Research Methods in Armchair Linguistics

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> In science, a new theory is first invented, then disputed, and then perhaps generally accepted. But the man who invents it, while it is new, has no rational grounds for believing it; he discovers the grounds afterwards. Thus he differs from a lunatic only in the fortunate accident that his originally irrational belief turns out to be capable of rational defence.
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> Bertrand Russell, 'Insanity and Insight' (1934)

1 Universal Grammar is a Postulate

When Newton got hit on the head by the apple, he did not *know* that there was a single universal force of gravity that works the same way under a tree

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and among the Earth, Sun, Moon and stars. He didn't confirm by observation that the same force was at work, but rather he decided to *assume* it. That postulate allowed him to consider that empirical observations in one domain, say, that of apples under trees, could conceivably bear on empirical observations in another, say, orbiting planets—or to say it better, his postulate allowed him to treat apples and the planets as part of a single domain.

Newton's postulate of the uniformity of gravity seems obvious to us with hindsight, but the issue is not trivial. As physicist Sean Carroll (2022) puts it "We take this for granted now, but back in the day it was a dramatic leap to connect planetary motion to everyday occurrences in the local orchard." In 1676, a decade before the publication of Newton's *Principia*, the Italian scholar Geminiano Montanari implicitly rejects the Newtonian postulate, warning that "we all mislead ourselves when we want to discuss things that take place far from us, applying to them the same concepts we use for terrestrial things that we have in our hands" (quoted and discussed by Heilbron 2022). As discussed by Shapin (2018), Galileo and some of his contemporaries in the late sixteenth and early seventeenth centuries had already been challenging the view that Montanari still held decades later:

> Galileo's views on sunspots, along with a body of other observations and theorizing, profoundly questioned a fundamental Aristotelian distinction between the physics of the heavens and that of the earth. Orthodox thinking, from antiquity to Galileo's time, had it that the physical nature and principles of heavenly bodies differed in character from those that obtained on earth. ... [B]y asserting the similarity of heavenly and terrestrial bodies, Galileo implied that studying the properties and motions of ordinary earthly bodies could afford understanding of what nature was like universally. ... The motion of a cannonball could serve as a model for the motion of Venus. (Shapin, 2018, 17-19)

Not only did Newton also have to struggle against the Aristotelian orthodoxy, but the issue was still alive in the 20th century when the mathematical biologist J.B.S. Haldane remarked about the significance of the first spacecraft to reach the surface of the Moon, the 1959 Soviet Luna 2 lunar impactor mission, that "it is scientifically important to have hit the moon. It is a concrete proof that certain physical 'laws' or rules about the behaviour of matter hold good at least as far as the moon" (Haldane and Dronamraju, 2009, 159-60).

The perspective of this chapter is that the idea of an innate, genetically determined Human Language Faculty (sometimes called 'Universal Grammar' (UG) in one sense of the term) plays the same role in linguistics as Newton's assumption played in physics. Just as the assumption that data about apples falling can potentially bear on the analysis of planets in orbit, it is useful to think of UG more as a postulate that allows empirical work to proceed, than as a hypothesis or a theory. In concrete terms, the postulate of the existence of UG allows data from each language to bear on the analysis of all languages, and also on the characterization of the details of UG, as discussed below. There appears to be some plasticity in the Human Language Faculty, but plasticity only makes sense in the context of a deeper uniformity.

What does it mean to treat apples and planets or Quechua and Hungarian as elements of the same domain? It means that there is a (possibly to-be-determined) level of analysis at which apparently different entities can be analyzed in terms of the same properties—because they *consist* of the same properties. At this level, the color of an apple, its degree of ripeness, and the presence of a couple of wormholes in its surface are irrelevant to the comparison with a planet. The inventory of the relevant properties is the object of study of mechanics; and if we are realists about scientific theories, we expect our theory to be isomorphic to the object of study with respect to the properties posited in the theory. In the same vein, the postulate of UG means that there is a (possibly to-be-determined) level of analysis at which Quechua and Hungarian can be characterized using the same primitive notions.

Of course, mechanics does not recognize apples and planets in its ontology. Similarly, theoretical linguistics does not recognize everyday notions like Quechua and Hungarian, but only individual mental grammars (I-languages)[1] that can be characterized by a common (shared) universal set of properties—

[1]In a volume like this, it should be noted that at least some philosophers (e.g., Stainton 2011) find the rejection of the notion of 'public languages' by I-linguists to be preposterous. Unless otherwise indicated, the views of 'linguists' in this chapter will refer to my understanding of the views of Chomsky and those who broadly adopt his philosophical stances concerning linguistics—*What is the object of study?*; *What are legitimate methods of inquiry?*, etc. The details of particular linguistic frameworks are not relevant to our discussion, so I'll assume that one could be either a Minimalist (e.g., Adger, 2003) or a Lexical Functional Grammar (e.g., Bresnan et al., 2015) syntactician and still ascribe to Chomsky's foundational ideas about Universal Grammar, competence vs. performance, and so on.

the theory of general linguistics, (also sometimes called 'Universal Grammar'), should be isomophic to the object of study for linguists, the universal set of linguistic building blocks provided by the human mind.

2 UG-object and UG-theory

My impression is that Chomsky has always understood UG (or equivalent terms, from before he adopted the phrase "universal grammar") in this way, as a necessary assumption that allows empirical work on language to proceed, but discussion by both adherents and sceptics tends to miss or mask this perspective. UG is often presented as merely a controversial theory or a hypothesis for which linguists need to provide evidence, for example, by Dabrowska (2015) in a paper called "What exactly is Universal Grammar, and has anyone seen it?" where she says that "Universal Grammar (UG) is a suspect concept. There is little agreement on what exactly is in it; and the empirical evidence for it is very weak." This is quite a different perspective from treating UG as a postulate, which has a status similar to an axiom in mathematics.

The suggestion to treat UG as a background assumption, a postulate, is partly a rhetorical device designed to flip the null hypothesis. Instead of feeling pressure to prove the hypothesis of UG, linguists can show that it is only by assuming UG that we have achieved the sophisticated results of recent decades. General discussion of the existence and content of UG, of course, also treats the idea as a hypothesis and part of an articulated theory that can be subjected to elaboration and revision. So, without worrying too much about the exact terms—postulate, theory, hypothesis—we can again appreciate the parallel to Newton. The *assumption* that the same force was at work on apples and planets led Newton to the inverse square law (the gravitational force between two objects varies inversely with the square of the distance between them) and the notion of centripetal force. Having worked out such details with mathematical rigor, Newton could see that his initial postulate led somewhere good, and he was then able to formulate an articulated theory of Universal Gravitation. The proof of the value of the postulate was in the proverbial empirical pudding. So, in order to make my case, I'll have to provide some linguistic pudding below, since the "sophisticated results" to which I allude tend to be little known outside of the narrow circle of theoretical linguistics. Anyone who wants to reject the postulate or hypothesis

of UG will need to provide alternative accounts of the results sketched below in section 4.

Even some linguists complain that we shouldn't talk about UG until we look at more languages and get more data. Consider the following abusive appeal for empirical confirmation of a property of one postulated version of UG from within the linguistics community. Pullum and Scholz (2010) object to the claim by Epstein and Hornstein (2005) that 'discrete infinity' (or denumerable infinity) is a property of every human language, that is, it is part of UG.[2] Pullum and Scholz object to such a claim about every language "as if one by one they had all been examined by scientists and checked for discrete infinitude." The kind of empirical verification they are implicitly demanding is, of course, ridiculous and non-existent in any field. Physicists make claims about the mass and charge of electrons, yet they haven't checked every electron in the universe for these properties. To be consistent with their own logic, Pullum and Scholz should reject Universal Gravitation. The kind of generalization that Epstein and Hornstein are making is just normal science—proposing a tentative description of the world, based on a set of postulates and an infinitesimal set of observations guided by these postulates.

I propose that one source of difficulty in understanding UG as a postulate arises from the systematic ambiguity of the phrase Universal Grammar, alluded to above, which refers both to the innate, genetically determined language faculty, the object of study for the theoretical linguist, and to the linguist's scientific model of that faculty. Let's distinguish these two usages as UG-object vs. UG-theory. In some work, UG-object is referred to as the Human Language Faculty, or S_0, the initial state, at birth, of the Human Language Faculty. UG-theory, in contrast, can be equated with the field of general linguistics.[3]

[2]We have to be careful—in this case every language appears to have this fundamental property of discrete infinity. However, when I characterize reduplication below, I argue that the existence of reduplication in just one language demonstrates the necessity for certain computational power in UG. This does not mean that every attested language must manifest reduplication. I suspect that Epstein and Hornstein are actually implicitly applying Empirical Argumentation Device 5, introduced in section 4.5, below.

[3]I won't hesitate to use the UG terms anachronistically to refer to related notions, from before Chomsky started referring to Universal Grammar, because the issues are more important than the terminological history—an example would be the reference to "the general nature of Language" with capital *L*, in *Syntactic Structures* (Chomsky, 1957). Here, "Language" just means UG-object. Chomsky (1965, p.25) refers to this ambiguity of the term 'grammar', in general, not just with respect to Universal Grammar: the term

While linguists tend to be comfortable with the terminological situation, Green and Vervaeke (1997), a psychologist and a philosopher, highlight the potential for confusion arising from the systematic ambiguity of the term "grammar" (and its use in the phrase "Universal Grammar"), but in the process, they reveal an additional confusion:

> There is a systematic ambiguity in the term "grammar," an ambiguity that has caused much confusion among Chomsky's critics. It refers both to the knowledge that is hypothesized to be "in the head" of the human, and to the linguist's theory of that knowledge. In an effort to stem the confusion somewhat, Chomsky has recently adopted the term "I-language" to refer to the knowledge of language the human is thought innately to have, the "I" standing for individual, internal, and intensional.

The additional confusion that Green and Vervaeke introduce is that the question of nativism, the existence of a genetically determined UG-object, is distinct from the notion of I-language. Chomsky actually introduced the term "I-language" to refer to an *attained* state of the language faculty, after experience, for example in *Knowledge of Language* (Chomsky, 1986, p. 23):

> UG now is construed as the theory of human I-languages, a system of conditions deriving from the human biological endowment that identifies the I-languages that are humanly accessible under normal conditions.

"UG" here refers straightforwardly to UG-theory, as "the theory of human I-languages", the theory that characterizes the set of possible I-languages, which are considered to be real systems instantiated in human minds. But in the course of the sentence, we can see the shift to UG-object, "a system of conditions deriving from the human biological endowment". We'll return to this shift below, after I clarify Green and Vervaeke's confusion about I-language and innateness.

"grammar" can refer to an internally represented system of knowledge or to the linguist's account of that knowledge. The fact that Chomsky calls the internally represented system the speaker's "theory of his language", with apparent scare quotes, was a bit confusing, but I won't go into his reasons for doing so. Chomsky addresses the confusion directly on pp. ix-x of the 2014 Preface to the fiftieth anniversary edition of *Aspects of the Theory of Syntax* (Chomsky, 2014).

One could, in principle, be a psychologist who believes that humans have mental grammars, without believing in UG-object. One could potentially believe that mental grammars arise through "general learning mechanisms" without any language-specific categories. So belief in I-language does not entail belief in UG-object. On the other hand, nativist linguists must believe in the I-language perspective, because UG-object, and all subsequent states of the language faculty must be understood as individual—they are part of each person; internal—they are represented in the mind/brain; and intensional in the set theoretic sense—they consist of rules, patterns or functions, rather than lists or look-up tables, since the number of sentences of a language is unbounded, so the grammar cannot extensionally characterize (list) the set of sentences of the language.[4]

A good paraphrase for "I-language" is "mental grammar", and Jackendoff's 1994 informal equation is a useful guide to distinguishing UG from I-language: Mental Grammar = UG + Experience. In Chomsky's 1980 slightly more opaque formulation "One may think of the genotype as a function that maps a course of experience into the phenotype. In these terms, universal grammar is an element of the genotype that maps a course of experience into a particular grammar". Here, "universal grammar" clearly means UG-object. [5]

[4]See Chomsky (1986); Isac and Reiss (2013) for discussion of I-language, and section 1.1 of Volenec and Reiss (2020) for the logical relationship between I-language and innateness. I had been under the impression that it is obvious that any universal concept must be internal to (all) individuals. To my surprise, casual conversation with a few philosophers has revealed that some of them believe that, e.g., the number 2 is a universal whose existence transcends human minds, and thus is a universal but not internal notion. I imagine this apparently platonic view also holds for repeating decimals like $17.6399701\overline{3}$, but I can't make much sense of this, not least because it makes the platonic realm as uncountably crowded as the continuum. If, instead, numbers in the platonic realm are defined intensionally, then we might as well put that intensional procedure into individual minds, making it, once again, internal.

[5]Before proceeding we should recognize that the UG-theory / UG-object ambiguity is paralleled in pretty much every field, and for the same reasons. Consider the Wikipedia entry on the fundamental forces or interactions in physics—gravity, electromagnetism, weak interaction and strong interaction: "In physics, the fundamental interactions or fundamental forces are the interactions that do not appear to be reducible to more basic interactions." The sentence refers to physics as a theory and physics as an object of study at the same time. I won't consider here why such a situation tends to sow confusion in the case of "grammar", but not in "physics" or even "history", terms which refer simultaneously to the output of an academic discipline and to the object of study of the discipline.

3 UG-object as a logical necessity for empirical work

There is textual evidence to support the claim that Chomsky intends UG-object as a postulate. I provide just a few examples below with the caveat that the systematic ambiguity discussed above pervades all such discussion. My understanding of the reason for this is that it simply reflects Chomsky's realism—UG-theory is a model of UG-object, which is a real part of the world, in the same sense that the gravitational force and the sodium potassium pump are real. In various places, Chomsky explicitly rejects instrumentalism and discusses at length its history in chemistry (e.g., 2000a, p. 110-111; 2015, p. 108-109).[6]

I propose that Chomsky doesn't worry too much about the shifting between UG-theory and UG-object because he takes it for granted that one would only pursue a UG-theory if it were a realist theory of UG-object. This is obvious to Chomsky (in my understanding), but takes a bit of unpacking for most of us. The implicit reasoning goes something like this, with two parts: (a) If we don't make use of universal UG-theory, then there is no coherent sense to the term "general linguistics". Why not compare French, Swahili, the Python programming language, the rules of chess, tango dancing, and the Constitution of the United States of America? It is the postulate of UG that defines the domain of inquiry. We want to make a theory over a coherent domain of phenomena. Newton postulated that apples and planets fall into a single domain for his purposes, and linguists think that French and Swahili, but not chess, belong together. As discussed above this process of defining domains involves postulating an abstract set of properties that, for mechanics, say, includes mass, but not the Granny Smith vs. Golden

[6]Ironically for us, Haldane (Haldane and Dronamraju, 2009, p. 122) uses "parts of speech" to illustrate what he assumes is an obviously legitimate case of instrumentalism, in contrast to chemistry:

> But nobody knew how small the atoms were. And some philosophers said they were only conventions to help our thinking, like parts of speech in grammar or the decimal system in arithmetic. Chemical changes occurred as if there were atoms, but we could never know what matter was really made of.

Generative linguists hold that categories like *negative polarity items* and *wh*-words are real, natural objects (see below).

Delicious distinction.[7] (b) Once we accept (a), linguists obviously need a UG-theory containing a universal set of linguistic entities and operations of various sorts because they are trying to model human languages which are built from a universal set of linguistic entities and operations of various sorts. These are the things in the world that make languages and only languages form a natural class of entities. In other words, the theory and the object should be isomorphic. This is consistent with the idea that linguistics is a form of naturalist inquiry and that each language is a natural object, built from a genetically determined set of primitives (Chomsky, 2000a).[8]

In syntax, the existence of such innate categories, appears to be widely accepted—it seems that every generative syntactician at least implicitly accepts that all languages make use of universally available categories like anaphors, *wh*-question words, and so on. In phonology, by contrast, there is much less consensus. Chomsky and Halle (1965, fn. 24) are very clear concerning the postulation of a universal set of distinctive features for phonology:

> As has often been noted—cf., e.g., [Chomsky 1964b, p. 944-73; Chomsky 1964a, p. 65-110]—the assumption of a universal feature structure is made (often only implicitly) in every approach to phonology that is known, and clearly cannot be avoided. What is at issue only is the choice of features, not their universality...
>
> It is for such reasons as this that one does not 'construct features from scratch for each language'.

[7]It is worth pointing out that discussions of modularity in cognitive science tend to obscure the point that a module (like language) *defines* the elements of its domain. For example, it is not the set of faces in the world that defines the face recognition module; instead, our so-called face recognition module parses certain stimuli as faces, whether the input comes from light reflected from a person (a 'real' face), a computer screen, a cloud in the sky or a smiley face emoji. In some sense the so-called 'domain' of a module (e.g., things that look like faces) is actually, in the mathematical sense relevant to functions, its *range*, its set of possible outputs. See Chomsky's comment on the lack of a "mind-independent object" corresponding to a syllable, in Section 5, below.

[8]Things get really hairy, even in physics, when one tries to understand natural objects, in Chomsky's sense, in terms of our everyday notion of objects. Smith (1996, ch. 3) points out that "physics will be of no help in easing the existential angst of any ordinary individuals. *For there are no physical objects*... Individuals are not an ontological fixture of the physical world. Instead, they are part of the epistemic structure of physics-the-discipline... *Physicists will have to look to a theory of intentionality for an account of the notion of an individual, not the other way around.*"

It should be noted that this perspective on phonology appears to be very much a minority position today, even among phonologists trained in the generative tradition. For example, Reiss and Volenec (2022) is the sole contribution to a recent volume on phonological primes that adopts and defends the nativist position for features expressed by Chomsky and Halle. In this chapter, I maintain the universalist postulate in both syntax and phonology.

4 Theoretical linguistics as empirical science

In the previous sections, I claimed that UG is best construed as a postulate of linguistics that allows empirical work to proceed, rather than as a 'mere' hypothesis that needs to be confirmed or disproven. I attempted to clarify some of the confusion around the systematically ambiguous uses of the term "grammar" as referring both to an object of study and a linguist's theory about that object. For our purposes, these issues are most relevant to the ambiguity of the phrase 'Universal Grammar'. I then pointed out that the postulate of the existence of UG-object is necessary to define the domain of linguistics in a coherent fashion, and that this postulate is reflected in the practice of incorporating into the construction of UG-theory a fixed inventory of theoretical primitives. By virtue of the fact that linguists are realists about their science, they aim for an isomorphism between the UG-theory they construct and the UG-object that exists in the world. In that sense, linguists are just like other scientists, or at least those that abjure the instrumentalist view that theories are just tools we use to make predictions and describe phenomena, but with no deeper relation to their objects. In section 3, I reiterated the suggestion that the postulate of UG is necessary for any empirical work to proceed, and pointed out that, as Chomsky has said, everyone implicitly adopts this postulate when they claim to be engaged in general linguistics.[9]

[9]Real life inquiry is, of course, messy. We do not know in advance what will constitute a coherent domain and facts do not come labeled by an omniscient God telling us to which domain an observation is relevant. Gravity does not completely determine how objects fall—friction and magnetic forces might also be relevant. In this case, physics happens to be able (in principle) to combine all these factors into a single account by calculating the total force to which an object is subjected, but that is no guarantee that such a synthesis will always be possible. For example, grammars play some role in determining what people say, but there is no coherent theory that predicts what a person will say at any given moment, given the fact that they may, perhaps, choose to speak French, English

In this section, I try to show that theoretical generative linguistics, what I reclamatorily call 'armchair linguistics', is, in its actual practice, a robust scientific field of inquiry that has yielded impressive *empirical* results with no reference to a laboratory, a statistical analysis, or large-scale online corpora, all of which I throw together into a category I sloppily call 'lab linguistics'.[10] I

or Swahili; they may lie or tell the truth; they may speak formally or informally; they may use sarcasm; they may stutter or lose track of what they wanted to say; they may get distracted by someone walking by; they may try to mimic Donald Trump's dialect; or an anvil might fall on their head and cut short their intended utterance. The physics of falling objects presents a much simpler problem than that of predicting speech (and of course we know that, given the three body problem of gravity, we still have to settle for simplification and approximation even in physics).

Even in the abstract domain of linguistic analysis, at the pre-theoretical stage of the study of languages, we can't be sure that every observed phenomenon should be part of a single unified theory. Languages differ in the kinds of distinctions they encode. For example, Hungarian has no gender differences for third person pronouns, like English *he* vs. *she*, and French not only differentiates the pronouns like English, but also requires agreement of adjectives with these pronouns, according to an arbitrary grammatical 'gender' system. Just because there is a tradition of treating such phenomena as 'linguistic', there is no guarantee that they should be analysed in the same way as, say, negative polarity or *wh*-movement. In fact, such considerations have motivated Chomsky to distinguish what he calls the "Narrow Faculty of Language", FLN, from the "Broad Faculty of Language", FLB (e.g., Hauser et al. (2002)). People can argue about where the boundaries should fall (e.g., Pinker and Jackendoff (2005)), and they can argue about how much, say, the study of syntax bears on the study of phonology; but cutting up a pretheoretical domain like "language" into distinct subdomains as knowledge progresses is standard practice (and it may turn out that some phenomena are not amenable to scientific inquiry at all). For a parallel within cognitive science consider Pylyshyn's (2003) discussion of the many processes and systems involved in what is pretheoretically called "seeing":

> To use the term 'vision' to include all the organism's intellectual activity that originates with information at the eye and culminates in beliefs about the world, or even actions is not very useful, since it runs together a lot of different processes. The same tack was adopted by Chomsky, who uses the term "language" or "language capacity" to refer to that function that is unique to linguistic processing, even though understanding natural language utterances clearly involves most of our intellectual faculties.

The detection of edges and textures and colors involves different processes from the inference that three distinguishable regions in a visual display correspond to just two objects, with one object partially occluding a portion of another. These are just some of the processes involved in what we call 'seeing' in everyday language.

[10]For a disparaging use of the term 'armchair linguistics' see Ibbotson and Tomasello (2016), and for a response see this entry on the knitting and sewing

support this view of armchair linguistics by presenting a number of Empirical Argumentation Devices which only make sense in the context of UG, and which are foundational tools of the trade for theoretical linguists, even when they are not named or recognized as such—well-trained students learn to use them implicitly.

It is curious that whole careers are launched to explore how language is used, how language is acquired, and how language is instantiated in the brain, with minimal concern for what language *is*. Armchair linguists have discovered that they can get insight and make predictions if they analyze languages in terms of patterns and elements that at some level of analysis can be described as, for example, unaccusative verbs, applicative constructions, negative polarity items, vowel harmony, reduplication, and so on. For linguists, these notions constitute what language is (at some, non-final level of abstraction), and knowing what language is is a challenge that is logically prior to the challenges of finding out about the neurological implementation of language or how language learning works. If learnability theorists and neuroscientists are not talking about the acquisition or neural instantiation of things like vowel harmony or negative polarity items or ergative-absolutive case marking systems, then as far as armchair linguists are concerned, they are not talking about language.

It is important to keep in mind that scorn for armchair linguistics can only backfire for lab linguists. It would be bad news for anyone doing corpus studies of language, statistical analysis, or experimental work, if the categories and concepts of armchair linguistics are not well-grounded, because then all that lab work will also be built on a shaky foundation. The experimentalist, the corpus linguist and the statistician need the armchair linguist to tell them what to count and measure. In fact, "[t]here is a long history of laboratory-based work that investigates foundational constructs of generative grammar" (Phillips and Lasnik, 2003), and the quality of this work reflects a deep understanding of theory.

4.1 Empirical science can be wrong

Of course, none of the above implies that armchair linguists are guaranteed to be correct in their analyses. The issue under discussion is whether they

blog of Allison Cameron, a former undergraduate student of mine: http://woolandpotato.com/2016/10/05/scientific-american-says-universal-grammar-is-dead-a-response/.

are acting like (other) scientists. It is evident that most theoretical linguists *think* they are engaging in empirical science. This commitment to science is embodied by Chomsky's work arguing that it is appropriate to study linguistics using the tools and methods of the natural sciences, because language, properly conceived of as I-language, is a natural object, and not an artefact or the result of convention (but see Koster (2006, 2009) for a rare, explicitly contrary view from a syntactician, and see Balari and Boeck (2012) for a rejoinder). Chomsky points out that the dismissal of linguistics as a natural science by many philosophers and others is based on no arguments whatsoever, just an implicit methodological dualism (Chomsky, 2000b, p.76), a prejudice against the application of scientific methods to properties of the human mind. Note that at issue here is not how good current scientific theories of language happen to be, but rather whether or not they should even be pursued (see Chomsky 2000a,b; Reiss and Volenec 2021; Isac and Reiss 2013) .

It should be clear that the degree to which a particular theory turns out to be better than another is irrelevant to the status of the theory's adherents as empirical scientists. If quantum loop theory turns out to be better than string theory, nobody would say that the string theorists haven't been doing science. Similarly, if Lexical Functional Grammar turns out to be better than Minimalism, we shouldn't therefore say that the Minimalists haven't been doing science. Linguistics is an empirical science because it adopts scientific methodologies, regardless of whether or not the existence of binary Merge turns out to be an illusion, just as nineteenth century physicists who believed in the existence of the ether as the medium of electromagnetic waves were physicists, despite being wrong about the ether.[11]

4.2 Empiricist vs. empirical

Before delving into a sampling of the kinds of empirical work that can be done from the armchair, I offer one further justification for undertaking this demonstration. Robert Hammarberg, one of only two rationalist, Chomskyan phoneticians I know of,[12] had a pretty sanguine view of the future when he pointed out that that "Chomskian linguistics is explicitly anti-empiricist, and

[11]It is impossible to resist mentioning here the 'discovery' of N-rays by French physicist Prosper-René Blondlot in 1903 (Nye, 1980; Rostand, 1960). When it turned out that N-rays did not exist, nobody claimed that Blondlot was not a physicist.

[12]The other is my former Concordia colleague, Veno Volenec.

all indications are that current philosophy of science is moving toward a rejection of the empiricist programme" (1976, p. 354). However, there seems to be a recurring confusion between Chomsky's clear anti-empiricism—his identification of his work with the rationalist, Cartesian tradition (Chomsky e.g., 1966), and an ungrounded notion that Chomsky rejects the idea that linguistics can be an empirical science.[13] For example, the former Director of Research at Google, Peter Norvig (2011) says that "one more reason why Chomsky dislikes statistical models is that they tend to make linguistics an empirical science." Similarly, Ibbotson and Tomasello (2016) claim that "evidence has overtaken Chomsky's theory, which has been inching toward a slow death for years." Such comments not only ignore the massive literature of sophisticated analyses of many, many languages produced by generative linguists, not least by Chomsky himself, but also they ignore Chomsky's explicit endorsement of applying the methods of the natural sciences in linguistics, as in papers like "Language as a natural object" (Chomsky, 2000a).

The discussion in the next subsection serves the dual purpose of illustrating how UG serves as a postulate allowing empirical work to proceed and also the back and forth process of using empirical work to elaborate and fine-tune the contents of UG-theory as research proceeds, a process already described in 1957, in *The Logical Structure of Linguistic Theory*, but published much later (Chomsky, 1985).

> In constructing particular grammars, the linguist leans heavily on a preconception of linguistic structure, and any general characterization of linguistic structure must show itself adequate to the description of each natural language. The circularity is not vicious, however. The fact is simply that linguistic theory has two interdependent aspects. At any given point in its development, we can present a noncircular account, giving the general theory as an abstract formal system, and showing how each grammar is a particular example of it. Change can come in two ways—either by refining the formalism and finding new and deeper underpinnings for the general theory, or by finding out new facts about

[13]The importance of this distinction is pointed out in fn. 6 of Katz and Bever (1976): "'Empiricism' is also to be distinguished from 'empirical'. A theory is empirical if it is about the empirical world, and as such confirmable or disconfirmable on the basis of observation and experimentation. Chomsky's rationalism is every bit as empirical as Bloomfield's empiricism."

languages and simpler ways of describing them.

I now turn to identification of some of the Empirical Argumentation Devices that are used in these interdependent aspects of linguistic theory.

4.3 Empirical argumentation devices

I have chosen linguistic phenomena from several domains to illustrate Empirical Argumentation Devices. These represent phenomena from various linguistic domains at varying distances from my own areas of expertise and I make no claim of originality for the discussions. Each example is presented in a simplified form, where subtlety, responsible citation, and occasionally full accuracy have been sacrificed for the sake of exposition of the kinds of reasoning linguists use. Given the intended audience of this volume, I hope that the benefits of my informal presentation outweigh any scholarly sins I may have committed. Any non-linguist who is intrigued by my examples is encouraged to turn to the research literature and experts in various branches of theoretical linguistics for a more nuanced view.

4.3.1 EAD 1: Newton's Move

The first EAD has been introduced already. The postulate of UG, and Newton's postulate, are probably paralleled implicitly by work in all scientific domains. One needs to decide in advance—of course, subject to revision—what kinds of observations count as data.[14]

[14]In order to avoid a long discussion of this point, I revert to an argument from authority. Heisenberg reports Einstein to have said "But you don't seriously believe that none but observable magnitudes must go into a physical theory? ... Possibly I did use this kind of reasoning [for Relativity Theory] but it is nonsense all the same... In reality the very opposite happens. It is the theory which decides what we can observe."

Closer to home for linguists, in a passage cited in part above, Hammarberg (1976) says that

> Chomskian linguistics is explicitly anti-empiricist, and all indications are that current philosophy of science is moving toward a rejection of the empiricist programme (Fodor, 1968, pp. xiv *ff*). A key feature of the new programme is exactly a reevaluation of the concept of observation. Observations are now held to be judgments, and these judgments are made in terms of the criteria provided by the paradigm. Thus the taxonomy of a discipline is to be regarded as imposed from above, rather than emerging from below, i.e., rather than emerging in the form of brute facts before the unprejudiced eyes

A particularly clear indication from Chomsky that this is the role of UG in linguistics comes from *Knowledge of Language* (1986, p. 38):

> Because evidence from Japanese can evidently bear on the correctness of a theory of S_0 [the initial state of the language faculty–cr], it can have indirect—but very powerful—bearing on the choice of the grammar that attempts to characterize the I-language attained by a speaker of English.

In other words, it is by *postulating* UG that linguists can treat Japanese and English data as relevant to each other, just as apple and planet data are relevant to each other for Newton. Chomsky's statement demonstrates, contrary to prejudices both inside and outside linguistics, that generative linguistics is clearly an empirical science—in fact, the postulate of UG expands the empirical base for an analysis of English to include data from all human languages. So Chomsky recognizes a massively larger empirical base for each language than anyone who denies UG—without UG, each data point is actually only relevant to a single language. Of course, no linguist works in this way, despite their anti-UG protestations.

Here's how linguists use the reasoning alluded to in the quotation above. Suppose that Linguist Rim has constructed a grammar for the English-type I-language of a speaker Kyle. In constructing this grammar, $G_{R/Eng}$, Rim has made use of a set of categories and operations that constitute the contents of her UG-theory, UGt_R, which she posits is a model of UG-object, a component of Kyle's mind, and that of every other human. So, UGt_R is the theory of UG-object according to Rim. Now suppose that Linguist Sarah constructs an alternative grammar for Kyle's I-language, $G_{S/Eng}$. (We'll assume that the two grammars are not just notational variants.) Just like Rim's, Sarah's grammar makes use of a set of categories and operations that constitute the contents of *her* UG-theory, UGt_S, the theory of UG-object according to Sarah.

Suppose further that the two grammars for Kyle's I-language are extensionally equivalent: every string that Rim predicts is grammatical for Kyle is predicted to be grammatical by Sarah, too. And every string that Rim

---

> or ears of the researcher. The relevance of this to the study of phonetics and phonology should be obvious: the concept of the segment, which is indispensable to phonetics and phonology, is a creature of the paradigm, not of the raw data. [Hammarberg 1976, p. 354]

predicts to be ungrammatical for Kyle is predicted to be ungrammatical by Sarah. Because linguists believe that I-languages, mental grammars, are real things in the world, it is impossible that both $G_{R/Eng}$ and $G_{S/Eng}$ are the correct grammar (model) of Kyle's I-language (but let's suppose that one of them is).

Now, suppose that Rim and Sarah next try to model Hisako's Japanese-type I-language by constructing grammars $G_{R/Jap}$ and $G_{S/Jap}$ (Rim's grammar of Japanese and Sarah's grammar of Japanese, respectively.) These grammars will have to be built from the components provided by UGt_R and UGt_S, respectively—that's what it means for them to each have a UG-theory.

Finally, suppose that Sarah's grammar is a good model of Hisako's mental grammar, but Rim's is not. In other words, Sarah's UGt_S allows her to model both English and Japanese, whereas Rim's UGt_R only allows her to model English. We can conclude that Sarah's model of English was the correct one (remember, we are supposing that one of them is correct), and that Rim's was incorrect. We further can conclude that Sarah's UGt_S is a better model of UG-object than Rim's—note that there is, of course, only one true UG-object, but that every theoretician may have their own UG-theory. Without the postulate of UG, there is no reason to think that data from Japanese should be any more relevant to the choice of which English grammar is correct than data concerning bird migration or soap bubbles.

4.3.2 EAD 2: Recurrent categories

This EAD is really an elaboration and exemplification of the previous one. If languages are not assumed to be manifestations of a single language faculty or Universal Grammar, then we might expect the analysis of each language to force us to start *ex nihilo*, with no preconceptions about what we might find grammaticalized (cf. Haspelmath, this volume). Well, perhaps that is a bit strong—we might expect to find the recurrence of concepts and categories that belong to general human cognition.

While it is impossible to quantify such observations, it appears to be the case that, in fact, there are a number of characteristics of languages that (a) recur over and over in pretty much every language we study, and (b) serve no conceivable role in the service of language for communication, that is, they do not contribute to meaning.

One of the most intriguing examples of such a recurrent category is the *negative polarity items* (NPIs) represented by English words like *any, any-*

thing and *ever*, as well as idioms like *a red cent* and *lift a finger*. We'll consider complexities below, but for now, let's say that these items occur in syntactic positions that are in the scope of a *downward entailing operator* (DEO), including negation. Consider these examples:

(1) Negative polarity items

a. John didn't eat any cookies.

b. John didn't eat any chocolate cookies.

c. John didn't eat any baked goods.

d. *John ate any cookies.

The string in (1a) is grammatical, and, furthermore, we know that the truth of the proposition expressed by (a) entails the truth of the proposition expressed by (b), because "chocolate cookies" is more specific than "cookies", or equivalently, the set of chocolate cookies is a subset of the set of cookies. Any statement that is true of (all) cookies is true of chocolate cookies. In contrast, John may have eaten pie, so (a) might be true while (c) is false. Here we see that "baked goods" is less specific than "cookies". In (d), without negation, the string is illformed—it appears that *any* can't appear without negation.

If we remove negation, the entailments reverse, and the strings cannot contain NPIs as they did above:

(2) a. John ate (*any) chocolate cookies.

b. John ate (*any) cookies.

c. John ate (*any) baked goods.

If we know that John ate chocolate cookies, then we know that he ate cookies, and we also know that he ate baked goods. This is upward entailment, from more specific to more general.

Note that negative polarity items like *any* do not fall into the parts of speech we learn in grammar school. A temporal adverb like *ever* can also be a negative polarity item:

(3) a. John hasn't ever eaten chocolate cookies.

b. *John has ever eaten cookies.

It seems that, like *any*, the word *ever* is somehow dependent on the presence of negation (or some other DEO).

The same is true for the idiomatic NPIs: *He wouldn't lift a finger to help his own mother* is grammatical, whereas **He would lift a finger to help his own mother* can only be interpreted as a nerdy sarcastic joke of some kind, because it is not grammatical if the string *lift a finger* is supposed to correspond to the idiomatic expression.

There are many other DEOs, the elements that allow the occurrence of NPIs, beyond the example of negation given thus far. For example, in English, *hardly, without, never, few* and *before* are DEOs but *often, with, always, many* and *after* are not, as illustrated in (4).

(4) Some more downward entailing operators

Non-DEO w/ *Any	DEO w/Any
John **often** wears ***any** socks	John **hardly** wears **any** socks
John left **with** ***any** socks	John left **without any** socks
John **always** wears ***any** socks	John **never** wears **any** socks
Many cats saw ***any** dog	**Few** cats saw **any** dog
After you eat ***anything**, call me	**Before** you eat **anything**, call me

Here's an amazing fact about the DEOs, the elements that allow *any* and other NPIs to appear: they obey de Morgan's Law of logic that governs the combinations of *and* and *or* with negations like *not*. For example, note that the members of these sentence pairs have the same meanings:

(5) De Morgan's Law and NPIs

a. John doesn't drink (any) beer or (any) wine.

NOT**(p** OR **q)**

b. John doesn't drink (any) beer and he doesn't drink (any) wine.

NOT**(p)** AND NOT**(q)**

c. John hardly drinks (any) beer or (any) wine.

HARDLY**(p** OR **q)**

d. John hardly drinks (any) beer and he hardly drinks (any) wine.

HARDLY**(p)** AND HARDLY**(q)**

Note that *John often drinks beer or wine* does not entail that *John often drinks beer and he often drinks wine—often* is not a DEO.

NPIs and DEOs occur in all languages and it appears that children must have access to de Morgan's Law in order to know the distribution of NPIs.[15] In my opinion, these facts are enough justification for linguists to shout from the mountaintops about innate knowledge and UG, but there is more.

Not only overt DEOs like *not, never* and *before* license the appearance of NPIs, but also polarity (YES-NO) questions and conditionals:

(6) Have you eaten any cookies today?

(7) If Sue has eaten any cookies today, John will kiss me.

Without giving a formal analysis, note that if the answer to (6) is *no*, then the answer is also necessarily *no* to the question *Have you eaten any chocolate cookies today?*, but not to *Have you eaten any baked goods today?*. Similarly, if it is the case that John will kiss me in accordance with (7), then he will kiss me regardless of whether the cookies happened to have been chocolate ones or peanut butter ones. But I am not guaranteed a kiss if Sue ate a babka instead of cookies. These facts hold for every single language ever studied. The recurrence of these patterns in every single language is a breathtaking discovery about the structure of the human mind. This knowledge gives us great predictive power, and it is hard to imagine treating it as anything but an empirical result. NPIs and DEOs are basic building blocks of language—they are part of Universal Grammar. However, no computer language has any analogue to NPIs. If anyone wants to do a corpus study of NPIs, it will rely on the armchair work that has identified the category in the first place.

4.3.3 EAD 3: French data is English data is Japanese data

Of course the facts of language are not always apparent from superficial observation. Many English sentence appear to contradict the generalizations just made about NPIs. Consider the following:

(8) He'll eat anything!

(9) He'll eat anything whatsover!

[15]The most important reference on NPIs is probably Ladusaw (1979). Another important thesis is Gajewski (2005). Gualmini (2014) reports on experimental work with children related to entailment relations. Later papers by these three authors and many others are relevant to this broad topic.

(10) He'd kiss anyone who would have him.

These examples of *any* illustrate so-called 'free choice *any*'. Linguists are willing to claim that these example of *any* actually represent a homophone of the earlier cases. Now this seems like an attempt to 'save the phenomenon', since these sentences show *any* without negation or any other DEO. However, we have a nice argument. If we translate these two English sentences into French, the results are interesting:

(11) John didn't eat anything.

- John n'a rien mangé

(12) John eats anything!

- John mange n'importe quoi!

It looks like French distinguishes the two hypothesized versions of English *anything*. Since French makes a distinction, it is clear that it is a real distinction that languages *can* make. And since we know that languages have homophones, it becomes plausible that English actually has two forms pronounced *any*.[16]

But think of what we have done: we have assumed that the analysis of French can tell us about the analysis of English. What licenses this reasoning? Only the belief in Universal Grammar allows us to construct this kind of argument. It turns out that every linguist makes such arguments implicitly, all the time, yet some of them deny a belief in Universal Grammar.

What we have just seen is an illustration of the Japanese-English discussion above, based on homophony in one language. In this example we appealed to French, rather than Japanese, to determine the correct analysis of English. Looking at *French*, we could see that it was justified to treat the *English* NPI *any* and the *English* free-choice item *any* as two different words.

[16]This discussion masks many complexities, including the existence of phenomena such as negative concord and negative quantifiers, dialect variation in French including a mismatch between standard written French and spoken varieties, but the form of the argument given here is common—evidence that language A makes a distinction that language B does not make overtly can be used to argue that an apparent inconsistency in the analysis of B is in fact not problematic. This relates to a larger (but underappreciated) point that only makes sense in the context of the postulate of UG: Linguists should not aim for parochial elegance or economy of analysis for each language, but rather elegance and economy for their UG-theory.

This is just a reiteration of our point that UG is a necessary postulate: by assuming UG (just as Newton assumed universal gravitation), Chomsky has made it clear that the empirical data relevant to the study of English-type grammars includes facts from French. Our armchair linguistics turns out to be *hyper-empirical*, as we assume that observations from any language potentially bear on the analysis of every language.

Szabolcsi (2023 Submitted) discusses this EAD quite explicitly:

> . . . I will look at a small selection of cases where, I believe, cross-linguistic insights have been important to big questions in the theory of semantics and the syntax/semantics interface, irrespective of whether the consumers and beneficiaries of the insights had an interest in the specific languages that the insights were based on, per se.
>
> . . .
>
> [S]ometimes the clues that English offers are so subtle that they do not easily catch the theoretician's fancy. Finding that other languages make the same thing glaringly visible may reveal that it is a big deal. In such cases, the cross-linguistic insight prompts us to ask theoretical questions that might remain unasked otherwise. Second, sometimes just one or two languages already reveal that what we have on our hands is a big deal, but what a good analysis of it should be remains elusive. Larger-scale semantic typologies that rely on targeted and fine-grained investigations have been able to bring us much closer to solving such theoretical puzzles.

One of Szabolcsi's examples is quite simple:

> predicate logic clearly points to the operations shared by *every, each, all, both, and, too, also* (i.e. conjunction) on the one hand and by *some, or, either*, and interrogatives (i.e. disjunction) on the other. But the motley crews of distinct items in English do not force one to find these underlying operations in the compositional semantics and investigate their semantic and morpho-syntactic status. By contrast, the systematic presence of a specific particle in the first set across many languages (e.g., Japanese *mo*) and another in the second set (e.g., Japanese *ka*) prods us to ask these questions.

The Japanese *mo* vs. *ka* marking provides independent *empirical* evidence that the grouping of the English words was on the right track, that it was carving nature at her proverbial joints. Without UG, the correlation would be a bizarre coincidence.

Of course, everybody already knew this... at least implicitly. This is why analysis of new languages never starts from scratch. Furthermore, if we do decide that we need a new category to analyze a newly attested language, we immediately expect to find that category instantiated in other languages. We assume there are words, and nouns, and NPIs, and so on, in each language we come across.

4.3.4 EAD 4: Combinatorics

If we accept simple mathematical results (like $2 + 17 = 19$) as facts, then simple combinatoric calculations can be offered as empirical evidence that a fairly simple symbol system is rich enough to model the "welter of descriptive complexity" manifested by the languages of the world. Linguists have discovered that speech sounds are not treated as atomic units, but are rather composed of smaller elements called distinctive features. In one of the most common versions of distinctive feature theory, segments like the fricatives /s/ and /z/ are sets of valued features. These two segments correspond to sets that are identical, except that /s/ contains a valued feature −VOICE (corresponding in a complex and indirect way to the fact that it involves no vocal fold vibration) and /z/ contains a valued feature +VOICE. A third possibility is a segment /S/ that contains no valued feature for VOICE—I'll allow this possibility here, but I won't justify this decision.

Now, suppose that there are twenty such features provided by Universal Grammar for the encoding of speech segments with phonetic correlates such as rounding vs. spreading of the lips, lowering vs. raising of the tongue, raising or lowering the velum to control airflow through the nasal passage, and so on. Since each feature can be absent from a segment or else take the value '+' or '−', this means that there are 3^{20} possible speech segments, intensionally defined by UG, about 3.5 billion. So, a UG with just twenty-two basic symbols for defining speech segments (twenty features and the two values, '+' and '−') allows for languages to contain any subset of those 3.5 billion segments. English-type grammars have maybe a few dozen of these segments, including /i/, /θ/, and /ŋ/; Hawaiian-type grammars have about eleven distinct segments; and Northern Ndebele has fifteen clicks, along

with many other segments. So, treating a language as just an inventory of segments, how many languages does our modest UG define intensionally? The set of languages is just the power set, the set of all subsets, of the set of segments. For each language, we need to specify whether or not it contains a given segment in its inventory. Since there are 3.5 billion $= 3.5 \times 10^9$ segments, there are $2^{3.5\times10^9}$ languages (segment inventories) intensionally defined by our UG. This is comfortably above what Gallistel and King call "essentially infinite", meaning greater than the number of particles in the universe, which is estimated to be about 2^{285}. And now imagine what the number of languages would be if all the other postulated elements of UG (morphosyntactic as well as phonological) were included. Languages contain ordered phonological rules and for a given set of n rules, there are $n!$ orderings (n choices for the first rule, $n-1$ for the second, *etc.*). So for a set of just ten rules, there are $10! = 3,628,800$ orderings. But this is just the number for a fixed set of rules. For a language with, say, twenty segments, there are about 176,000 rules of the form 'a $\rightarrow$ b / c __ d'. There are about 7.5×10^{45} distinct sets of ten rules available from a set of 176,000 rules ("176,000 choose 10"). Each such set of 10 can be ordered in 3,628,800 ways. And we haven't even left phonology yet. Some languages place adjectives after the noun they modify and some before, so that doubles whatever meta-astronomical number we have already arrived at. And so on.

Such combinatoric facts do not prove the existence of UG, and they certainly do not prove the existence of specific content in UG—we surely do not know exactly what the innate set of features is—but the numbers do provide a plausibility argument. It may be possible to "to abstract from the welter of descriptive complexity certain general principles [and basic units] governing computation that would allow the rules of a particular language to be given in very simple forms" (Chomsky, 2000a, 122). The combinatorics also support the idea of a UG encoded in the genome and instantiated in the brain, since the "less attributed to genetic information ... the more feasible the study of its evolution" (Chomsky, 2007) and its neural implementation.

Combinatorics of a small inventory of basic elements and operations is exactly what Gallistel and King (2009) propose as a desirable model for cognition of all kinds, from insect navigation to human language:

> What is needed is an architecture that combats combinatoric explosions with combinatorics. The key to that architecture is a read/write memory. It must be possible to store sequences

> that actually occur in a memory capable of storing a great many [...] sequences, drawn from the essentially infinite number of possible such sequences, and to compare those stored sequences to whatever sequences may prove to be relevant. This architecture uses memory and combinatorics to cope with the finitude of the actual.

This discussion of combinatoric explosion is applicable to the richness of Gallistel and King's example of possible stored sequences—consider that the twenty-six letters of the alphabet allows for 26^5 (about 12 million) possible five-letter strings, and we can apply the same reasoning to strings of speech segments. However, combinatoric explosion also applies to the size of the intensionally defined segment inventory and the number of possible languages, discussed above. So we have three 'levels' of combinatoric explosion arising from a UG containing a modest twenty-two symbols.

4.3.5 EAD 5: Minimal computational complexity

A child does not know in advance which language they are going to be learning, so they have to be equipped to learn any language. When Chomsky (1957) showed that finite state models are insufficiently powerful to generate English-type grammars, he was able to conclude that finite state models are thus insufficiently powerful to model Language—what he would now call the Human Faculty of Language.[17] Critics of UG, whether within or outside

[17]A reader suggests that I am exaggerating here the empirical nature of Chomsky's claim, and that I should temper it by recognizing the implicit assumption that there is no bound on the distance between dependent elements:

> Chomsky's strictly a priori argument is that *if* human languages allow for phenomena like arbitrarily distant, but dependent, expressions (*if* ... *then*), then they are not expressible with finite state models.
>
> That languages do work in this way is not exactly an observation. All we observe are finite instances of displacement. It is a theoretical inference that arbitrarily large displacement is a trait of English.

I think this is literally correct, but in fact irrelevant because a parallel complaint could be made about pretty much any empirical claim. Chomsky observes long distance dependencies of various types in English sentences, and there is no evidence to suggest that there are any constraints on the distance over which these dependencies hold, in terms of a number of words. Rather than taking it as a "theoretical inference" that English allows arbitrarily large displacement, it is best seen as due respect for Ockham's Razor and gen-

the linguistics academic community complain that we shouldn't make claims about UG until we have looked at many more languages (but they don't ever specify how many would suffice). However, the brilliance of Chomsky's argument is that it shows how one *can* make empirical discoveries without leaving the armchair. No matter how many remote villages one visits to document new, exotic languages, there is absolutely no data that can undermine the empirical result based on English alone. The Human Language Faculty must have access to something more powerful than a finite state machine, just in case a learner happens to be born in Cinncinati.

We can apply Chomsky's armchair methodology over and over again. For example, the Warlpiri language of Australia makes the plural of nouns via full reduplication, so *kurdu* 'child' is pluralized as *kurdukurdu*, and *mardukuja* 'woman' is pluralized as *mardukujamardukuja*. What is the sound of the plural marker? Well, unlike, say the [z] of *dogs*, there is no fixed sound of the plural in Warlpiri. It is better described as a *variable* x that is assigned a pronunciation identical to that of the noun it combines with. So x is assigned the phonological value [kurdu] when attached to the noun *kurdu*, and it is assigned the phonological value [mardukuja] when attached to the noun *mardukuja*. Since children don't know in advance whether they will be learning English or Warlpiri, UG has to provide them with access to such variables, as well as a mechanism for concatenating the variable with the element that assigns it a value. The fact that English and Finnish lack reduplication cannot bear on the discovery that variables that can be assigned a phonological value and concatenation must be provided by the UG toolkit.

In my own work (Reiss, 2003), I have suggested that some phonological rules require the power of existential quantification to express non-identity between segments—there needs to be a way to say that there exists a feature with respect to which the two segments have different values. If my claim is correct, then I am necessarily attributing the power of quantificational logic to the human phonological faculty, thus available to *all* languages, since, as Jerry Fodor pointed out on many occasions, "it is never possible to learn a richer logic on the basis of a weaker logic" (1980, p. 148), that is, no system can learn a logic more powerful than the ones it already has available.

eral elegance. Positing, in spite of a lack of evidence, that there is a limit on the length of long-distance dependencies is as wrong as positing that prime numbers play a role in syntactic computation, or that water has consisted of H_20, only since we began analyzing it, and that it might consist of something else starting next week. The critique is logically valid, but useless, since this is as good as it gets in empirical science.

4.3.6 EAD 6: Detection of non-superficial patterns

The discovery of recurrent, potentially universal patterns of linguistic data often relies on the capacity to see beyond superficial distinctions. This is not the place to provide an overview of all the impressive discoveries in morphosyntax of recent decades, but some brief examples will provide a sense of how non-trivial the empirical facts can be, and how the assumption of UG allows linguists to treat superficially distinct phenomena in a unified fashion.

Consider first, so-called ergative-absolutive case marking. In the familiar English or Latin nominative-accusative system, the single argument of an intransitive verb like *sleep* takes the nominative case, just like the subject of a transitive verb like *kick*:

(13) Nominative-accusative case pattern of English

a. *I* am sleeping

b. *I* am kicking him

c. He is kicking *me*

The form *I* is called 'nominative' and the form *me* is called 'accusative'.

In an ergative-absolutive system, in contrast, the single argument of an intransitive verb takes the same case form ('absolutive') as the *object* of a transitive verb. Here's a toy example that we'll call Penglish:

(14) Ergative-absolutive case pattern of Penglish

a. *Me* am sleeping

b. *I* am kicking him

c. He is kicking *me*

The form *I* in this language, used only for transitive subjects, would be called 'ergative', and the form *me* used for objects and intransitive subjects would be called 'absolutive'. Now, many, many languages follow the Penglish pattern, however, some languages don't show any changes in the forms of pronouns at all—they have no overt case marking. Nevertheless, we do get patterns like the following:

(15) Crypto ergative-absolutive patterns

i. In Samoan, a verb is marked as plural (shown by reduplication of a syllable) if it is transitive and the object is plural, or if it is intransitive and the sole argument is plural. This means that the verb is plural in sentences translated as in (bde), but singular in (ac):

   a. The boy is sitting. (The verb is *nofo*)
   b. The boys are sitting (The verb is *nonofo*)
   c. The boys catch the mouse (The verb is *pu'e*)
   d. The boys catch the mice (The verb is *pupu'e*)
   e. The boy catches the mice (The verb is *pupu'e*)

   Compare the plural subjects in (bcd). Sentence (c) has a singular verb because the object is singular. Sentence (e) has a plural verb despite the singular subject *the boy*, because the object *the mice* is plural.

ii. In Cree, the form of a verb stem is determined by the gender ('animate' vs. 'inanimate') of the object in a transitive sentence, and by the gender of the sole argument in an intransitive sentence.

   a. The *dog fell* (ANIMATE verb stem)
   b. The **rock fell** (INANIMATE verb stem)
   c. The girl *saw the dog* (ANIMATE verb stem)
   d. The girl **saw the rock** (INANIMATE verb stem)

   I've used italics and bold to encode the gender agreement. In (a) and (b) the sole argument (what we would call subject of the intransitive) determines the shape of the verb: *fell* in (a) shows an animate verb stem because *dog* is animate; *fell* in (b) shows an inanimate verb stem because *rock* is inanimate. But in (c) and (d) it is the object that agrees with the verb stem, and the subject is irrelevant.

So, the assumption of UG allows us to look beyond the superficial forms of sentences and unite Penglish, Samoan and Cree into a single pattern in which the sole argument of an intransitive acts like a transitive object. This contrasts with English in which the sole argument of an intransitive (*I am sleeping*) acts like a transitive subject (*I am kicking him*).

I have presented this distinction in terms of a difference among languages, but this is an oversimplification. In some languages, it is apparent that there are two categories of intransitives—one that treats the sole argument like a transitive subject, and one that treats the sole argument like a transitive object. In Lakhota, a Siouxan language, the pronominal markers on verbs differ in form depending on which verb occurs. Here's another schematic example, using independent pronouns to reflect the forms of Lakhota verb markers:

(16) Fake Lakhota

a. *Me* am sleeping

b. *I* am singing

c. *I* am kicking him

d. He is kicking *me*

The sole argument of (a) is marked like the object in (d), whereas the sole argument in (b) is marked like the subject in (c). This 'split-intransitive' system seems quite exotic until we note that Italian manifests exactly the same pattern:

(17) Italian

a. *Gianni* ha mangiato la torta

Gianni has eaten the cake

b. *Gianni* ha telefonato

Gianni has called

c. È arrivato *Gianni*

Gianni has arrived

In Italian, the sole argument of the verb 'has called' in (b) occurs *before* the verb, just like the subject of 'has eaten' in (a). In contrast, the sole argument in (c) occurs *after* the verb 'has arrived', just like the object 'the cake' in (a). (These are the default positions, when there is no special focus or contrast expressed by the sentences.) There are two kinds of intransitive verbs in Italian, just as in Lakhota! If Lakhota is exotic, so is Italian. Note also that

in addition to the position of the sole argument, these two kinds of Italian intransitives use different auxiliary verbs, *ha* vs. *è*.[18]

This discussion is meant to show that superficial diversity among languages can sometimes be analyzed, using the methods of the armchair, to detect underlying patterns that no laboratory procedure will expose. Of course, a universal account of verbs and their arguments in all languages remains a topic of research.

This kind of deep analysis is only available if we can see beyond superficial patterns and posit abstract elements and structures. But what is the ontological status of these elements and structures? Are they just elements of our theories? If there is no Faculty of Language, no UG-object, then that is the only possibility—they are just parts of our theory. But that leaves no explanation for the recurring utility of such elements and structures in language after language, and it leaves no explanation for certain apparent gaps, such as the fact that no language treats objects and transitive subjects alike, to the exclusion of intransitive subjects. I have not provided a syntactic account to unify all these phenomena, but there is a rich literature on which this brief survey is dependent.

4.3.7 EAD 7: UG as a set of building blocks

The notion of combinatorics discussed above applies not only within a narrow module of language, such as the combinations of valued features that make up segments, but also across modules. We are not surprised when we find reduplication marking a distinction in Samoan verbs, as above, or in a construction like the following in Yoruba:

(18) Yoruba NPIs:UG as a set of building blocks

I saw a N	*I didn't see a* N	gloss
ilé	ilékilé	'house'
ẹiyẹ	ẹiyẹkẹiyẹ	'bird'

In Yoruba, the phonological material of a noun N is copied, and the two copies are concatenated with an intervening [k], to produce a structure N-k-N that has the meaning 'any N'. In other words, we construct a negative

[18] Of course, my syntactician colleagues know that English also shows evidence of having the same split among intransitive verbs, but the discussion of how this "unaccusative" vs. "unergative" distinction is manifested in English would take us too far afield (cf. Perlmutter 1978; Burzio 1986).

polarity item version of each noun using reduplication. All the pieces are familiar from other languages—we have seen reduplication in Warlpiri and Samoan, and we saw English and French NPIs. Components from different modules of the language faculty—a morphological process like reduplication and a syntactico-semantic property like negative polarity participate in the desirable combinatoric explosion described by Gallistel and King (2009).

Only the assumption of UG leads us to expect such discoveries in Yoruba and recognize the building blocks. In contrast, no language derives word forms by reversing the sequence of segments in other word forms. There is no reason to believe that UG allows such an operation, despite the fact that it is trivial to state.

4.3.8 EAD 8: Identifying structures

Statistical analysis depends on the collection of data that counts tokens belonging to various categories or falling somewhere on a scale of values. However, statistics can't tell us what to count. In Natural Language Processing (NLP), a field that is often housed in computer science departments, experts typically assume that a given (text) corpus consists of (well-formed) sentences, and they might calculate the probability of a certain word occurring before or after some other word, within a given window. Note that such work takes the notion of sentence for granted, but this is not at all trivial, given the possibility for sentences to be embedded in other sentences, and the fact that standard punctuation and orthography do not necessarily reflect real linguistic properties. NLP work also assumes that it is obvious what counts as a word, and that the noun *run* is different from the verb *run*, for example, but these are real problems (Elkahky et al., 2018). So, notions like word, verb and noun, which can only be given coherent definitions as mental categories must be assumed in order to even get started doing NLP. Bromberger and Halle 2003 complain that "[i]n fact, physicalists among phoneticians", that is self-declared materialists or empiricists who deny that they need the mentalist categories of armchair linguists, "are all closet mentalists." The same conclusion holds for the neuroscientist, corpus linguist or NLP expert—to even begin their work, they rely on mentalist categories like segment, syllable, word, question, morpheme, active, passive, etc. (as discussed especially with regard to the neuroscience of language in papers such as Poeppel 2012 and Embick and Poeppel 2015).

From personal experience, I know that scholars outside of linguistics are

sometimes flabbergasted by what we accept as data, and our lack of statistical measures of confidence for, say, grammaticality judgments. There is no reason to argue about this; it is enough to consider what it would look like if armchair linguists did insist on incorporating mindless statistical analysis into their work. One could spend one's research funding asking an English-speaking subject a thousand times whether this is a well-formed question: *What did the cat eat?* Or even worse, one could ask a thousand 'English' speakers each one time if that question is well-formed.[19] There will be pretty robust statistics confirming our intuition that indeed the question is grammatical.

However, instead of doing that kind of statistical work, guaranteed to give robust results, one could build a model in which *What did the cat eat?*, *Who did Bill see?* and *Which fish did the cat eat?* are all tokens of an abstract type of sentence. Then one might go further, and show that these are also members of the same type: *What does Mary think the cat ate?* and *Who does Mary think Bill claimed Fred saw?*, and even *Who saw Bill?* and *Which cat did Mary claim saw Bill?*. The point is that a statistical analysis of, say, *wh*-questions relies on the categories discovered in the armchair. Facts about *wh*-questions are not derivable from raw data because there is no raw data about *wh*-questions. The results from the armchair, not the eye-tracker or the stats package, are pretty impressive. They include accounts of the contrast between *Who does Mary believe Bill claims to have married?* and ill-formed **Who does Mary believe Bill's claim to have married?* It also includes an account of the contrast between *What do you like bacon with?* and **What do you like bacon and?* Note that the accounts of these distinctions, developed in the armchair, turn out to not be parochial explanations of the questions that English speakers hear and say, but rather they turn out to generalize fairly well to all languages (although, many puzzles remain to be explained, as expected in a complex domain of inquiry). And of course, it is only the postulate of UG that licenses the comparison of *wh*-words of English with elements in Mandarin, Quechua, Hungarian, and Urdu with completely different phonetics.

For a non-linguist, it may come as a shock that armchair based research has even offered arguments that in a sentence like *What does Mary claim*

[19]Of course, 'English' is in scare quotes since, under the I-language perspective, there is no such entity as English or Swedish or Hindhi, there are just a bunch of individual I-languages, some of which are more alike than others.

Bill believes Fred said Sue denies Irving ate? there is evidence that the sentence initial *what*, which must be interpreted as the object of the last verb *ate*, actually 'passes through' all the intermediate clauses. That is, the sentence must be modeled as something like this: *What$_i$ does Mary claim t_i Bill believes t_i Fred said t_i Sue denies t_i Irving ate?*, where each t_i is a 'trace' of the movement of *what* from its position as object of *ate* to the front of the sentence. I won't reconstruct the argument in full here, but it consists of the application of EAD 3: there are languages in which there is an audible effect on all of the intermediate clauses in such structures (see examples in Torrego 1984, Henry 1995, Haïk 1990). In English, where there is no such overt evidence, we are licensed to assume the step-by-step movement by virtue of the postulate of UG. The simplest account of Language, consistent with the data, is of course, that all languages in fact use step-by-step movement of *wh*-elements. Ultimately, we might find in English independent evidence for such an analysis—the postulate of UG encourages us to keep looking. This is an armchair research program *par excellence*.

4.3.9 EAD 9: Learnability arguments

I have already introduced the concept of phonological features above. Suppose a language L has just the four vowels /i,e,u,o/, which for our purposes can be identified with the vowels of English *beat, bait, boot* and *boat*, respectively. The vowels /i,u/ are typically analyzed as containing the feature +HIGH, corresponding in some measure with the relatively high position of the tongue and jaw in contrast with the −HIGH /e,o/. The vowels /u,o/ are analyzed as +ROUND, correlating with rounding of the lips, whereas /i,e/ have no lip rounding, and thus are −ROUND. However, there is another feature that distinguishes these two pairs: /i,e/ are analyzed as −BACK since the highest part of the tongue in their articulation is towards the front of the mouth, whereas /u,o/ are +BACK, since the highest part of the tongue is towards the back of the mouth when these vowels are articulated. Other languages have vowels like /y/, corresponding to what is written in French as *u* and in German, Turkish and Hungarian as *ü*. This vowel demonstrates the independence of the features BACK and ROUND, because /y/ is −BACK like /i/, but +ROUND like /u/. There are many other features relevant to the characterization of vowels, but for the moment, we restrict discussion to these three.

Now, phonologists believe that the rules of a language make reference to

what are called natural classes of segments—the notion *natural class* is part of a theory of humanly possible rules. A natural class is a set of segments that can be characterized by a conjunction of valued features. So in our hypothetical language L, we can identify the natural class of vowels /i,u/, which consists of all and only the vowels that have the property +HIGH. We can also identify the natural class of vowels /e,o/ that have the property −HIGH. A natural class may contain a single member, such as the class containing just /o/, which consists of all and only the vowels containing the properties −HIGH, +BACK and +ROUND. These natural classes partially define the set of rules of a language, since a rule can only make reference to natural classes. This means that no rule can refer, for example, to /i,u,o/ but not /e/, because there is no conjunction of features shared by the first three to the exclusion of /e/.

An almost universal assumption among phonologists is that natural classes should be captured with a minimal amount of information: the more compactly the classes are defined, the more compactly the rules are defined. Such compactness is taken as an equivalent of theoretical elegance and a reflection of adherence to Occam's Razor. The problem with this view is that it fails to account for how the learner arrives at the "elegant" solution. Trouble arises when we consider the preference for minimalist specification in the context of the acquisition of the particular I-language L.

Consider a rule of L that makes reference to the natural class containing /i,e/. In the context of L, this class can be identified, as noted above, as the class of vowels containing −BACK. However, there are two alternatives that are extensionally equivalent to that analysis. We could equally characterize the class in question as the set of all and only the vowels that contain −ROUND, or as the set of all and only the vowels that contain −HIGH *and* −ROUND. Given the widespread assumption that minimalization of featural descriptions is desirable, most phonologists would favor one of the first two characterizations of the natural class, the ones that use a single feature.

However, Gorman and Reiss (2023) argue that this minimization approach suffers from two problems, once the issue is framed in terms of the process of language acquisition and learnability theory. First, as we see, there is not a unique solution that satisfies the minimization criterion, since characterization of the class consisting of /i,e/ can be done with either −BACK or −ROUND. A learning algorithm should, ideally yield a unique output grammar for a given course of experience for the learner. No proposal for choosing among competing minimal characterizations of natural classes has

been proposed in the literature, and the potential lack of a unique solution is typically ignored.

Second, Gorman and Reiss (2023) cite a demonstration by Chen and Hulden (2018) who show that, in general, the search for a minimal characterization of a natural class is computationally intractable due to combinatoric explosion. With just one feature, F, we can define three segments and three natural classes of segments. Treating segments as sets of features, we have the segments {+F}, {−F} and the underspecified { }. The natural classes that can be defined are [+F] which has the member {+F}; [−F] which has the member {−F}; and [ ] which has the members {+F}, {−F} and { }. With three features, the number of natural classes is $3^3 = 81$; with five features, the number of classes is $3^5 = 243$; and with twenty-four features, the number of natural classes is $3^{24} \approx 282$ billion. So, the search space for finding a minimal characterization of a natural class grows exponentially with the number of features that we attribute to UG. There is no solution to the problem of searching through such a space of possibilities in "polynomial time", since there is no polynomial with a fixed highest exponent that expresses the size of the search space. Adopting the *P-cognition hypothesis* (Frixione 2001; van Rooij et al. 2019; van Rooij 2008), the idea that any feasible model of knowledge acquisition must be solvable in polynomial time, Gorman and Reiss (2023) reject feature minimization in rules in favor of maximization, for which they provide a simple algorithm that is tractable and also yields a unique output. Although it has not been explicitly discussed previously in the literature, the phonology community appears to implicitly accept the P-cognition hypothesis, so Gorman and Reiss' assumptions are not radical.

Looking merely at alternative extensionally equivalent grammars, phonologists have favored minimal specification in rules. However, Gorman and Reiss (2023) are able to leverage the 'empirical' mathematical result of Chen and Hulden (2018) to choose maximal representations of natural classes as more psychologically plausible than the superficially more elegant alternatives. The approach expands the range of data beyond that of forms in a single language L, to include the facts of computational complexity theory. By taking more 'facts' into account, the maximalist solution is more empirically grounded. This EAD can be applied whenever a posited model of grammar entails a learning algorithm that is inconsistent with the P-cognition hypothesis.

4.4 And more...

Several more EADs can be added immediately to the inventory sketched above. In the interest of brevity, I just hint at them here—they will be obvious to a linguist. I called EAD 3 'French data is English data is Japanese data', and along the same lines we might propose an EAD 10, called 'English data is English data'. I have in mind work like the discovery by Liljana Progovac (Progovac, 1988, 1991, 1993) of the parallels between the analysis of negative polarity items like *any* and *ever*, and the analysis of anaphors like *herself* within a single language. We can describe the distribution of these items in English by reference to a few basic notions like locality (in terms of embedded clauses) and a purely structural relation defined on syntactic tree structures, 'c-command'. EADs 3 and 10 can combine to allow us to see, for example, that the behavior of English NPIs is basically identical to that of Icelandic anaphors (both need to be c-commanded by a particular type of thing, but locality is not important); and that Japanese NPIs act just like English anaphors such as *herself* (both need to be *locally* c-commanded by a particular type of thing). Again, results like this are very well supported empirically, and linguists should be shouting them from the mountain tops, because nobody else knows about them.

Finally, here's another EAD that is so obvious to linguists that we have a hard time even noticing that we are using it. It is just another example of basic linguistic reasoning. The trees that linguists use to represent syntactic structure express several notions, including the claim that sentences are not merely strings of words, but rather more complex structures. Sometimes we propose that a given string of words corresponds to two different sentences, two different tree structures. In some cases, the differences in tree structure are justified by appeal to meaning distinctions; in other cases, the differences are justified additionally by reference to related sentences. For example, *What did Mary hit the dog with?* can be construed as related to the sentence *Mary hit the dog with her cane* (where it is understood that the cane was used to hit the dog), but not as related to *Mary hit the dog with prize-winning parents* (where it is understood that the dog's parents have won prizes).

A third kind of argument for structure is even simpler to follow. The French string, *le marchand de draps anglais* (word-for-word, literally 'the merchant of cloth English') can either refer to a merchant who sells English cloth or an English merchant who sells cloth. In the first meaning, *English* modifies only *cloth*, and the structure can be represented thus, which

is equivalent to a particular tree structure in which ***draps anglais*** forms a constituent: [le [marchand [de [draps anglais]]]]. In this case, the *s* at the end of *draps* is pronounced as [z]. The structure associated by linguists with the other meaning, the one in which *anglais* modifies the merchant, and not the cloth, corresponds to this bracketing: [le [marchand [de draps]] anglais]. Here, there is no constituent (no matched set of brackets) containing only the words *draps* and *anglais*. Lo and behold! In this case, the *s* of *draps* is not pronounced at all.

If we replace the adjective *anglais* with, say, *français* 'French', the two structures would be pronounced identically. In other words, in *le marchand de draps français*, the string remains ambiguous to a listener as to the syntactic structure of the spoken phrase, but linguists know that if they use an adjective beginning with a vowel, like *anglais*, the hidden structural differences will be audibly marked.[20] This method of 'Unmasking hidden structure' will be EAD 11, the last we will discuss. I assume that my colleagues can expand this list without much effort.

5 Conclusion

The use of the Empirical Argumentation Devices laid out above is standard practice among working linguists, even if we do not have standard labels for these methods. I have suggested that the EADs involve observation and analysis of linguistic phenomena in the context of an assumption or postulate of Universal Grammar. Just as Newton's postulate of universal gravitation led him to find links between falling apples, tides and planetary orbits, linguists are able to see regularities across human languages by virtue of the postulate of UG. UG is thus best conceived not as a theory or a tentative hypothesis, but as a background assumption that defines an empirical domain, and takes

[20] One must resist the temptation of thinking that the grammar provides different pronunciations *in order to* distinguish the two meanings: as mentioned, no distinction is made when the adjective begins with a consonant; and the ambiguity found with, say, *français* also relies on the fact that this adjective can be used both with the singular noun *marchand* and the plural noun *draps*—other adjectives do distinguish singular and plural. Grammars do not worry about ambiguity (or anything else), and both syntactic and phonological derivations often do create new ambiguities that are not present in their input. In phonology, the creation of ambiguity is called 'neutralization' and in syntax it is called 'structural ambiguity'. Underlying homophones, like *knight* and *night*, provide yet more evidence that linguistic behavior is full of ambiguity for the listener.

on the status of the null hypothesis. It is the adoption of the UG postulate that licenses us to treat empirical data from each language as potentially bearing on the analysis of all other languages. Anyone who denies UG has no grounds for importing analytic categories from one language to the study of another. In this sense, the Chomskyan, UG-based perspective is explicitly more richly empirical than competing *theoretical* approaches.

We can also compare armchair linguistics to *lab* approaches (to use my sloppy term). A survey of recent job ads for linguistics faculty positions shows a preference for lab linguistics—corpus linguistics, statistical methods and experimental approaches are doing quite well in terms of job postings, without any requirement for a firm basis in linguistic theory. In fact, many of these jobs will be filled by candidates holding degrees in computer science, psychology or other fields. In my opinion, this is in large part due to an insecurity among many theoretical linguists—they don't view their own field as an empirical science, and they think that the experimental methods of statisticians, psychologists and neuroscientists will bring linguistics more credibility as 'real' science.

This insecurity by some theoretical linguists is mirrored by a scorn by lab linguists of armchair work. As noted above, lab linguistics is critically dependent on what arises *ex cathedra*, since the categories of language are not manifested directly in 'raw data' (Hammarberg, 1981). It is a commonplace that word boundaries, and thus words, are the *output* of speech perception and other cognitive modules, not definable by reference to acoustic signals: there are silent parts *within* words, for example inside the [sp] cluster in a word like *spot*, and there is typically no silent part *between* words in a sentence.[21] Concerning the level of the syllable, Chomsky (2015, p.126) says that "No one is so deluded as to believe that there is a mind-independent object corresponding to the internal syllable [ba], some construction from motion of molecules perhaps, which is selected when I say [ba] and when you hear it." Moving to more abstract categories like *wh*-elements and NPIs, the categories become no more concrete (physical). Lasnik et al. (2000, p. 3)

[21]I can't help mentioning that I recently pointed this out to an international group of photonics physicists and engineers while we were writing a $24 million grant application for a project that involved voice analysis. They were so amazed to learn that there is not a straightforward mapping between words and silent parts of the waveform, that they insisted that this fact be included in the submitted application. I teach this in week two of my undergraduate language and mind course by making the students attempt to find word boundaries in the waveform of a recorded sentence. (No, we didn't get the grant ☹.)

comment on the abstractness of linguistic categories at all levels:

> The list of behaviors of which knowledge of language purportedly consists has to rely on notions like "utterance" and "word." But what is a word? What is an utterance? These notions are already quite abstract. Even more abstract is the notion "sentence." Chomsky has been and continues to be criticized for positing such abstract notions as transformations and structures, but the big leap is what everyone takes for granted. It's widely assumed that the big step is going from sentence to transformation, but this in fact isn't a significant leap. The big step is going from "noise" to "word".

Nonetheless, we have seen that such abstract (mental) categories can indeed be fruitfully studied—hypotheses about them can be formulated, tested and revised and retested. The fact that the categories are abstract, that is, mental, does not mean that they are not real: "Linguistic theory is mentalistic, since it is concerned with discovering a mental reality underlying actual behavior" Chomsky (1965).

In addition to confusing anti-empiricist with anti-empirical, Peter Norvig, in the blog cited above says that

> one more reason why Chomsky dislikes statistical models is that they tend to make linguistics an empirical science (a science about how people actually use language) rather than a mathematical science (an investigation of the mathematical properties of models of formal language). Chomsky prefers the latter, as evidenced by his statement in *Aspects of the Theory of Syntax* (1965):
>
> > Linguistic theory is mentalistic, since it is concerned with discovering a mental reality underlying actual behavior. Observed use of language . . . may provide evidence . . . but surely cannot constitute the subject-matter of linguistics, if this is to be a serious discipline.
>
> I can't imagine Laplace saying that observations of the planets cannot constitute the subject-matter of orbital mechanics or Maxwell saying that observations of electrical charge cannot constitute the subject-matter of electromagnetism"

Norvig appears to object to Chomsky's term 'mentalistic', because he takes it to mean something like 'dreamt up by a flaky scholar with no connection to observation and no intention to seek confirmation'—basically something like the disparaging reading of 'armchair science' that I am attempting to dispel here. Another problem with Norvig's complaint is that, for some reason, he provides a definition of linguistics ("a science about how people actually use language") that is completely idiosyncratic and belongs to no established research community. A third problem is that Chomsky, and any other linguist who creates mathematical models of language, is only interested in the mathematical properties of those models insofar as those properties correspond to the properties of human language! That is pretty much definitional—linguists are trying to figure out the structure of human language. Someone interested in the mathematical properties of the models themselves is probably best referred to as a mathematician, or mathematical linguist (interested in mathematically defined sets of strings, not natural languages), or maybe a theoretical computer scientist. Fourth, Norvig confuses the subject matter of a science, the object of study, with the sources of evidence. Electromagnetism is not a theory of meter readings, and linguistics is not the study of observed speech, for all kinds of reasons—the competence-performance distinction, the fact that people code-switch from one language to another within an utterance, etc.

Chomsky, Laplace and Maxwell, I assume, are realists—their theories are models of the world—whereas Norvig is advocating a retreat from realism that goes further even than instrumentalism. Under his apparent view that science is about the observations scientists make, there is no place for inference or understanding. All that remains is statistical restatements of observations. Chemists have been able to produce unobserved molecules like plastics, and even unobserved elements like technetium and plutonium, precisely because they are interested in the principles of how particles combine, and not merely in what molecules and atoms they happen to have observed (Reiss, 2022). Those two particular elements were first synthesized and then found later in nature—they could only be synthesized if chemists were interested in something other than their observations.

In contrast to Norvig's *empiricist* perspective, I suggest that armchair linguistics appears to walk, quack and swim like the ducks of other *empirical* sciences, so we may as well treat it as a member of the flock.

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