CHAPTER FIVE

The Case for Linguistic Nativism

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Linguistic nativists hold that child-learners come to the language acquisition task equipped with certain domain-specific innate knowledge that enables them to succeed in this task in which they would otherwise fail. Many of these nativists further hold that this innate knowledge is in fact knowledge of certain grammatical principles true of all natural languages. These principles, the set of which they dub "universal grammar" (UG, for short), are said to constrain severely the class of possible natural languages, thereby making successful acquisition possible on the basis of the limited empirical evidence available to child-learners in the learning environment about the language to be learned.[1] In the years since the demise of behaviorism in the late 1950s and early 1960s, linguistic nativism has gradually become the received view within cognitive science on matters concerning the innate contribution of the learner to language acquisition,[2] though there continues to be significant empirical debate among nativists as to just what exactly is innate and how it is to be characterized. There also continues to be a number of linguists, philosophers, and psychologists who either reject linguistic nativism out of hand in favor of what might be described as a broadly empiricist conception of language acquisition or else argue that a compelling case has yet to be made for linguistic nativism.[3] These critics do not have anything that could be described as a reasonably well-developed alternative to the increasingly detailed models of child language acquisition presented by nativists and based on nativist principles. Rather they tend to focus critically on the arguments advanced in support of linguistic nativism, most notably on so-called poverty of the stimulus arguments (discussed below). These critics allege that for various reasons these arguments fail to establish the nativist conclusion that they are intended to establish; they argue that these arguments are formally invalid, or they fail to rise to a sufficient standard of proof, or they rest on certain dubious unstated assumptions, or they are crucially vague at critical points, or they depend on empirical premises that are either false or at least not empirical proven. So at the very least, according

to these critics, the case for linguistic nativism has yet to be made, and empiricism in these matters is still a live option.

The arguments for linguistic nativism are certainly not apodictic, but, then, virtually no arguments for any claim of any importance in empirical science ever are. Nevertheless these arguments are considerably stronger than anti-nativist critics admit. The case for linguistic nativism is compelling – enough so that researchers are certainly justified in attempting to work out the details of a nativist account of language acquisition. Of course, many such details remain to be worked out, and currently accepted hypotheses about the learning environment, learning mechanisms, and what is acquired will undoubtedly suffer the fate of most other empirical scientific hypotheses, turning out to be at best only rough approximations of the truth. But the attempt to work out a nativist account is not the fool's errand that some empiricists have attempted to make it out to be. And if bets were being taken on how the debate between nativists and anti-nativists will turn out, the smart money would be on the nativists.

In the present paper we examine the case for linguistic nativism, focusing first on the so-called "poverty of the stimulus" arguments on which linguistic nativists commonly rely. We consider the reasons that anti-nativists find these arguments unconvincing, concluding that while anti-nativists typically hold these arguments to an unreasonably high standard of proof, they are right to complain that these arguments, as they are actually presented, are often lacking in crucial empirical detail. Without such detail, these arguments are best construed, we argue, as a kind of "demonstration" argument for linguistic nativism. We conclude our examination of the case for linguistic nativism by considering a kind of argument provided by formal learning theory that is arguably more empirically robust and thus less vulnerable to anti-nativist criticisms. We begin our discussion by providing some historical background for the current debate between nativists and anti-nativists.

Some Historical Background

The current debate between linguistic nativists and their critics is hardly new. In many ways it is a rerun, if not simply a continuation, of a debate that begin in the seventeenth century, one that finds even earlier echoes in Plato's *Meno*, where Socrates undertakes to establish that an untutored slave boy has unlearned knowledge of certain necessary truths of geometry.[4] Like Plato, seventeenth-century rationalists such as Descartes and Leibniz were impressed by the fact that we seem to know a great deal that cannot possibly have been acquired only through the senses. But whereas Socrates attributed such knowledge to a dim remembrance of things learned in a previous existence, seventeenth-century rationalists attributed such unlearned knowledge to innate endowment. Learners, they argued, come to the learning task with certain innate domain-specific knowledge that enables them to learn what they do. Thus, for example, we have, rationalists argued, knowledge of God as a necessary being with all perfections, despite our never having had sensory experience of any such being; similarly, we have knowledge of an isosceles triangle as one that has two sides of (absolutely) equal length, despite our never having had sensory experience

of such a triangle, in both cases because we are innately endowed with that knowledge. Seventeenth- and eighteenth-century empiricists such as Locke, Berkeley, and Hume, for their part, argued that such knowledge could be, and in fact was, acquired on the basis of sensory experience alone, using the domain-general inductive learning mechanisms hypothesized by empiricists.

The issue separating rationalists and empiricists has never been, as some believe, that empiricists failed to credit the mind with any innate structure.[5] Empiricists clearly assumed that the hypothesized perceptual apparatus and domain-general inductive learning mechanisms were innate. But unlike rationalists, empiricists assumed that this innate structure imposed no substantive restrictions on the knowledge that could be acquired. Empiricists identified knowledge with complex ideas constructed out of sensory experience, and there were, as they saw it, no restrictions on the sorts of complex ideas that the hypothesized innate inductive mechanisms could cobble out of the deliveries of innate sensory mechanisms. Rationalist accounts, by contrast, denied that knowledge acquisition involved inductive generalization over the deliveries of the senses. They regarded knowledge acquisition as a non-inferential, brute causal process that mapped a course of sensory experience into a body of knowledge. On the rationalist account, sensory experience played a quite different role in knowledge acquisition than empiricists imagined: specific sensory experiences served to occasion specific innate knowledge that was latently present in the mind. This innate knowledge effectively constrained what one could possibly learn and thus know, for one could come to know only what was innately (and latently) present in the mind.

For all the polemics and spilling of ink that characterized the debate between seventeenth- and eighteenth-century rationalists and empiricists, the debate was ultimately inconclusive, both because the issues in dispute were not framed with sufficient precision, and because the relevant empirical evidence was not in hand. Neither party had anything like a concrete proposal for how we come to know what we know; indeed, neither party had a precise, empirically well-supported specification of what it is that is learned and hence known. As well, neither party had anything more than the glimmer of an idea of what aspects of sensory experience were relevant to the acquisition of specific sorts of knowledge. Thus, neither party was in a position to decide the crucial question of whether sensory experience in combination with inductive learning strategies was even in principle sufficient to account for the knowledge that we in fact have. But all this began to change with the advent of modern generative linguistics in the late 1950s and early 1960s. First, linguists developed a reasonably precise characterization of one particular domain of human knowledge, viz., what it is one knows when one knows a natural language. Subsequently, developmental psycholinguists working largely within the generative linguistics tradition began to develop increasingly precise characterization of the primary linguistic data available to the child-learner. Learning theorists were finally in a position to begin to address fruitfully the crucial question of whether, as empiricists claimed, domain-general learning strategies were sufficient to account for the ability of child-learners to acquire any natural language on the basis of their access of data, or whether, as rationalists (now calling themselves nativists) claimed, successful language acquisition required that child-learners come to the acquisition task equipped with certain innate domain-specific knowledge about the language they would

learn, knowledge that would effectively constrain the class of languages that they could learn (on the basis of available primary linguistic data). Much of the discussion and debate, especially within linguistics, focused on so-called poverty of the stimulus arguments, which linguistic nativists such as Chomsky argued provided compelling empirical support for their position.

Poverty of the Stimulus Arguments

Linguistic nativists rely heavily on poverty of the stimulus arguments (PoS arguments, for short) to make their case that acquisition of a natural language requires that the child-learner come to the learning task with certain innate domain-specific knowledge of language. PoS arguments take a variety of forms, but the basic idea is that you don't get rich output from impoverished input without a significant, specific contribution from the learner that makes up for the impoverished nature of the input. As applied to language acquisition, the basic idea is that if you consider both the rich complexity of the languages that learners acquire and the relatively impoverished data on the basis of which they acquire their languages, one must conclude that learners succeed in this acquisition task only because they come to the task already knowing a lot about the languages that they will eventually acquire. Here is Chomsky's well-known formulation of the argument:

> It is clear that the language each person acquires is a rich and complex construction hopelessly underdetermined by the fragmentary evidence available. . . . Nevertheless, individuals in a speech community have developed essentially the same language. This fact can be explained only on the assumption that these individuals employ highly restrictive principles that guide the construction of grammar. Furthermore, humans are, obviously, not designed to learn one human language rather than another. . . . Powerful constraints must be operative restricting the variety of languages.[6] (Chomsky, 1975, pp. 10–11)

The conclusion of the argument, it should be noticed, is *not* that knowledge of these grammatical principles is innate; rather it is that in order to come to know what they do on the basis of such impoverished data, learners must come to the learning task with certain domain-specific knowledge (specifically, of grammatical principles) – knowledge that will enable them to acquire any natural language on the basis of the relevant, impoverished data for that language. The PoS argument itself is *non*committal as to whether this knowledge that the successful learner must bring to the learning task is innate, or whether, as some (e.g., Piaget) believe, it is acquired earlier, perhaps on the basis of nonlinguistic sensory experience.

The argument for linguistic nativism therefore involves more than the direct inference from the poverty of linguistic data to the innateness of linguistic knowledge. Rather the argument involves two steps: (i) a PoS argument from the poverty of linguistic data to the conclusion that the learner must come to the learning task with certain domain-specific knowledge about what is to be learned, and (ii) a second argument, not necessarily a PoS argument, to the effect that this antecedent domain-specific knowledge could not itself be learned and must therefore be innate. And if, as Chomskyans claim, this innate knowledge takes the form of a universal grammar

(UG), i.e., a set of grammatical principles true of all possible natural languages, then there will have to be a third argument to the effect that (iii) this innate, domain-specific knowledge is properly characterized in terms of such universal principles.

Nativists, including Chomsky himself, have tended to focus almost exclusively on the first step in this argument for linguistic nativism, which establishes only that the learner must come to the learning task with certain domain-specific knowledge. They do this, not because they think that this is all there is to the argument for linguistic nativism, but rather because they think, correctly it seems, that recognizing the need for this domain-specific knowledge is the crucial step in the argument for linguistic nativism that empiricists have traditionally and stubbornly resisted. As long as empiricists remain convinced that language acquisition can be accounted for in terms of domain-general learning mechanisms, they will find any sort of nativism unmotivated. But if they can be brought to recognize the need for domain-specific knowledge, they will be forced, nativists assume, to face the question that will eventually drive them to nativism, namely, how could such knowledge possibly be acquired.[7]

Chomsky's own conclusion that the domain-specific knowledge that learners bring to the learning task is innate, i.e., that it is determined endogenously and not on the basis of sense experience, rests on the following argument from theoretical parsimony:

1. There are at present no substantive proposals as to how such domain-specific knowledge might be acquired.
2. In the absence of any such proposal, it is reasonable on grounds of theoretical parsimony to conclude that this knowledge, which is apparently species-specific, is, like other species-specific traits, innate; i.e., it is endogenously determined, since to conclude otherwise would be to presume that the development of cognitive structures is to be treated differently than the development of physical structures elsewhere in the body.
3. Hence, it is reasonable in the absence of such proposals to conclude that this domain-specific knowledge is innate.

Chomsky presents just this argument from theoretical parsimony in his reply to Piaget, who famously held that the required constraints were "constructions of sensorimotor intelligence":

> I see no basis for Piaget's conclusion. There are, to my knowledge, no substantive proposals involving "constructions of sensorimotor intelligence" that offer any hope of accounting for the phenomena of language that demand explanation. Nor is there any plausibility to the suggestion, so far as I can see. . . . The expectation that constructions of sensorimotor intelligence determine the character of a mental organ such as language seems to me hardly more plausible than a proposal that the fundamental properties of the eye or the visual cortex or the heart develop on this basis. Furthermore, when we turn to specific properties of this mental organ, we find little justification for any such belief, so far as I can see. (Chomsky, 1980b, pp. 36–7)

Other nativists have offered a different sort of argument for the claim that the domain-specific knowledge is innate.[8] This argument, which might be dubbed the

"impossibility-of-acquisition argument," runs as follows: If domain-specific knowledge of the constraints on possible natural languages is acquired, then it must be acquired on the basis of either linguistic data or nonlinguistic data. It cannot be acquired on the basis of linguistic data, since even if sufficient linguistic data were available, the learner would be able to induce the relevant constraints from this data only if he or she, acting as a "little linguist," already understood the language or languages that exhibit the constraints, which by assumption the learner does not. But the learner is not going to be able to induce the constraints in question from nonlinguistic data either, for the simple reason that these data do not exhibit these domain-specific constraints. Hence, the learner is not able to acquire knowledge of the constraints in question, and such knowledge must be innate. While this impossibility-of-acquisition argument might be described as a kind of PoS argument, inasmuch as the argument trades on the absence of relevant evidence, Chomsky's argument from theoretical parsimony clearly is not. But the crucial point remains: there is more to the argument for linguistic nativism than simply a PoS argument from impoverished linguistic data.

The Anti-Nativist Response to PoS Arguments

Over the years nativists have focused on a small number of poster examples of PoS arguments to make their case for linguistic nativism. The best known of these examples is, no doubt, Chomsky's PoS argument regarding polar (yes/no) interrogative constructions in support of the claim that child-learners come to the acquisition task knowing that grammatical rules and principles are *structure dependent* (in the sense of being defined over specific syntactic structures rather than over non-structural features such as ordinal position in the sentence).[9] Chomsky argues that in learning to form polar interrogatives, child-learners hear sentences such as (1) and (2):

1 The man is wearing a jacket.

2 Is the man wearing a jacket?

On the basis of such pairs, child-learners come to know that (2) is formed by "moving" the auxiliary "is" to the front of the sentence. But then when faced with the task of forming the polar interrogative corresponding to (3), they unerringly produce sentences such as (4), but never (5), despite the fact that they have, Chomsky claims, never heard sentences such as (4):

3 The man that is standing on the corner is wearing a jacket.

4 Is the man that is standing on the corner wearing a jacket?

5 *Is the man that standing on the corner is wearing a jacket?

Child-learners seemingly know that it is the main clause auxiliary that is to be moved, despite the fact that based solely upon the linguistic data available to them, viz., sentences such as (1) and (2), (5) is equally plausible. Chomsky concludes that the child-learner comes to the learning task knowing that grammatical rules and principles are structure dependent, so that in constructing the rule for polar interrogatives, the child-learner never entertains the possibility that the relevant rule is something like "move the first auxiliary to the front of the phrase," despite the fact that such a rule is consistent with the empirical data available to the child; instead, the child-learner presumes, correctly, that the rule is something like "move the main clause auxiliary to the front of the phrase," since this rule is consistent both with the available data and the knowledge that grammatical rules and principles are structure dependent.

Other well-known examples of PoS arguments endeavor to show: (i) that child-learners of English must come to the acquisition task knowing the structure of complex noun phrases, based upon their understanding that an anaphoric pronoun such as the English "one" can have as its referent a complex noun phrase, despite the fact that linguistic data available to the learner may include only sentences in which the anaphoric "one" takes a noun as its referent (see Hornstein and Lightfoot, 1981); and (ii) that child-learners of English come to the acquisition task knowing the possible parametric variation exhibited by natural languages (as regards binding relations, word order, null subjects, and so on) as well as the default values of each of the parameters that define a language (see, e.g., Wexler, 1991; Gibson and Wexler, 1994).

Anti-nativist critics have challenged these PoS-based arguments for linguistic nativism on a number of different (but quite predictable) grounds. Some, like Piaget, have been prepared to concede the conclusion of the PoS argument to the effect that success in these learning tasks requires that the learner come to the task with certain domain-specific knowledge of language, but they deny that this antecedent knowledge need be innate. The relevant knowledge, they argue, could have been acquired elsewhere, on the basis of nonlinguistic experience. Others concede that the PoS arguments establish that the child-learner must come to the learning task with certain innate domain-specific biases, but they deny that these biases need take the form of innate *knowledge*. Rather child-learners are said to come to the learning task furnished with certain innate learning *mechanisms*, rather than knowledge, that in some manner impose certain domain-specific learning biases.[10] Most anti-nativist critics, however, are not prepared simply to concede the conclusions of PoS arguments; they recognize the difficulty of blunting the nativist implications of these arguments once conceded. They challenge the PoS arguments themselves, arguing on one ground or another that the arguments fail to establish what they claim to establish, namely, that the child-learner comes to the learning task with certain domain-specific knowledge or biases that make language learning possible. For most anti-nativist critics, there is in fact *no* poverty of the stimulus, either because (i) the linguistic data upon which the learner acquires language is not as impoverished as nativists claim, or because (ii) the language acquired is not as complex as nativists claim, or both. Or if there is a poverty of the stimulus, it is one that (iii) a learner could remedy in ways other than by a domain-specific contribution on the part of the learner. Most critics adopt the first of these three positions, arguing that contrary to what nativists claim, the relevant evidence that would allow acquisition of the relevant knowledge is, as a

matter of empirical fact, available to the learner in the learning environment, so that at the very least nativists have not made a case for a poverty of the stimulus. Thus, for example, Cowie (1999) and Pullum and Scholz (2002) argue against the assumption, widely held by developmental psycholinguistics, that child-learners acquire language on the basis of positive evidence only, i.e., on the basis of data drawn from the language to be acquired; they argue that at the very least there is what they call "indirect" negative evidence.[11] With respect to Chomsky's PoS argument from polar interrogatives, they argue that contrary to what Chomsky claims, learners do in fact have access in the learning environment to sentences such as (4), and they present as evidence for this claim the fact that such sentences appear with some frequency in the *Wall Street Journal*. They don't actually establish the frequency with which such sentences appear in the linguistic corpus to which child-learners are exposed, much less that child-learners actually register and make use of such sentences as are available in the learning corpus.[12] It is enough to discredit the argument, they assume, simply to show that the child-learner *might* have access to the relevant data. Anti-nativists also argue against PoS arguments by challenging nativist characterizations of what is learned, arguing that PoS arguments presume defective, or at least contentious, grammatical characterizations of what's learned, so that one can have no grounds for confidence in any nativist conclusions based on them.

The aim in virtually every case is to discredit PoS arguments by challenging the nativist's characterization of input data or output knowledge. Anti-nativists rarely claim to have proven the nativist's characterizations to be false, which of course would be a decisive refutation of their arguments; rather they claim, more modestly, to have shown that nativists have failed to shoulder the burden of proof to the anti-nativist's satisfaction. For all the nativist has shown, these anti-nativists argue, the characterizations of input data and output knowledge, and hence the conclusion of the PoS arguments, *might* be false, and this bare possibility, they argue, leaves open the possibility both that nativism is false and (consequently) that some form of empiricism is true.

Anti-nativists critics often write as if they imagine that PoS-based arguments are intended to convert the committed anti-nativist. This is simply not the case. It would be a fool's errand to undertake to convert anyone who holds PoS arguments to the unreasonable standard of having conclusions that are not possibly false, for no empirical argument can meet that standard. But even if PoS arguments are evaluated under some more reasonable standard of acceptability, anti-nativists will probably remain unconvinced, and for basically two reasons. First, as presented these arguments typically do not provide adequate empirical evidence in support of the crucial premises about what is acquired and the linguistic evidence on the basis of which it is acquired, thus permitting anti-nativists to question the truth of the premises. Second, in themselves these arguments provide no reason to suppose that their conclusions are empirically robust, in the sense of continuing to hold under "perturbtions," i.e., different reformulations, of the premises that reflect the our uncertainty about the relevant empirical facts. Put another way, given our uncertainty about the relevant empirical facts, anti-nativists question whether we can have any confidence in an argument based on any particular specification of these admittedly uncertain facts.

This lack of detailed accompanying empirical support for the premises, coupled with the lack of demonstrated empirical robustness of the conclusions, makes it difficult

to regard these arguments, at least as they have been presented, as anything more than demonstration arguments, i.e., arguments that are intended to demonstrate the sort of reasoning that leads linguistic nativists to their view. Given the obvious theoretical and empirical complexity of the acquisition problem, specifically, the difficulty of specifying (i) what precisely is acquired in acquiring a language, (ii) the data on the basis of which whatever is acquired is acquired, and (iii) the cognitive processes, including any innate biases, that effect the acquisition – such arguments alone *cannot* make a compelling case for linguistic nativism. Indeed, they cannot make a compelling case even for the crucial claim that learners come to the learning task with certain domain-specific knowledge that makes successful acquisition possible. Nothing less than the following two theoretical developments would turn the trick: (i) a theoretically well-developed, empirically well-supported nativist account, i.e., one that makes essential use of nativist assumptions, of how child-learners acquire the languages that they do on the basis of their access to linguistic data, and (ii) the concomitant failure of empiricist efforts to develop a similarly theoretically well-developed, empirically well-supported account which does *not* make essential use of nativist assumptions.[13]

Although there has been considerable progress over the last 25 years in the development of nativist computational accounts of natural language acquisition, at present neither nativists nor empiricists have accounts that are sufficiently well developed theoretically and well supported empirically to bring final closure to the dispute over linguistic nativism. There has been a great deal of empirical work within generative linguistics to specify in precise terms what it is that a child-learner acquires when he or she acquires a natural language, and these specifications have become increasingly sensitive over the years to the obvious requirement that whatever is acquired must be the sort of thing that *provably* can be acquired on the basis of the child-learner's given access to data in the learning environment. There has also been considerable empirical work within developmental linguistics to specify precisely what data is available to learners regarding the specific linguistic constructions that they master. There has, at the same time, been a growing body of research in "formal learning theory" (discussed below) that attempts to integrate these specifications of what is learned and the data on the basis of which it is learned into a computationally explicit account of the cognitive processes that map the latter into the former.[14] It is not possible to survey this work here, but suffice it to say that nativist assumptions underpin it at every turn (see Wexler, 1991). PoS-based considerations, for example, guide the development of the computational account of acquisition processes, suggesting to researchers the sorts of biases that have to be built into these processes if they are to succeed in their task. During this same period in which nativist assumptions have so dominated psycholinguistic research, *nothing* has emerged that could plausibly be described as even the beginnings of a non-nativist account of language acquisition. In the absence of such an account, anti-nativists have been reduced to playing the role of a loyal opposition (some would say fighting a rearguard action), criticizing nativist PoS arguments, objecting to specific nativist proposals, pointing out research results that might possibly favour a non-nativist account, and so on. Thus, for example, one finds many anti-nativist criticisms of the well-known poster examples of PoS arguments, criticisms that, as I said above, typically

focus on establishing that these demonstration arguments are not decisive disproofs of the possibility of an anti-nativist account (e.g., Cowie, 1999; Pullum and Scholz, 2002). One finds arguments to the effect that certain connectionist architectures, e.g., simple recurrent networks, hold promise as a way of explaining how learners might exhibit the learning biases that they do, though without the intervention of domain-specific antecedent knowledge (e.g., Elman et al., 1996, but see Sharkey et al., 2000). One similarly finds arguments to the effect that learners are able to compensate for the apparent poverty of the stimulus by employing certain stochastic procedures (again, Cowie, 1999; Pullum and Scholz, 2002). But as suggestive as these criticisms and results may be, they don't really add up to anything that suggests that empiricist accounts are a live option at this point. All this of course could change, but at this point in time there is simply no evidence of an impending empiricist renaissance. Perhaps the most that anti-nativists might reasonably hope for is that as the nativist research program is elaborated and modified in response to the usual theoretical and empirical pressures that drive research programs we might eventually reach a point where the resulting account of language acquisition becomes unrecognizable as either nativist or empiricist, as least as we presently understand these terms. In such event, the question of which view turned out to be correct will be moot, and anti-nativists might take some solace in the fact that nativism, as currently conceived, turned out not to be correct.[15]

The Formal Learning-Theoretic Case for Linguistic Nativism

For some four decades now, Chomksyan linguists, most notably Chomsky himself, have been the principal advocates for linguistic nativism, making the case for that view in terms of PoS arguments of the sort described above. During this same time period, there has emerged from the intersection of formal language theory and recursive function theory, and largely independently of empirical generative linguistics, a field of mathematical inquiry known as "formal learning theory" (FLT). Over the last 25 years, acquisition theorists have increasingly availed themselves of the analytically powerful, mathematically precise framework that FLT provides for conceptualizing the acquisition of natural language. Serious acquisition theories are now routinely formulated in FLT terms, and proposed acquisition theories are expected to satisfy the following FLT-based adequacy condition:

> the learning procedure attributed to child-learners by the acquisition theory should *provably* be able to acquire the hypothesized class of natural languages on the basis of the data that the theory hypothesizes child-learners utilize in acquiring the languages that they do.

Many acquisition theorists who have adopted the FLT framework find in the results of their FLT-based acquisition research, *empirically robust* support for linguistic nativism that is independent of that provided by PoS arguments of the sort described above. It is not possible to spell out in any detail here the support that FLT provides for linguistic nativism, but we can provide some sense of its tenor.

Formal learning theory, as the name suggests, studies the learnability of different classes of formal objects (languages, grammars, theories, etc.) under different formal models of learning.[16] The specification of such a model, which specifies in formally precise terms (i) *a learning environment* (i.e., the data which the learner uses to learn whatever is learned), (ii) *a learning function*, and (iii) *a criterion for successful learning*, determines (iv) *a class of formal objects* (e.g., a class of languages), namely, the class that can be acquired to the level of the specified success criterion by a learner implementing the specified learning function in the specified learning environment.[17]

Much of the early work in FLT concerned itself with extensions and generalizations of the so-called Gold paradigm, initiated by Gold's 1967 seminal paper "Language identification in the limit." In this paper Gold examined the learnability of different classes of formal languages on the basis of two different data formats, under a success criterion of strict identification in the limit. Gold proved a number of important learnability results, most famously an unsolvability theorem for text presentation whose interpretation and import for linguistic nativism has been the subject of continuing debate within cognitive science.[18] Subsequent work in FLT has examined learning models that differ widely in their specification of all three parameters of the model (viz., learning environment, learning function, and success criterion). Formal learning-theoretic results typically compare models that differ only in their specification of one of the three parameters, showing that a class of languages learnable on one specification of the parameter in question is not learnable on a different specification of that same parameter. Many of the results are unsurprising: there are learnable classes of languages that cannot be learned by computable learning functions, that cannot be learned on noisy text (i.e., text that includes sentences drawn from the complement of the language to be acquired), that cannot be learned on incomplete text, and so on. But there are also some very surprising results, some of which refute very basic theoretical assumptions within psychology. (For example, there is a widely held assumption that a "conservative" learning-on-errors strategy, of abandoning a hypothesis only when it fails to explain the data, is not restrictive as regards what can be learned. FLT shows this to be false.)[19]

There is no direct or immediate application of these various learnability results to the current debate regarding linguistic nativism; in themselves these results do not make a case for linguistic nativism. But they do serve to map out the conceptual space within which any plausible theory of natural language acquisition must be articulated, and they do provide researchers familiar with these results with a pretty good sense, "intuitions" as mathematicians might put it, as to the learnability of particular classes of languages under different specifications of the three parameters that define a learning model. And it is here, arguably, that the FLT case for linguistic nativism begins to emerge.

From studying the learnability consequences of varying the three parameters that define a particular formal learning model, FLT theorists develop a rather clear understanding of how changes to the different parameters interact with one another to affect the learnability of broad classes of formal languages. As they study the learnability properties of what linguists take to be the class of possible natural languages, these theorists also develop a pretty clear sense of the sort of restrictions that must be imposed on that class (in the form of restrictions on the hypotheses that a learner

implementing a certain learning strategy can entertain and conjecture) if it is to be learnable (to the level of the empirically relevant success criterion) on the basis of the kind of data that developmental psycholinguists hypothesize that child-learners employ in the course of language acquisition. As a result of this research, virtually all FLT theorists have concluded that, as Chomsky argued on the basis of PoS considerations, these restrictions have to be pretty severe in order to assure learnability: successful child-learners must come to the learning task with significant domain-specific knowledge of the languages that they will acquire, where this knowledge is realized in the form of constraints on the sort of hypotheses they will entertain and conjecture in the course of the learning task.

The FLT case for linguistic nativism just outlined is not, as Cowie (1999) and other anti-nativist critics have supposed, simply a kind of PoS argument. Obviously, the FLT case for linguistic nativism concludes, as do the PoS arguments, that learners are successful in acquiring the natural languages that they do on the basis of the sort of data children acquire languages only because they come to the learning task with certain domain-specific knowledge. But these FLT-based arguments do not turn, as PoS arguments do, on specific, detailed assumptions either about the principles that characterize the grammatical competence that learners acquire or about the linguistic data on the basis of which they acquire this competence. For this reason, FLT-based arguments for linguistic nativism are not vulnerable, in the way PoS arguments are, to the usual sorts of criticisms raised by anti-nativists. Nor do these arguments rely on detailed assumptions about the learning mechanisms employed by learners. Rather FLT-based arguments rely only on *very general* assumptions about the nature of the acquired competence, learning data, and learning mechanisms.

FLT-based arguments are also not vulnerable, as PoS arguments seemingly are, to the anti-nativist objection that the knowledge of specific grammatical principles that PoS arguments propose to explain *might* be the consequence of the acquisition, *in the learning environment*, of other linguistic knowledge, on the basis of other linguistic data. Consider once again Chomsky's PoS argument, based on polar interrogatives, for the claim that child-learners come to the learning task knowing that linguistic rules are structure dependent. Nothing in that argument precludes the possibility that the child-learners acquire this knowledge, perhaps as an interaction effect, in the course of acquiring other linguistic knowledge. FLT-based arguments avoid this vulnerability because they concern themselves with the antecedent knowledge required to acquire *entire* languages (or grammars) rather than simply specific grammatical components thereof.

The FLT case for linguistic nativism becomes only stronger as one starts to incorporate within the learning model empirically more plausible and detailed specifications of (i) the class of possible natural languages, (ii) the learning environment in which child-learners acquire the languages that they do, and (iii) the cognitive capacities that learners exercise in the course of language acquisition (learning strategies, memory limitations, etc.). FLT theorists find themselves forced even more strongly to the conclusion that Chomsky is right in thinking that there must be fairly severe constraints on the class of possible natural languages, and that to succeed in the acquisition task learners must come to the task knowing these constraints.

Importantly, FLT also provides a mathematically precise framework within which one can address the question of just *how empirically robust* one's nativist conclusions are in the face of uncertainty regarding the empirically correct specification of (i) the learning environment, (ii) the learning function, (iii) the success criterion, and (iv) the class of possible natural languages. One can vary (i), (iii), and (iv), both separately and in combination with one another and to a degree that reflects one's empirical uncertainty about empirically correct specification of each. One then determines for each of these variations the learning function provably required in order to acquire the specified class of possible natural language to the specified success criterion in the specified learning environment. To the extent that under all such variations the required learning function entails that learners come to the learning task with domain-specific knowledge about the languages they will acquire, then to that extent one's nativist conclusions are empirically robust. Thus far there has been no systematic undertaking of this sort, but it would be fair to say, based on the formal learnability results to date for proposed formal acquisition theories, the case for linguistic nativism looks to be empirically quite robust. Put more simply, the conclusion that linguistic nativism is true appears to be pretty stable over a wide range of different but empirically plausible assumptions about both the parameters that define the learning model and the class of possible natural languages.

Conclusion

In conclusion, five points deserve emphasis. (i) The case for linguistic nativism finds independent support from both PoS arguments and FLT-based arguments. (ii) These arguments are not apodictic; like any argument based on empirical premises, they are only as good as their premises. But (iii) the preponderance of available evidence suggests that these arguments are generally sound and empirically robust, and hence (iv) child-learners do come to the learning task with antecedent domain-specific knowledge, and the most plausible explanation of how learners come by this knowledge is that it is innate. But (v) any final verdict on linguistic nativism must await the development of a theoretically well-developed, empirically well-supported account of natural language acquisition, one that satisfies the minimal adequacy condition imposed by FLT, namely, that the hypothesized learning procedures provably be able to acquire the class of natural languages, to the empirically appropriate success criterion, on the basis of the sort of evidence that child-learners in fact employ in the course of language acquisition.

Notes

1 Classical statements of linguistic nativism are to be founded throughout the writings of Noam Chomsky, especially in Chomsky, 1966, 1975, 1980a, 1980b, 1988.

2 For a popular exposition of this received view, see Pinker, 1994.

3 E.g., Elman et al., 1996; Cowie, 1999; Sampson, 1999; Pullum and Scholz, 2002; and Scholz and Pullum, 2002.

4 See Chomsky, 1966 for his perspective on the seventeenth-century debate. See also Cowie 1999, pp. 3–66.
5 See Katz, 1967, pp. 240–68.
6 In an earlier formulation, Chomsky put the argument this way:

> It seems plain that language acquisition is based on the child's discovery of what from a formal point of view is a deep and abstract theory – a generative grammar of his language – many of the concepts and principles of which are only remotely related to experience by long and intricate chains of quasi-inferential steps. A consideration of . . . the degenerate quality and narrowly limited extent of the available data . . . leave[s] little hope that much of the structure of the language can be learned by an organism initially uninformed as to its general character. (Chomsky, 1965, p. 58)

7 Failure to appreciate that PoS arguments are intended to establish only that successful learners must come to the learning task with certain domain-specific knowledge has led empiricist critics such as Cowie (1999) to complain that these arguments establish less than they are supposed to establish, namely that learners come to the learning task with certain innate knowledge of language. It has led nativist supporters such as Nowak et al. (2002) to conclude that by "innate" linguistic nativists really mean "before data," i.e., knowledge that learners bring with them to the learning task.
8 See, e.g., Matthews, 2001.
9 See, e.g., Chomsky, 1975, pp. 30–3; 1980a, pp. 114–15; 1980b, pp. 41–7, 1986, pp. 7–13; also Lightfoot, 1991, pp. 3–4 and Pinker, 1994, pp. 233–4. For a nuanced discussion of PoS arguments, see Wexler, 1991.
10 Whether there is a substantive issue here depends crucially on how, computationally speaking, such knowledge is realized. Most critics who have pressed this issue presume without argument a representationalist theory of propositional attitudes (cf. Fodor, 1987) according to which having an attitude toward some proposition (e.g., knowing that *P*) is a matter of having a mental representation with the propositional content *P* that plays the appropriate functional/causal role in cognition. This presumption is especially evident in the arguments of Elman et al. (1996) against the position that they term "representational nativism."
11 For a defense of the standard assumption, see Marcus, 1993.
12 For discussion, see Matthews, 2001 and Crain and Pietrowski, 2002.
13 But even this might not be enough to bring the committed anti-nativist on board. If the history of science is any indication, many anti-nativists would remain unconverted. For as historians of science are fond of pointing out, scientific progress generally comes not through conversion of an entrenched scientific community to a new view, but through attrition: defenders of discredited theories simply die off, leaving the field to younger proponents of the replacing view.
14 Wexler and Culicover, 1980, and Berwick, 1985 are early examples of such work. More recent examples include Gibson and Wexler, 1994; Bertolo, 1995; Niyogi and Berwick, 1996; Sakas and Fodor, 2001; and Yang, 2002.
15 I am reminded here of the remark, cited by Hilary Putnam, of a famous Nobel laureate in chemistry who wryly noted that contrary to what historians of science always teach, the existence of phlogiston was never disproved, by Joseph Priestley or anyone else, that, on the contrary, phlogiston turned out to be valence electrons!
16 A class of languages is counted as learnable just in case every language in the class is learnable, to the specified success criterion, on the basis of the specified kind of data for that language.

17 For a general introduction, see Feldman, 1972; Valiant, 1984; Kelly, 1996; and Jain et al., 1999. For applications to the problem of natural language acquisition, see, e.g., Wexler and Culicover, 1980; Berwick, 1985; Matthews and Demopoulos, 1989; and Bertolo, 2001.

18 For a careful discussion of Gold's unsolvability result and its implications for the current nativist/empiricist debate, See Johnson (2004). See also Matthews, 1984; Demopoulos, 1989; and Nowak et al., 2002.

19 See Jain et al., 1999 and Osherson et al., 1984.

References

Bertolo, S. (1995). Maturation and learnability in parametric systems, *Language Acquisition*, 4, 277–318.

— (ed.) (2001). *Language Acquisition and Learnability*. Cambridge: Cambridge University Press.

Berwick, R. (1985). *The Acquisition of Syntactic Knowledge*. Cambridge, MA: MIT Press.

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

— (1966). *Cartesian Linguistics*. New York: Harper & Row.

— (1975). *Reflections on Language*. New York: Pantheon.

— (1980a). *Rules and Representations*. New York: Columbia University Press.

— (1980b). On cognitive structures and their development: a reply to Piaget. In M. Piattelli-Palmarini (ed.), *Language and Learning: The Debate between Jean Piaget and Noam Chomsky*. Cambridge, MA: Harvard University Press.

— (1986). *Knowledge of Language*. Westport, CT: Praeger.

— (1988). Generative grammar: Its basis, development and prospects. *Studies in English Linguistics and Literature*, special issue. Kyoto: Kyoto University of Foreign Studies. (Reprinted as On the nature, acquisition, and use of language, in W. Lycan (ed.), *Mind and Cognition*. Oxford: Blackwell, 1990.)

Cowie, Fiona (1999). *What's Within: Nativism Reconsidered*. Oxford: Oxford University Press.

Crain, S. and Pietrowski, P. (2002). Why language acquisition is a snap. *The Linguistic Review*, 19, 163–83.

Demopoulos, W. (1989). On applying learnability theory to the rationalism-empiricism controversy. In R. Matthews and W. Demopoulos (eds.), *Learnability and Linguistic Theory*. Dordrecht: Kluwer.

Elman, J., Bates, E., Johnson, M., Karmiloff-Smith, A., Parisi, D., and Plunkett, K. (1996). *Rethinking Innateness*. Cambridge, MA: MIT Press.

Feldman, J. (1972). Some decidability results on grammatical inference and complexity. *Information and Control*, 20, 244–62.

Fodor, J. (1987). *Psychosemantics*. Cambridge, MA: MIT Press.

Gibson, E. and Wexler, K. (1994). Triggers. *Linguistic Inquiry*, 25, 407–54.

Gold, E. M. (1967). Language identification in the limit. *Information and Control*, 10, 447–74.

Hornstein, N. and Lightfoot, D. (1981). Introduction. In *Explanation in Linguistics: The Logical Problem of Language Acquisition*. London: Longman.

Jain, S., Osherson, D., Royer, J. S., and Sharma, A. K. (1999). *Systems That Learn* (2nd edn.). Cambridge, MA: MIT Press.

Johnson, K. (2004). Gold's theorem and cognitive science. *Philosophy of Science*, 71, 571–92.

Katz, J. (1967). *Philosophy of Language*. New York: Harper & Row.

Kelly, K. (1996). *The Logic of Reliable Inquiry*. Oxford: Oxford University Press.

Lightfoot, D. (1991). *How to Set Parameters*. Cambridge, MA: MIT Press.

Marcus, G. (1993). Negative evidence in language acquisition. *Cognition*, 46, 53–85.

Matthews, R. (1984). The plausibility of rationalism. *Journal of Philosophy*, 81, 492–515. (Reprinted in Matthews and Demopoulos (eds.) (1989). *Learnability and Linguistic Theory*. Dordrecht: Kluwer.)

— (2001). Cowie's anti-nativism. *Mind and Language*, 16, 215–30.

Matthews, R. and Demopoulos, W. (eds.) (1989). *Learnability and Linguistic Theory*. Dordrecht: Kluwer.

Niyogi, P. and Berwick, R. (1996). A language learning model for finite parameter spaces. *Cognition*, 17, 1–28.

Nowak, M., Komarova, N., and Niyogi, P. (2002). Computational and evolutionary aspects of language. *Nature*, 417, 611–17.

Osherson, D., Stob, M., and Weinstein, S. (1984). Learning theory and natural language. *Cognition*, 17, 1–28.

Pinker, S. (1994). *The Language Instinct: How the Mind Creates Language*. New York: William Morrow.

Pullum, G. and Scholz, B. (2002). Empirical assessment of stimulus of poverty arguments. *The Linguistic Review*, 19, 8–50.

Sakas, W. and Fodor, J. (2001). The structural triggers learner. In S. Bertolo (ed.) *Language Acquisition and Learnability*. Cambridge: Cambridge University Press.

Sampson, G. (1999). *Educating Eve*. London: Cassell.

Sharkey, N., Sharkey, A., and Jackson, S. (2000). Are SRNs sufficient for modelling language acquisition? In P. Broeder and J. Murre, *Models of Language Acquisition*. Oxford: Oxford University Press.

Scholz, B. and Pullum, G. (2002). Searching for arguments to support linguistic nativism. *The Linguistic Review*, 19, 185–223.

Valiant, L. G. (1984). A theory of the learnable. *Communications of the ACM*, 27, 1134–42.

Wexler, K. (1991). On the argument from the poverty of the stimulus. In A. Kasher (ed.), *The Chomskyan Turn*. Oxford: Blackwell.

Wexler, K. and Culicover, P. (1980). *Formal Principles of Language Acquisition*. Cambridge, MA: MIT Press.

Yang, C. (2002). *Knowledge and Learning in Natural Language*. Oxford: Oxford University Press.