Origins of language — constraints on hypotheses

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Possible and impossible hypotheses of language origins

Contents

Preface

The origin of our capacity for language is a complex topic, requiring input from many disparate fields, from linguistics to paleoanthropology. Specialists in any one field are often unfamiliar with the evidence from other relevant disciplines.

I perceive a need for an integration of knowledge from all relevant fields, outside as well as inside linguistics, in a single work. My purpose in writing this book is to bring together the material needed for such an integration, and to take the first steps towards the synthesis needed for a thorough understanding of the evolution of language.

My principal aim here is not to "sell" any new theory of my own. What is novel in this work lies more in the synthesis of and drawing conclusions from existing data, and the systematic evaluation of existing theories. Throughout the book, it is my intention that the line of argument be data-driven, not theory-driven.

A large part of the book has the character of a scholarly review, presenting in a coherent manner the relevant evidence and theories from all the disciplines involved, with ample references to primary sources. From there I proceed to review different hypotheses proposed for the origin of language, and evaluate the hypotheses in the light of the evidence reviewed earlier in the book. This leads to firm conclusions concerning which hypotheses remain tenable, and which do not.

As the book is mainly aimed at linguists, I have chosen to place less emphasis in my review on evidence from linguistics proper, and more on fields with which a linguist may be less familiar, notably evolutionary biology, primatology, and paleoanthropology. At the same time, I have tried to keep the book readable for both linguists and non-linguists interested in the field of language origins.

An evolutionary perspective permeates the book. But I wish to emphasize here that by no means is the origins of language solely a question of biological evolution — cultural and cognitive issues are likely to have been at least as important as biology for the origin of human language, even though less hard data are available.

My own background is in a totally different field — I was originally trained as a physicist, and got my Ph.D. in particle physics in 1990 at the University of Lund, Sweden, and went on to a postdoc position in astroparticle physics. But my interests already then were broader than just physics, and I took a lot of extra courses on the side, actually ending up with second bachelor's degree in economics. And then, in the early 1990s, I took an introductory course in linguistics, taught by Professor Gisela Håkansson, still at Lund. And I was hooked... Thanks to Gisela for being such an inspiring teacher!

But unlike too many physicists, who come into a new field thinking they know it all, I didn't start right away writing the book to reform the field of language origins. Instead I got registered as a regular undergraduate in linguistics, went through all the courses, and eventually defended my master's thesis a couple of years ago (Johansson, 2002) — thanks to my advisor Jordan Zlatev, whose constructive criticism cleared away a lot of fuzzy thinking — while I was still making a living teaching physics.

I am currently associate professor of physics and assistant dean at the School of Education and Communication in Jönköping, Sweden, where I mainly work with teacher education. As a professor with a broad background at a small college, I'm teaching a wide diversity of courses, not just physics proper but everything from introductory philosophy to human evolution. Next year I'll be giving my first course in linguistics, with this book as the main text.

Chapter 9

HYPOTHESES OF LANGUAGE ORIGINS

The previous chapters have all dealt with various background material needed in order to understand the constraints on language evolution hypotheses. In this and the following chapters, the focus will be on the main issue itself — why and how and when did the human language capacity evolve among our ancestors? There are two main issues in explaining the evolution of any feature (Byrne, 2000):

- *Historical*: at what time, and at what point in the family tree, did different aspects of language appear?
- *Causative*: what were the selective advantages that drove the evolution of language, and what evolutionary precursors did it evolve from?

The causative issue is the main focus of chapter **??** and 10, with historical data used mainly to constrain causative hypotheses. Possible selective advantages are discussed in chapter **??** and possible evolutionary precursors in chapter 10. The main thrust of the current chapter is to clarify the structure of the problem.

It is clear from the previous chapters that there is much that we simply do not know about the human capacity for language, certainly concerning its history, but also concerning the details of its implementation in modern humans. It is far from well established exactly how and where the human brain processes language, and the links between linguistic theory and neurological observables are tenuous at best. This means that firm conclusions will be difficult to achieve.

A reasonable starting point in the analysis of the evolution of language, is the last common ancestor of us and the chimpanzees. Presumably this ancestor had roughly the same capabilities and exaptations that modern chimpanzees do, so what needs to be explained here is how we went from chimpanzee-like[1] to human-like linguistic abilities, in less than ten millions years. The principal questions to be answered here are the two that Bickerton (2001) succinctly express as *"How did meaningful units (words or signs) evolve?"* and *"How did syntax evolve?"*(p 583). All else is ancillary.

This removes quite a few areas from consideration, notably the entire sensory system — as shown in chapter 5, the senses of an ape are perfectly adequate for language perception already. Likewise, the apparent capacity for at least proto-symbolic thought (see p 131) and self-awareness (see p 153) among apes show that these two areas also can be dissociated from the origin of language.

At the opposite extreme, those unique human features that are exquisitely adapted for language, notably our vocal tract, cannot be invoked as explanations for the evolution of language either — language must have been in use *before* natural selection had any reason to adapt the vocal tract for it. So the vocal tract can be disregarded as well, at least in the early stages of language evolution. The vocal tract adapations can, however, be used to constrain the time frame of speech origins.

[1]The linguistic abilities of chimpanzees are not negligible, as shown in chapter 7, but we are concerned here only with the capabilities that humans have but chimps lack, notably the universal acquisition of and habitual use of a rich language with complex syntax.

9.2 Dimensions of language evolution hypotheses

There are several dimensions along which to classify hypotheses about how we acquired our language capacity. Among the more important ones are[5]:

- *Adaptation vs. spandrel*
- *Early vs. late*
- *Gradual vs. sudden*
- *Speech first vs. gestures first*
- *Innate and genetically determined vs. learned and culturally determined*

The dimensions should not be interpreted as either-or dichotomies, but as continua along which different hypotheses can be located at different points. The different dimensions are not totally disconnected from each other either. Hypotheses with early language tend to be gradual and adaptationist as well, and vice versa. And late sudden hypotheses tend to postulate that speech came first, rather than signs.

The available evidence from the preceding chapters constrains these five dimensions in various ways:

9.3 Adaptation vs. spandrel.

Evolution is a strong force for shaping our bodies and minds. But this does not mean that every single feature has been shaped by natural selection to perfection. Many aspects of our bodies may have evolved for some other use than their current function (exaptations), or may simply be accidental byproducts (spandrels) or leftovers (vestigial), with no particular adaptive function in themselves (Gould & Lewontin, 1979; Gould, 1997). Male nipples are a case in point — female nipples are obviously adaptive, but it is likely that males have nipples, not because they are of any use, but simply because both male and female embryos follow the same developmental program, and it's embryologically simpler to give nipples to both of them than to just one (Gould, 1992).

[5] Hauser & Chomsky & Fitch (2002) propose a related hypothesis space, but with three dimensions:

- *"Evolved as a unique adaptation for communication vs. some other computational problem"*, corresponding to my *Adaptation vs. spandrel*.
- *"Gradual vs. saltational evolution"*, corresponding to my *Gradual vs. sudden*.
- *"Uniquely human vs. shared with other species"*, which I have chosen not to include as an independent dimension. Some aspects are covered in my *Innate vs. learned* dimension.

(Dimension definitions quoted from Hauser et al (2002, fig 3, p 1571).)

From the point of view of language, the difference between exaptation, spandrel, or vestigial feature, really doesn't matter — neither of them evolved *for language*. Whether they have, or had, some non-linguistic use is beside the point.

And given that it is established beyond reasonable doubt that we, with all our advanced cognitive and linguistic abilities, have evolved from ape-like creatures lacking those features, it is not a matter of *whether* the features that we use for language are the product of evolution — they must be. The question is whether they were shaped by natural selection for linguistic purposes, or not. Botha, in a series of papers (2001a; 2002b; 2002a), attempts to show that there is insufficient evidence to establish either of these possibilities, mainly due to what he regards as various definitional and epistemological shortcomings in the literature that he reviews. But Botha, apart from spending too much effort on unhelpful word games, appears to have missed the point that either one or the other (or some combination) must be true, unless one wishes to postulate some model of language origins totally at odds with evolutionary biology.

Here, as elsewhere in this section on language evolution hypotheses, it must be kept in mind that these issues are not black-and-white dichotomies. Some language-related features may be adaptations, and others may be spandrels. And even a single feature may have a mixed origin, starting out as a spandrel and then being fine-tuned — adapted — for language.

But do adaptations or spandrels predominate among the features that we use for language? To begin with, there is a chicken-and-egg problem at the very beginning of language evolution — with no language at all there will be no selection pressure towards adapting our bodies and minds for language use, and without such selection pressure we won't be adapted for language use — implying that the first steps towards language had to be based on pre-existing features that had originally evolved for some other purpose. The co-opting of exaptations is thus a necessary *first* step in language evolution, or for that matter in the origin of any evolutionary novelty.

But what about language in its modern form? Pinker & Bloom (1990) argue strongly in favor of language as an adaptation, based on both its complexity and its obvious usefulness: "*Evolutionary theory offers clear criteria for when a trait should be attributed to natural selection: complex design for some function, and the absence of alternative processes capable of explaining such complexity. Human language meets this criterion:...*" (p 707). The argument is further elaborated by Pinker (1994; 1998a).

Carstairs-McCarthy (1999) on the other hand apparently consider language to be a pure exaptation, and Gould (1997) and Bickerton (1995) seriously consider the possibility of language being a spandrel. Chomsky (1988) can also be interpreted this way — he certainly argues that our mathematical ability is a spandrel (p 168f), but he is less explicit about language; the closest he comes is *"It surely cannot be assumed that every trait is specifically selected. In the case of such systems as language or wings, it is not easy even to imagine a course of selection that might have given rise to them."* (p 167). Neither of them, nor Botha (2002b), however, offers any strong counters to the complexity argument of Pinker & Bloom (1990) above.

Lightfoot (2000) presents a rather peculiar argument against language being an adaptation. To begin with, he brings up an ultra-adaptationist strawman that he calls a "singularist" (p 235), arguing that singularists believe that every single feature of every organism is adaptive in itself, and that nothing but natural selection ever affected any feature[6]. Then he goes on to argue that a specific grammatical rule, applied in a particular subcase, appears to be dysfunctional for that subcase, therefore that rule for that subcase cannot be an adaptation and must be a spandrel. Thus the strawman is defeated — but I doubt any real adaptationist (as opposed to strawmen) would deny that there exist features that have side effects that are not necessarily adaptive[7]; the main feature can still be an adaptation, shaped by natural selection, if its benefits outweigh the side effects. Furthermore, it is far from obvious that the the feature invoked by Lightfoot is actually dysfunctional — both Bickerton (2003) and Deacon (2003b) propose functional explanations for it. Nevertheless, Lightfoot seems to believe that he has ruled out adaptation as an explanation for this grammatical rule — and then in a total non sequitur he goes on to argue that *"of course, precisely the same could be true of UG as a a whole: UG may have evolved as an accidental side effect of some other adaptive mutation. [...] Natural selection may have played no direct role in the evolution of UG specifically."* (Lightfoot, 2000, p 245).

Evolution is a complex process, with many subprocesses. Natural selection is one of them, but nobody is claiming it is the only one — the question is how important it is, *how much* of the present state of, in this case, our biological language endowments, have been shaped by natural selection for linguistic purposes. Arguing like Lightfoot (2000) does not move that debate forward.

Andrews et al (2002) is a more serious discussion of how to disentangle natural selection from other evolutionary processes. It is not specifically about language, but more concerned with general principles of evolutionary inference. But its examples are largely picked from human cognition, so much of it may be adaptable to the case of language. In the article, Andrews et al analyze a number of related criteria that may be used to distinguish adaptation from non-adaptation:

[6] This particular strawman is not unique to Lightfoot (2000), it can be found also in e.g. Wuketits (in press) and in various other places in the anti-adaptationist literature.

[7] This is common enough in biology to have a technical term of its own, *pleiotropy* — see e.g. Futuyma (1998).

- Comparative evidence
- Fitness maximization
- Beneficial effects
- Optimal design
- Tight fit between feature and function
- Special design

None of these criteria is sufficient on its own — all are susceptible to both type I and type II errors, both failing to find adaptations when they are real, and finding adaptations where there aren't any.

The main conclusion of Andrews et al (2002) is that it is far from easy to demonstrate conclusively either that any particular individual feature is an adaptation, or that it isn't, but that the burden of proof must be balanced between adaptationists and "exaptationists". In an attached commentary Haig & Durrant (2002) add the crucial point that we should be less concerned with proof for or against adaptation, and more concerned with inference to the best explanation.

On a genetic level, it is possible to distinguish genes that have been subject to recent natural selection from genes that have changed merely due to random unselected mutations — the statistical distribution of gene variants in the population is different. It is interesting to note that the only known "language gene", FOXP2 (see p 103), shows a distribution in modern humans indicating strong natural selection (Enard et al, 2002; Pinker, 2003), which strengthens the case for language being an adaptation.

I find the case for language as an adaptation, at least in its full modern form, compelling. Both the complexity criterion of Pinker & Bloom (1990) and the majority of the criteria from Andrews et al (2002) listed above are amply fulfilled. This by no means excludes the possibility that language co-opted numerous other systems, either spandrels or exaptations, but the final assembly and refinement of the human language capacity into the exquisitely fine-tuned complex system we have today, must have been an adaptive process.

This conclusion does not, however, tell us to what extent this adaptation is a matter of biological evolution, and how much of it is cultural or memetic evolution, to what extent we are adapted to use language, and to what extent language is adapted to be used by us. That issue, already discussed in section 3.5.2, will be further addressed in section 9.7 below.

9.4 Early vs. late.

Did our language capacity evolve long ago, in the early stages of hominid evolution, or was language evolution a late development, taking place in anatomically modern *Homo sapiens*? “Early” would mean at least several hundred thousands of years ago, and possibly one or two million years ago, whereas “late” would be within the past 100,000 years or so. As noted earlier, the time frame of language evolution is not strongly constrained by either fossils or anatomy alone. Our biological language adaptations cannot be younger than 60,000 years or so, and are very unlikely to be younger than 100,000 years (see p 74), but they can in principle be much older. Exactly how much older depends on the language capacity of apes — but even without ape language, human language could have evolved at any time after our common ancestor with chimpanzees, 5 million years ago or more (p 50). Neither “early” nor “late” hypotheses can be firmly excluded on paleontological grounds alone, though “late” hypotheses with biologically based language faculties are severely constrained. Hypotheses in which language emerges through cultural evolution are less constrained.

The constraints get quite a bit firmer when the evolution of our speech organs and hearing is taken into account. As discussed in sections 5.1 and 5.2, there are signs of speech adaptations in Neanderthals, implying that the last common ancestor of us and the Neanderthals had some form of speech, pushing back the lower limit on the origin of speech to half a million years or so, effectively ruling out “late” hypotheses. It should be noted, however, that this does not mean that full human syntactical language has to be that old — some simpler form of spoken proto-language may be enough to drive the evolution of speech adaptations.

9.4.1 Art and technology as proxies for language?

The archeological record has frequently been invoked as support for the late, sudden appearance of language, due to the perception of a technological and creative revolution around 40,000 years ago.

Language use, of course, does not fossilize, at least not before the invention of writing, but other forms of symbol use may, and may be used as indicators that some level of symbolic abilities has been reached. The use of ancient art, including pigments and personal ornaments, as indicators that the artists were capable of symbolic thought, or even as an indicator that language had evolved (Mellars, 1998), is fairly common: “*The pieces of ochre, ... were clearly intended for decorative or ritual use. This proves that the people who made them must have been capable of subtle thought, and probably indicates that they spoke a language of syntax and tenses, Professor Henshilwood said.*” (Henderson, 2002, p 1, online version; see also Henshilwood et al (2004)). The logical connection from decorated ochre to grammatical details is, however, not overwhelmingly supported.

The supposedly sudden appearance of advanced art and advanced tools in the caves of Europe about 40,000 years ago is taken as evidence of a cognitive leap. However, the appearance of a sudden dramatic "cultural revolution" around 40,000 years ago, has turned out to be largely an illusion caused by the predominance of European sites in the documented archeological record, and possibly some Eurocentrism among archeologists (Henshilwood & Marean, 2003). *Homo sapiens* did indeed invade Europe rather suddenly about 40,000 years ago, bringing along an advanced toolkit — but that toolkit had been developed gradually in Africa[8] over the course of more than 200,000 years (McBrearty & Brooks, 2000; Van Peer et al, 2003). Kuhn et al (2001) remain skeptical of the interpretation of McBrearty & Brooks (2000), but later discoveries of less ambiguous works of abstract art (Henderson, 2002; Henshilwood et al, 2002; Balter, 2002a; Recer, 2002; Harms & Yellen, 2002) and personal ornaments (Henshilwood et al, 2004; Holden, 2004a) add further support to the long timescale of McBrearty & Brooks (2000). The debate over the supposed revolution is reviewed by Balter (2002c), Bar-Yosef (2002), and Henshilwood & Marean (2003).

Art is reasonably regarded as indicative of abstract and symbolic thought, and it is commonly argued, though not self-evident, that "*[a]bstract and symbolic behaviors imply language, ...*" (McBrearty & Brooks, 2000, p 486), but McBrearty & Brooks (2000) certainly have a point also in the less commonly realized continuation of the sentence "*..., but it is doubtful that the point at which they first can be detected coincides with the birth of language.*" (p 486). If we can observe signs of art or other symbolic behavior, we might infer, following the logic of McBrearty & Brooks (2000) and others, that the artists had language, but the converse does not apply — the absence of fossilizable art does not imply absence of language[9].

This inference from art to language, or at least from art to symbolic capacities adequate for language, is interesting in view of the additional evidence that has been uncovered recently that appears to show that simple art actually predated the appearance of anatomically modern *Homo sapiens* (Keys, 2000; Bahn & Vertut, 1997), in the context of *Homo heidelbergensis* or possibly even *Homo erectus*. Objects that can reasonably be interpreted as art have been found associated also with Neanderthals (Appenzeller, 1998; Wynn & Coolidge, 2004; d'Errico et al, 2003), though much simpler than the figurative art of later *Homo sapiens* (Conard, 2003), which would push back the origin of the biological capacities needed for art at least to the common ancestor of Neanderthals and us, some 500,000 years ago. And given that the symbolic

[8]According to d'Errico (2003), there are precursors also at Neanderthal sites in Europe, and Hovers et al (2003) present ochre finds from modern humans in the Middle East from around 100,000 years ago.

[9]For that matter, the absence of fossilizable art does not even imply the absence of *art* — most art among modern humans isn't fossilizable, and it is not difficult to imagine a long period with only perishable art (body painting, wood carving, etc.) before anybody got around to making stone statuets or painting in deep caves.

capacities needed for art are also needed for language, and are interpreted by some as indicative of the presence of language, this adds support to the possibility of an early appearance of language, in agreement with the limits inferred from anatomy on page 168. As for art itself, as a cultural phenomenon, either independent invention in both lineages, or horizontal memetic transfer between us and Neanderthals, are conceivable, but a common origin of art may still be the simpler hypothesis. So far, we have insufficient data for any firm conclusions on that point.

One serious problem with the inference from art to human language, is that traces of both proto-symbolic thought and artistic acitivites have been observed in apes. Both chimpanzees and gorillas happily produce paintings when supplied with canvas, brushes, and paint. And at least one language-trained ape has even been reported to describe what her works of art represent (Patterson & Linden, 1981), which would seem to indicate that the apes themselves regard their art as representational. One could, rather optimistically, argue that chimps have the capacity for both art and language, saving the inference, but making it useless for elucidating the history of *human* language. The alternative appears to be to exercise caution in drawing conclusions from art to language.

A related argument is that of Barnes (1997), who postulates language as a requirement for religion, for much the same reasons as for art — religion requires the ability to reason symbolically about abstract categories. Müller (1866) proposed instead a more direct role for religion in the origin of language, with religious awe as the root of the need for speech (Gans, 1999c).

Archeological data on the origins of religion are unfortunately sparse and controversial — much Paleolithic art, from statuets to cave paintings, has been interpreted in religious terms, but other interpretations cannot be excluded (Bahn & Vertut, 1997). The same is true for prehistoric ceremonial burials (Gargett, 1999). This uncertainty means that the religious argument adds no constraints to the possible origins of language.

9.5 Gradual vs. sudden.

Did we acquire our language capacity in one single step, without intermediate forms, or did we go through a long sequence of successive proto-language stages?

To begin with, it should be noted that there is perennial confusion over the word "sudden" as used in deep historical and geological contexts. A process that took, say, 10,000 years would appear very gradual to the participants — but would appear instantaneous in the fossil record to paleontologists working a million years later, and would be labeled as a "sudden" event by them. Many evolutionary transitions belong in this category of events that are paleontogically sudden but on human timescales gradual, and this is the root of the debate surrounding "punctuated equilibrium" (Eldredge & Gould, 1972)

— the hypothesis of punctuated equilibrium proposes that evolutionary transitions are *geologically* sudden, not necessarily sudden on human timescales: *"... the punctuations of punctuated equilibrium do not represent de Vriesian saltations, but rather denote the proper scaling of ordinary speciation into geological time.*" (Gould, 2002, p 768).

However, most proponents of gradual evolution of language intend the process to be geologically slow, and most proponents of sudden evolution are saltationists, talking about a single jump from ape-like to human-like language abilities, so this problem is not severe when it comes to differentiating between hypotheses in this context. What is a problem, however, is that Gould's point in the quote above is commonly forgotten, and Gould is often cited in support of saltationism (cf. footnote 2 on p 12).

Another problem with this dichotomy between gradual and sudden language evolution, is that both sides are primarily discussing the biological evolution of the human language capacity. But biology is only one aspect of language evolution and, as discussed in section 3.6, the aspect slowest to evolve. Cultural and memetic evolution is relevant as well, and can be orders of magnitude faster.

But regardless of whether we are discussing biology or memetics, the sudden single-step evolution of something as complex as the human language capacity is highly problematic. If we have an innate dedicated "language organ" and a universal grammar that is genetically specified at the level of detail assumed in e.g. Lightfoot (2000), with genes for individual grammatical rules, this requires a large number of highly specific genes working together in a coordinated pattern. And the simultaneous *de novo* evolution of many coordinated genes is so utterly unlikely that "sudden" hypotheses in that case become totally untenable without divine intervention, *contra* Chomsky (1988) and Bickerton (1990)[10]. The only context in which "sudden" single-step hypotheses are not totally ridiculous is if most of the bodily and cognitive features that we use for language evolved for some other purpose, and were available as exaptations, with only some minor additional change needed to put all the pieces together as a workable language organ, and even then some intermediate stages of proto-language would appear necessary to render the hypothesis evolutionarily plausible. Carroll (2003) definitely has a point in that *"the temptation to invoke macromutational models for 'rapid change' [...] must be resisted in the absence of genetic evidence.*" (p 852).

When discussing language evolution, the prerequisites for evolutionary processes (listed on p 12) must be kept in mind. An important point here is that heritable variation in language abilities is necessary, otherwise there is nothing for

[10]It should be noted that Bickerton himself has now acknowledged that his earlier position was biologically ridiculous — see footnote 2 on p 80 in Bickerton (2003).

natural selection to select. To the extent that language is innate, this heritable variation must be genetic. For gradual language evolution to be tenable, the variations ought to be of rather modest magnitude, whereas hypotheses of sudden language origins ought to predict all-or-nothing variation, either full language capacity or nothing at all.

As was shown in section 5.3.3 in the context of SLI, the evidence supporting the existence of genes that affect language is quite compelling, at least in the case of FOXP2. But FOXP2 defects (and SLI in general) only cause partial loss of language, not the total loss that would be expected if language were the result of a single macromutation. Furthermore, Stromswold (2001) finds strong evidence of a heritable component in the existing variation in language abilities, even between people with no evident language abnormalities. The existence of such small-scale genetic variability is consistent with expectations from gradual, but not sudden, hypotheses.

One might invoke also the non-negligible heritability of verbal IQ, but it is unclear both to what extent verbal IQ is independent of other cognitive abilities (Alarcón et al, 1999), and to what extent verbal IQ actually measures language abilities in the sense relevant here.

Pinker & Bloom (1990) add some more data and anecdotal evidence supporting variability in our syntactic abilities, but they also point out that, while feeding on variation, natural selection also eliminates variation — if only the most able individuals breed, and their offspring inherit their abilities, the spread in ability will decrease with each subsequent generation, unless new variation is added in the form of mutations. Early hominids may well have varied in linguistic abilities, even if little such variability had remained today.

Also to be considered in this context is the argument, usually based in the Chomskian paradigm, that our language capacity is a monolithic universal grammar module (Chomsky, 1982), a unified whole in which variation is logically impossible. But there are several ways around this argument:

- Even if grammar, as an abstract entity, may be monolithic, its implementation in our brain may be more or less efficient — even if all people use the same universal grammar, it is possible that some can acquire and process language faster and easier than others. That shows us a conceivable evolutionary path from an initial state where the same grammar was handled in a slow and muddled way by whatever cognitive and heuristic abilities were available, through more and more efficient neural circuits, towards the modern human brain with which we effortlessly acquire language at an early age.

- It is not self-evident that grammar actually is monolithic, with no imaginable partial proto-grammar. We'll return to this point in section 10.4 below.

- The existence of SLI and aphasia patients with partial language deficits demonstrates that blocks can be taken out of the "monolith" without the total collapse of language.

- The gradual evolution of tightly coupled apparently monolithic systems was discussed on page 16, and there is no reason to believe that the conclusion there isn't applicable to language. The fact that for Chomsky *"...it is not easy even to imagine a course of selection* [towards language] ..." (1988, p 167) is not a strong counterargument. Pinker (2000) has a better case when he states that *"the game theorists have demonstrated the* **evolvability** *of the most striking features of language..."* (p 442, emphasis added).

Another aspect of this is "Chomsky's paradox" (Li, 1997), the apparent contradiction between the apparently highly optimized universal grammar, and the generally non-optimized "bricolage" (Duboule & Wilkins, 1999) character of evolved systems (Botha, 1999). But, as Li (1997) shows, this contradiction is only apparent, and not a serious argument against language being a product of evolution. Likewise, Newmeyer (1992) argues that autonomy of grammar does not exclude functional explanations, from which it follows that evolutionary ones are not excluded either. Jackendoff (cited by Botha (1999)) instead resolves the paradox by arguing that language isn't perfect, that it does have the patchwork character typical of evolved systems.

In conclusion, the gradual evolvability of our apparently monolithic grammar is far from excluded (Pinker, 1994; Jackendoff, 1999b). And given the near-impossible odds against the single-step appearance of something as complex as language, we can conclude that the evolution of language is overwhelmingly more likely to have been gradual, in the sense of entailing many small evolutionary steps, rather than a single leap. If biological evolution dominated the process, as it would have to if language is innate in any strong sense, then the process can be expected to be geologically slow. On the other hand, if language is largely the product of memetic evolution, then even a gradual process may appear geologically sudden.

9.6 Speech first vs. gestures first.

Did language first evolve in the spoken modality dominant today, or was another modality, presumably gestures, used in the early stages?

Darwin (1872) felt quite certain about the origin of language:

> *I cannot doubt that language owes its origin to the imitation and modification, aided by signs and gestures, of various natural sounds, the voices of other animals, and man's own distinctive cries.*

(Darwin, 1872, p 56)

Unfortunately, this is one of the rare cases where Darwin's intuition led him partially astray — there is good reason to doubt the homology of animal calls and human speech[11]. This means that it is not self-evident that language started with sounds, precursors to the speech modality. The "signs and gestures" that Darwin invoke as aids may conceivably have been the main modality of early language instead.

Language *per se* is basically modality-independent, as long as the modality used supports a sufficiently rich structure. In modern society, a large fraction of all language use is written rather than spoken. If anything, the written modality supports more complex language than the spoken. Other alternative modalities can easily be imagined, and quite a few have been used, both in ape language experiments[12] (see chapter 7) and in the teaching of severely retarded non-speaking children (Savage-Rumbaugh & Lewin, 1994).

Written language is of course derived from spoken in evolutionarily recent times, and so it is not highly relevant to the origin of our language capacity[13]. But another alternative modality, sign language, is more interesting in this context. Sign language, just like spoken or written language, is a *bona fide* language (Sandler, 1993; van der Hulst & Mills, 1996), with all the functionality of any other modality.

That the first human language was a sign language, fully or partially based on gestures, is a possibility conjectured by Condillac (1746, cited in Wells (1987)) and Darwin (1871, cited in Radick (2000a)), popularized by Auel (1980) and Reeves et al (1996) and discussed more seriously by Stokoe (1978), Corballis (1992; 2002; 2003), Mueller (1996), Armstrong et al (1995, cited in King (1996)), Rizzolatti & Arbib (1998) and Miklósi (1999), among many others.

Sign language displays the same features as spoken language, not only in its mature form, but also in its development and in its neurological organization. Children of deaf signing parents "babble" in sign language during their early development (Petitto & Marentette, 1991; Berent, 1996; Petitto et al, 2001b), start signing at the same age and with the same basic vocabulary as the first words of hearing children (Cheek et al, 2001), and their further development goes through basically the same stages as hearing children (Locke, 1997). In the case of bimodal bilingual children, simultaneously acquiring both a signed and a spoken language, the parallels are very clear, with the same child attain-

[11] But see Cowley (2002).

[12] An interesting case is when the two chimps Sherman and Austin (p 131) apparently invented a new modality on their own, spontaneously, when deprived of their usual computerized system (Savage-Rumbaugh & Lewin, 1994).

[13] Nevertheless, Clark (2000) appears to be arguing that writing came first: "*Pinker observes that speech may be an instinct, but not writing, but it can be argued that the written form is older.*" (p 411-412). But I find it difficult to take his proposal seriously, and will not consider it any further here.

ing various linguistic milestones simultaneously in sign and speech (Petitto et al, 2001a). The formation of pidgins and creoles have been observed among deaf people (Goldin-Meadow & Mylander, 1998; Goldin-Meadow, 1999; Helmuth, 2001a). Brain lesion studies, as reviewed by Hickok et al (1996; 1998a; 2001), show a pattern of sign language aphasia among the congenitally deaf that resembles speech aphasia among hearing patients in the correlations between deficit patterns and affected brain areas. Likewise neuroimaging experiments (Neville et al, 1998; Hickok et al, 1998b) see similarities between speaking and signing[14]. There are also minor differences between speech and signing in the brain, but it is unclear how much of this is simply attributable to the different sensory and motor areas involved.

Even among people using spoken language, gesturing is firmly wedded to language use (Goldin-Meadow, 1999) — your hands are likely to be moving even when you are talking on the telephone, and even congenitally blind people (who can hardly have acquired the habit by observing others) gesture while speaking, also when addressing a blind listener (Iverson & Goldin-Meadow, 1998). Normal hearing children acquire the use of symbolic gestures in parallel with speech acquisition (Acredolo & Goodwyn, 1988), and there is some evidence that gesturing actually precedes speech in acquisition (Goodwyn & Acredolo, 1993; Goldin-Meadow, 1999). At the very least, gesture is as important as speech in early child communication, before the advent of rudimentary syntax in the two-word stage (Iverson et al, 1999).

And the manual dexterity required for gesturing is present in many primates, including our closest relatives (see chapter 7), so it is reasonable to assume that it has been present for a long time among our ancestors, tens of millions of years at least. Apes also have the cortical control of their hands needed for sign language (Corballis, 1999), while lacking the corresponding vocal control, as discussed on p 81 (though a complication is that they also appear to lack voluntary control of facial expressions, ubiquitously used in human gestural communication (Premack, 2004)). Accordingly, wild chimpanzees can communicate voluntarily and flexibly with gestures, whereas their vocalizations are mainly involuntary (Tomasello, 2003). Interesting in this context is that in chimpanzees fine motor movements of the hands are frequently accompanied by sympathetic mouth movements, hinting at a possible path from gestures to speech (Waters & Fouts, 2002).

[14]Including the surprising observation that brain areas normally used for auditory processing are involved in sign processing in congenitally deaf individuals (Nishimura et al, 1999; Hickok et al, 1998b). Petitto et al (2000) make the same observation, and conclude that the brain areas traditionally believed to handle auditory speech processing are in fact more general modality-independent language modules. An alternative explanation could be that these brain areas are indeed auditory in hearing people, but lie fallow in deaf people and are recruited for sign processing.

Mimesis (or mimetics[15] — not to be confused with memetics; see p 23) concerns the art of miming or, as Donald (1997) puts it, *"us[ing] the whole body as a representational device"* (p 4, online edition) or *"...as a communication device..."* (p 6), which both Donald (1997) and MacNeilage (1994) regard as a vital first step in the evolution of language. It is not an unreasonable suggestion that miming, imitating, and pretending can be regarded as proto-symbolic activites that may be related to the origin of language, particularly if language started in a gesturing modality, for which miming abilities are plausible exaptations — modern sign languages still have considerable mimetic components (Newport, 1982). A possible mimetic origin for syntax was discussed already by Condillac (1746) and Reid (1765).

Zlatev (2001a) identifies a mimetic stage in human ontogeny, at which preverbal children acquire awareness of self and others, and take the first steps on the road towards social communicative competence, using miming and gestures for communication. This stage, and the self-consciousness and social interactions that it entails, *"appears to be the only way to acquire true meaningful language."*, according to Zlatev (2001a, p 179). The role of mimesis in language ontogeny is further discussed in Vihman & Depaolis (2000).

There is little clear evidence of mimesis in apes, but it is not unknown in dolphins (Bauer & Harley, 2001).

The hypothesis of Rizzolatti & Arbib (1998), that the roots of language can be traced to the so-called "mirror neurons", has some parallels with mimetics, but has a neural rather than a behavioral basis. "Mirror neurons" make up a neural system that is activated both by performing a certain action, and by observing — either seeing or hearing (Théoret & Pascual-Leone, 2002; Buccino et al, 2003) — the same action performed by others. This is very likely part of the neural basis of imitative learning, with the mirror neurons performing a high-level synthesis role in the network of neural connections reviewed by Schaal (1999). Rizzolatti & Arbib (1998) hypothesize that the mirror neurons also led to a system of gestural communication, with iconic gestures mimicking the action that's the topic of communication. The gestural system would have included both manual and oro-facial gestures, with speech growing out of the oro-facial gesturing system. It is interesting to note that the mirror system in monkeys is located in their equivalent of Broca's area (Schaal, 1999; Théoret & Pascual-Leone, 2002). However, even though we share the mirror system with monkeys and apes, apparently located in our Broca's area (Iacoboni et al, 1999; Buccino et al, 2003), there are qualitative differences between the imitative learning of humans and other primates (Call & Tomasello, 1995; Tomasello et al, 1993; Nagell et al, 1993, but see also Voelkl & Huber

[15] Clark (2004) makes a distinction between mimesis — telling-by-showing in general — and mimetics — mimesis with sounds only, onomatopoeia.

(2000)) — but interestingly enough, enculturated apes who have grown up with humans show human-like imitative learning (Tomasello et al, 1993; Bjorklund et al, 2002).

But if language did first evolve in a gesturing modality, why did we switch to speech? This question can only be answered speculatively, but there are obvious advantages of speech over gestures:

- Speech is more efficient, using less time and energy (Knight, 2000).
- There is no need to see each other, an advantage in the dark, or in heavy vegetation (Rousseau, 1755).
- Speech calls attention to the speaker in a way that gestures do not (Rousseau, 1755).
- The hands are not needed for communication, making it possible to work or carry things while communicating (Carstairs-McCarthy, 1996).

Sign language has corresponding advantages in very noisy environments, or when stealth is an issue, situations in which people even today communicate with gestures. One can well imagine a gradual transition from gesturing to speech, with intermediate stages similar to those depicted in Auel (1980), in which sign language is augmented by a few sounds.

Bradbury & Vehrencamp (2000) review the economic viability of communication systems, setting a lower limit for the accuracy of signal coding, below which it is not worthwhile for receivers of signals to pay any attention to their content. In this model, it makes sense for communication systems to start out by using as signals such behavior that potential receivers have already evolved to pay attention to for other reasons. Much animal communication can readily be interpreted within such a framework. It is unclear, but would be relevant to investigate, whether hominoid vocalizations or gestures are better from this perspective.

An alternative possibility is that gestures and speech were used in parallel in the beginning, while the production and reception of both modalities were still in their infancy (Bickerton, 2003). According to Rowe (1999), such multicomponent signaling improves detectability and discriminability beyond that possible with either component alone.

If gestures came first, then this implies early language, since anatomical speech adaptations turn up in fossils well before the postulated time frame for late language.

Alternatively, if speech came first, then we have two possibilities:

- Early speech, gradually evolving in articulation, starting with the sounds that apes can produce, with selection pressure from speech driving the anatomical reconstruction of the speech organs. This kind of coevolution of speech organs and language is evolutionarily plausible.

- Late speech — but this is problematic for the same reasons as late signing; language must be in place before obvious anatomical language adaptations.

In either case, language evolution must be well underway before the anatomical speech adaptations can be selected for. And since some of these adaptations go all the way back to the last common ancestor of *Homo sapiens* and Neanderthals, more than half a million years ago (see p 80), this effectively rules out late language.

9.7 Innate and genetically determined vs. learned and culturally determined

Reviewing the full debate on whether language is innate in humans, and if so, what this means[16], is beyond the scope of this book. On one level, innateness is hardly controversial in the limited sense that Chomsky alluded to when he said *"I have no idea what the phrase* [innateness hypothesis] *is supposed to mean and correspondingly have never advocated any such hypothesis — beyond the truism that there is some language-relevant distinction, ... , between my granddaughter and her pet kitten (...)."* (Chomsky, quoted in Stemmer (1999)) — it is self-evident that humans have innate, genetically determined language-relevant abilities that kittens don't. It is also uncontroversial that language is learned, in the limited sense that the particulars of individual languages aren't innate.

What is controversial, however, is to what extent the innate abilities that we unquestionably do have are specifically linguistic, and to what extent they constitute a genetically hardwired "universal grammar". Chomsky, e.g. (1965), as well as other linguists working within the Chomskian paradigm, e.g. Pinker (1995), commonly make much stronger claims about innateness than Chomsky's kitten quote above. But the debate is often unnecessarily polarized — it is not a matter of total genetic determinism on one side, and total *tabula rasa* conditioning on the other (Seidenberg & MacDonald, 1999; Jackendoff, 1999a), despite the rhetoric of both sides. Innateness is more complex than that (Khalidi, 2002).

The claims of "strong innateness" rest on two main pillars:

- The universality of certain language features (Chomsky, 1988). Particularly compelling is the emergence of the same universal features in the indepen-

[16]Innateness is a somewhat problematic concept, lacking a clear and coherent definition — see e.g. Scholz (2002) for a brief review of the complexities involved.

dent origin of creoles (Bickerton, 1995, but see also Owens (1990) and Mufwene (2002))[17].

- The poverty of the stimulus (Chomsky, 1965; Chomsky, 1986; Laurence & Margolis, 2001) — the impossibility of language acquisition without having the central concepts of language available *a priori*, in an innate language acquisition device (LAD) (Chomsky, 1965; Wanner & Gleitman, 1982).

  This is not just a practical matter of learners receiving insufficient and too noisy input — it is argued that, as the space of all possible grammars is infinite, it is impossible in principle to identify the target grammar of acquisition without innate constraints on the search space. There is no learning algorithm that can learn an arbitrary language from finite input, without constraints (Gold, 1967, cited in Komarova & Nowak (2003)).

Arguments against innateness take several different forms. Laurence & Margolis (2001) review and dismiss a variety of philosophical objections; I choose instead to focus on empirical issues, particularly from outside linguistics proper:

- The poverty of the genes. We simply don't have enough genes to specify in detail all the complex neural connections in a putative language organ (Mueller, 1996) — no more than 30,000 or so[18] have to account for the entire human body and brain (Pääbo, 2001; Claverie, 2001). Even when the number was still believed to be twice as large, this was regarded as a severe problem for any hypothesis proposing detailed genetic specification of our cognitive capacities (Buller & Hardcastle, 2000). The problem is exacerbated by the fact that we share the vast majority of those genes with the other apes. Changes in gene expression and regulation can explain quantitative differences easily enough — but complex and truly unique human features place a heavy burden on the tiny number of non-shared genes. Worden (1995), discussed in section 3.6, calculates a very low limit, a few kilobytes, on the amount of new genetic information that can have accrued in our genome since our last common ancestor with chimps — if his limit is accurate, this severely limits any innate differences between us and chimps,

[17]DeGraff (2003), a linguist who happens to be a native Creole speaker, objects quite strongly to how Bickerton and others portray Creole languages, arguing basically that Creoles are no different from any other languages, and should not be treated as primitive "linguistic fossils".

[18]Two caveats are in order here:

– Processes such as alternative splicing can produce more than one protein from one gene.

– New patterns of gene expression can re-use the same gene in new contexts.

But neither of them changes the effective number of genes by the order of magnitude needed to affect the substance of the argument (but see also Marcus (2004)).

leaving barely enough room even for the obvious bodily differences, much less any universal grammar. Lorenzo & Longa (2003) argue that Chomsky's Minimalist program requires just a small number of genes for the specification of its postulated innate components, but I do not find their argument compelling — see p 38.

- Brain development is highly plastic (see p 110), and dependent upon the sensory impressions received at an early age (Wong, 1995; Mueller, 1996). Those systems that are understood in more detail (like vision; see p 110) are *not* genetically hardwired in the detailed sense that an innate grammar would need to be[19]. Instead, only the rough outlines are laid down genetically — the optical nerve is led to the occipital lobe of the brain under genetic control — and the detailed neural connections are then gradually formed and pruned, in response to the sensory data received during a critical period. That language acquisition is not handled by a hard-wired device in a specific location in the "language areas" of the brain is demonstrated by the fact that language acquisition can follow the normal pattern even if the entire left hemisphere of the brain is absent (Stowe & Haverkort, 2003).

- Language universals may have other causes than an innate grammar. And how universal are they really? Linguists who search for universals in language will generally find what they are looking for. But what conclusions can be drawn from this? Here is a list of some conceivable ways of explaining language universals without innate grammar:

  – When complex sets of data are studied and analysed, spurious structures and correlations are often found even when in reality there are none whatever. As a physics student, I was frequently reminded of the danger of over-interpreting complex datasets — is this problem excluded in the search for Universal Grammar? Tomasello (2003) questions the reality of grammatical universals, apart from those deriving from general cognitive considerations, arguing that they are based on a too-narrow sample of languages, or on forcing "odd" languages into a prescribed form, making the argument for universals circular.

  – Many similarities between languages may be adequately explained by their having a common origin. It appears quite likely that *all* human languages have a common origin, if one goes far enough back in time — otherwise one would have to assume that language was independently developed by several distinct groups of proto-humans. This is

[19] Smell is an apparent exception (Barinaga, 2001), but smell is evolutionarily ancient, and does use up a very large number of genes, about 5% of the total number of genes in our entire genome.

certainly possible, but the evolution of a *single* innate universal grammar, common for all mankind, actually *requires* that all languages have a common origin, spoken by the first people to evolve UG, in order to be compatible with standard Darwinism. And if a common origin has to be postulated anyway, why not let this common origin explain the universal features — to introduce innateness at this point would seem to go against Occam's razor.

- All extant languages have been acquired by human children. Biases in the acquisition system — which need *not* be a matter of innate grammatical principles — can shape what form of language is acquired. The observed universals may reflect more general acquisition biases, rather than specifically an innate grammar (Kirby & Christiansen, 2003). Languages, as memetic species, will adapt to be acquirable by whatever cognitive equipment children have — are universals the result of natural selection among languages?
- In order to be a useful instrument for communication, a language has to meet certain basic criteria. Is it possible that some principles of Universal Grammar can be explained by their being, logically or pragmatically, *necessary* features of a language? Deacon (2003b) develops this idea further, invoking semiotic constraints — symbols have to connect with their referents in a way that can be parsed — to explain the universal features of grammar[20].

■ The impossibility of language acquisition without an innate language acquisition device is not self-evident[21]. To begin with, this argument is based

[20]Paradoxically, this would make Universal Grammar *more* universal than the innatist UG — the semiotic constraints apply not only to human language users, but to *any* symbolic system of communication. UG would be truly universal in the same way, and for the same reasons, as mathematics.

[21]In an interesting twist of logic, Bever (1982) reverses the logic of the impossibility argument. The standard syllogism of the impossibility argument can be stated as follows:

1) Language has property P_i

2) P_i cannot be learned by any known theory of learning

3) Therefore P_i is innate

But what about this syllogism:

1) Language has property P_i

2) P_i cannot be transmitted by any known genetic mechanism

3) Therefore P_i is learned

(Adapted from Bever (1982), p 432)

It is not self-evident that one syllogism is more valid than the other. Bever (1982) proceeds from this point into an odd Platonic essentialist view of language; I prefer to regard this as a challenge to premise on particular assumptions about what is actually acquired in language acquisition. "*The notion of what constitutes important evidence for learning a particular structure is not theory-neutral.*" argue Seidenberg & MacDonald (1999, p 575), who make a distinction between the abstract "competence grammar" that is central to the Chomskian approach, and the more pragmatic learning for functional communication that they see as the primary goal of language acquisition. This undercuts the "poverty of the stimulus" argument in that "*... many of the classic arguments rest on the assumption that the child's task is grammar identification, and these arguments simply no longer apply if the task is instead acquiring the performance system underlying comprehension and production.*" (Seidenberg & MacDonald, 1999, p 574). Similarly, Clark (2001), using a statistical instead of a symbolic grammar in his computer model, "*conclude[s] that the Argument from the Poverty of the Stimulus is unsupported by evidence.*" (p 1).

But even within the Chomskian paradigm, the issue is not entirely clearcut. E.g. the lack of negative evidence in the learner's input is frequently cited as evidence against learnability (Marcus, 1993; Marcus, 1999b; Pinker, 1995), but Saxton (1997) and Strapp (1999) provide examples of negative input that children may use. Furthermore, comprehension comes before production in language acquisition (Bates, 1993; Burling, 2000; Newmeyer, 2003a) — and there is no shortage of negative feedback for miscomprehension (Savage-Rumbaugh, 1990; Savage-Rumbaugh et al, 1993).

And the speech that language learners hear is rather different from normal adult discourse. Surprisingly young children can exploit linguistic and non-linguistic cues as an aid in speech perception and language acquisition (Shady & Gerken, 1999). As is well known, those adults who interact with language acquirers enrich their speech in such cues, sometimes to the point of nongrammaticality (Chafetz et al, 1992), creating what is known as "motherese"[22] (Elliot, 1981; Pinker, 1995), "parentese" (Chafetz et al, 1992) or "child directed speech (CDS)" (Rivero, 2004) when directed towards children, and "teacher talk"[23] (Håkansson, 1987) when directed towards adult learners. Even phonetic contrasts are enhanced (Kuhl et al, 1997), making phonemes easier to distinguish, and the segmentation of speech into words is facilitated by many parents commonly using isolated words rather than full sentences (Wagner, 2001b). The gestures that ac-

2 of both syllogisms. Premise 2 of the first syllogism is related to the classical 'Poverty of the stimulus' argument, but contains also more general learnability arguments, whereas premise 2 of the second syllogism is similarly related to the 'Poverty of the genes' argument above. Whether either poverty argument is valid, is an empirical issue that remains to be settled.

[22] A usage which I, being a father, consider sexist.

[23] Why not "teacherese" ?

company speech are likewise modified into a “gestural motherese” that may function to reinforce or disambiguate speech (Iverson et al, 1999). Child directed speech is pragmatically adapted to the communicative competence of the child, with interactions kept very simple for the first nine months, and then increasing rapidly in complexity (Rivero, 2004). There are, however, examples of cultures where speech to children does not appear to be adapted like this, without obvious ill effects on language acquisition (Pinker, 1995).

- The timing of language acquisition, and particularly the relative timing of monolingual and bilingual acquisition, does not support the existence of an innate Universal Grammar (UG).

  In a simplistic form, my argument here is that, if children do have UG innate, then no time is needed to acquire it. All the time a child uses for language acquisition is then spent on acquiring the particulars (lexicon, parameter settings, etc) of whatever language(s) the child acquires. Acquiring two languages doubles the amount of particulars to learn, which ought to double the acquisition time. Thus, the innateness hypothesis predicts bilingual acquisition to be much slower than monolingual, contrary to observations.

  More formally, the argument can be expressed as follows:

$$t_{a1} = t_{UG} + t_\ell \tag{9.1}$$

$$t_{a2} = t_{UG} + t_{\ell i} + t_{\ell j} = t_{UG} + 2t_\ell \tag{9.2}$$

  using the symbols defined below:

  – t_a : The acquisition time needed for a child to acquire its native language(s).
  – t_{a1} : t_a for a monolingual child.
  – t_{a2} : t_a for a bilingual child.
  – t_{UG} : The part of t_a spent in acquiring Universal Grammar, the core common to all languages.
  – t_ℓ : The time it takes to acquire language-specific features (lexicon, language-specific rules and parameter-settings) of a single language. It is probably a fair approximation to assume that t_ℓ is the same for all languages. $t_{\ell i}$ and $t_{\ell j}$ represent the acquisition times for the two languages of a bilingual.

  If the innateness hypothesis is true, then $t_{UG} = 0$ (as UG is then innate, no acquisition of it is needed). Thus:

$$t_{UG} = 0 \tag{9.3}$$
$$t_{a1} = 0 + t_\ell = t_\ell \tag{9.4}$$
$$t_{a2} = 0 + t_{\ell i} + t_{\ell j} = 2t_\ell \tag{9.5}$$
$$t_{a2} = 2t_{a1} \tag{9.6}$$

If the innateness hypothesis is false, then it can be assumed that t_{UG} is large compared to t_ℓ, a reasonable assumption considering the view of innatists that UG cannot possibly be acquired in the time available to a child. Thus:

$$t_{UG} \gg t_\ell \tag{9.7}$$
$$t_{a1} = t_{UG} + t_\ell \approx t_{UG} \tag{9.8}$$
$$t_{a2} = t_{UG} + t_{\ell i} + t_{\ell j} = t_{UG} + 2t_\ell \approx t_{UG} \tag{9.9}$$
$$t_{a2} \approx t_{a1} \approx t_{UG} \tag{9.10}$$

There exists a fair number of studies of rates of language acquisition in bilingual children (see e.g. Romaine (1989), Harding & Riley (1986), Petitto et al (2001a), and references therein). The variations between individual children are very large (as is also the case for monolingual language acquisition), but the consensus that I extract is that t_{a2} is possibly somewhat larger than t_{a1}, but not significantly so, and by no means twice as large : *"In very general statistical terms, bilingual infants and children start speaking slightly later than monolinguals, but they still remain well within the degrees of variation for monolingual children."* (Harding & Riley, 1986), and *"Even when the onset of acquisition is delayed in the bilingual, children apparently make up for the time lost,. . . "* (Romaine, 1989, p 195) and *"The results provided strong evidence that bilingual acquisition caused no language delays"* (Wagner, 2001a, p 509).

Romaine (1989) and Petitto et al (2001a) discuss another aspect of bilingual acquisition, namely the pattern of acquisition : *". . . bilingual children seem to pass through the same developmental milestones in much the same order and the same way in both their languages as monolinguals do in their respective languages,. . . "* (Romaine, 1989, p 195). Romaine (1989) takes this as evidence in favour of the innateness hypothesis, but the reasons for this are not evident — to me it implies rather that language acquisition is either some kind of maturation process, or correlated with non-linguistic developmental stages. The comparative acquisition times clearly do not support the innateness hypothesis.

- There is no shortage of alternative theories of language acquisition that do not postulate an innate language acquisition device, though not all of them have a firm basis in modern linguistics. A rough classification of language acquisition theories:

- Empiricist theories
  - ◇ Connectionism, reviewed by Rispoli (1999), with attached discussion and comments, pro and con: (Chater & Redington, 1999; Ellis, 1999; Feldman, 1999; MacWhinney, 1999; Maratsos, 1999; Gobet, 1999; Hahn, 1999; Valian, 1999; Plunkett et al, 1999).
  - ◇ Probalistic and distributional approaches (Redington & Chater, 1997; Plunkett, 1997; Seidenberg et al, 2002; Clark, 2001).
- Cognitivist theories
  - ◇ Schemas, of several types (Arbib & Hill, 1988; Mandler, 1994).
  - ◇ Functionalist approaches (Bates & MacWhinney, 1982).
  - ◇ Language emergent from cognition (Gomez & Manning, 1997).
- Social-cognitive interactionist theories
  - ◇ Socio-perceptual language emergence (Zukow, 1990).
  - ◇ Cultural acquisition of language (Harkness, 1990).
  - ◇ Ecological language acquisition (Dent, 1990a; Dent, 1990b).
  - ◇ Context-based language acquisition (Walczak, 2002).
  - ◇ Usage-based language acquisition (Tomasello, 2000b).
- Neo-nativist theories
  - ◇ Chomsky (1965)
  - ◇ Optimality (Prince & Smolensky, 1997; Tesar, 1998; Archangeli, 1999, but see Fodor (1997)).

Optimality and connectionism have the attractive feature that they are amenable to direct computer simulations of language acquisition, and appear to work, at least for the "toy languages" that are computationally tractable (Prince & Smolensky, 1997; Parisi, 1997), with some modest achievements also with natural language (Palmer-Brown et al, 2002). Interestingly enough, simple recurrent neural networks show the same type of bias in language learning as human learners (Kirby & Christiansen, 2003). Furthermore, both optimality and connectionism are eminently compatible with Chomsky's (1982) Government & Binding grammar (Uriagereka, 1999), and only take issue with Chomsky's innatist language acquisition model. Smolensky (1999) presents a formal grammar within a connectionist framework.

Probabilistic and distributional approaches can also be simulated with computers, but have been studied with real children as well, learning artificial "languages". It turns out that small children are equipped with quite powerful statistical-learning capacities with language-like input, even extracting syntactical and other patterns believed to require algebraic processing (Altmann, 2002). Possibly relevant in this context is that the kids manage this not only with speech-like input, but also with tone sequences, implying that whatever machinery they're using isn't speech-specific (Gomez & Gerken, 2000).

It should be kept in mind also that language acquisition is an iterated process — the output of language acquisition in one generation, becomes input for the next — and that both the human language acquisition equipment, and language itself, can evolve over time. The evolutionary iterated learning of Kirby & Christiansen (2003) is an attractive structure taking all these processes into account.

- The ape language experiments reviewed in chapter 7, to the extent that their results are accepted, argue against the necessity of innate language-specific abilities (cf. p 134).

The innateness issue is, as far as I can tell from the arguments and available evidence, far from settled. There is a disturbing tendency for the debate to be split along disciplinary lines, with mainly linguists on the innateness side, and mainly cognitive scientists on the other, which indicates a lack of adequate communication between the fields. There is merit in the arguments of both sides. On one hand, the arguments for underlying universals in the structure of human languages are compelling — but on the other hand the successes, however modest, of the explicitly computational models, optimality and connectionism, indicate that the supposed impossibility of language acquisition without a Chomskian language-specific language acquisition device may not be as absolute as claimed (even though at least optimality postulates other innate features). Furthermore, the "poverty of the genes" argument conclusively shows that strong claims of a complex and fully genetically determined innate grammar are untenable. Possibly a model with a few innate fundamentals at the bottom, but with social interactions playing the main role for acquisition, can be a reasonable compromise model, consistent with the evidence from both sides?

The impact of the innateness issue on language evolution is actually rather modest, if subtle. Nobody doubts innateness in Chomsky's kitten sense (see p 178), which implies that *some* language-relevant genetic changes must have taken place along the human lineage, since the last common ancestor we shared with kittens, which was a primitive mammal sometime in the Cretaceous, perhaps 100 million years ago (Murphy et al, 2001). Many, but not all, of those changes can be located to the last five million years, after we and the the other apes parted company in the family tree — there is certainly a difference in language abilities, not only between young Miss Chomsky and her kitten, but also between the gorilla Koko (see p 135) and her[24] kitten.

Innateness does have an impact on the issue of gradual vs. sudden language evolution, as mentioned above. Innate complex features cannot evolve suddenly with any reasonable probability — intermediate steps are necessary. Even with the rather modest degree of innateness that is empirically well-established, a gradual transition is more biologically plausible, *contra* Chomsky (1988).

Nevertheless, even though an innate grammar may not be *necessary* for language acquisition, this does not prove that humans don't have one anyway, since an innate grammar would certainly facilitate language acquisition, even without being strictly necessary. The Baldwin effect, described on page 28, implies that if language has been a central part of human behavior for a sufficiently long time, an innate predisposition to acquire language (which may or may not mean an innate grammar) is a possible result — but see also Deacon (2004).

On the non-genetic side of the issue, we need to consider the different levels of language-related evolution, discussed on page 29. Very little empirical data is available concerning the cultural or memetic evolution of language, but it would nevertheless be an error to discount such processes and focus exclusively on the biological evolution of a hypothetical innate language acquisition device. Even though little is known, it would be highly surprising if language, regarded as a memetic-type entity, did not change over evolutionary time. As discussed in section 3.5.1, selection for both improved learnability and communication can be expected to occur. In parallel with this memetic evolution, there may be biological evolution towards an innate language acquisition device — but memetic evolution is a much faster process, so the result is likely to be biased towards languages that are easy to learn, rather than towards learners who are innately good at learning languages (Bull et al, 2000).

In conclusion, it may well be that the final resolution of the innateness debate will be a compromise, with coevolution of language memes and acquisition genes (Kirby, 1996). It is certainly not a simple black-or-white dichotomy. The suggestion of Deacon (2003b), neither nature nor nurture, but instead semiotic constraints, is also an interesting possibility, explaining the existence of universals without invoking an innate grammar.

[24] Yes, the gorilla Koko also had a pet kitten (Patterson & Linden, 1981).

9.8 Summary

- *Adaptation vs. spandrel*
  - Not either-or, has to be some of both.
  - Spandrel/exaptation:
    - Cannot adapt for language until language already present ⇒ First step towards language must be based on spandrels/exaptations.
    - Many features that we use for language already present in other apes ⇒ Exaptations.
  - Adaptation:
    - Obvious selective value today — the fitness of a language-less human near zero.
    - Complex package appearing to be designed for its current function.
    - Some features fine-tuned for language use.
  - We have biologically adapted to language use, and language has culturally adapted to be used by us — but which process is more important?
- *Early vs. late*
  - Speech adaptations detectable in fossils:
    - Hearing fine-tuned.
    - Breathing control enhanced.
    - Hyoid bone in modern form.

    All of the above present in Neanderthals, and by implication in the common ancestor of us and Neanderthals, 500,000 years ago.
  - Symbolic behaviour:
    - Archeological signs of early symbolic behaviour:
      - Engravings.
      - Ornaments.
      - Pigment use.
      - Burials.
    - These signs do *not* suddenly appear 40,000 years ago, as commonly believed.

Summary, continued

- *Early vs. late, continued*
  - Symbols, continued
    - Early gradual appearance of more and more signs of symbol use, across at least 100,000 years, mainly in Africa.
    - Possible hints of symbolic behaviour outside *Homo sapiens* as well, in Neanderthals and possibly *H heidelbergensis*.
  - Early appearance of speech adaptations and symbolic behaviour rules out a late appearance of language. Our ancestors 500,000 years ago had some form of speech, if not necessarily full human language, and our ancestors at least 100,000 years ago, and possibly 500,000 years ago had some symbolic capacity.
- *Gradual vs. sudden*
  - Two-pronged argument for gradual appearance:
    - Fossil and archeological signs of language do not appear suddenly all at once — see the previous point.
    - Language is a complex adaptation. To the extent that language has a biological basis, it must be a matter of many genes. Lots of coadapted genes do not suddenly appear together in a coordinated package, but have to coevolve gradually. Furthermore, some of our features are fine-tuned for language.
  - How gradual is gradual?
    - What is strictly ruled out is single-step saltationism.
    - Gradual evolution need not be geologically slow — a process that takes 10,000 years will still look instantaneous in the fossil record.
    - The actual time needed for language to evolve depends on many factors, including:
      - How much of our language ability is based on pre-existing exaptations, and how much new features are needed?
      - How much biological evolution, and how much cultural evolution?

Summary, continued

- *Speech first vs. gestures first*
  - Speculations that the first language may have been a sign language have a long history, from Condillac (1746), and are still popular.
  - Arguments for gestures first:
    - ◇ Apes have both the dexterity and the cortical control needed for gesturing, but not for speaking.
    - ◇ Easier to imagine the very earliest stages of proto-language, with mimesis and iconic proto-words, in a gestural system rather than a spoken one.
    - ◇ Mirror neurons provide a possible path into iconic gestures — but monkeys have these neurons as well, so why don't they gesture?
  - Arguments for speech first:
    - ◇ Speech is universal among human cultures today.
    - ◇ If gestures were first, an additional evolutionary step, the switch from gestures to speech, is required. More parsimonious to postulate that speech was first.
  - Either gestures first or speech first remains tenable. Insufficient evidence to exclude either possibility.
  - It need not be one or the other — the earliest forms of language may well have used both.

Summary, continued

- *Innate vs. learned grammar*
  - Arguments for innate and genetically specified:
    - Universals in language.
    - Poverty of the stimulus, and related language-acquisition issues.
  - Arguments for learned and culturally emergent:
    - Poverty of the genes.
    - Brain plasticity in ontogeny.
    - Alternative views of language acquisition.
    - Some language abilities present in non-humans.
    - Language can memetically adapt to our brains faster than we can genetically adapt to language.
  - Third possibility: neither nature nor nurture. Language universals may be logically necessary in order for language to function as a symbolic system.
  - None of the possibilities has overwhelming support. Specifically, the case for a genetically specified grammar and an innate language acquisition device is not nearly as strong as is commonly believed.

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