so on. These corollaries are so intuitively appealing and intelligible to our common-sense understanding of the world that we often forget that this mechanical conception of the physical was effectively demolished by one of Newton's discoveries in the late 17th century. Specifically, Newton's notion of gravity affects objects at a distance, without any medium or body. Thus, his proposal was regarded by the leading scientists of the day as the reintroduction of an "immaterial," "occult" cause that Cartesian contact mechanics had eliminated long before. The mechanical philosophical conception of the material world, where causality among the physical is confined to immediate contact of the physical as a matter of principle, thus turned out to be an incorrect scientific hypothesis, and so is our common-sense understanding of the world.

Ever since Newton undermined Cartesian mechanical philosophy, the concept of the 'physical', the object of study in physics, has been subject to constant falsification, modification, extension and refinement, consistently departing from people's common-sense intuitions: Newton's unified analysis of terrestrial and planetary motion in terms of universal gravity lay beyond the bounds of mechanical philosophy, and thus the domain of the physical needed to incorporate such an "occult" force as action at a distance (gravity); the problem of explaining electricity and magnetism in terms coherent to Newtonian mechanics was deemed unsolvable, and ultimately was effectively overcome by incorporating electromagnetic fields as physical entities; the problem of accommodating chemistry to physics led to the introduction of even more complex hypotheses about the nature of the physical world, e.g., quantum mechanics. In this course, our common-sense beliefs and intuitions were shown to be irrelevant to natural science.

Then, there is little reason to contend that the scientific conception of the 'physical' provided by the latest physics is complete and absolute by any means. Rather, one may well expect that the eventual unification of any other currently divergent special sciences with physics may, if such a unification is ever forthcoming, require a rather radical revision of physics and its conception of the physical.

Given these considerations, one should now be able to swallow the conclusion that there are no rigorous criteria for what counts as physical that can constitute the reduction base for the naturalization of semantics (1). On the one hand, if we invest the term 'physical' with our unanalyzed common-sense intuitions about material substance, the relevance of such common-sense beliefs and concepts to scientific inquiry has been shown to be scarce since Newton, so it has little use in the linguistic sciences. On the other hand, if we were to incorporate the results of contemporary sciences into the conception of the physical ("scientific physicalism"), then the 'physical' in such a conception would include whatever the best current scientific theories postulate, to which we have no reason not to add principles and entities that the current "best theory" of generative grammar postulates (SEM, for example). Then, the term 'physical' should be regarded as nothing more than a rhetorical device of clarification, without any substantial import (Chomsky 2009). In either case, there can hardly be any issue of 'naturalization' in the sense envisaged by traditional semantic naturalizers (i.e., reduction to the physical).

Why, then, do they concern themselves so persistently with semantic naturalism? It would not be out of place to conjecture that they are still firmly entrenched in unanalyzed mind-body dualism. Presumably, influenced by the traditional concern for the "mind-body problem," once posed by Descartes as a naturalistic research question but later dissolved by Newton, traditional semantic naturalizers still believe that their investigation should not stay in such "occult" areas as "inside the head," and that they must somehow let their linguistic semantics relate to physical things in the outside world or observable behaviors of organisms, so as to take advantage of the "safer" ontology of the latter. While such "physicalism" always exhibits a strong appeal to our common-sense understanding of the world, it is no longer warranted as a natural scientific framework, as pointed out above.

Then, traditional semantic naturalizers, by adhering to the reductionist project in (1), effectively commit themselves to "the view that we must abandon scientific rationality when we study humans "above the neck" (metaphorically speaking), becoming mystics in this unique domain, imposing arbitrary stipulations and *a priori* demands of a sort that would never be contemplated in the sciences, or in other ways departing from

normal canons of inquiry" (Chomsky, 2000b:76), namely what is called *methodological dualism*.

3 Epistemological Cartesianism

3.1 *Creative aspect of language use* In the previous section, we saw that contemporary cognitive scientists convince themselves of methodological un-Cartesianism, i.e., the conviction that there should be no conceptual or methodological barriers that preclude serious inquiries into the mind in a way different from other sciences of the physical. Methodological naturalism in generative grammar is one instantiation of this neutral research attitude. At the same time, however, contemporary generative grammarians also respect Descartes's strategy to circumvent the problem of theoretically intractable human mental activities, as I will point out in what follows.

At the time that Descartes was pushing his mechanical account of the world to its limit, he was also aware that his mechanical explanation had certain limitations, which had to do with the *creative aspect of language use* (Chomsky, 1966/2009). In the *Discourse on the Method* (1637), Descartes says:

> [No animal or machine] could…use words, or put together other signs, as we do in order to declare our thoughts to others. For we can certainly conceive of a machine so constructed that it utters certain words, and even utters words which correspond to bodily actions causing a change in its organs... But it is not conceivable that such a machine should produce different arrangements of words so as to give an appropriately meaningful answer to whatever is said in its presence, as the dullest of men can do. (Descartes 1998: 32)

Specifically, taking his observation concerning the creative language use by normal people as a crucial piece of evidence, he concluded that the human mind apparently goes beyond any mechanical account, and thus human individuals cannot be modeled by any sort of automaton. This was the ground for his postulation of *res cogitans* (the mind) as the second substance, counterposed to *res extensa* (body, the physical), only the latter of which he hoped to explain mechanically. The Cartesian metaphysical mind-body dualism was thus formulated as a naturalistic empirical hypothesis, and his "mind-body problem" was posed as a research question for want of an eventual unification of these two domains of inquiry.

The Cartesian conception of the physical was shown to be untenable by Newton, who reintroduced the "occult" notion of gravity to the causal theory of physical phenomena. Although Newton's dissolution of mechanical philosophy was then perceived with profound dismay by leading scientists of the day, and even by Newton himself, it also had a certain positive effect, namely effectively undermining the conceptual barrier that stood in the way of "natural sciences of the mind," as we saw above.

However, we should bear in mind here that the characterization of *res cogitans* (the mental, whose effect is most notably evidenced in the normal use of language) as a matter that does not withstand mechanical scientific analysis was basically kept intact by Newton's dissolution of the mechanical conception of the body. In Chomsky's (2000b:84) words, "Newton eliminated the problem of "the ghost in the machine" by exorcising the machine; the ghost was unaffected." And "the ghost," i.e., the unbounded creativity of the human mind as externalized in language use, seemed to remain as mysterious and scientifically unintelligible as before.

Admittedly, the mystery of mental activities may never be overcome by human intelligence, due to its own genetically imposed limitations. This possibility is argued for by McGinn (1991, 1993, 1999) among others. In McGinn's (1999:59) words, in relation to the hard problem of human consciousness (a favorite topic for philosophers of the mind):

> The conceptual skeleton that has served us so well in astronomy, physics, biology, mathematics, and linguistics (give or take the odd nagging backache) will not support the weight of the consciousness problem. Our scientific faculty thus has the wrong "grammar" to solve the problem. It is precisely for this reason that we experience the problem as peculiarly deep, as conceptual, as distinctively philosophical. It is why understanding consciousness is not just a project within normal science. Not only do we need a "paradigm shift" to come to grips with consciousness; we need a fundamentally new structure of thought.

Perhaps a more concrete characterization of the limitations of our science-forming capacity can be found in Chomsky (1988:35-36).

> The production problem[, or] what I called "Descartes's problem," [is] the problem of accounting for "the creative aspect of language use," one aspect of the more general problem of accounting for choice of action that is evoked by situations but not determined by them, as in ordinary, normal human behavior, linguistic behavior included. About these problems, there is very little to say. It seems, in fact, that the problems elude our conceptual grasp. We understand and can deal with problems that can be formulated in terms of such notions as determinacy, randomness, probability distributions and input-output systems, but as the Cartesians rightly stressed, these concepts are not adequate or appropriate here. But we have no other concepts, and therefore are at a loss as to how to proceed in this area. We do not know how to deal with action that is unbounded in scope, indeterminate but not random, influenced but not caused by internal states, evoked but not determined (even probabilistically) by situations, coherent and appropriate, evoking thoughts in others similar to our own, and so on. As the Cartesians emphasized, humans are only "incited and inclined" while mechanisms are "compelled" (randomness apart) to act in certain ways in particular circumstances and under particular internal arrangement of parts. These problems remain mysteries. They escape our conceptual grasp, and may lie beyond our cognitive capacities and intellectual competence. At any rate, there is nothing very serious to say [at the level of theoretical understanding] about the production problem, except in very limited areas (e.g., the study of speech errors).

Thus, while our limited cognitive capacity might be well-suited to solving certain problems of determinacy, randomness, probability, and input-output systems, there is no guarantee that the problem of creative language use falls within these limited domains.

In retrospect, then, Descartes's mechanical philosophy was offering an important epistemological hypothesis, i.e., that the unbounded creativity of human mental acts is scientifically intractable. In what follows, we will refer to this contention as *epistemological Cartesianism*. Although Descartes's metaphysical mind-body dualism was eliminated later, this particular epistemological contention has been accepted more or less at face value by a number of cognitive scientists. In the course of establishing natural sciences of the mind, cognitive scientists carefully avoided involving in their computational theories the complexities of human free actions, a residue of *res cogitans*, a yet uncleared "ghost": thus, cognitive scientists of vision never ask how a particular human individual decides to use the visual system to, say, enjoy a movie or read a book. And linguists have every reason to take the same course, too: thus, no one has succeeded in providing an intelligible computational theory of how a particular human individual uses, say, the English expression "It is hot here" to convey a request for a glass of Coke, a ticket to Iceland, or turning on an air conditioner.

Then, how can we proceed to construct a reasonable, explanatory theory of human language? It is advisable for methodologically naturalistic (methodologically un-Cartesian) linguists to take the same course as the ordinary sciences do. That is to say, one should start with obvious empirical *facts*, and define the object of inquiry, as simple and clearly as one can, based on these factual observations. We will argue below that this is exactly what generative grammarians do.

3.2 *Grammar as a natural object* One of the distinct characteristics of human beings is that each individual, apart from serious pathology, can acquire one or more *grammars* of natural languages from a finite amount of linguistic experience in his/her infancy. Considerations of the poverty of the stimulus (Plato's problem) convinced Chomsky and others to propose that the human mind possesses a substantive innate mechanism that constitutes the basis of the acquisition/growth of such a linguistic capacity. This biological endowment, the *faculty of language* (FL) as we call it, is reasonably assumed to be a distinct module of the human mind, with its own internal rules and constraints. *Generative grammar* refers to an explicit scientific theory of grammars as instantiations of FL. To emphasize its biological foundations, generative grammar is nowadays also called *biolinguistics* (see Lenneberg 1967; Jenkins 2000).

Thousands of years of linguistic investigation share the belief, dating back as early as Aristotle, that the grammar of natural language is in essence a system of pairings of "sound" (or "signs") and "meaning." Cartesians further observed that the capacity to pair sounds and meanings in human language exhibits unbounded creativity: humans can produce and understand an infinitude of expressions that go far beyond the narrow range learned from direct experience, despite the fact that many expressions are previously unheard of or too long and/or senseless to be produced. This Cartesian observation specifically led Chomsky (1955/1975; 1957, et seq.) to suppose that the grammar of human language must include, minimally, a system that

recursively manipulates linguistic representations that can be assigned to corresponding sentences. This minimally necessary component of grammar is usually called *syntax*. Contemporary generative grammarians have concluded that syntax should include, at least as one of its components, *Merge*, a recursively applicable operation that combines a finite number of linguistic forms into a larger form that it can further operate on. Whether syntax consists of more than just Merge (say, labeling algorithms, Agree, etc.) or can be optimally reduced to this single operation; whether it is distributed over many different subcomponents with their own idiosyncratic rules and constraints (as assumed in, e.g., the so-called (Extended) Standard Theory) or is confined to a single uniform component (Uriagereka, 1999; Chomsky, 1995b, 2000a, 2008); how many interfaces it has with the neighboring performance systems; and what the exact nature of such interface boundaries is; are all open empirical questions, which generative grammarians naturally debate in various ways. However, no matter how these issues are ultimately settled, the biological existence of this very generative capacity in the human mind/brain is beyond any doubt. This generative capacity, which makes infinite use of Merge (and possibly other kinds of form-to-form mapping operations) to generate linguistic forms in its humanly unique way, then, is a *bona fide* natural object that we can study as such, taking whatever evidence is available. This natural object, presumably distinctively human, is appropriately called *(generative) grammar*, and so is the naturalistic theory surrounding it, exploiting systematic ambiguity associated with these terms (Chomsky, 1965). Thus, as long as we are studying grammar, in particular its recursive-generative system (syntax), we are pursuing a natural science. More than sixty years of investigation have shown, somewhat surprisingly, that this mind-internal natural object can be fruitfully investigated with more or less the same rationale and methodology that have been adopted for other natural sciences (see Chomsky 1955/1975, 1957, 1965, 1981, 1986, 1995a,b, 2000b, 2007a to name just a very few).

Another obvious fact is that the infinite forms that syntax generates are used to pair sound (or sign) and meaning. More specifically, these forms can be used by an individual, appropriately and meaningfully with regard to whatever purposes s/he might use them for, often (but not necessarily) with corresponding 'externalization' (association with overt sounds or signs). This everyday observation justifies another foundational assumption, namely that grammar can somehow interface with some 'thought' system responsible for conceptual-intentional utilization of such syntactic forms, which we may call the *Conceptual-Intentional* system (*CI*), as well as some articulatory-perceptual system responsible for their 'externalization', or the *Sensorimotor* system (*SM*). It is hardly necessary to note that we have only a limited understanding of the exact nature of CI or SM (though we have more 'overt' evidence for the latter). Still, at the bare minimum, we should be able to conclude, from the above-mentioned everyday linguistic facts, that there *must* exist some such interfaces to CI and SM. The interfaces to these systems are commonly referred to as *SEM* and *PHON*, respectively.

Note that in this line of reasoning, we are *passively* postulating CI as a rather gross sum of performance mechanisms that syntax can interface with on the 'meaning' side, for want of better understanding of how human thought works. In doing so, generative grammarians hope that the inquiry into the nature of FL, when developed, can eventually clarify something about the nature of this hypothetical construct (CI). But such an expectation is in principle *secondary* to the scientific study of the forms and workings of grammar, since grammar can generate forms regardless of how 'meaningful' they are for thoughts (cf. *colorless green ideas sleep furiously* and countless other semantically anomalous examples). Whether the theory of grammar can eventually meet such expectations will depend on the empirical progress and prospects it will yield in due course. This is the nature of any scientific investigation: there is no *a priori* guarantee that we can construct any explanatory scientific theory of how human grammar works, let alone how the forms it generates can be utilized by the external performance systems.

That said, the fruitful results that more than half a century of investigation has borne constitute a reason to be optimistic, to some extent, about such a prospect. And, of course, we are naturally interested in the nature of SEM. What does SEM look like? How does syntax form SEM from an unorganized array of lexical items? What kinds of instruction does SEM provide for CI? How strongly does SEM configure the 'thought' associated with the corresponding sentence? These are, again, all open empirical questions, to which we can seek serious answers as our investigation proceeds, with the same rationale and methodology as are adopted for empirical investigations into any other natural objects (Chomsky, 1995a).

3.3 *Internalism as methodology* In Section 2, we reviewed the traditional approach to the naturalization of semantics (1), reproduced here.

(1) Traditional approach to the naturalization of linguistics/semantics:
   a. Assume what is "semantic" (i.e., entities and relations required by one's prior conception of linguistic semantics)
   b. Assume the ontology of the "physical"
   c. Provide re-characterizations of (a) in terms of either reduction to or supervenience on (b)

We saw that traditional semantic naturalizers are stuck with the ideology that the study of mental phenomena such as linguistic semantics should be grounded by some ontology of the "physical," even though they do not provide any scientifically informative characterization of the physical that can serve as the reduction base for their purpose, effectively committing themselves to methodological dualism.

The vicious doctrine of methodological dualism is counterposed to *methodological naturalism*, a naturalistic approach to the mind, adopted by generative grammarians, that "investigates mental aspects of the world as we do any others, seeking to construct intelligible explanatory theories, with the hope of eventual integration with the "core" natural sciences." (Chomsky, 2000b:76). For them, the starting point is the empirically motivated biological existence of grammar: they discovered countless facts that demonstrate the poverty of the stimulus (Plato's problem), and demonstrated that these facts can only be explained by attributing a substantial innate biological mechanism to the human mind/brain. They further discovered that this biological mechanism must be somehow capable of making "infinite use of finite means" to derive the discrete infinity of the human linguistic generative capacity (Wilhelm von Humboldt, see Chomsky 1966/2009; McGilvray 2009), which has led contemporary generative grammarians to conclude that the biological mechanism in question should be characterized, at the bare minimum, by some sort of 'recursive function' R. A further discovery was the pervasive 'dislocation' property of the recursive structure-generating system, whose barest characterization is claimed Chomsky (2004) to be provided by identifying R with *Merge*, whose unboundedness results in the bifurcation of external Merge (structure building) and internal Merge (Move with the copy theory of movement; see Chomsky 1993, 1995b). Thus, at the present stage of understanding, we put forward Merge and its recursive structure generation, viz. *syntax*, as an indispensable principle of the best theory of grammar that unifies explanations of these foundational discoveries. As the understanding of linguistic phenomena progresses, further elaboration of the theory of FL is forthcoming, taking whatever evidence is or becomes available. And it is this empirical theory of generative grammar that serves as the "first philosophy" of a methodologically naturalist inquiry into FL.

Now, apart from the issue of physicalism (step (1-b)), one may also take issue with the fact that traditional semantic naturalizers typically start their investigation by *presuming* some prior conceptions of semantics, deeply rooted in their philosophical doctrines. Such presupposed semantic theories vary across:

(2) a. *representational*, or *referential semantics*, i.e., the contention that linguistic representations in human consciousness 're-present' (or are 'about', or 'refer to') things in the world (Fodor 1987, 1990, 1994, 2008),
   b. *denotational semantics*, i.e., the contention that each linguistic term is assigned as its semantic value a 'denotation', characterized by the extension of the term or some Fregean abstraction (Russell 1905; Frege 1997),
   c. *truth conditional semantics*, i.e., the contention that for each language L, there is a truth theory that can serve as the core of an adequate theory of meaning for L (e.g., Davidson 1967, 1969; Montague 1974, rooted in Tarski's (1936/1994; 1983) definition of truth),
   d. *sociological* conception of linguistic meaning, i.e., the contention that meaning of linguistic expressions, or their 'normative' usage, is primarily determined collectively by the speech community (Lewis 1972; Putnam 1975; Dummett 1986),

and so on. The hypotheses in (2) are *externalistic*, in the sense that the semantic notions envisaged by these hypotheses necessarily speak to various relations between language and mind-external things 'out there' (or maybe some FL-external but still mind-internal representation of these things, for some of them). Indeed, virtually all traditional semantic naturalizers' theories can be characterized by one or another conjunction of these ideas.

Once a semantic naturalizer buys any such externalist presuppositions as to the nature of language, the problem of naturalization becomes more or less a matter of restating, in some sort of "physical" terms, whatever semantic entities s/he is led by these presuppositions to posit. Consequently, s/he is further

led to posit non-mental, i.e., externalist, notions like Dretske's conception of information (Dretske, 1981; Fodor, 1990), causal theory of reference (Kripke, 1980), community languages (communalects) (Putnam, 1975; Dummett, 1986), epistemically optimal conditions (Stampe, 1977; Stalnaker, 1984), Tarskian T(ruth)-schemata (Tarski, 1936/1994, 1983) and so forth to fulfill the naturalization requirement (see Loewer 1997 for an overview). Consequently, the course of naturalization that most traditional semantic naturalizers envisage takes the form of reduction as in (1), which arises as a consequence of their adoption of ideological physicalism in step (1-b), along with the externalistic assumptions (2) for (1-a).

However, recall that we are now provided with the biological reality of generative grammar, in particular syntax as its component that assures discrete infinity, for which the concern for naturalization does not arise, insofar as the current best linguistic theory requires its existence (it is "physical," according to scientific physicalism). We should ask to what extent the externalist conceptions of linguistic semantics in (2) are to be justified as naturalistic hypotheses to be incorporated into the science of grammar.

First of all, it should be stressed that the hypotheses in (2) are *optional* in the science of grammar, in that rejection of one or even all of them does not affect the explanatory power of the science of grammar in any significant way: we can proceed perfectly well to construct generative grammar just based on meaningless sentences like *colorless green ideas sleep furiously*, which readily excludes bases for reference, truth-conditions, practices of speech communities, etc. Compare the hypotheses in (2) with, e.g., foundational assumptions in generative grammar, such as that there must be some genetically endowed innate mechanism that maps finite linguistic data to attained I-languages (UG, the initial state of FL), that UG enables *some* recursive generative device, for which *Merge* is currently the most promising candidate, and that this recursive generative device somehow relates to CI and SM. There is likely to be no serious linguistic science that drops either one of these assumptions, but, in contrast, none of the additional semantic hypotheses in (2) is essential to that degree. Indeed, more than a half century of generative-biolinguistic inquiry has provided a number of fruitful results and insights, essentially without any significant recourse to (2). These assumptions can be optionally supplemented, if one wishes, but they suggest no alternatives to the science of generative grammar.

Moreover, we should also bear in mind that once one employs terms like *reference*, *true*, *denote*, and others as scientific terminology, they become technical innovations, in which case they should be deprived of common-sense intuitions, just like *tensors*, *undecidability*, *Merge*, or *SEM* in the technical sense. Hence, we cannot factually test our intuitions against these hypothetical artifacts, which just mean exactly what their inventors tell us they mean (cf. Chomsky 1995a:42, Chomsky 2000b:148). The gap between our raw intuitions about referential properties of linguistic utterances and these stipulated-as-linguistic terminological artifacts is still daunting (see also Chomsky 2003).

Further, if we decide to treat these externalist relations involving linguistic expressions and mind-external things, then we are effectively stepping out of our biology, in particular the biologically real natural object, viz. FL generative grammar. The resultant theory would not be properly biological anymore, hence not biolinguistic or generative-grammatical. Of course, one's going outside of human biology does not necessarily entail going outside of the boundaries of serious naturalistic sciences. However, human individuals can talk about virtually all sorts of things recognizable by the human mind. Thus, unless we are given some independent characterization of what in the FL-external world can enter into such externalist relations, the domain of these notions would be unbounded, which in effect makes such an 'E-linguistic' project a 'theory of everything', hence impossible or at best intractable, as pointed out by McGilvray (1998:237). The (un)likelihood of such an 'E-linguistic science' is anyway orthogonal to the legitimacy of the biological-computational science of generative grammar (biolinguistics, 'I-linguistics'), since there is no known evidence that the properties of the FL-internal computation, apart from use, are affected by FL-external factors. Thus, that sort of 'E-linguistic science', if any, may be supplemented to but suggests no alternative to I-linguistics (generative grammar). See a similar comment by Chomsky on sociolinguistics (Chomsky 1995a:50, Chomsky 2000b:156). See also Lohndal & Narita (2009) for relevant discussion.

Then, if we want to avoid the intractability of unbounded creativity, whose nature may be forever beyond human understanding (McGinn 1991, 1993, 1999 among others), it is perhaps not the best naturalistic decision to start an inquiry into natural language semantics by *presupposing* that the science of meaning must involve relations between linguistic expressions and FL-external things in the world, be they reference, denotations, or truth-conditions. These assumptions are in need of strong empirical justification, even before we should be concerned with "naturalizing" semantics, whatever that amounts to.

The question is, then, whether we can provide any substantial empirical support for the *addition* of any

of the hypotheses in (2), to the extent that a theory with such additional hypotheses would still constitute the best linguistic theory. We don't know the answer *a priori*, so different researchers may bear different expectations, while the obvious difficulty is to tease apart these aspects of linguistic behaviors from the fundamentally intractable domain of creative language use. Therefore, some may well be skeptical about the prospects for such a project, due to epistemological Cartesianism.

Contra various externalist projects in linguistics and philosophy, generative grammarians avoid the issue of unbounded creativity by focusing on the organism-internal and mind-internal *mechanism* of language (grammar), refraining from the *use* of it. This is what Chomsky (1995a, 2000b) calls the *internalist* approach to language. By restricting their domain of inquiry to the internal mechanism, internalists attempt to preserve their theory of grammar away from the intractability of unbounded creativity. In this regard, the internalist approach to language amounts to "the *methodological decision* to study *less*, prior to studying *more*: to study the *organism*, prior to the infinitely more complex task of studying how it embeds in a social, physical, and cultural surrounding," to borrow Hinzen's words (2006a: 161) (see also Collins 2009).

3.4 *The minimalist program as methodological naturalism* As exercised by internalists, the methodological decision to keep to some existing scientific knowledge as a fixed starting point of inquiry is a rather common strategy in the natural sciences. Indeed, the history of science shows that naturalistic inquiry frequently proceeds without bothering much to find philosophical or metaphysical grounds for scientific knowledge. Recall, e.g., that Newton famously remarked "I frame no hypotheses" as to his (regretful, to him) inability to find the ultimate ground for the "immaterial" force of gravity in mechanical philosophy. This suggestion was in fact the one that was followed in the post-Newtonian era quite generally, leading to the situation where "[w]e have in our own days so accustomed ourselves to the abstract notion of forces, or rather to a notion hovering in a mystic obscurity between abstraction and concrete comprehension, that we no longer find any difficulty in making one particle of matter act upon another without immediate contact." (Lange, 1890:308)

To take another example, the unification of chemistry with fundamental physics was delayed until the 20th century, but even well before that, earlier chemistry seemed to proceed fairly well by letting "chemical affinity be received as a first principle, which [they could not] explain any more than Newton could explain gravitation," and deferring "accounting for the laws of affinity, till [they] have established such a body of doctrine as he has established concerning the laws of gravitation," basically the course recommended by the 18th-century British chemist Joseph Black (cited by Schofield 1970:226; see also Chomsky 2003, 2009).

Indeed, as Friedman (1993:48) remarks, "the philosophers of the modern tradition are not best understood as attempting to stand outside the new science so as to show, from some mysterious point outside of science itself, that our scientific knowledge somehow 'mirrors' an independently existing reality. Rather, [they] start from the fact of modern scientific knowledge as a fixed point, as it were. Their problem is not so much to justify this knowledge from some 'higher' standpoint as to articulate the new philosophical conceptions that are forced upon us by the new science." The fact of scientific knowledge, whether generative-biolinguistic or otherwise, can be regarded as no less than a body of reality in the natural world, and it is not so much in need of philosophical justification from some 'higher' standpoint, say of brute ideological physicalism, as it is to be *discovered*, not to be *stipulated*, in accordance with the naturalist rationale and methodology.

The science of generative grammar proceeds where it is to proceed, with little need to await permission from independently stipulated physicalism, whatever that amounts to. No progress is guaranteed *a priori*, let alone any success, and, therefore, "we can do no more than seek 'best theories', with no independent standard for evaluation apart from contribution to understanding, and hope for unification but with no advance doctrine about how, or whether, it can be achieved." (Chomsky 1995a:7, Chomsky 2000b:112) Researchers in this discipline seek no more than to refine their theory of grammar in accordance with whatever empirical data become available.

There is no *a priori* criterion for what counts as data relevant to linguistic inquiry; presupposing anything of this sort would be a methodologically dualist move. We can only reasonably assume that there is still something fundamentally unintelligible in mental aspects of the world that once led the Cartesians to postulate the 'second substance' (*res cogitans*) and seek a metaphysical and methodological alternative to mechanical scientific inquiry. This is the mystery of unbounded creativity, which most notably surfaces in the normal use of language. The first and foremost difficulty for the science of the mind is, then, to discern a set of empirical

observations that can be reasonably regarded as a systematic reflection of some deeper principle(s) of a mental mechanism that allows uncaused and unbounded access by, but is still crucially organized distinctly from, the unboundedness and creativity of the human mind. This is not a difficulty specific to the scientists of the mind, but probably a more acute one, given that their objects of inquiry are, as it seems, in more 'direct contact' with such a 'ghost' than, say, gravity or electromagnetism are.

To respect this epistemologically Cartesian caution requires meticulous scrutiny, for the use of language seems to be able to manufacture, taking various cues from experience, all sorts of artificial rule-systems like science, religion, music, institutional laws, rules of language games and maybe even a certain amount of 'phonological' or 'semantico-morphological' rules that may pervasively tuck in language production and linguistically structured thoughts. We should be careful not to be confused by these artificial systematicities, or intentionally regularized 'mental behaviors'.

This methodological decision not to stipulate anything beyond what is virtually empirically necessary is often referred to as the *minimalist program for linguistic theory* (Chomsky 1993, 1995b *et seq.*), but there is nothing specifically linguistic about this research agenda. It is just another name for methodological naturalism that takes epistemological Cartesianism seriously, which is in fact akin to the 17th century Cartesian mechanical philosophy in nature, in that both of them are in their essence working methodologies to find a proper domain for scientific inquiry. By limiting their domain of inquiry to *res extensa*, the 17th century Cartesians carefully severed their sciences from the fundamental unintelligibility of human free actions. Minimalist biolinguists continue to respect this very Cartesian methodology by remaining in the realm of virtually empirically necessary mechanisms of the mind (i.e., grammar), carefully distinguished from intractable unbounded creativity. They are, in this respect, quite Cartesian.

At the same time, however, minimalist-internalists are also methodologically un-Cartesian in not confining the domain of their natural sciences to the prison of *res extensa*, taking advantage of Newton's dissolution of the metaphysical mind-body dualism. The minimalist program for generative grammar is, then, a *neo-Cartesian* project, as we may call it.

It is rather a regrettable fact that the term "minimalism" is sometimes wrongly construed as a mystic or even methodologically dualist doctrine that misguidedly disrespects empirical facts and incorporates vague concepts like simplicity and optimality into the theoretical vocabulary, without serious empirical justification (see, e.g., Kinsella & Marcus 2009; Kinsella 2009). But this is plainly a misinterpretation (Narita & Fujita, 2010). Minimalists are not mystics but, on the contrary, honest and serious realists: they decide not to presuppose any methodologically dualist doctrine, and *therefore*, just in order to respect epistemological Cartesianism, they decide to start from the limited set of postulates of valid virtual empirical necessity. It is true that minimalists attempt to seek simplicity and optimality, whose conceptions are not yet clarified or defined, but they do so, as any other natural scientists do, not as a matter of presupposed doctrine but as a matter of working methodology, which was continuously found to be extremely useful in the entire history of science from Galileo and other 17th century natural philosophers onwards.

Due to their epistemological Cartesianism, naturalist-minimalists try their best to eliminate recourse to postulates that are not justified with certainty as virtually empirically necessary. In earlier frameworks of generative grammar, there were a lot of theoretical constructs that were later shown not to count as virtually empirically necessary, such as the varieties of government, the Empty Category Principle, D- and S-structures, the bifurcation of phrase-structure rules and transformations, bar-levels in X-bar theory, indices, and so on (Chomsky, 1995b, 2000a, 2004, 2007a). In the course of naturalistic inquiry, these postulates were naturalistically accused of being theoretically redundant, descriptively inadequate, and/or inherent stipulations that go beyond virtual empirical necessity. However, it should also be noted that they were originally argued for by means of some real poverty-of-the-stimulus facts, many of which still pose valid problems that await alternative explanations. The difficulty specific to generative grammar is again quite naturalistic, which is that we haven't yet come up with good theoretical postulates, other than Merge, that crosscut and link the explanations for the remaining poverty-of-the-stimulus facts and are in themselves demonstrated as virtually empirically necessary.

The same minimalist-internalist scrutiny should apply to the technical apparatus posited in the domain of linguistic semantics, too, insofar as it is claimed to be part of FL and thus to be a topic that falls within the purview of generative grammar. Take, for example, statements like " 'snow' refers to (or represents or denotes) snow," or " 'John is hungry' is true iff John is hungry." Statements of these types constitute a purported basis for contemporary model-theoretic denotational semantics, be it externalistic or posited in

the form of FL-internal postulates. It is presumably true that an English speaker's effortless understanding of these statements owes quite a lot to some FL-internal mechanisms, including the SEMs assigned to these English expressions. The generation by syntax of these SEMs is in turn based on the biologically endowed semantic features (let's dub them SEMs) of the lexical items (LIs) employed in these SEMs, such as SEM(*John*), SEM(*hungry*), SEM(*snow*), in addition to SEM(*refer*), SEM(*true*), and so forth. On one hand, there are indeed nontrivial poverty-of-the-stimulus arguments for the existence of the intrinsic semantic features of these LIs—an English speaker comes to possess knowledge of what these LIs mean, in large part without any conscious effort or any explicit training. On the other hand, there is presumably no biologically endowed innate knowledge that contributes to the interpretations of *denote*, *represent*, or *iff*, since these words are technical terms, whose references are set *a posteriori* by their innovators. And so are the particular occurrences of terms *refer to* and *true* in these theory-laden statements. It is possible that SEM(*denote*), SEM(*represent*), and SEM(*iff*) each represent an empty set, and the denotations of these terms are supplemented *a posteriori* by creative language use in service of some particular human-made projects (e.g., formal semantic description). Correspondingly, we are not sure whether there are any facts of naturalistic interest (such as the poverty of the stimulus) for statements of the sort " 'snow' refers to (or re-presents or denotes) snow," or " 'John is hungry' is true iff John is hungry."

These comments, however, should not be taken by model-theoretic semanticists as discouragement. There are indeed a number of professional journals and publications for contemporary semantics where a growing number of interesting observations are descriptively presented for a number of particular words and constructions in a variety of natural languages, many of which indeed seem to be valid poverty-of-the-stimulus facts that await naturalistic explanations: discoveries of the conservativity of natural language quantifiers, specificity and definiteness effects of various sorts, information-theoretic regularities, patterns and conditions of structural entailment (downward or upward) sanctioning certain dependencies (say negative and positive polarity), and various others. It is just that the commonly employed technologies like semantic types, Fregean function applications and strict compositionality in terms of model-theory are so far not demonstrated by some independent poverty-of-the-stimulus argument as virtually empirically necessary postulates. In short, there are a number of valid empirical observations of semantic interest, but so far few postulates that are demonstrated as virtually empirically necessary to unify and link explanations for these observations, a situation that is quite commonly attested in any naturalistic inquiry.

It might be that the semantic postulates of the model-theoretic kind will be eventually demonstrated as virtually empirically necessary by some crucial poverty-of-the-stimulus facts. Or it might be that the postulates that are already demonstrated as virtually empirically necessary in the study of syntax, say Merge, SEMs of LIs, and SEM, will contribute a lot to the eventual unification of the yet-unrelated explanations of these empirical data, probably with radical modification and refinement of these postulates. This is just one of the many unification problems that generative grammar faces.

3.5 *Approaching semantics from below* One of the questions that generative grammar faces is:

(3) How much of the interpretive/semantic properties of a given linguistic form (sentence, noun phrase, etc.) is determined ('carved out') by the syntactic generation of its SEM?[3]

As Hinzen (2008) points out,

> [T]he philosophical and linguistic answer to [(3)] for nearly 700 years has arguably been: by and large, nothing. Ever since the nominalists under Occam's lead demolished Modistic Universal Grammar in the early 14th century, language was largely regarded as an arbitrary means to express thought: It is deprived of any intrinsic relation to either the structure of the thoughts conveyed or, for that matter, the external world out there, which language can be used to describe. It is a tool for conveying thought, not its cause. If so, language is deprived of the role it was given by the Modists: that of an instrument of knowledge, a format in which systematic knowledge of the world is possible. (Hinzen, 2008:349-350)

However, the advent of generative biolinguistics, or specifically its recognition of grammar (FL) as a natural object, has opened up a fresh way to address question (3). Indeed, (3) has become one of the leading

[3] Hinzen (2008:349) proposes to call this question *Uriagereka's question* (Uriagereka 2008; see also Narita 2009b).

research questions in generative grammar since Chomsky's (1955/1975) influential analysis of constructional homonymity (structural ambiguity) (see Chomsky 1955/1975; 1957). Now that we are given the biological existence of generative grammar and its SEM-interface, it becomes an open question for human biology what aspects of CI-interpretation of a sentence or a phrase are configured by the syntactic derivation of its associated SEM.

Again, numerous facts about constructional homonymity already suggest that the contribution of syntax to CI-interpretation is solid and nontrivial. Moreover, Hale & Keyser (1993, 2002) convincingly argue that the argument structure and θ-theoretic properties of lexical items are largely determined by syntax, a leading idea that has fostered much subsequent research. Further, Borer (2005a,b, 2017), in articulating her exo-skeletal approach to the syntax-CI interface, convincingly argues that the CI-interpretations assigned to lexical items are not fully determined by their intrinsic features statically stored in the lexicon but rather strongly configured by the hierarchical structuring of SEM within which they are embedded. Chomsky (2004, 2007a, 2008) also observes that the duality of semantics (conceptual, θ-theoretic, "D-structure" interpretations v.s. computational, discourse-related, "S-structure" interpretations), one of the pervasive features of CI, correlates rather closely with the bifurcation of external and internal Merge (see also Narita 2009a, 2014).

Building on these results, an even stronger position is argued for by Hinzen (2006b; 2007; 2008) and Uriagereka (2008). According to their view, syntax is not a tool for expressing independently constructed propositional thoughts. Rather, syntax lies at the heart of the generation of such humanly possible propositional thoughts, and certain empirical properties of thought contents *derive from* the dynamic configuration of SEM by syntax (Uriagereka's 2008 *radical co-linearity thesis*; see also Hinzen 2008; Narita 2009b).[4] For example, the structural coherence and independence of CPs at the mapping of syntax to SEM perhaps play a crucial role in explaining why 'propositions' so prominently arise, to our mind, as units of semantic analysis. Rather than stipulating them as given, we might be able to "deflate" such mysterious entities "into the notion of a CP" (Hinzen, 2006b:179-180), and we might also envisage more or less the same sort of deflation with respect to other postulated entities of thought, too, such as *events*, seemingly closely tied to *v*P, *referentiality*, to DP, and so on. More generally, it is "as if syntax carved the path interpretation must blindly follow." (Uriagereka 1999:275/2002:64, Hinzen 2006b:250, Chomsky 2007a:15) The consequence of their claim is that syntax is *the* generative engine that provides the forms of humanly possible linguistically structured thoughts. Effectively, syntax therefore *is* a theory of semantics (see Hinzen 2006b, 2007, 2008, Uriagereka 2008; see also Narita 2009b).

Hinzen and Uriagereka's notion of the strong co-linearity of syntax and semantics is, again, an empirical hypothesis that is to be contested with many other hypotheses concerning the syntax-semantics interface. Only future empirical inquiry will advise us whether this is an adequate theory of human semantics with empirical support or rather misguided.

I would like to here emphasize one important prospect that the Hinzen-Uriagereka approach holds. As we have noted above, the discrete infinity of human sentences and many other facts amply support the biological existence of syntax, and thus its generation of CI-interpretable representations (SEM). They are, then, *bona fide* natural objects "that we can study as such, even though we see them, somewhat miraculously, systematically condition properties of linguistic meaning that we can empirically attest." (Hinzen, 2006b:235) Then to the extent that certain properties of linguistic meaning associated with SEM are shown to be carved out by syntax along the lines suggested by Hinzen and Uriagereka, they are 'naturalized', or specifically *biologized*, thanks to the 'safe' ontology of syntax and SEM that the usual scientific realism naturally assigns to them.

Chomsky refers to the research program initiated by Hinzen and Uriagereka as "a novel approach to what has been called 'naturalization of meaning'." (2007a:15; see Hinzen 2006b:235; see also McGilvray 1998,

[4] Hinzen & Sheehan (2013) and Hinzen (2014) propose the term *un-Cartesian linguistics* to refer to the research program that pursues the radical co-linearity of language and thought in the sense defined here. Hinzen's un-Cartesian hypothesis thus holds that "the cognitive mechanism generating human-specific thought and those generating language should be the same," and that "language thereby becomes a *principle of cognitive organization* and no *separate* theory of human-specific thought is required." (Hinzen, 2014:227). Perhaps we may coin some term, like *language-thought un-Cartesianism*, to refer to this contention. In contrast, the Cartesian hypothesis, as defined by Hinzen & Sheehan (2013), holds that "*thought* is universal and immutable in this species, while language is merely a contingent way of *expressing* it in a physical medium" (xvi), though, in the same place, they also admit that "Descartes himself may never have defended it" (xvi). See also note 8.

2002, 2009) It can be summarized as follows:

(4) The generative grammar-based approach to the naturalization of semantics:
   a. Assume the ontological reality of generative grammar as a natural object
   b. Provide empirical characterizations of syntax and SEM as the science of generative grammar leads to
   c. Provide sufficient characterizations of interpretive/semantic properties of linguistic meanings determined by the generation of SEM, to the extent that this move is feasible and empirically reasonable at all

In articulating the research program in (4), Hinzen and Uriagereka are suggesting that we can build on the natural science of generative grammar as our fixed starting point, and seek to see how much it can tell us about the characteristics of natural language semantics. At least some aspects of natural language semantics have been already known to be carved out by syntax, leaving the question as to exactly *how much* of it is carved out by syntax (question (3)) open to further empirical inquiry.

4 Metaphysical trans-Cartesianism

In the preceding discussion, we argued that the minimalist-internalist program for generative grammar is both methodologically un-Cartesian and epistemologically Cartesian, in that it rejects Descartes's mind-body dualism as a conceptual and methodological barrier for cognitive sciences, while it nevertheless respects Descartes's advice to avoid insurmountable complexities of unbounded creativity. Before concluding the paper, I would also like to briefly attend to the fact that contemporary minimalist biolinguistics further aims at discovering the so-called "third-factor" principles, i.e., domain-general laws of nature that are not specific to language. I would like to claim that this aspect of the minimalist-biolinguistic program is *metaphysically trans-Cartesian*, in that it attempts to overcome the traditional Cartesian mind-body dualism and redefine their domain of inquiry in such a way that it cross-cuts physical as well as mental aspects of the world.

Each natural science has its own domain of inquiry, which is characterized by the virtually empirically necessary postulates for that domain. As for generative grammar, one of the most important discoveries is that Merge is a virtually empirically necessary operation that provides explanations for some of the crucially relevant and previously seemingly disparate empirical facts. Current generative-(bio)linguistic inquiry tends to take the form of pushing the 'Merge-only' hypothesis, which seeks to reduce as many theory-internal postulates to Merge as possible (Chomsky, 2007a,b; Berwick, 2011; Berwick & Chomsky, 2015; Kato et al., 2016; Narita et al., 2017; Narita & Fukui, forthcoming), for the simple reason that so far linguists have not succeeded in pinning down any other theoretical construct as virtually empirically necessary as Merge.

However, it is not true that generative grammarians have nothing other than Merge to rely on to investigate their domain of inquiry. In this context, consider Newton's dissolution of the metaphysical mind-body dualism again: as we have seen, Newton's destruction of *res extensa* in effect demolished the conceptual barrier for the possibility of natural sciences of *res cogitans*. What is more, it also effectively emancipated the domain of the laws of physics from the prison of *res extensa*. The mind-body dualism declined, and we were explicitly told by Newton that we have no valid metaphysically closed framework of the physical that partitions off the domain of application of physical laws as a matter of principle. This conclusion troubled traditional Cartesians a great deal, and Newton was then very often accused of his reintroduction of the immaterial occult force to the domain of physics. But, for the purpose of pursuing cognitive sciences, we can regard this Newtonian conclusion as rather advantageous. Specifically, there is no longer a well-defined boundary of the coherent physical domain in the post-Newtonian era. Correspondingly, then, there is no longer any principled reason to exclude the possibility that the set of laws of physics, chemistry, theories of computation, and all other natural sciences are also applicable to the domain of the mind as well. We can only conjecture, as the Cartesians did, that unbounded creativity still resists explanations in terms of these physical laws, but the possibility becomes an open empirical question for the discovered mental mechanisms, subtracted from creative use. There are indeed quite a few general laws of nature that have been discovered and independently justified by physicists and other scientists as virtually empirically necessary in their respective domains of inquiry.

The set of domain-general laws of nature that figure in and affect the structure of human language, but are not specific to it, is now commonly referred to as the *third factor of language design*: 'third', because it is in

addition to the first factor (genetic endowment specific to human language) and the second factor (experience) of language design (Chomsky, 2005, 2007a, 2008). The null hypothesis is that general laws of nature are also applicable to the mental aspects of the world. This conclusion is even required by a physicalist statement of the sort "everything that exists in the world is physical." The successful progress of physics in the 20th century adds another historical plausibility argument for such a null hypothesis. Indeed, the *inapplicability* of such generalized laws of nature to a certain domain, e.g. language, would be a nontrivial empirical finding that requires explanation.

That said, the nature of the third factor that enters into generative grammar is admittedly quite ill-understood at this early stage of biolinguistic inquiry. But there are already some proposals. For example, consider the principle of *economy of derivation* proposed by Chomsky (1995b:138-145):[5]

(5) *Principle of economy of derivation*:
For each pair P of SEM and PHON, syntax chooses the least costly derivation to generate P, where the cost of derivation is determined by some syntax-internal metric, such as the number of derivational steps (Merge, Agree, etc.).

Fukui (1996) points out that this economy principle can be regarded as the linguistic (and hence discrete) version of Hamilton's Principle of Least Action, a fundamental unifying minimum principle in physics from which numerous laws in various subfields of physics can be deduced, including the laws of mechanics, optics, electricity, and magnetism.[6,7]

An important corollary of the principle of economy of derivation is that there can be no superfluous derivational step in a given syntactic derivation that does not contribute to some interpretive outcome at CI. Building on this consideration, Narita (2009a) postulates a strong syntax-semantics co-linearity thesis, which he calls *Derivational Full Interpretation* (DFI):

(6) *Derivational Full Interpretation* (DFI) (Narita 2009a:240,(50)):
Every syntactic operation correlates with interpretation at CI.

Adopting Pietroski's (Pietroski, 2005, 2007, 2008, to appear) conjunctivist semantics reviewed above, Narita claims that Merge of X and Y correlates with, or even maybe just *is*, the '&'-conjunction of SEM(X) and SEM(Y) at CI. He further claims that X's θ-marking Y at CI correlates with minimal search (Agree) of an edge-feature from X to Y in syntax, and that from the assumption that the mode of application of the relevant θ-marking operation is constrained by the principle of economy of derivation, we can deduce the effect of the so-called θ-Criterion, a condition that any argument category must receive one and only one θ-role. He further claims that the observation that any optional application of internal Merge is required to yield some new discourse-related interpretation (see Reinhart 1997, 2006; Fox 2000; Chomsky 2001) can be seen as another corollary of DFI.

It is significant to observe that the principle of economy of derivation (5), as a likely corollary of a law of nature (Hamilton's Principle of Least Action), leads generative grammar to adopt a more transparent syntax-semantics mapping, such as DFI (see Uriagereka 2008 for a different approach). The relevant properties of CI-interpretation are thus, as we may claim, 'naturalized' by natural law, the third factor of language design.

Another potential example of the third-factor principles is the principle of *symmetry* in nature, whose relevance to generative grammar is discussed in Narita & Fukui (forthcoming) (see also Jenkins 2000; Citko 2011; Fukui 2011; Fukui & Narita 2017; Narita & Fukui 2016). It has been widely recognized in physical sciences that nature favors symmetry. We observe an infinitude of symmetric patterns in the universe, from the endless forms of biological organisms (spheres in cell division, bilateral designs of skeletons, etc.) to the structures and trajectories of inorganic matters (snowflakes, elliptic orbit of planets, etc.). Capitalizing on such observations, many mathematicians and physicists have become convinced that symmetry is indeed an overarching principle of the physical world (see, e.g., Weyl 1952).

Mathematically speaking, symmetry of a natural object O can generally be characterized as invariance

[5] Some researchers claim that the domain of such economy considerations is localized to well-defined parts of a given derivation, e.g., phases (Chomsky, 2000a, 2008). See also Collins (1997); Uriagereka (1999).

[6] One of the familiar examples is the effect of Fermat's Principle of Least Time in optics, which states that a ray of light in traversing a route from one point to another follows the path that requires least time.

[7] See Al-Mutairi (2014) for critical discussion. See also Narita (2017).

of O under some transformation T. If O consists of *n* components, C_1, ..., C_n, then, applications of T never affect the internal properties or relations of C_1, ..., C_n. In other words, for O = $\{C_1, ..., C_n\}$ to be symmetric, it is necessary that there exists some property or relation that holds of C_1, ..., C_n that stays invariant under T. Narita & Fukui (forthcoming) call this necessary condition of symmetry *extrinsic uniformity*.

(7) *Extrinsic Uniformity of Symmetric Objects*:
An object O = $\{C_1, ..., C_n\}$ is *extrinsically uniform* $=_{def.}$ For some transformation T, there exists some property P or relation R that holds of C_1, ..., C_n and stays invariant under T.

For example, a regular hexagon (instantiated by snowflakes honeycombs, etc.) is extrinsically uniform, given that *being of the same length k* holds of its six sides, and this property/relation stays invariant under, say, a reflection transformation. Similarly, a starfish is extrinsically uniform, given its five arms are of the same length, shape, etc., that stays invariant under, say, a 72° rotation.

The condition in (7) is a relatively weak, but still necessary. In addition to (7), Narita & Fukui (forthcoming) propose that we can also define a stronger notion of uniformity. Specifically for objects in nature, organic or inorganic, we can distinguish, among many other possible transformational operations, the very generative procedure GP that is directly at stake in the formation of those objects. We will define invariance of C_1, ..., C_n with respect to GP as *intrinsic uniformity*.

(8) *Intrinsic Uniformity of Symmetric Objects*:
An object O = $\{C_1, ..., C_n\}$ is *intrinsically uniform* $=_{def.}$ For the generative procedure GP that yields O, all the properties and relations assigned by GP equally hold of its components, C_1, ..., C_n, i.e., no property P or relation R assigned by GP makes a component C_i distinct from any other component C_j ($1 \leq i,j \leq n$, $i \neq j$).

For instance, consider the process of cell division. It can be understood as a generative procedure GP that applies to a cell C and yields a pair of identical duplicates of C: GP(C) = $\{C_1, C_2\}$. Here, the object $\{C_1, C_2\}$ is intrinsically uniform, given that C_1 and C_2 share the exact same properties of shape, chemical compositions, etc. To take another example, consider the process of recursive branching in snowflake-formation. Details aside, it consists of a series of molecule arrangements, driven by hydrogen bonds and other physical conditions, that collectively shape 6 branches. If we call the composite of these processes *GP*, then a snowflake O consisting of six branches B_1, ..., B_6 is intrinsically uniform, given that B_1, ..., B_6 are identical with respect to the properties assigned by GP (hexagonal shape, chemical compositions, etc.), and no property or relation assigned by GP to B_1, ..., B_6 makes B_i distinct from any other B_j ($1 \leq i,j \leq 6$, $i \neq j$).

It is certainly not true to say that every object in nature is intrinsically or extrinsically uniform. The human body, for instance, is not completely intrinsically uniform, due to dominant right-handedness, asymmetrically positioned intestines, etc. After all, perfect symmetry is rarely observed in the real world, for multiple reasons such as fluctuating external conditions, accidental damage, etc. That said, it is also true that nature exhibits cases where intrinsically uniform objects are formed, especially in idealized environments, where extrinsic conditions not directly relevant for the generation are appropriately controlled. For such cases, we may say that the relevant procedure GP satisfies the *Symmetry Principle*.

(9) *Symmetry Principle*:
GP yields intrinsically uniform outputs.

Narita & Fukui (forthcoming) propose that several (or, perhaps, all) generative procedures within human language can also be shown to satisfy the Symmetry Principle. They claim that the operation *Merge*, be it formulated as the familiar binary version (10) or an unbounded *n*-ary one (11), is a GP satisfies the Symmetry Principle.

(10) Merge(α, β) = $\{\alpha, \beta\}$

(11) Merge(Σ_1, ..., Σ_n) = $\{\Sigma_1, ..., \Sigma_n\}$ ($n > 0$)

In the case of binary set-formation in (10), for example, no structural relations assigned to α and β, such as *term-of* and *sister-of*, make α or β distinct from the other: they are equally terms of the output O = $\{\alpha, \beta\}$, they are mutually sisters of each other, and no asymmetric relation, such as precedence, is assigned to the

pair of α and β to make one distinct from the other (contra, e.g., Kayne 2011; Zwart 2011). In this sense, the output of the GP Merge ((10) or (11)) does satisfy intrinsic uniformity.

Narita & Fukui (forthcoming) argue that Merge takes the form it does, perhaps because its emergence is, evolutionarily and/or developmentally, critically conditioned by the Symmetry Principle, a third-factor principle whose domain of application surely ranges over the physical world. So long as this hypothesis is on the right track, we may say that Merge is, in a certain sense, "physicalized" via the fundamental principle of nature. For discussion, see Narita & Fukui (forthcoming), who further propose that the effect of the Symmetry Principle widely extends to other parts of generative grammar.

As we have seen, minimalist-internalists are honest and serious realists who start their inquiry from the limited set of virtually empirically necessary postulates, including the language-specific Merge-operation and empirically successful postulates borrowed from other naturalistic inquiries (the third factor). To the extent that effects of the physical laws of nature penetrate the domain of FL (grammar), this mental mechanism is naturalized/'physicalized', in a way quite different from how traditional semantic naturalizers' reductionism couched in ideological physicalism. It certainly goes beyond the Cartesian mind-body dualism, though not really in the way Descartes envisaged: while the minimalist-internalists fully respect epistemological Cartesianism (circumventing unbounded creativity), the third-factor principles they seek overarch and cross-cut metaphysical mind-body dualism, governing both physical and mental aspects of the world. In this manner, the pursuit of the third factor can be regarded as *metaphysically trans-Cartesian*.

To what extent the pursuit of such "naturalization" of grammar (metaphysical trans-Cartesianism) is feasible and plausible is an open empirical question, to which we cannot and should not provide any *a priori* answer. Again, due to the still-daunting intractability of unbounded creativity, we can only reasonably proceed to address this question by sticking to and refining our set of virtually empirically necessary postulates, taking whatever evidence is or becomes available.

5 Concluding remarks

The possibility of natural sciences of the mind was opened up by the 17th century scientific revolution, where natural science came to take its modern shape. The conceptual barrier precluding such a naturalistic inquiry was first posed as a by-product of Descartes's mechanical philosophy, but was later eliminated by Newton. However, even today, the mystery of unbounded creativity essentially remains much in the same form as Descartes observed with puzzlement, and the serious naturalistic inquiry into the nature of mind is presumably only possible when the issues of unbounded creativity are avoided even in the study of mental aspects of the world. Thus, natural sciences of the mind are *methodologically un-Cartesian* while *epistemologically Cartesian*, in that they reject Descartes's metaphysical mind-body dualism, while they nevertheless respect Descartes's strategy to avoid the complexity and intractability of unbounded creativity. Further, some such sciences can also be *metaphysically trans-Cartesian*, in that they take full advantage of the dissolution of mind-body dualism and seek to find physical ("third-factor") principles that cross-cut both physical and mental aspects of the world.

In this squib, I argued that generative grammar under the rubric of the minimalist program is essentially such a *neo-Cartesian* project, whose three distinct characteristics can be summarized as follows.

(12) *Neo-Cartesianism* in generative grammar:[8]

a. *Methodological un-Cartesianism*:
the conviction that there is no conceptual or methodological barrier preventing natural sciences of the mind, contra Cartesian mind-body dualism.

b. *Epistemological Cartesianism*:
the conviction that the unbounded creativity of human mental acts (some of which are externalizable in speech) lies beyond our scientifically tractable domains of inquiry.

c. *Metaphysical trans-Cartesianism*:
the conviction that we can fully take advantage of the dissolution of mind-body dualism, and seek to find physical ("third-factor") principles that cross-cut both physical and mental aspects

[8] Perhaps Hinzen & Sheehan (2013) and Hinzen (2014) *language-thought un-Cartesianism* discussed in note 4 may constitute the fourth component of neo-Cartesianism, although it may not be as essential to generative grammar as the other three components listed here.

of the world.

Neo-Cartesian (bio)linguists start from empirical observations, notably on the poverty of the stimulus, that clearly demonstrate the existence of nontrivial innate knowledge, and they take as real whatever theoretical postulates are shown to be virtually empirically necessary, without caring much about philosophical justification of them by means of, say, crude ideological physicalism. There is nothing special about this line of approach; it is common practice in most of the natural sciences. It is methodological naturalism.

It was pointed out that there is currently no interesting conception of physicalism that can pose a complete and coherent boundary of the physical for which physics can in principle provide explanations. Correspondingly, we have no principled boundary between 'physical sciences' and 'mental sciences'. The situation is, then, just that there are a number of partially or completely (un)related empirical observations in the physical and mental aspects of the world, each of which potentially indicates the ontological reality of some virtually empirically necessary postulates, be they general relativity, electromagnetic fields, the Principle of Least Action, Merge, quanta, prime numbers, LIs, θ-roles, or whatnot. We can do no more than to seek the best theories of the given set of empirical observations, making use of whichever of these postulates are found useful, without presupposing any stipulations as to how general each postulate's domain of application can be.

Methodologically speaking, then, all the existing sciences are, more or less, unified under the general rubric of the methodological naturalism, and the challenge that remains is to find true linking hypotheses that provide explanations for one or more of these observations, probably with substantial modification and refinement of the postulates that have been thought of as virtually empirically necessary. No progress is guaranteed, let alone any success, but this has been, again, and always will be, the norm for naturalistic inquiry.

References

Al-Mutairi, Fahad Rashed (2014). *The Minimalist Program: The Nature and Plausibility of Chomsky's Biolinguistics*. Cambridge University Press, Cambridge.

Berwick, Robert C. (2011). All you need is Merge: Biology, computation, and language from the bottom up. Sciullo, Anna Maria Di & Cedric Boeckx (eds.), *The Biolinguistic Enterprise: New Perspectives on the Evolution and Nature of the Human Language Faculty*, Oxford University Press, Cambridge, MA, 461–491.

Berwick, Robert C. & Noam Chomsky (2015). *Why Only Us: Language and Evolution*. MIT Press.

Boghossian, Paul (1991). Naturalizing content. Loewer, Barry M. & Georges Rey (eds.), *Meaning in mind: Fodor and his critics*, Blackwell, Oxford, 65–86.

Borer, Hagit (2005a). *Structuring Sense, Volume I: In Name Only*. Oxford University Press, Oxford.

Borer, Hagit (2005b). *Structuring Sense, Volume II: The Normal Course of Events*. Oxford University Press, Oxford.

Borer, Hagit (2017). *Structuring Sense, Volume III: Taking Form*. Oxford University Press, Oxford.

Chomsky, Noam (1955/1975). *The Logical Structure of Linguistic Theory*. ms. Harvard University, 1955. Published in part in 1975, New York: Plenum.

Chomsky, Noam (1957). *Syntactic Structures*. Mouton, The Hague. 2nd edition, (2002).

Chomsky, Noam (1965). *Aspects of the Theory of Syntax*. MIT Press, Cambridge, MA.

Chomsky, Noam (1966/2009). *Cartesian Linguistics: A Chapter in the History of Rationalist Thought*. Cambridge University Press, Cambridge, 3rd edition edn. Supplemented with a new introduction by James McGilvray.

Chomsky, Noam (1981). *Lectures on Government and Binding*. Foris, Dordrecht.

Chomsky, Noam (1986). *Knowledge of Language*. Praeger, New York.

Chomsky, Noam (1988). *Generative Grammar: Its Basis, Development and Prospects*. Studies in English Linguistics and Literature, Kyoto University of Foreign Studies, Kyoto.

Chomsky, Noam (1993). A minimalist program for linguistic theory. Hale, Ken & Samuel J. Keyser (eds.), *The View from Building 20: Essays in Linguistics in Honor of Sylvain Bromberger*, MIT Press, Cambridge, MA, 1–52.

Chomsky, Noam (1994). *Language and Thought*. Moyer Bell, Wakefield, RI.

Chomsky, Noam (1995a). Language and nature. *Mind* 104. 413, 1–61.

Chomsky, Noam (1995b). *The Minimalist Program*. MIT Press, Cambridge, MA.

Chomsky, Noam (2000a). Minimalist inquiries: The framework. Martin, Roger, David Michaels & Juan Uriagereka (eds.), *Step by Step: Essays on Minimalist Syntax in Honor of Howard Lasnik*, MIT Press, Cambridge, MA, 89–155.
Chomsky, Noam (2000b). *New Horizons in the Study of Language and Mind*. Cambridge University Press, Cambridge.
Chomsky, Noam (2001). Derivation by phase. Kenstowicz, Michael (ed.), *Ken Hale: A Life in Language*, MIT Press, Cambridge, MA, 1–52.
Chomsky, Noam (2003). Internalist explorations. Hahn, Martin & Bjørn Ramberg (eds.), *Reflections and replies: Essays on the Philosophy of Tyler Burge*, MIT Press, Cambridge, MA, 259–288.
Chomsky, Noam (2004). Beyond explanatory adequacy. Belletti, Adriana (ed.), *Structures and Beyond: The Cartography of Syntactic Structures*, Oxford University Press, New York, 104–131.
Chomsky, Noam (2005). Three factors in the language design. *Linguistic Inquiry* 36, 1–22.
Chomsky, Noam (2007a). Approaching UG from below. Sauerland, Uli & Hans-Martin Gärtner (eds.), *Interfaces + Recursion = Language?: Chomsky's Minimalism and the View from Semantics*, Mouton de Gruyter, Berlin and New York, 1 –29.
Chomsky, Noam (2007b). Biolinguistic explorations: Design, development, evolution. *International Journal of Philosophical Studies* 15(1), 1–21.
Chomsky, Noam (2008). On phases. Freidin, Robert, Carlos Otero & Maria Luisa Zubizarreta (eds.), *Foundational Issues in Linguistic Theory: Essays in Honor of Jean-Roger Vergnaud*, MIT Press, Cambridge, MA, 133–166.
Chomsky, Noam (2009). The mysteries of nature: How deeply hidden? *The Journal of Philosophy* 16:4, 167–200.
Citko, Barbara (2011). *Symmetry in Syntax: Merge, Move, and Labels*. Cambridge University Press, Cambridge.
Collins, Chris (1997). *Local Economy*. MIT Press, Cambridge, MA.
Davidson, Donald (1967). Truth and meaning. *Synthese* 17, 304–323. Reprinted in Davidson (1984).
Davidson, Donald (1969). True to the facts. *Journal of Philosophy* 66, 748–764. Reprinted in Davidson (1984).
Descartes, René (1998). *Discourse on Method and Meditations on First Philosophy*. trans. by Donald A. Cress, Hackett Publishing Company, 4 edn.
Dretske, Fred I. (1981). *Knowledge and the flow of information*. MIT Press, Cambridge, MA.
Dummett, Michael (1986). A nice derangement of epitaphs: some comments on Davidson and Hacking. Lepore, Ernest (ed.), *Truth and Interpretation: Perspectives on the Philosophy of Donald Davidson*, Basil Blackwell, Oxford.
Fodor, Jerry A. (1987). *Psychosemantics*. MIT Press, Cambridge, MA.
Fodor, Jerry A. (1990). *A theory of content and other essays*. MIT Press, Cambridge, MA.
Fodor, Jerry A. (1991). Replies. Loewer, Barry M. & Georges Rey (eds.), *Meaning in mind: Fodor and his critics*, Blackwell, Oxford, 255–319.
Fodor, Jerry A. (1994). *The elm and the expert*. MIT Press, Cambridge, MA.
Fodor, Jerry A. (2008). *LOT2: The Language of Thought Revisited*. Oxford University Press, Oxford.
Fox, Danny (2000). *Economy and Semantic Interpretation*. MIT Press, Cambridge, MA.
Frege, Gottlob (1997). The Frege reader. ed. by Michael Beaney. Oxford: Blackwell.
Friedman, Michael (1993). Remarks on the history of science and the history of philosophy. Horwich, Paul (ed.), *World Changes: Thomas Kuhn and the Nature of Science*, MIT Press, Cambridge, MA, 37–54.
Fukui, Naoki (1996). On the nature of economy in language. *Cognitive Studies* (Bulletin of the Japanese Cognitive Sciense Society), 3, 51–71. Reprinted in Fukui (2006).
Fukui, Naoki (2011). Merge and bare phrase structure. Boeckx, Cedric (ed.), *The Oxford Handbook of Linguistic Minimalism*, Oxford University Press, Oxford, 73–95.
Fukui, Naoki & Hiroki Narita (2017). Merge and (a)symmetry. Paper presented at the Kyoto Conference on Biolinguistics, Kyoto University, March 12, 2012. [Video available at: <http://hosts44b.iimc.kyoto-u.ac.jp:8080/ess/echo/presentation/ebab5d2c-1bc5-41bd-8dec-0236091c6bba>]. Published in Naoki Fukui (2017). *Merge in the Mind/Brain*. Routledge.
Hale, Ken & Samuel J. Keyser (1993). On argument structure and the lexical expression of grammatical relations. Hale, Ken & Samuel J. Keyser (eds.), *The View from Building 20: Essays in Linguistics in Honor of Sylvain Bromberger*, MIT Press, Cambridge, MA, 53–110.
Hale, Ken & Samuel J. Keyser (2002). *Prolegomenon to a Theory of Argument Structure*. MIT Press, Cambridge, MA.
Hinzen, Wolfram (2006a). Internalism about truth. *Mind and Society* 5, 139–166.

Hinzen, Wolfram (2006b). *Mind Design and Minimal Syntax*. Oxford University Press, Oxford.
Hinzen, Wolfram (2007). *An Essay on Names and Truth*. Oxford University Press, Oxford.
Hinzen, Wolfram (2008). Prospects for an explanatory theory of semantics. *Biolinguistics* 2(4), 348–363.
Hinzen, Wolfram (2014). What is un-Cartesian linguistics? *Biolinguistics* 8, 226–257.
Hinzen, Wolfram & Michelle Sheehan (2013). *The Philosophy of Universal Grammar*. Oxford University Press, Oxford and New York.
Hume, David (1756). *The History of England*, vol. 6. Liberty*Classics*.
Jenkins, Lyle (2000). *Biolinguistics: Exploring the Biology of Language*. Cambridge University Press, Cambridge.
Kato, Takaomi, Hiroki Narita, Hironobu Kasai, Mihoko Zushi & Naoki Fukui (2016). On the primitive operations of syntax. Fujita, Koji & Cedric Boeckx (eds.), *Advances in Biolinguistics: The Human Language Faculty and Its Biological Basis*, Routledge, London/New York, 29–45.
Kayne, Richard S. (2011). Why are there no directionality parameters? Washburn, Mary Byram, Katherine McKinney-Bock, Erika Varis, Ann Sawyer & Barbara Tomaszewicz (eds.), *Proceedings of WCCFL 28*, Cascadilla Proceedings Project, Somerville, MA., 1–23.
Kinsella, Anna R. (2009). *Language Evolution and Syntactic Theory*. Cambridge University Press, Cambridge.
Kinsella, Anna R. & Gary F. Marcus (2009). Evolution, perfection, and theories of language. *Biolinguistics* 3:2-3, 186–212.
Kripke, Saul (1980). *Naming and Necessity*. Harvard University Press, Cambridge, MA.
Lange, Frederik Albert (1890). *History of materialism and criticism of its present importance*, vol. Vol. I. Trübner & Co., Ludgate Hill, London.
Lenneberg, E. H. (1967). *Biological Foundations of Language*. John Wiley and Sons, New York.
Lewis, David (1972). General semantics. Davidson, D. & G. Harman (eds.), *Semantics of Natural Languages*, Reidel, Dordrecht, 169–218.
Loewer, Barry M. (1997). A guide to naturalizing semantics. Hale, Bob & Crispin Wright (eds.), *A companion to the philosophy of language*, Blackwell, Oxford, 108–126.
Loewer, Barry M. & Georges Rey (eds.) (1991). *Meaning in mind: Fodor and his critics*. Blackwell, Oxford.
Lohndal, Terje & Hiroki Narita (2009). Internalism as methodology. *Biolinguistics* 3:4, 321–331.
Marr, David (1982). *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*. Freeman, New York.
McGilvray, James (1998). Meanings are syntactically individuated and found in the head. *Mind and Language* 13, 225–280.
McGilvray, James (2002). MOPs: The science of concepts. Hinzen, Wolfram & Hans Rott (eds.), *Belief and Meaning: Essays at the Interface*, Ontos, Frankfurt, 73–103.
McGilvray, James (2009). Introduction to the third edition. Noam Chomsky (2009) *Cartesian Linguistics: A Chapter in the History of Rationalist Thought, Third Edition*. Cambridge: Cambridge University Press, 1-52.
McGinn, Colin (1991). *The Problem of Consciousness*. Basil Blackwell, Oxford.
McGinn, Colin (1993). *Problems in Philosophy*. Basil Blackwell, Oxford.
McGinn, Colin (1999). *The Mysterious Flame: Conscious Minds in a Material World*. Basic Books, New York.
Montague, Richard (1974). *Formal Philosophy: Selected Papers by Richard Montague*. ed. by Richmond H. Thomason, Yale University Press, New Haven.
Narita, Hiroki (2009a). Full interpretation of optimal labeling. *Biolinguistics* 3:2-3, 213–254.
Narita, Hiroki (2009b). How syntax naturalizes semantics: A review of Uriagereka (2008). *Lingua* 119:11, 1767–1775.
Narita, Hiroki (2014). *Endocentric Structuring of Projection-free Syntax*. John Benjamins, Amsterdam/Philadelphia.
Narita, Hiroki (2017). Review of Fahad Rashed Al-Mutairi's (2014) *the minimalist program: the nature and plausibility of chomsky's biolinguistics*, cambridge university press. ms. Tokai University.
Narita, Hiroki & Koji Fujita (2010). A naturalist reconstruction of minimalist and evolutionary biolinguistics. *Biolinguistics* 4:4, 356–376.
Narita, Hiroki & Naoki Fukui (2016). Feature-equilibria in syntax. Fujita, Koji & Cedric Boeckx (eds.), *Advances in Biolinguistics: The Human Language Faculty and Its Biological Basis*, Routledge, London/New York, 9–28.
Narita, Hiroki & Naoki Fukui (forthcoming). *Symmetry-driven Syntax*. Routledge.

Narita, Hiroki, Hironobu Kasai, Takaomi Kato, Mihoko Zushi & Naoki Fukui (2017). 0-Search and 0-Merge. Fukui, Naoki (ed.), *Merge in the Mind-Brain*, Routledge, London/New York, 127–154.
Pietroski, Paul M. (2005). *Events and Semantic Architecture*. Oxford University Press, Oxford.
Pietroski, Paul M. (2007). Systematicity via monadicity. *Croatian Journal of Philosophy* 7, 343–374.
Pietroski, Paul M. (2008). Minimalist meaning, internalist interpretation. *Biolinguistics* 2:4, 317–341.
Pietroski, Paul M. (to appear). *Semantics Without Truth Values*. Oxford University Press, Oxford.
Putnam, Hilary (1975). The meaning of 'meaning'. Gunderson, Keith (ed.), *Language, Mind and Knowledge*, University of Minnesota Press, Minneapolis, vol. VII of *Minnesota Studies in the Philosophy of Science*.
Reinhart, Tanya (1997). Quantifier scope: How labor is divided between QR and choice functions. *Linguistics and Philosophy* 20, 335–397.
Reinhart, Tanya (2006). *Interface strategies: optimal and costly computations*. MIT Press, Cambridge, MA.
Rønning, Magnus Stavik (2008). Naturalizing meaning: Jerry Fodor's theory of content. MA thesis, Universitetet i Oslo.
Russell, Bertrand (1905). On denoting. *Mind* 14:56, 479–493.
Schofield, Robert E. (1970). *Mechanism and materialism: British natural philosophy in an age of reason*. Princeton University Press, Princeton.
Stalnaker, Robert (1984). *Inquiry*. MIT Press, Cambridge, MA.
Stampe, Dennis W. (1977). Towards a causal theory of linguistic representation. *Midwest Studies in Philosophy* 2, 42–63.
Stoljar, Daniel (2000). Physicalism and the necessary a posteriori. *The Journal of Philosophy* 97:1, 33–54.
Stoljar, Daniel (2001). Two conceptions of the physical. *Philosophy and Phenomenological Research* 62:2, 253–281.
Stoljar, Daniel (2006). *Ignorance and imagination: the epistemic origin of the problem of consciousness*. Oxford University Press, Oxford.
Tarski, Alfred (1936/1994). *Introduction to Logic and to the Methodology of the Deductive Sciences*. Oxford University Press. Forth edition, ed. by Jan Tarski, originally published in Polish in 1936, New York.
Tarski, Alfred (1983). *Logic, Semantics, Metamathematics, papers from 1923 to 1938*. ed. John Corcoran, Hackett Publishing Company, Indianapolis.
Uriagereka, Juan (1999). Multiple Spell-Out. Epstein, Samuel David & Norbert Hornstein (eds.), *Working Minimalism*, MIT Press, Cambridge, MA, 251–282.
Uriagereka, Juan (2002). *Derivations: Exploring the Dynamics of Syntax*. Routledge, London.
Uriagereka, Juan (2008). *Syntactic Anchors: On Semantic Structuring*. Cambridge University Press, Cambridge.
Weyl, Hermann (1952). *Symmetry*. Princeton University Press, Princeton.
Zwart, Jan-Wouter (2011). Structure and order: asymmetric merge. Boeckx, Cedric (ed.), *The Oxford Handbook of Linguistic Minimalism*, Oxford University Press, Oxford, 96–118.