Conversations on cognitivism and the study of language

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Prelude | *A long time ago, in the 1950s, the world of the social sciences was dominated by a fruitless paradigm known as behaviorism. The evil Burrhus Frederic Skinner was its champion, and he banned from the face of the earth all discussion of concepts, ideas, meaning, or mental entities of any sort. Then came Noam Chomsky, the epic linguist and father of cognitive science, who demonstrated the heretofore unseen complexity in human speech. Chomsky had the polemic ability to topple the behaviorist machine, and since Chomsky has come on the scene the study of language has blossomed, and with it our awe of the human mind.*[1] *Chomsky's students, largely following in his tradition, and his antagonists alike, have found their research largely choreographed by his ideas, as they have opened whole new areas of linguistic inquiry. This story, of course, is simplified and exaggerated. Suppose we want to make sense of it. What should we do? We might sit down Noam Chomsky and B. F. Skinner, and have them chat about language and the validity of cognitive inquiry. An alternate approach would be to interview Chomsky and Skinner individually, possibly with selected younger scholars of language. Here, based on writings of selected scholars and interviews with them, I attempt to get a feel for the history and sociology of the recent study of language.*

B F. Skinner, on language

You have mentioned the need to bring the methods of science to human affairs. What does this entail?
If we are to enjoy the advantages of science in the field of human affairs, we must be prepared to adopt the working model of behavior to which a science will inevitably lead. We must expect to discover that what a man does is the result of specifiable conditions and that once these conditions have been discovered, we can anticipate and to some extent determine his actions. This possibility is offensive to many people. It is opposed to a tradition of long standing which regards man as a free agent, whose behavior is the product, not of specifiable antecedent conditions, but of spontaneous inner changes of course. To suggest that we abandon this view is to threaten many cherished beliefs. The alternative point of view insists upon recognizing coercive forces in human conduct which we may prefer to disregard. It challenges our aspirations, whether worldly or otherworldly.[2]

You mention that it "has generally been assumed that to explain behavior, or any aspect of it, one must attribute it to events taking place inside the organism."[3] What is the problem with this?
In the field of verbal behavior this practice was once represented by the doctrine of the expression of ideas. An

[1] Prof. Elizabeth Bates has deftly pointed out to me the oversimplification of this statement. In my interview with her, she noted that American Learning Theory could not be uniformly characterized as anti-mentalistic, in the sense of B.F. Skinner. She said the characterization of everything before Chomsky as a wasteland in which everybody agreed with Skinner is simply false. Prof. Steven Pinker gives a more traditional cognitive scientific view of science in the 1950s. Pinker (Language Instinct, 21-22) says: "In the 1950s the social sciences were dominated by behaviorism, the school of thought popularized by John Watson and B. F. Skinner. Mental terms like 'know' and 'think' were branded as unscientific; 'mind' and 'innate' were dirty words. Behavior was studied by a few laws of stimulus-response learning that could be studied with rats pressing bars and dogs salivating to tones."
[2] Science and Human Behavior, 6-7
[3] Verbal Behavior, 5

utterance was felt to be explained by setting forth the ideas it expressed. If the speaker had had a different idea, he would have uttered different words or words in a different arrangement. If his utterance was unusual, it was because of the novelty or originality of his ideas. If it seemed empty, he must have lacked ideas or have been unable to put them into words. If he could not keep silent, it was because of the force of his ideas. If he spoke haltingly, it was because his ideas came slowly or were badly organized. And so on.[4]

There is obviously something suspicious in the ease with which we discover in a set of ideas precisely those properties needed to account for the behavior which expresses them. We evidently construct the ideas at will from the behavior to be explained. . . . When we say that a remark is confusing because the idea is unclear, we seem to be talking about two levels of observation although there is, in fact, only one. It is the *remark* which is unclear. [5] One might also attempt to explain behavior by appealing to its meaning. But we cannot successfully supplement a framework of semantic reference by appealing to the "intention of the speaker" until a satisfactory psychological account of intention can be given![6]

How do you view language, Professor Skinner?
Actually, perhaps I should clarify a matter of terminology. What you have referred to as language is in reality best approached as verbal behavior. Language exists in dualist mind space, but behavior is objective, something we can observe.

Verbal behavior has been thought of as a rather complex subject matter, but you are optimistic.
It would be foolish to underestimate the difficulty of this subject matter, but recent advances in the analysis of behavior permit us to approach it with a certain optimism. New experimental techniques and fresh formulations have revealed a new level of order and precision. The basic processes and relations which give verbal behavior its special characteristics are now fairly well understood.

How does your approach differ from other approaches to verbal behavior?
Previous approaches have fallen short of a functional analysis.

What do you mean by functional analysis?
The terms "cause" and "effect" are no longer widely used in science. They have been associated with so many theories of the structure and operation of the universe that they mean more than scientists want to say. The terms which replace them, however, refer to the same factual core. A "cause" becomes a "change in an independent variable" and an "effect" a change in a dependent variable. The old "cause-and-effect connection" becomes a "functional relation." The new terms do not suggest ***how*** a cause causes its effect; they merely assert that different events tend to occur together in a certain order.[7]

Okay. How have other approaches to verbal behavior fallen short?
Linguistics, for example, has recorded and analyzed speech sounds and semantic and syntactical practices, but comparisons of different languages and the tracing of historical changes have taken precedence over the study of the individual speaker[8]; psychology has collected facts and sometimes put them in convenient order, but in this welter of material it has failed to demonstrate the significant relations which are the heart of a scientific account.[9]

What is your goal in studying verbal behavior?
The ultimate aim is the prediction and control of verbal behavior.[10]

If you wanted me to say "Please get me a glass of water," what would you do?
Probably, the easiest way to do this would be to say to you “Ask me 'please get a glass of water.'” Or else, I could

4 Verbal Behavior, 5-6
5 Verbal Behavior, 6
6 Verbal Behavior, 9
7 Science and Human Behavior, 23
8 Verbal Behavior, 4
9 Verbal Behavior, 5
10 Verbal Behavior, 12

insure that you were thirsty, by offering you salty food, for instance, and that you were thinking about water, by getting myself a glass, which would increase the probability that you would ask for a glass of water.

Author's Note: *Skinner does speak of 'probability' in relation to verbal behavior. I wonder what conception of probability he had. A review of the statistics used in his research (1 have only looked at Science and Human Behavior and Verbal Behavior, both of which seem directed to a largely popular audience, and are essentially free of numbers of any sort) might indicate whether he was prepared and competent to see material reality as underdetermined, even after incorporation of all independent variables in a model. My sense is that Skinner's mention of 'probability' comes into play mostly where the data are noisy, and it is difficult to establish the 'functional relations.' I'm not yet able to determine, however, whether Skinner thought of reality itself as possibly including stochastic elements.*

Thanks. What first drew you to the study of verbal behavior?
In 1934, while dining at the Harvard Society of Fellows, I found myself seated next to Professor Alfred North Whitehead. We dropped into a discussion of behaviorism and I began to set forth the principal arguments. Following our discussion, he agreed that science might be successful in accounting for human behavior provided one made an exception of *verbal* behavior.[11]

Is your (1957) book* Verbal Behavior *the culmination of your career?
Well, it has brought science a step further. We no longer must appeal to ideas to explain verbal behavior.

You suggest that ideas do not exist in a physical sense, or at least that they cannot be observed. Might that be a question for neuroscience?
I'm not sure what you mean. Behavior exists, and we can measure it. A given behavior, call it X, invariably occurs when the relevant independent variables are in place. A functional relation does not need to be informed by brains. Eventually it will be possible to know, an instant ahead of time, when X is going to occur, by monitoring the state of the brain. But that could have been inferred already by monitoring the relevant independent variables in the environment. Neuroscience can illustrate the mechanisms by which behavior is induced, but adds nothing to the functional relation.

Thanks for your time, Professor.

Author's note: In compiling this I was impressed at how little Skinner offered to the study of language. I think it is profitable, however, to consider the profoundly different intellectual environment in which Skinner wrote, and to consider how, in the absence of halfway plausible neural models, and any foreseeable real-time neuroscience, his ideas made more sense. His contribution to clinical work has apparently been large: A psychology graduate student mentioned to me that she has found Skinner's ideas very useful in her work with autistic children.

[11] Verbal Behavior, 457

Noam Chomsky, on language

What is it that for you, Professor Chomsky, makes language intriguing?
The study of language is deeply rooted in Western philosophy, and is closely tied to the study of human nature. There are several reasons for the importance of language in the study of human nature.) One reason is that language appears to be a true species property, unique to the human species and a common part of our shared human biological endowment, with little variation among humans apart from rather serious pathology. Furthermore, language enters in a crucial way into thought, action, and social relations.[12]

Can you characterize, for the layman, the principal questions to be addressed in the study of language?
I take four questions as the essential framework for further inquiry:[13]

1) What is the system of knowledge? What is in the mind/brain of the speaker?
2) How does this system of knowledge arise in the mind/brain?
3) How is this knowledge put to use in speech?
4) What are the physical mechanisms that serve as the material basis for this system of knowledge and for the use of this knowledge?

The first question was the central topic of inquiry in the philosophical grammar of the seventeenth and eighteenth centuries.[14] My work does not focus on it.

The second question, that of how knowledge arises in the mind/brain, is a special and important case of Plato's problem, the question of how human beings come to know so much, during their short existence. Plato proposed that knowledge was remembered from an earlier existence. A modern restatement of Plato's conclusion would be that certain aspects of our knowledge and understanding are innate, genetically determined, on a par with the elements of our common [human] nature that cause us to grow arms and legs rather than wings. This version of the classical doctrine is, I think, essentially correct.[15,16]

I largely focus on the third question. Actually, I should divide that question into two parts, perception and production. These parts are often mistakenly combined, but in fact it is possible to characterize perception of language without fully understanding its production. And perceptual knowledge of a language does not translate neatly into production ability. The perception problem has to do with how we interpret what we hear. The production problem, which is considerably more obscure, has to do with what we say and why we say it. Consider two people who share exactly the same knowledge of[17] Spanish, but whose proficiency in its use varies greatly. One might be a poet, the second an utterly pedestrian language user who speaks in cliches. It is hard to see how knowledge can be identified with ability, still less with disposition to behavior.[18]

As for the last question, on what physical mechanisms serve as the material basis for linguistic knowledge in the speaker, 1- The fourth question is a relatively new one, in fact one that is still on the horizon. Insofar as the linguist can provide answers to questions 1,2, and 3, the brain scientist can begin to explore the physical mechanisms that exhibit the properties revealed in the linguist's abstract theory. In the absence of answers to these questions, brain scientists do not know what they are searching for; their inquiry is in this respect blind.[19] I take the four questions as the essential framework for further inquiry. I have nothing to say about question 4 because little is known. [20]

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12 Managua Lectures I, 1-2
13 Managua Lectures I, 3
14 Managua Lectures I, 3
15 Managua Lectures I, 3-4
16 Chomsky believes he has maintained the correct essentials of Plato's doctrine, while purging it of "the error of pre-existence." Prof. Liz Bates believes that Chomsky "has tried to re-establish the error of preexistence." It seems to me that connectionist models presume less at the outset than Chomsky does here.
17 This statement seems to me to presuppose something like a Universal Grammar, or Universal Bioprogram, which has been "uncovered," or had its "parameters set," in the case of individual speakers. The course of the Universal Grammar provides an interesting vehicle from which to look at recent study of language. At the extreme nativist end, possibly somewhat in reaction to the behaviorism of the era, is Chomsky. Connectionism, with Rumelhart and McClelland proposing that networks can learn language without explicitly representing rules, is an opposite approach.
18 Managua Lectures I, 9- 10
19 Managua Lectures I, 6
20 Managua Lectures I, 8.

You have mentioned that the complexity of language would make it difficult to learn. What is innate?
It seems that the child approaches the task of acquiring a language with a rich conceptual framework already in place and also with a rich system of assumptions about sound structure and the structure of more complex utterances. They constitute one part of the human biological endowment, to be awakened by experience and to be sharpened and enriched it throughout the course of the child's interactions with the human and material world. In these terms we can approach a solution of Plato's problem, not entirely unlike Plato's own, though "purged of the error of preexistence."

How do children acquire language, from your perspective?
It seems clear that reinforcement, casual observation, and natural inquisitiveness (coupled with a strong tendency to imitate) are important factors, as is the remarkable capacity of the child to generalize, hypothesize, and "process information" in a variety of very special and apparently highly complex ways which we cannot yet describe or begin to understand, and which may be largely innate, or may develop through some sort of learning or through maturation of the nervous system.[21] The manner in which such factors operate and interact in language acquisition is completely unknown. There are well-known difficulties in determining to what extent inborn structure, maturation, and learning are responsible for a particular form of a skilled or complex performance. It may be that genetic maturational factors enable the organism to select, for instance, phonologically relevant information. To the extent that this is true, an account of the development and causation of behavior that fails to consider the structure of the organism will provide no understanding of the real processes involved.

Does the language the child encounters shape his or her development of linguistic competence?
Suppose that you take a kitten and you raise it with something over the eyes which allows the light to come in but not in patterns, just diffuse light. Then what we discover is that this system of computation is destroyed.[22] So the mature cat will literally not see objects if it has only been presented with diffuse light and not patterns. There has to be a sufficiently rich environmental stimulation for the genetically determined process to develop in the manner in which it was programmed to develop. The term for this is 'triggering'; that is, the experience does not determine how the mind will work but it triggers it, makes it work in its own largely predetermined way. It is a little like an automobile. When you turn the key in the ignition, it acts like a car, not an airplane. That is because it's built like a car. But if you don't turn the key, nothing's going to happen.[23] Let's take a young lamb. It's known that if you take that lamb and separate it from its mother and raise it in isolation, [it's perceptual abilities] will not develop properly. Now the mother is not teaching the lamb how to perceive depth, but there is something about the interaction between a lamb and its mother which enables the visual system to work the way it's designed to work. The point is that the mind has very rich capacities, but certain kinds of stimulating environments are necessary for these capacities to function. These capacities are not being taught. They are simply being allowed to function in the way in which they are designed to develop.[24]

Is the lexicon innate?
There is a recent issue of a linguistics journal that has a long detailed article trying to give the meaning of the word 'climb.' And it is very complicated. But every child learns it perfectly right away. Now that can only mean one thing. Namely, human nature gives us the concept 'climb' for free. That is, the concept 'climb' is just part of the way in which we are able to interpret experience available to us before we even have the experience. That is probably true for most concepts that have words for them in language. This is the way we learn language. We simply learn the label that goes with the preexisting concept. So in other words, it is as if the child, prior to any experience, has a long list of concepts like 'climb,' and then the child is looking at the world to figure out which sound goes with the concept. We know that the child figures it out with only a very small number of presentations of the sound.[25,26]

Thanks Professor.

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[21] This seems to be a very pro-learning statement, relative to the breadth of Chomsky's work.

[22] Author's note: So these parts of the brain were already there, in some nascent form? In response to a question following Lecture 5, (196-197)**.** Chomsky states the following: "We know from experimental work on animals that the parts of the brain that are concerned with perception simply do not develop properly, in fact, they degenerate severely, unless presented with the right kind of stimulation at the right period of development."

[23] Chomsky's response to an audience question following the first lecture at Managua, 172

[24] Chomsky, in response to a question after his first lecture at Managua, 172-173

[25] Chomsky, in response to a question after his fifth lecture at Managua, 190-191

[26] Chomsky seems confused about how he thinks the innateness works. It seems the child already has the concept 'climb,' and just needs to learn the sound the concept goes with. Yet if we had not read that statement, we might have been led to believe that *the concept* of 'climb' also developed. I understand that the philosopher Jerry Fodor has possibly a more nuanced explanation of this, in which there is some set of atomic concepts which coalesce together around words.

Chomsky on Skinner's *Verbal Behavior*

Dr. Chomsky, you recently reviewed Skinner's book* Verbal Behavior. *Tell me about it.
Skinner's thesis is that external factors consisting of present stimulation and the history of reinforcement (in particular, the frequency, arrangement, and withholding of reinforcing stimuli) are of overwhelming importance in understanding the complexities of verbal behavior.

When I asked Skinner how to get someone to say "Please get me a glass of water," I was not sure he answered my question. Do you think he answered it?
The insights that have been achieved in the laboratories of the reinforcement theorist, though quite genuine, can be applied to complex human behavior only in the most gross and superficial way. Since Skinner's work is the most extensive attempt lo accommodate human behavior involving higher mental faculties within a strictly behaviorist schema, a detailed documentation would be of great interest. But Skinner has failed lo provide this.

In your review of* Verbal Behavior*, you talk at length about reinforcement. Could you explain that for us here?
Skinner makes it very clear that in his view reinforcement is a necessary condition for language learning and for the continued availability of linguistic responses in the adult. However, the looseness of the term *reinforcement* as Skinner uses it in the book under review makes it entirely pointless to inquire into the truth or falsity of this claim. What had been hoped for from the psychologist is some indication how the casual and informal description of everyday behavior in the popular vocabulary can be explained or clarifies in terms of the notions developed in careful experiment and observation, or perhaps replaced by a better scheme.[27] Recent work has shown that novelty and variety of stimulus are sufficient to arouse curiosity in the rat and to motivate it to explore an environment, and to learn, since on a presentation of two stimuli, one novel, one repeated, the rat will attend to the novel one. Rats will learn to choose the arm of a single-choice maze that leads to a complex maze, running through [the complex maze] being their only "reward"; monkeys and apes will solve rather complex manipulation problems that are simply placed in their cages. In these cases, solving the problem is apparently its own "reward."[28] Results of this kind can be handled by reinforcement theorists only if they are willing to set up curiosity, exploration, and manipulation speculate somehow about acquired drives for which there is no evidence outside learning takes place in these cases[29]

How would you summarize your review?
[I]f we take [Skinner's] terms in their literal meaning, the description covers almost no aspect of verbal behavior, and if we take them metaphorically, the description offers almost no improvement over traditional formulations.[30]

What should Skinner have done?
Describing the production aspect of language is beyond the current state of knowledge. A more reasonable immediate goal is to characterize the grammar of a language L in something like the way a deductive theory gives an enumerable set of theorems. With a precise enough formulation, this general theory can provide a uniform method for determining, from the process of generation of a given sentence, a structural description which can give a good deal of insight into how this sentence is used and understood. Some rules of grammar are obligatory, others optional. The optional rules of a grammar can be viewed as the selective mechanisms involved in the production of a particular utterance. The problem of specifying these integrative processes is nontrivial [but is] not beyond the range of possible investigation.[31] When the abstract structure of a grammar is described, the behavioral description of speech may become less daunting.

Professor Chomsky, rumor has it that you never actually read Skinner's* Verbal Behavior. *Is that true?
[Chomsky doesn't answer.][32]

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[27] Chomsky's review of Skinner's *Verbal Behavior*, IV
[28] I am not sure that "solving a problem" is a broad enough characterization of this. It works in Chomsky's case, to describe language learning, but how will it work in instances where the experimenter does not know what the problem is, that is being solved?
[29] Chomsky's review of Skinner's *Verbal Behavior,* V
[30] Chomsky's review of Skinner's *Verbal Behavior,* XI
[31] Chomsky review of Skinner's *Verbal Behavior,* XI
[32] That Chomsky never read Verbal Behavior is widely rumored. In his review, Chomsky refers to specific pages throughout Verbal Behavior, as well as to

Skinner, on the threat of cognitivism[33]

The practice [of referring to ideas as causes of verbal behavior] may have been defensible when inquiries into verbal processes were philosophical rather than scientific, and when a science of ideas could be imagined which would some day put the matter in better order; but it stands in a different light today. It is the function of an explanatory fiction to allay curiosity and to bring inquiry to an end.[34]

The variables of which human behavior is a function lie in the environment. Take, for example, the so-called process of association. In Pavlov's experiment a hungry dog hears a bell and is then fed. If this happens many times, the dog begins to salivate when it hears the bell. The standard mentalistic explanation is that the dog "associates" the bell with the food. But it was Pavlov who associated them! "Associate means to join or unite. The dog merely begins to salivate upon hearing the bell. We have no evidence that it does so because of an internal surrogate of the contingencies. Cognitive association is art invention. Even if it were real, it would go no further toward an explanation than the external contingencies upon which it is modeled. [35]

Your work has demonstrated at great length the importance of nurture. Is nature also important in development of organisms?
Color vision is part of the genetic endowment of most people, and it develops or grows in a physiological sense, possibly to some extent after birth. Nevertheless, most stimuli, [for instance the names of colors] acquire control because of their place in contingencies of reinforcement.[36]

You reject the notion that an animal might do something, not because of particular stimuli in the environment, but simply because it "feels like doing it at the moment."[37] Why?
Suppose animals simply do what they feel like doing. What is the next step in explaining their behavior? Clearly, a science of animal behavior must be replaced or supplemented by a science of animal feelings. [. . . We would then] have abandoned an objective subject matter in favor of one of dubious status, accessible only through necessarily defective channels of introspection.[38]

Is the term "image " problematic, as used by cognitivists?
Sensory data are often said to be stored as images, much like the images said to represent the real world. Once inside, they are moved about for cognitive purposes. There is a familiar experiment on color generalization [in which a pigeon's rate of pecking depends on how much a new color] differs from the original: rather similar colors evoke fairly high rates, very different colors very low rates.

A cognitive psychologist might explain the matter in this way: The pigeon takes in a new color (as "input") , retrieves the original color from memory, where it has been stored in some processed form puts the two colored images side by side so that they may be easily compared, and after evaluating the difference, responds at the appropriate rate. But what [explanatory] advantage is gained by moving from a pigeon that responds to different colors on a disk to an inner pigeon that responds to colored images in its mind? The simple fact is that because of a known history of

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Skinner's earlier book The Behavior of Organisms (1938). As Dr. Bates and I discussed "Chomsky used the invitation to review that book as an opportunity to lay out his own manifesto: he wrote about what he thought Skinner's beliefs were, and in fact you know it was a very interesting manifesto against the empiricist epistemologies across the board but it was not really a review of Skinner's book and I don't know how or why Skinner could respond to it."

33 I have not found an article in which Skinner addresses Chomsky directly. This article is entitled "Why I am not a Cognitive Psychologist." It appeared in the Fall 1977 issue of the journal Behaviorism, 5(2), 1-10. A reprint of can be found in the book Approaches to cognition: colttrusts artd controversies, Knapp, T.J., & Robertson, L.C. (eds.). Hillsdale, NJ : Lawrence Erlbaum Associates, 1986

34 Verbal Behavior, 6

35 "Why I am not a Cognitive Psychologist," 1

36 "Why I am not a Cognitive Psychologist," 2. It is ironic that Skinner would pick the pigeon for a behaviorist account, in which an animal responds "to the world." Pigeons may have five color receptors, versus the human three (Varela, Palacios, & Goldsmith, 1993). giving them a different, and richer, experience of color.

37 Skinner refers to Waddington's review of a book by Tinbergen: Waddington, C. **14.** ***New York Review:*** February 3, 1974.

38 "Why I am not a Cognitive Psychologist," 3. Skinner mentions that introspection is not a reliable way to learn about the mind. Chomsky mentions that it is not possible to do experiments on the brains of living human beings. Neither of them would have dreamed of the progress seen recently in minimally invasive real-time brain imaging.

reinforcement, different colors[39] control different rates.[40]

Is cognitivism a threat?
Besides slowing the development of the sciences of behavior and physiology, the appeal to cognitive states and processes is a diversion which could well be responsible for much of our failure to solve our problems. We need to change our behavior and we can do so only by changing our physical and social environments. We choose the wrong path at the very start when we suppose that our goal is to change the "minds and hearts of men and women" rather than the world in which they live.[41]

Thank you, Professor Skinner.

Steven Pinker on language and the Chomskyan tradition

Prof. Steven Pinker, of the MIT department of brain and cognitive sciences, is a prominent linguist and developmentalist. His critique[42] of Rumelhart and McClelland's "On Learning the Past Tenses of English Verbs"[43] resulted in much improvement of that model. His 1994 book The Language Instinct *is an eclectic collection of information and narration of his ideas, for a popular audience. Pinker falls in the Chomskyan tradition in his beliefs about the innateness and unlearnability of language.*

Dr. Pinker, what is it that excites you about language?
All normal humans possess language, from the most culturally advanced to the stone-age tribes hidden from our knowledge for tens of thousands of years. Language is one of nature's engineering marvels. Darwin put it well when he concluded that language ability was "an instinctive tendency to acquire an art." Language is not learned, in the sense that we learn cultural artifacts such as the way the federal government works. A three year old is a master of grammar in ways that the best computers cannot equal.

Dr. Pinker, what leads you to characterize language as an instinct?
Actually, my reference is more to the *acquiring* of language being instinctual. Two main areas of evidence come in here: language cannot be learned by general learning mechanisms given the stimuli a child receives, and it has an identifiable seat in the brain. It may even be controlled by specific genes.

Instincts are commonly thought of in terms of knee-jerk reactions. Isn't language too flexible for that?
We need a broader understanding of instinct than that. I think William James described language well when he noted that just because an organism has an instinct, that instinct need not act as a "fatal automaton," in the sense of a knee-jerk reaction. James was right to state that cause many instincts compete within us.

What is the history of the idea of language as an instinct?
Actually it has a long history.[44] In this century, the most famous argument that from Noam Chomsky, the linguist who first unmasked the intricacy of the system and perhaps the person most responsible for [the cognitive revolution].

Did Chomsky point something out, that had been missed before?

[39] It seems that Skinner is talking of different colors *in the world,* rather than different neurons in, say, V4, I wonder whether Skinner knows that pigeons have a more complex color vision scheme than human beings, in which they can discriminate between blends of colors that are the same to the human eye. In his critique of the influence of the computer on cognitive psychological theories he laments the marginalization of 'sensory-psychology and physiology,' so we could give him the benefit of the doubt.

[40] "Why I am not a Cognitive Psychologist," 7

[41] "Why I am not a Cognitive Psychologist," 10. Here we see Skinner's deep interest in engineering society.

[42] Pinker. S. and A. Prince. On language and connectionism: Analysis of a parallel distributed processing model of language acquisition. *Cognition* (28). 73-193.

[43] Rumelhart, D. E. and J. L. McClelland. On Learning the Past Tenses of English Verbs. *Parallel Distributed Processing, Vol. 1.* Cambridge, MA: MIT Press, 1987.

[44] Pluto's error of pre-existence, Bates would say.

Chomsky called attention to two fundamental facts about language. First, virtually every sentence that a person utters or understands is a brand-new combination of words, appearing for the first time in the history of the universe. Therefore a language cannot be a repertoire of responses; the brain must contain a recipe or program that can build an unlimited set of sentences out of a finite list of words. [And children develop complex grammars] rapidly and without formal instruction... therefore, [Chomsky] argued, children must innately be equipped with a plan common to the grammars of all languages.[45]

What did this mean, according to Chomsky?

Children, Chomsky argued, must be innately equipped with a plan common to the grammars of all languages, a Universal Grammar, that tells them how to distill the syntactic patterns out of the speech of their parents. Chomsky said:

> human cognitive systems, when seriously investigated, prove to be no less marvelous and intricate than the physical structures that develop in the life of the organism. Why, then, should we not study the acquisition of a cognitive structure such as language more or less as we study some complex bodily organ?
> At first glance, the proposal may seem absurd, if only because of the great variety of human languages. But a closer consideration dispels these doubts. Even knowing very little [of the substance of linguistic universals,] we can be quite sure that the possible variety of language is sharply limited.[46]

> The language each person acquires is a rich and complex construction hopelessly underdetermined by the fragmentary evidence available [to the child]. 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.[47]

Is language something that* could *be taught?

In fact, we can show that they know things they could not have been taught. One of Chomsky's classic illustrations about the logic of language involves the process of moving words around to form questions. [48]

What did Chomsky make of this?

Chomsky reasoned that if the logic of language is wired into children, then the first time they are confronted with a sentence with two auxiliaries they should be capable of turning it into a question with the proper wording.[49]

Chomsky reasoned that if the logic of language is wired into children, then the first time they are confronted with a sentence with two auxiliaries they should be capable of turning it into a question with the proper wording. This should be true even though the wrong rule, the one that scans the sentence as a linear string of words, is simpler and presumably easier to learn.

And it should be true even though the sentences that would teach children that the linear rule is wrong and the structure-sensitive rule is right-questions with a second auxiliary embedded inside the subject phrase-are so rare as to be nonexistent in Motherese. This is what Chomsky calls "the argument from the poverty of the input," and [it is his] primary justification for saying that the basic design of language is innate.[50] Chomsky's claim was tested with three-, four-, and five- yew olds, [and his prediction was correct.]

How was it tested?

One of the experimenters controlled a doll of Jabba the Hutt, of Star Wars fame. The other coaxed the child to ask a set of questions, by saying, for example, "Ask Jabba if the boy who is unhappy is watching Mickey

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45 Language Instinct, 22

46 The wide variety in natural languages is something that connectionists believe plays into their hand. The theory of Universal Grammar is still criticized for being Anglo-centric, and that the regularities that emerge after consideration of many languages, turn out to approximate the rule 'easier things coming in before harder things'.

47 Chomsky, N. *Reflections on language.* Pantheon, 1975.9-1 *1.* Quoted in Language Instinct, 22-23

48 Language Instinct, 40

49 Language Instinct, 40

50 I wonder if there has never been a corpus of actual speech heard by an infant, to determine whether or not this construction is heard? In any case, why would it matter whether the mother was the onc who spoke the phrase, and whether she was speaking Motherese when she uttered it? Shouldn't getting this data be top priority for investigators of language development?

Mouse." The children cheerfully provided the appropriate questions, and, as Chomsky would have predicted, not a single one of them came up with an ungrammatical string like *Is it the boy who unhappy is watching Mickey Mouse?,* which the simple linear rule would have produced.[51]

Is language is localized in the brain?
Broca's aphasia and SLI are cases where language is impaired and the rest of intelligence seems more or less intact.[52] I Of course, it could simply be that language requires more cognitive resources to use, except that there are people with perfect language and idiot intelligence. Language, then, is essentially separate from the rest of mental function.[53],[54]

Sometimes, children develop on schedule, except for their language abilities.[55] To have command of a language, you don't need the intellectual wherewithal to function in society, the skills to keep house and home together, or a particularly firm grip on reality. Indeed, you can possess all these advantages and still not be a competent language user, if you lack just the right genes or just the right bits of brain.[56]

Could language be more of a cultural endowment than a biological one?
The standard social science model treats language as more of a cultural endowment.[57] But this cannot explain the rapid development of language in human populations. For instance, we have seen pidgins become creoles in a single generation. And we have seen deaf children systematize the deficient signing of their parents into a language, even without contact with other deaf children.[58]

Are the ways in which languages form questions arbitrary?
The particular ways that languages do form questions are arbitrary, species-wide conventions; we don't find them in artificial systems like computer programming languages or the notation of mathematics. The universal plan underlying languages, with auxiliaries and inversion rules, nouns and verbs, . . . and so on, seems to suggest a commonality in the brains of speakers, because many other plans would have been just as useful. [59],[60]

Thank you, Professor.

Professor Elizabeth Bates, on language

The late professor Elizabeth Bates championed using connectionist models as keys to thinking about, and modeling, language acquisition. Dr. Bates directed the Center for Research in Language at the University of California, San Diego, where she was a professor in the departments of cognitive science and psychology. Quotes from Dr. Bates are from a March 4, 1999 lecture on language acquisition, and a March 10, 1999 interview. Some quotes have been condensed, and rearranged. Questions have been adapted to facilitate readability.

What kind of a problem is language?
Language is 'a special problem': mapping a high dimensional meaning space through a low-dimensional channel. Looking at historical, or diachronic linguistics, elucidates this. For example, there is a pressure on languages to evolve for perceptual clarity: be as clear as possible, which would tend to make languages bigger,

[51] Language Instinct, 42
[52] Language Instinct, 50
[53] Language Instinct, 45-48
[54] Here, Bates notes the dubious history of phrenology, and the current lack of certainty in textbooks as to the location of Broca's area and Wernicke's area.
[55] Language Instinct, 48
[56] Language Instinct, 53-54
[57] Language Instinct, 18
[58] Language Instinct, 37
[59] Bates: that was the idea, but it is breaking down as we look at a greater variety of languages. What do you think of the 'silent modules?'
[60] Language Instinct, 43

longer, clearer, more articulate ... on the other hand, because we also produce speech, there is an ever-present pressure to be efficient: get that stuff out there as fast as you can.

This is a very rich problem space, a lot of constraints in it; we would argue that the class of human grammars, the grammars that have survived and been acquired by successive generations of children, have the properties they do because those are the only possible ways to solve this problem. And there may be more than one solution. Richly inflected language with variable word order have vastly different properties than austere word order rigid languages.
And those may represent two different paths through this problem space. It may be that if you take one path at time t, it restricts where you can go in the space later on. Now I think one can believe in universals, without coming to the conclusion that being universal makes something innate. [61]

Grammars represent the class of possible solutions to the problem of mapping back and forth between a high-dimensional meaning space with some universal properties and a low-dimensional channel that unfolds through time, heavily constrained by limits on the information processing.

Now we know some things about this problem. We know, for example, that it is a constraint satisfaction problem. Multiple parallel constraints have to be solved to get the thing to work. It is also ... a dimension reduction problem, [like] squeezing through a waist of hidden units. We also know that in the domain of language, many of these constraints are in direct competition.

Innateness has been an ever-present, vaguely defined idea. In your book* Rethinking Innateness, *you and your co-authors propose a set of levels in which a trait or behavior can be innate. What goes into that?
We have, it turns out, maybe one percent of our genes that other primates do not. If every neuronal connection related to language had to be specified in the genome, there probably wouldn't be enough genes. But what we are noticing is that although there is probably not enough information to specify all relevant cortical connections, there seem to be other types of innateness. For example, maybe the general patterns of cortical connectivity between regions of the brain are innately specified. Indeed, this definitely seems to be the case in visual processing: given the opportunity to do so, information from the eyes goes straight from the thalamus to V1. Another way in which language could be innate is through innate specification of timing in maturational processes. Specification of timing is requires the least genetic information of the alternatives. And these levels of innateness may coexist. [62],[63]

In some sense, the concept of emergence is more clear than the concept of innateness. Classically, the options were empiricism (in which knowledge was thought to come in, through the senses), and nativism (in which knowledge was recovered). It is a third alternative, where empiricism and nativism were the classical choices. It is similar to Piaget's constructivism.

My favorite example of emergence, which I stole from D'arcy-Thomson, who stole it from Banani, and Rumelhart and McClelland in their '86 book, which is very embarrassingly attributed to me, is the honeycomb. And you look at that form, which shows up reliably, universally, in bee-life, nobody sends the little bees to hexagon school: there is no tutoring, no feedback to little bees in order to make these forms ... therefore, you might conclude that bees have innate hexagon knowledge. However, as D'arcy-Thomson points out, ... if you pack 2D circles, you get hexagons; in 3D with spheres, you get rhombic dodecahedrons. ... this structure emerges inevitably from the interaction of the bees.[64]

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[61] One would like to see clearly laid-out what the universals are.

[62] Dr. Bates noted that certain neurons are active in the final stages of a chess match, but that we would not *therefore conclude that 'chess neurons' are innately specified.*

[63] This taxonomy, which Bates proposed in Rethinking Innateness, is not one that people have widely accepted. So people at MIT don't necessarily agree with that taxonomy, and don't find it necessary to specify at what level they meant to say the grammar was innate.

[64] *Growth and Form* by D'arcy-Thompson describes how biological systems have evolved with a constrained set of processes provided by nature.

How has connectionism contributed to the concept of emergence, and to the study of language?
I think that what connectionism has done has been to provide a formal precise testable set of demonstrations of what the concept of emergence is, a theory of emergence, as an alternative to both innateness and learning by copying, that what connectionism has shown us is that new structures don't have to be innate, *or* in the environment: something new can emerge across the course of development that is not predictable from either the environment, or [from] what the genetic constraints are. In the 1960's, when efforts to build speech perception computers failed, people started saying "it must be innate". In fact a classic argument in linguistics is to point out, again and again and again and again the peculiarity and the arbitrariness and the weirdness and the exquisitely detailed properties of grammars of different languages, and to say *explain that! ... You can't explain that, it's too hard!,* and that might or might not prove be the case, but the demonstrations of the peculiarity and the weirdness of language do not in and of themselves constitute evidence that the mechanisms that are responsible for processing information are also peculiar; that is an empirical question.

Neural networks have been very useful as feasibility arguments, because there have been a lot of claims made in language acquisition, by people in the MIT camp, that certain aspects of language are un-learnable, that [they] just could not be done in the absence of a lot of innate knowledge. To the extent that simulations show that, *here, a relatively simple device could do it,* it's an existence proof, and then people debate about whether it really is, or whether it was done with a trick and it's really not legitimate, and that is how the argument goes. So there are existence proofs about learnability.

There are also existence proofs about the kind of number and kinds of mechanisms you need to get a certain outcome. So, in the U-shaped function [of overgeneralization of rules in formation of irregular verbs which] was classically used as 'compelling evidence' that there needs to be one device that learns by rote and one by rules, the demonstration that you could get the same set of behaviors in a single mechanism [with] a neural network that works by analogy many people found compelling, as an existence proof that you don't have to have two mechanisms to get this result. Now, you could always say 'Yeah, well but ***kids*** have two mechanisms, and in fact some scholars say exactly that.

What variation among languages is there in language development?
At the level of the lexicon is the culture influences the relative magnitude and timing and variation, but not the absolute kinds of milestones. For instance, nouns seem to come in before verbs.

Is there a universal bio-program, as Derek Bickerton calls it, for the development of grammar that all children show in every language? A lot of people believed in the 1960s and 1970s that if we did cross-linguistic research on early language development, it would be like wheat versus chaff. We'd lay all of these languages on top of each other and the universal bioprogram would emerge, and all these language-specific details would fall off. It turns out that the variations across languages are so huge, it's getting hard to find something in the intersect that all languages show. Now, it looks more like "easy things come before hard things." It had been thought, for instance, that there would be a stage of telegraphic speech, in which children would have word order but not morphology. That depends on the amount of morphology in the language. In Italian, for instance, morphology is seen at the one-word stage. A child will say "mommy (possessive, holding up mommy's sock)", "mommy (accusative, holding the spoon to mommy's mouth)," late in the one-word stage. So it is not the case that there is a universal stage of telegraphic speech that all children go through where they have word order and do not have morphology; that depends on the language.

At MIT, they talk about 'parameter-setting', to deal with the variability among languages. Language acquisition involves listening to your data, and discerning which kind of language you are learning. Chinese has no verb morphology. What do Chinese kids do with their verb morphology module? It is silent, just turned off.

Dr. Bates, on personal issues in the study of language

Dr. Bates has called the study of language the "Bosnia-Herzegovina" of science, and has herself been called "the princess of darkness" by devotees of neo-Chomskyan explanations of language acquisition.

Are issues in language personal?
I think that the issues are sufficiently vexed and difficult and hotly contested that it is the case in fact that within the study of language sometimes it becomes personal. There are a couple books out documenting this point: The Linguistic wars;[65] Frederick Newmeyer's Linguistic Theory in America, from the early 1980s.[66] So yes, it's lively personal as well as scientific debate. Although the issues of innateness, localization and domain-specificity are logically separable, language researchers tend to adopt one of the following approaches:

Chomsky, Pinker, MIT, on language:	Bates, San Diego, on language:
phylogenetically discontinuous, based on innate, language-specific mechanisms, which are localized, and modular	phylogenetically continuous, based on developed, general learning mechanisms, which are distributed throughout the brain, and which interact with higher and lower level processes

Could we isolate some scholars who take advantage of the logical independence of these issues?
For the most part, people just haven't thought about how these are separate issues. So people tend to follow one approach and assume, having set the innateness parameter, that you believe in modularity and that you believe that speech is special, and it's domain specific, and it's localized and so on.

Is "the data" something that well-informed researchers coming from different traditions tend to see in different ways right now?
There are some subfields in which parties on both sides would agree what the relevant evidence is; they just disagree in how to interpret it, how much good evidence there is on one side rather than the other; they evaluate it differently. But they at least agree [on] what the evidence ought to be. There are other subfields in which people can't even agree on what the evidence *should be,* much less what it is.

You mentioned that we fail to see the cognitivism in American Learning Theory from the time of Skinner, and that we attribute too much to Chomsky.
I think there's this kind of cult of personality around Chomsky, and a tendency to attribute to him, the move back toward rationalist in the cognitive era, in the 1960s, and I think that's attributing a little bit too much historical force to Chomsky. He was a Hegelian hero, the right guy at the right place at the right time, but if you look at what was happening in other fields that were really not touched by him the same thing was happening.

Piaget for example had been writing an explicitly mentalistic rationalist theory – it was emergentist rather than nativist, kind of constructivist emergentist theory of the child's mind; he had been writing for decades about mental structures in children, and you know how they develop-his work wasn't even translated into English until the 1960s. when all of a sudden the Zeitgeist was moving back toward mentalism and people got interested in Piaget. That was totally unmotivated by Chomsky.

[65] Harris, R. A. ***The Linguistics Wars.*** New York: Oxford Univ. Press, 1993
[66] Newmeyer, F. ***J. Linguistic theory in America*** Orlando : Academic Press, 1986

Or to take another example if you take research on animal learning.[67] That kind of work, this kind of complete change of direction toward rationalism and mentalism in animal learning was also completely independent of linguistics and Chomsky.

The move toward cognitivism and the whole birth of cognitive psychology around the serial computer as the metaphor of the mind happened in parallel to Chomsky but it would have happened anyway, because suddenly there was this compelling metaphor for the mind that we could build with our hands.

Is there a debt that connectionism has to the Chomskyan tradition?
I don't know what [you mean] it would be. If you go back to the 1950s, what you find is that there are two kinds of computational architectures that people were starting to explore: the serial digital computer, the Von Neumann, machine, and the perceptron. It was kind of like Cain and Abel. Now we all know what happened with Cain and Abel. Essentially what happened is Minsky and Papert[68] killed off research on perceptrons, and except for a few "John the Baptists" who kept up work on those systems, like Stephen Grossberg, for the most part they pretty much stopped.

Chomsky's whole linguistic theory is deeply conceptually rooted in the architecture of the serial digital computer, and Chomsky's hierarchy, theories of strings of symbols and classification of kinds of grammars, is used in data structures courses even today, in computer science. So modern linguistic theory in the MIT tradition is profoundly, and I think irreversibly, rooted in the assumption that the mind is like a serial digital computer.

When connectionism came roaring back in the [1980s], as the alternative to symbolic architectures, it ipso facto constitutes a challenge to Chomsky's theories of the mind, and grammar, because it's a totally different architecture, [a] totally different set of principles, and essentially everything that goes into the MIT grammar is now open for reconsideration. So I don't think there's any debt at all.

Can you give me a story or two of someone who's maybe moved closer lo the connectionist camp?
There are any number of interesting cases out there in adult psycholinguistics of people who have changed their perspective: possibly one of the most influential is Michael Tanenhaus, at Rochester University – Tanenhaus was originally a student of Tom Bever's who was one of the original sets of psycholinguistics in the 1960s inspired by MIT theory[69] and Tanenhaus was very much a modularist; he believed that the different components of the architecture for language operate independently, and so on. He has made a complete transition; he now is a flaming interactionist; he believes in top-down effects penetrating the operation of lower-level modules, so hence they're not modules. So Tanenhaus was a very important convert; because he is one of the best known teachers of other young psycholinguists, so when he changed an entire generation of young psycholinguists changed with him. So this, very quickly – over the span of a couple of years.. . the minority party began to be at least a compelling alternative.

Do people from different camps, say, you and Chomsky. enjoy chatting over lunch at conferences?
Some do; it depends on the people – I've actually published papers with people of opposing camps, so it's *possible* to use the differences of opinion as a spotlight rather than a weapon. But, it isn't always done that way, in fact that's the exception unfortunately in the world.

[Chomsky and I] don't attend the same conferences. I have certainly read a lot of Chomsky's work, and tried to understand what he means by innate; I think he's been pretty clear, and I think we radically disagree, and I'm not sure what could be repaired, or what common ground we could reach, because he doesn't seem to respect the lines of

[67] There was an explicit march toward mentalism and nativism in the 1960s. People began to discover the ethologist, Konrad Lorenz and Niko Tinbergen, and Karl Von Frisch. They began to do these studies of preparedness or constrained learning, so . . . Sara Shettleworth wrote a wonderful review, in which they showed some things like the "brightness of water experiment" by Garcia; you have rats who simultaneously experience a bright light, a loud noise-a buzzer, and a new taste, okay? and then one of two things happens to them: either they get sick to their tummy or they get an electric shock. They will connect the noise and light to the electric shock but not to the food; they will connect the taste to the sickness, but not the electric shock, as if the animal already has certain kinds of associations set up in the brain that attract other kinds of associations. Dr. Bates also noted that Konrad Lorenz received a Nobel Prize in biology for his biology-of-behavior studies, especially on imprinting in birds; Niko Tinbergen shared the above Nobel Prize, for his work on biology of behavior in fish; Karl Von Frisch shared the same prize, famous work on 'bee dancing' as a communicative system; and Sara Shettleworth did a review paper on “constraints on learning.”

[68] Minsky, M. L. & Papert, S. *Perceptrons; art introduction to computational geometry.* Cambridge, ***MA,*** MIT Press, 1969.

[69] Bever coauthored a book with Jerry Fodor on the modularity of language: Fodor, J. A., T. G. Bever, & M. F. Garret. *The psychology of language: an introduction to psycholinguistics and generative grammar.* New *York,* McGraw-Hill, 1974.

evidence that I think are relevant. So if you can't agree about what the relevant evidence is, it's hard to have a conversation at goes anywhere.

Prof. John Batali mentioned that Chomsky had seen his simulation of the emergence of grammar, and likes it. Is there some common ground here?
A number of people in Chomsky's camp have interpreted John's work to mean that you can evolve an innate grammar. I don't interpret John's work that way at all; but, we all have a right to our own interpretation. It would be important to ask John what he believes. I think the simulation's interesting; we have to ask what it is exactly that evolved. And this is why in *Rethinking Innateness* we try to distinguish between innate representations, innate architectures, and innate variations in timing.

Of course something about the human brain makes the human brain innately capable of language, when your dog's brain is not, and it's not just that [the human brain] bigger, because a child with half a brain can go on to acquire perfectly normal language. So clearly there's something that's innate; the question is what is it. For Chomsky that something is innate knowledge, innate representations. Now is that what John Batali has simulated- the evolution of innate *knowledge,* the actual synaptic connections – or is what John has modeled something else, something that we would categorize as changes in the initial architecture?

What are the differences between you and your colleagues recent work on language and the work of Steven Pinker?
I think that Pinker's critique[70] of the Rumelhart-McClelland paper[71], the Pinker-Prince critique was an excellent piece of work: I think they worked very hard to try and understand what Rumelhart and McClelland had done, and many of the flaws they pointed-out were valid; many of the flaws they pointed out were not particularly relevant, all of that time they spent in that critique about the wickelfeatures; well *fine* do the simulation [yourselves] with something else.

I think that one of the things that, although I respect that Pinker and Prince paper a lot, precisely because of that paper a great deal of work was done after that addressing those concerns. Pinker refuses to acknowledge- he says "Oh they didn't really do it; they didn't really do it" – which is not true, so he has not kept up the hard work of' keeping up a careful analysis of what the subsequent simulations did. He simply speaks to his audience and says "Ph! Ignore these people I already showed that what they're doing is specious," so he has not continued to the kind of careful exegesis and critical analysis he did in 1988.

Part of the problem I have with Pinker recently is that even though he's extremely well-trained as an empirical scientist with Roger Brown and Steve Kosslyn and even though I disagree with a lot of his conclusions, I think his early work was certainly good, credible, fair; I think he's made some pact with the Devil along the line here; he's no longer responsive to or constrained by serious empirical evidence; he's too busy getting rich, and being toasted in New York book critic circles, and so on. I mean he's now become an expert on everything; he wrote an article in the New York Review of Books last fall on *neo-naticide,* and how there was an evolutionary neural circuit that our ancestors evolved in the difficult times out there on the savanna, which occasionally goes off in today's women under stress, and it's just, you know, part of their innate inheritance – I mean he's an expert for Christ's sake on neonaticide?

He's an expert on *all* human nature: his latest book was *How The Mind Works*[72] He's willing to tell just so stories, and to play very fast and loose with evidence, in ways that I just think have removed him from the arena of serious science. So there was a time when 1 think we could and did sit down and debate the evidence. I now think he doesn't respect the evidence enough to really sit down and face it.

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70 Pinker, **S.** and A. Prince. On language and connectionism: Analysis of a parallel distributed processing model of language acquisition. *Cognition (28).* 73-193.

71 Rumelhart, D. E. and J. L. McClelland. On Learning the Past Tenses of English Verbs. *Parallel Distributed Processing, Vol. 11.* Cambridge, MA: MIT Press, 1987.

72 Pinker, S. *How the mind works.* New York: Norton, 1997.

Reflection and thoughts for further research

Jonathan Nelson

This paper has been something of a conversation, and I will not pretend to have a specific thesis which most stands out in my mind, as I ruminate on the issues and data. The following is a list of observations of mine, and areas where it seems that research is called-for. Skinner is a dead horse, to be sure, but in his own context, his ideas start to make sense. As long as it was impossible to look inside the mind, scholars felt compelled to think of other methods of inquiry. Chomsky was in almost the same situation as Skinner, except that Chomsky was willing to study the formal system of language. On a deeper level, they both wanted to, as Chomsky put it, "exorcise the demon in the machine." Bates has reflected that connectionism enables deeply mentalistic concepts to be studied, while still staying away from "spooky stuff." The recent growth of neural modeling techniques and real-time brain imaging technologies seems unprecedented in the history of the world, and Chomsky and Skinner would have come up with different theories because of this had they been beginning their careers today.

Chomsky and Skinner clash because of their contradicting views of human nature. I wonder how their epistemologies led them to their views of humanity, or if epistemology arid ontology developed largely in interaction with each other.

Chomsky's theory has been criticized as Anglo-centric. What languages did he speak? Are linguistics students in general required to be competent in more than one family of languages? Did Skinner have the mathematical-logical competence to make sense of Chomsky's critique?

Is there a corpus of the actual speech heard by an infant? That should be a top priority for investigation. Microphones aren't especially physically intrusive, and courts have upheld the right of scholars to keep their data private. The development of a corpus of the text actually heard by infants should be an achievable goal.

The issue of innateness could use some more development. The taxonomy from *Rethinking Innateness* is a good start. Liz Bates says being shared by natural languages does not make a characteristic of language innate; Steven Pinker says that the ways in which languages are structured is arbitrary, and must reflect their innate nature. I would be greatly aided by a concise statement of just what regularities are, or may be, seen in the world's natural languages.

Bates has noted the dubious phrenological history of Broca's and Wernicke's areas. We need her to write a chapter which tells the neural story of language development, complete with diagrams and sample exercises, the way it should be told. Do people at MIT really talk about 'silent modules'?

Data is theory laden, and especially so in the study of language. It is amazing to me how one scholars 'obvious fact' is the next scholars untruth, throughout the field. And the antagonism of the debate must make it difficult for scholars to call each other and talk about the unanswered questions and unclear nuances. Pinker, for his part, said of Chomsky that he "is a paper-and-pencil theoretician who wouldn't know Jabba the Hut from the Cookie Monster." Evidently some fields (physics, as mentioned in class) are less prone to dogmatic theorizing. Historically, what evidence do we have of the sociological makeup of fields changing? ■

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