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Kanzi, evolution, and language

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> What an irony it is, that the supposed attempt to bring homo sapiens down a few notches in the natural order has taken the form of us humans hectoring another species into emulating our instinctive form of communication, or some artificial form we have invented, as if that were the measure of biological worth. The chimpanzee's resistance is no shame on them; a human would surely do no better if trained to hoot and shriek like a chimp, a symmetrical project that makes about as much scientific sense. (Pinker 1994, p. 351)

What is the significance of attempting to get members of other species to learn human languages or their variants? Such studies are often considered to be of more dubious value than studies of natural communication in a species in its own environment. There is a big difference between comparing such natural forms of communication to human language, and comparing extremely unnatural forms, such as bonobos who have learned an English based form of artificial symbolic representation. I will argue today that even the most unnatural experiments can be of vital use in reasoning about the origins of human language. My argument rests on two points, first, the fundamental importance and the structure of comparative studies, and second, the crucial role of development in understanding claims about language capacities. These days, more and more people buy the idea that comparative studies are useful, even including Chomsky, in a recent paper he coauthored with Hauser et al. (2002). But an understanding of capacities is also essential, as I shall argue.

Claims of human uniqueness have been ubiquitous in discussions of the evolution of language. One of the most vocal recent advocates of this view is Steven Pinker. Pinker argues that human language capacity should be understood as a 'module' that evolved in the hominid line – that is, it is uniquely human. Included in this module are capacities to produce and consume language, which includes the ability to hear and parse syntax, as well as the syntactical and semantic abilities necessary for producing sentences. (1994, p. 373) This whole suite of behaviors is called the language instinct, which is modular in its structure.

Human uniqueness

Let's think about evolutionary uniqueness and novelty and what is involved. Evolutionary explanations are fundamentally stories of descent with modification. From the history of life we know that there are very few true innovations – totally new characters or structures that can then be modified through evolutionary forces on variants. For example, consider the evolution of the blue whale from the primitive, insectivorous hedgehog-like ancestor living 50 million years ago. In this dramatic evolutionary change from primitive mammal to blue whale, there are only two characteristics that are not mere modifications of primitive mammalian features: the skin on the roof of mouth, which is cornified and folded into sheets of baleen; and the dorsal and tail fins, made of skin and fiber. Similarly, while the insect wing was a genuine evolutionary novelty, the innumerable variations on it among the insects are just that, variations on the same basic structure.

This question of genuine novelty always appears in discussions of human uniqueness: is the trait we're interested in a new thing, evolutionarily, or is it – like nearly all traits of nearly all species – a modification of a trait present in ancestors? Here is one way to put what I'm concerned about: Many researchers tend not to discriminate between characters and structures that are actually ancestral, but that have been modified (in ways that may be quite dramatic) in human beings, and characters and structures that are genuinely novel (somewhat misleadingly called by taxonomists, 'derived'), that is, that appeared and were modified strictly within the hominid lineage.

This distinction between an ancestral and modified character, and a novel (or 'derived') character within a lineage, is very important when giving evolutionary accounts. Even if the explanation appeals almost entirely to natural selection as the primary force of evolution in a specific case, there is always also some hypothesis necessary about the source of variation on which selection acts. In the case of a 'uniquely human' trait that hypothesis is – usually explicitly – that the character or structure *itself*, and not just the variations on it, arose within the hominid lineage.

In terms of evolutionary inference, then, the claim that a character is 'uniquely human' is extremely strong. It means that the character (trait) and its variations arose only *after* (or at) the hominid line split off from all other ape lineages. It also means that no version or variant of the character may be found in ape or other primate lineages, because this would put the ancestral character much further back in the phylogeny. In such a situation, the evolutionary explanation would have the task of explaining why and how the character was *modified* the way it was, in the hominid lineage, while acknowledging/recognizing that the character itself is not, in its existence, uniquely human.

Recently, there has been much attention paid to efforts to describe or explain what the biological basis is of the universal human capacity to learn to comprehend and use language. These efforts are often tied to the independent question of explaining why language capacity evolved, which usually involves

giving an adaptive story of the selective advantages of language use (like help in coordinated hunting, or bartering).

I favor the approach defended by Terrence Deacon to the question of the biological basis of language capacity (1997). Deacon's approach is a developmental one – he emphasizes and explores the range of potentialities that lie in brain tissues. Which of these potentialities gets enacted is strongly dependent on two types of factors: biases and specific environmental forces. This happens on an individual basis, but shared environments can make for shared results across entire species. Deacon's basic view is that, given how brains grow up from a fertilized egg, and specifically, similarities between how human brains grow compared to other primate brains, against a background of enormous genetic overlap, we shouldn't be surprised to find some overlap of the capacities to learn such refined modes of using the brain as symbolic representation. He sketches an account that explains how a psychological universal – such as the capacity and aptitude to learn language – can arise from a set of physiological biases.

In his own words, ''It is misleading to imagine that what is innate in our language abilities is anything like foreknowledge of language or its structures. Rather than a language organ or some instinctual grammatical knowledge, what sets human beings apart is an innate *bias* for learning in a way that minimizes the cognitive interference that other species encounter when attempting to discover the logic behind symbolic reference'' (1997, p. 141).

Deacon thus ties the capacity for symbolic representation to the ability to forget the indexical connections of particular utterances, which involve too much concrete information. Symbolic representation is made possible by conditional associations in the prefrontal areas, which involve a poor memory for details and context. (He also emphasizes the likelihood that symbolic representation and processing itself created selection pressure for increasing the relative resources devoted to the prefrontal cortex.)

I like Deacon's approach because he focuses on describing a set of developmental *possibilities*, and suggests how these mere possibilities may actually lead to a near-universal psychological phenotype. One of the chief advantages of this view is that it does not involve a hopelessly simplistic or deterministic genetic foundation for language ability. But much more significantly, Deacon's account is of the recruitment of speech and language centers from areas of the brain previously committed to motor functions further back in our lineage.

This is also the view taken by Greenfield (1991), who argues that language and tool use share an underlying cognitive basis, one that allows for hierarchical structure (1991). This opens the possibility that some of these language centers could appear in non-linguistic species; or, more precisely, that the areas of the brain utilized in language use and learning by human beings – and especially the role of the prefrontal cortex in symbolic representation – may, in closely related species in our lineage, also contain the capacity for symbolic representation. This is why Kanzi the bonobo is so important.

Kanzi has, it appears by the evidence, learned a number of things previously thought by many to be impossible in non-human primates. (Let me note immediately that I am aware of objections to these interpretations of the evidence from Kanzi, but I am going to present what I think are legitimate and defensible inferences from the data as I understand them.)

He has learned to use 90 symbols on a lexigram keyboard in processes of symbolic representation. He has created two rules of syntax or proto-syntax for his own expressions. Most importantly, he demonstrated early and spontaneous learning of symbolic representation as an infant, and has demonstrated the capacity to comprehend spoken language in grammatical constructions of a complexity comparable to a human 21/2-year-old child (Savage-Rumbaugh et al. 1986; Greenfield and Savage-Rumbaugh 1990).

He was an infant of 6 months when his foster mother, Matata, was a subject in an experiment by Susan Savage-Rumbaugh and Duane Rumbaugh, in which they were trying to teach her to comprehend and use abstract symbols on a keyboard to represent objects, actions, and ideas. Kanzi was in the room because he needed to be near his mother; no one was paying any attention to him during the training processes. At 2 years of age Kanzi began to use the symbol keyboard himself, on his own initiative and unexpectedly. He seemed to have already learned the most important thing of all, and the thing that the experimenters had apparently failed to teach his mother – the concept of symbolic representation, having an abstract symbol on the keyboard stand in for an object, action, or idea which may not be present or available to immediate sense experience. Kanzi had also learned the specific meanings of several of the abstract keyboard symbols, and started to use them spontaneously early on the first day of his formal language training. Given that he had already spontaneously mastered the notion of symbolic representation, it was relatively easy to introduce new symbols and meanings to Kanzi (Savage-Rumbaugh and Lewin 1994).

The second striking thing about Kanzi is that he apparently learned to comprehend spoken language. We couldn't say that he was completely untrained in this, because the experimenters talked along with their use of the symbol keyboard. But we do this with our pet dogs and cats, and we don't think that they can actually parse grammatical statements. But it seemed that Kanzi could do this. Through an amazing series of experiments that has to be seen to be believed, the Rumbaugh's tested Kanzi's ability to comprehend spoken sentences from a person out of sight (thus avoiding the issue of body language).

Let me emphasize this: Kanzi shows comprehension of a subset of normal spoken English, including the ability to analyze a variety of grammatical constructions, even sentences with subordinate clauses. Kanzi was tested with 660 novel, pragmatically anomalous, but syntactically correct requests to manipulate foods, objects, or tools, such as 'put the soap on the apple' or 'make the dog bite the snake.' It is crucial that many were intended to be anomalous,

that is, requesting specific actions that Kanzi never would have done or seen, such as 'take the lettuce out of the microwave' (Savage-Rumbaugh and Lewin 1994, pp. 170ff.).

The fact that these requests are pragmatically anomalous, and require doing things that are outside anything Kanzi has experienced, strongly bolsters the conclusion that he is not just using semantic analysis to guess at the meaning of sentences. In other words, there was meaning conveyed through the structure of the sentences, which Kanzi understood. His success rate was 74% for the entire set of 660 sentences. The same sets of sentences were tested on a human child of two and a half years, whose success rate was 65%.

Savage-Rumbaugh notes that many of the errors made by both Kanzi and the human child were semantic, not syntactic. Most important were sentences like 'Get the ball that's in the group room' Comprehending embedded phrases like this has been claimed to be uniquely human. In order to understand the meaning you have to know that one word refers back to a specific word that occurred earlier in the sentence, and you have to know that the second word changes the meaning of the first word in a specific way. Kanzi scored 77% correct on such requests. The human child's score was 52%.

In addition to showing decisive evidence of having learned word-ordering rules, Kanzi also spontaneously regularized symbol combinations to produce a minimal but consistent syntactic order in his output. These analyses were done on 723 spontaneous word combinations, taken from nearly 14,000 utterances recorded over a 5-month period (Savage-Rumbaugh et al. 1986).

It is important to emphasize that Kanzi's success can't be attributed to improvements in training methods – he learned to understand speech and use lexigrams in symbolic representation spontaneously, without explicit training, without being taught. Kanzi (and his younger sister, Mulika, who was a later participant in these studies) were not taught that lexigrams stood for objects and events; they were not taught the difference between requesting and naming (a challenge that had been nigh impossible for Nim to overcome); and they were not taught receptive language skills. In all, Kanzi tested on a par with 2- to 3-year-old human children, who are widely acknowledged to have genuine comprehension of spoken grammatically complex language, even when they can't reproduce it.

Why is this important for our understanding of language? It had been supposed (not to say assumed dogmatically) that what linguists saw as the unified human capacity for symbolic representation, grammar and language was *unique* to the human lineage. (That is, it appeared somewhere along the hominid line, and not earlier.) Kanzi is not human, but he has this capacity in some measure; I think that this means that some aspect of language capacity arose earlier in the lineage, perhaps in the common hominid/chimp ancestor, perhaps earlier (de Waal 1999).

If this capacity did arise in the common bonobo/human ancestor, this means that the capacity would also be expected to be found in the Common chimp, the other species of chimpanzee. Thus, the really valuable and crucial experi-

ment to do would be to expose a common chimp to an environment like Kanzi's. This was done by Brakke and Savage-Rumbaugh (1995a), with striking results. While previous attempts to get common chimps to show language abilities had been mitigated failures of various types, when the two species were reared together, bonobo and common chimp, in a 4 year co-rearing project, the results from the common chimp were startlingly different from any results before achieved. Brakke and Savage-Rumbaugh did find some differences in bonobo and chimp performance, but nevertheless found all the basic semantic, syntactic and spoken English capacities in both species. This experiment showed the strong effects of environment (and age of exposure) on language learning. As Brakke and Savage-Rumbaugh (1995b) note, these data "indicate that many of the neural prerequisites for basic language acquisition were in place millions of years before anatomical changes… further neuronal growth and reorganization… and cultural growth facilitated their growth and elaboration." (1995, p. 138).

Drawing their conclusions more widely, they note that "the skills that all three extant species [bonobo, chimp, human] have in common were within the capacities of an ancestral form of anthropoid that lived around 6 or 8 million years ago." Specifically, "the ability to comprehend simple speech, understand referential symbol use, and engage in intentionally communicative routines appeared to have developed prior to the emergence of language as we typically think of it" (1995, p. 140; also Brakke and Savage-Rumbaugh 1996).

Thus, in other words, the comparative inference seems to go through. If bonobos and human beings have homologous parts adoptable for similar functions, then so should their closest relatives. And they do.

I don't mean to say that Kanzi has our exact same language capacities. But he has demonstrated that he has the brain capacities and the inclination to learn symbolic representation and a simple grammar. This possibility is denied by those, such as Steven Pinker and Paul Bloom, who assert that human beings are the only ones with such capacities, and who have given evolutionary accounts for the uniquely human evolution of a monolithic language ability.

After having asserted that language is "a complex organ that [the human species] alone possesses," and having pointed out that natural selection is the only explanation for the evolution of a complex organ, and comparing the language organ – as an organ unique to a species – to an elephant's trunk, Pinker gives a long list of qualities that human language has but that no animal has yet demonstrated (1994). These include: reference; use of symbols displaced in space and time from the referents; creativity; categorical speech perception; consistent ordering; hierarchical structure; infinity; and recursion.

Since the Kanzi data have been interpreted to show several of these qualities, it's clear that Pinker has rejected these interpretations entirely. In dismissing the Kanzi (and Mulika) data, Pinker writes, Kanzi "is said to use the symbols for purposes other than requesting – but at best only 4% of the time" (Pinker 1994, p. 341) I'd note that putting it this way is a bit misleading. One of the things that Kanzi requested frequently was that one human being does

something to another human being – he wasn't asking for himself to be the recipient of a requested item. In these utterances, the order of the people named conveyed meaning; 'Jane Tom tickle' means that Jane should tickle Tom, not that Tom should tickle Jane.

Pinker also writes, "[Kanzi] is said to use 3-symbol 'sentences' – but they are really fixed formulas with no internal structure and are not even three symbols long" (1994, p. 341). (He must not have seen the data paper, Savage-Rumbaugh et al. (1986)). Pinker says nothing directly about Kanzi's astonishing language comprehension performance, but does write that chimps (or bonobos) don't really understand verbal requests: "True, some of the chimps can carry out these commands more reliably than a two year old child, but this says more about temperament than about grammar: the chimps are trained animal acts, and a two year old is a two year old" (1994, p. 339). It's hard to resist pointing out that humans are trained animal acts, too.

One way to understand what a big mistake this is, is to consider what could be going on with Kanzi. Clearly, no bonobo ever evolved to have a brain that could handle symbolic representation, that would spontaneously learn symbolic representation at some early point in development, or that would be capable of comprehending spoken English. Bonobos do not have the anatomy to have anything like the human form of spoken symbolic language, although they do have a wide range of utterances. The ability to create spoken language is, indeed, apparently *uniquely* human. Oddly, the ability to comprehend spoken language is not. This means that none of the capacities that Kanzi used to perform these linguistic abilities was designed by natural selection for such tasks; rather, that was just a feature of Kanzi's brain, which it could, under this extremely special environment, learn to do those things.

Deacon proposes that Kanzi learned symbolic representation and verbal comprehension so easily because he was so immature at the time. This idea, he says, "forces us to turn our attention away from an essentialist perspective, focused on the contribution of something intrinsic to the species (i.e., an innate language competence or predisposition), and to pay attention to the relevance of maturational factors" (1997, pp. 125–126).[1]

But it is reasonable to suppose that whatever it is about Kanzi's brain that allows him to do these linguistic things in this specialized environment, is some version of the basic characters that allow *us* to do these linguistic things in our cultural environments. It also seems obvious that, in the hominid lineage, those basic abilities to do linguistic things were modified and refined, but the key point here is that the human versions of the characters are *modifications, not novelties*.

[1]Gauker (1990) proposes seeing the representational aspect of language as less central than its function in manipulating and controlling the environment. This may be especially well suited for non-human primate language studies, as he suggests, but is meant to apply to human communication as well (1990).

Note that Pinker and Bloom's (1990) selectionist account of the adaptive value of language in hominid evolution does not need to be discarded altogether, even if the basic capacities go further back in the lineage. Presumably, there is an important selectionist story to be told about how somewhere along the hominid line, these brain capacities got recruited to do these linguistic jobs in most members of the species.

But the crucial thing is that one of the key mysteries of the Pinker and Bloom account – where and how this language module popped, fully formed, into the options on which selection acted – has just disappeared, once the comparative biology is actually done. The features of brains that make symbolic representation and grammar possible are features of ancestral ape brains, modified during the course of human evolution into serving their present crucial role in human identity and culture. To say that language capacity is properly understood as a matter of degree is not to say that there is no difference between Kanzi and me. But by taking the usual approach of focusing on the normal final phenotypes output from bonobo culture and human culture – that is, on the fact that Kanzi's family members don't have language abilities, while mine do – we are in danger of making a serious error. By focusing instead on the neurological capacities and on development, we avoid the error of placing the crucial brain evolutionary changes in the wrong place on the human phylogeny. People usually have assumed that the biological bases are hopelessly different, but Kanzi shows us that they are not, and that environment can make an important difference in final adult phenotype. There are, of course, limits to what difference environment can make, and ultimately, we would have to refer to species-wide genetic differences to account for the different levels of response that bonobos and human beings have to an environment of spoken English and symbolic representation.

To summarize the situation with this case: A number of theorists have supposed – and previous evidence supported this presupposition – that human beings are the only animals capable of symbolic representation and the comprehension of language through grammar or syntax. For the past 10 or more years, however, there has been increasing, statistically significant, experimental evidence that there is a bonobo, Kanzi, who is capable of these very things, although to a markedly lesser extent than most mature human beings.

Now, taking the standard approach to evolutionary reasoning, we would ordinarily reach the conclusion that the relevant main capacities in the respective lineages are homologous, i.e., they evolved from an ancestral capacity in the common ancestor of Bonobos, chimps, and human beings, a group that lived approximately 5 million years ago. This is simply a standard application of comparative method in evolutionary reasoning (see discussion in de Waal 1999).

However, if you have a prior, independent commitment to the idea that all language capacities are uniquely hominid, then you're faced with two choices:

First, you could say that Kanzi does not, in fact, have these capacities (and this is the approach most frequently taken). Noam Chomsky has, in fact, when faced with the data from Kanzi, stated, ''if an animal had a capacity as biologically sophisticated as language but somehow hadn't used it until now, it would be an evolutionary miracle, like finding an island of humans who could be taught to fly'' (*Discover*, March 1991, p. 20). As Susan Savage-Rumbaugh understates the matter, this view seems to suggest 'lack of biological sophistication.' (1994, p. 165).

In fact, there's not even the suggestion of a miracle here, according to perfectly ordinary evolutionary biology. In fact, Chomsky's line of reasoning seems to be that, *given that* language capacities appeared only in the hominid line, it would be a miracle if they appeared outside that line. This is what I call 'real anthropocentrism.'

Pinker's objections are perhaps equally confused. He goes on about the 'mistake' that people make in thinking that chimps, as the living species closest to us, 'must have some ability that is ancestral to language' (p. 346), and he notes correctly that the real question is whether chimpanzee or bonobo traits and human traits are *homologues*. But then Pinker changes the subject, from brain ability to features of language itself: [the] ''question is whether human language is homologous to – biologically 'the same thing as' – anything in the modern animal kingdom'' (1994, p. 358). Pinker admits that other primates are relevant to this question, but denies that they've been taught to produce real signs, to group and order signs consistently, to convey meaning, and to use them spontaneously to describe events, although each of these have been claimed. Most significantly, Pinker says that even if it is true that chimps or bonobos do produce signs in this manner, it's *meaningless*: ''Does that show that the human ability to learn language evolved from the chimp ability to learn the artificial sign system? Of course not, any more than a seagull's wings show that it evolved from mosquitoes. Any resemblance between the chimps' symbols system and human language would not be a legacy of their common ancestor; the features of the symbol system were deliberately designed by the scientists and acquired by the chimps because it was useful to them then and there'' (1994, p. 348).

Here are the three errors:

1. Mistaken reasoning from homology.
2. Switching focus from language ability in the previous sentence to features of human language itself.
3. Also, they are concentrating on a final adult phenotype, and not on the capacities of development. (Later, Pinker writes that ''brains can be rewired only if the genes that control their wiring has changed'' (1994, p. 351).)

Or, as a second approach to the Kanzi case, you could say that there has been some kind of independent evolution, which allows Kanzi to use part of his brain to learn these symbolic, syntactical, and speech comprehension skills, and that this part of *his* brain has no relation to the parts of *our* brains that learn these same things. This seems farfetched, and there is no evidence supporting it,

but it's certainly possible, although it goes against standards of comparative evolutionary biology (see esp. de Waal 1999).

There are, I think, two sources of error in operation here. The first is the mistake of not going far enough back in the lineage because of prior [methodological and ontological] commitments. These prior commitments about human uniqueness have traditionally been held for religious reasons, but, in the recent cases, I have no idea what their psychological or ideological origins are. It is sufficient to note that, as an hypothesis about the time of introduction of a trait, the idea ought to be subject to contravening empirical evidence.

The second error in reasoning is that these thinkers are not paying enough attention to *the context of development*, when interpreting what adult phenotypes really tell us.

Bob Berwick (1998 ms.) seems to realize the import of comparative method: "So, for evolutionists, true novelties or new traits in a single lineage like language – autapomorphies – pose the greatest challenge… When a *unique* trait appears in a single evolutionary line, comparison becomes impossible" (1998 ms.). (Note that this either begs the question or assumes that human language itself is the trait.) But Berwick thinks that we cannot do comparative method because we have no 'close' cousins. Berwick criticizes people who claim that we do have close cousins on the basis of the enormous overlap in human and chimp and bonobo DNA, because small differences in DNA can lead to huge differences in final adult phenotype. But Berwick seems to grasp the importance in developmental studies; he notes Deacon's work on the conservation of developmental patterns in DNA, e.g., the genes for tissues that have the potential of learning some aspects of language.

Nevertheless, Berwick appears to have amnesia about the best evidence to date: "If this conservation runs true to form, then the lack-of-cousins dilemma might be resolved: for then the re-use of existing bricks and mortar will be the norm, and we would expect that other organisms have a hidden potential for some of the same neurological biocomputations as language, if not exactly language itself. [So far, so good] That road may well be an impossible one, and certainly difficult – mice will never be able to talk –" (1998 ms.). But we don't need mice; we have Kanzi, as Berwick seems to have forgotten.

Here's one way to understand this problem about underestimating the role of development. If the goal is to determine the origins and timing of derived and ancestral traits, the adult phenotypes may be actively misleading, especially when social and cultural environment play central roles in developmental processes, as they do for all apes. It may, in fact, be more instructive to imagine comparing the fertilized human egg, and its full range of potential abilities, with the fertilized bonobo egg, with its full range of potential abilities. One thing Kanzi did show decisively is that maturity matters in all sorts of skills; these experimental results clearly depended on catching the bonobo brain earlier in its development, and growing it up in a language and symbol-filled environment. Actually, we already have abundant reasons, quite independent of Kanzi, for believing that comparing only the mature forms of social pri-

mates will incorporate heavy doses of socialization to a specific culture. Given this developmental knowledge, it makes little sense to compare only the adult, enculturated forms, if we want to make conclusions about capacities and potentialities.

In other words, in order to draw conclusions about *potentialities*, we must investigate them. We already know that natural-born, mature Bonobos didn't use symbolic communication, and couldn't understand English. It was a mistake to conclude that they didn't have the potentiality to do so. And it was an even bigger mistake to think that this said something about the hominid monopoly on linguistic abilities.

Conclusion

The evidential importance of ape language studies lies in their ability to reveal capacities, especially capacities that are hidden in the normal life of the apes. Capacities are significant because they can tell us something about the brains of our closest relatives, evidence that is crucial to the comparative studies necessary to nail down the timing of the emergence of language abilities. Abilities and capacities are not the same as language practices, a mistake that Pinker makes. Capacities require more in depth investigation and alteration of the environment. Such experiments do not, of course, demonstrate that apes have the identical capacities as human beings. But they do not need to, in order to be evolutionarily significant. The common claims that the various components of human language ability coevolved together, at some point in the hominid lineage, are belied by this evidence from non-human primates. They cannot be sustained. More sophisticated views are necessary, ones that allow that different features of language abilities may have arisen at different places and times in the evolutionary tree. Pinker acknowledges this type of cooptation for the production of spoken language (1994, p. 360), but denies that any of the ape language studies might possibly be relevant to understanding the evolution of language.

I believe that the developmental component of ape language studies, and the evidence they therefore provide for capacities, has been misunderstood by many. Ape language studies are not about what animals do in the wild, they are about what ape brains can possibly do if they grow up in a certain type of language rich environment. This evidence is relevant to comparative evolutionary inference, and cannot be dismissed just because it is not about natural apes. The treatment of the ape language studies by Chomsky, Pinker, Bloom, and even in the recent Hauser et al. (2002) paper, is, in my view, woefully inadequate. Hauser et al. don't even mention the Kanzi studies, even while they endorse the importance of comparative studies. There is, I've argued today, a value in *unnatural* studies that has not fully been taken on board by those writing about the evolution of language.

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