A central question from a linguistic standpoint is: what aspects of language are hardwired, i.e. genetically endowed and therefore innate, and what aspects depend mainly on environmental factors? Heredity and environmental factors are intricately intertwined, and it is now clear that humans (and many other animals) possess far more developmental plasticity than was once assumed. Other possibilities exist too: some aspects of the language faculty might have emerged owing to self-organization (de Boer, Chapter 63, this volume), and language itself might also evolve (in some way) to be learnable (Chater and Christiansen, this volume).

Much theorizing about these matters assumes that any given property which we find in language is to be attributed either to a genetically determined cognitive faculty or else to the effects of external shaping effects such as functional pressures, the working of historical change, or other such non-inherited factors. I suggest in the survey below that this is a false dichotomy: that in fact, these two foundations for linguistic structure are not mutually exclusive, but rather that evolutionary
considerations lead us to expect a duplication of foundation for much of the structure of language as we find it.

Broadly and uncontroversially, the field of linguistics is concerned with the scientific study of language and its structure. When we try to be more precise, however, the object of inquiry in the field is less obvious, and has changed considerably over time. I will assume, following the ‘cognitive revolution’ of the past half century, that we want to study not sets of sounds, or words, or sentences, or texts in themselves, but rather the knowledge or cognitive capacity that underlies our production and understanding of these things.

However we characterize this capacity, it seems clear that it is a species-specific property of us as human beings. Absent severe and obvious pathology, all humans acquire and use language spontaneously, without the need for explicit instruction. Furthermore, no member of any other species appears to have this capacity, with or without instruction.

When we examine the communicative behaviour of other species, we find that this is quite different in character from human language. Communication in all other species is based on a fixed set of discrete possible messages, essentially limited to matters of the here and now. This set cannot be expanded by combining elements to form new and different messages. In nearly all cases, animal communication systems emerge without the need for relevant experience, although in some instances either the conditions of use or the precise external form of a message may be refined by experience. In instances where the system is grounded in learning, of which song in oscine songbirds is by far the most robust example, the actual system acquired still does not go beyond the character of an essentially fixed list. Even a bird with a repertoire of hundreds of songs still conveys the same basic message in the singing of any one of them.

Human language, in contrast, provides an unbounded range of discrete and distinct messages. As opposed to the communicative behaviour of other animals, these messages are produced voluntarily under cortical control, and are not bound to the presence of particular stimuli. The mechanism behind the unboundedness of language is twofold: two distinct discrete combinatorial systems interact to allow for an unlimited set of messages grounded in a manageable inventory of meaningful symbols (‘duality of patterning’; Hockett 1960). One subsystem combines members of a small set of individually meaningless sounds according to the phonological pattern of the language into meaningful words, which are in turn combined by a quite distinct subsystem, the language’s syntax, into phrases, clauses, sentences, etc. (The presence within the system that combines meaningful elements into larger constituents of two distinct subsystems, morphology and syntax, is a further remarkable property of human language, and one for which the functional motivation is at best obscure. See Carstairs-McCarthy (Chapter 47) for some discussion. The recursive, hierarchical nature of such combination is the basis for the open-ended expressive capacity it provides.
No other system of communication found in nature has these essential properties, and no non-human animal has—or has ever learned—a system with such structure. This should not be surprising, because language is grounded in our biology just as the often quite remarkable communicative systems of other animals are in theirs. Since we differ in these basic respects from even our closest relatives, chimpanzees and bonobos, the relevant capacity must have emerged in our evolutionary history since the time of the last common ancestor we share with them. The question is not whether this evolution took place, but how.

The re-emergence in the literature on linguistics of evolutionary discussion is largely due to the arguments of Pinker and Bloom (1990). They showed that human language has all of the basic character of an evolved system: a complex structure, with many specific mechanisms related to one another in partially arbitrary ways and collectively well suited to the function of expressing hierarchically organized propositional structures in a linear channel from which they can be recovered. The clear adaptive significance of this function, which enables the cumulation and communication of knowledge among members of a group, makes a strong case for an account in terms of evolution through natural selection. Subsequent discussion has made clear that the human language faculty meets the necessary conditions for such an account: a trait which is variable to at least some extent, where the variation is heritable such that phenotypic variation in the trait is plausibly associated with differential fitness.

While it is an article of faith among linguists that the human language faculty is completely uniform across the species, there is really no evidence for a conclusion as strong as that (see also Carstairs-McCarthy, Chapter 50). While it is undoubtedly true that a child raised in a community speaking any of the world’s languages will acquire that language, regardless of the language of the child’s biological parents, that does not mean there is no variation in the details of the acquisition of diverse languages by children of diverse ancestry. We do know that the language capacity has probably been relatively uniform for at least 40,000–50,000 years, since the settlement of Australia (whose indigenous languages are comparable in structure to those spoken elsewhere). While this suggests that there is not presently very much genetic variation in the language faculty, or at least that it has not been subject to much recent selection, the mere fact that any child can learn any language does not establish that there is no variation at all.

Evidence from a variety of sources for the heritability of variation in language abilities is surveyed in Stromswold (2001, 2010). An additional argument leading in the same direction is provided by Ladd et al. (2008), who note that specific alleles of two genes (MCPH1 and ASPM) that have been subject to recent selection and that are involved in brain growth and development have a distribution that corresponds strikingly with the distribution of tonal contrasts in the world’s languages. These authors do not at all claim to have found, as reports in the popular literature sometimes represented it, ‘genes for tone’. Rather, they suggest that genetic
differences, selected in this case for quite independent reasons, might result in a differential propensity to develop tonal contrasts in a language (though see Diller and Cann, Chapter 15).

We know that tonal distinctions come and go in the history of individual languages (see various papers in Fromkin 1978 for discussion). As a result, the observed asymmetry could result from a difference between populations in the predilection to make the kind of re-analysis that leads to the development of tone, with even very small differences showing significant effects over periods of thousands of years. The innovative alleles at issue here are associated with non-tonal languages, so their phenotypic effect seems to be to inhibit the emergence of tone and to facilitate its loss. There is no reason to believe that this effect on tone in language is at all the basis of the observed selection, but the observed effect does contribute to the demonstration that differences in the language faculty correspond to heritable genetic differences. See Diller and Cann, this volume, for further discussion.

The best evidence for the selectability of language, of course, would be the demonstration on the basis of molecular genetics that genes coding for language have in fact been under selection pressure. Unfortunately, with almost negligible exceptions, the relevant genes have not been established, nor a fortiori have we established the relevant relations between genotype and phenotype on the basis of which we could talk precisely about these genes ‘coding for’ language. As a result, arguments of this sort are quite impossible in our present state of knowledge.

Nonetheless, the human language faculty appears to have the characteristics of a system shaped by evolution. When we look at the communication systems of other species, we find that their biological nature is typically shaped in essential ways that provide privileged pathways for ecologically significant messages. For instance, the vomeronasal organ in mice is attuned to a limited range of odorants, primarily including pheromones that are the basis of much communicative behaviour in the species, and quite distinct both in its own physiology and in the brain region to which it projects from the more general olfactory system. The auditory systems of frogs, bees, and many other animals display particular sensitivities in exactly the frequency range in which energy concentrations are found in conspecific sound production. Given the centrality of language in human life, it would be quite remarkable if human biology had not been shaped evolutionarily by suitability for its functions.

Why, in fact, might we be tempted to believe otherwise? The treatment of these matters by Hauser et al. (2002) distinguishes ‘FLN,’ the ‘faculty of language in the narrow sense’ from ‘FLB’ or the ‘faculty of language in the broad sense,’ and suggests that the only uniquely human component of a unique faculty for language (or FLN) might well be recursive combination in the syntax. Everything else relevant to language and composing FLB, on their account, either is not specific to language or else has analogs or homologs in other (non-linguistic) species.
Even if this narrowly drawn conclusion is valid, however, it does not follow that the role of evolution is negligible in shaping the language faculty in modern *Homo sapiens*. Much of FLB, in Hauser et al.’s terms, is distinctively structured in ways that at least suggest adaptation driven by increased utility for its use in supporting language. Those properties relevant to language that have analogs in other species, such as the capacity for vocal learning and imitation, must nonetheless have evolved (convergently) in *Homo sapiens*, because they are absent in our near biological relatives. Even language-relevant traits with homologues in closely related species show signs of having been shaped in humans by their role in language. Categorical perception, for example, may be characteristic of mammalian auditory systems broadly, but the specific range of categories which we find in humans are evidently grounded in the details of speech articulation and its acoustic/auditory effects. We now know (Fitch 2002) that the descended larynx is not a uniquely human characteristic, since members of other species lower their larynx to exaggerate size in competitive interaction, or more generally when phonating. Nonetheless, the permanently lowered state of the human larynx is surely a response to the utility of such a position for producing a wide range of speech sounds, and the prominence of speech in our behaviour.

One might well accept the broad role of evolutionary pressure in the emergence of a language faculty, while denying that the specific structural properties we attribute to that faculty were shaped in that way. There is a strong appeal to the notion that these details are to be seen as emergent, derived from general properties of computational systems. On that approach, the precise form taken by human language is inevitable and necessary, and could not have been otherwise given the overall computational task to be performed.

While this argument is tempting, consider the parallel between human language and birdsong. Thousands of oscine species each learn their songs on the basis of models, usually ones heard in early life, and in most cases the range of songs that are (and indeed that can be) learned is rather narrow and species-specific. Surely it would be obvious to a nightingale scientist reasoning in an analogous way that the computational properties of song production necessarily lead to the consequence that a song must have a four part structure, with an $a$ portion (selected from within a specific range) followed by equally specific $\beta$, $\gamma$, and $\omega$ sections (Todt and Hultsch 1998). Were the scientist a zebra finch or a white-crowned sparrow, however, he or she would completely disagree, insisting that a completely different structure was the inevitable consequence of the computational nature of song. And song sparrow scientists would be sure they were all wrong.

The point here is that humans are a single species, so we can only study a single language faculty. Evolution is clearly capable of producing many distinct and highly individual learning spaces in the many species of songbirds (though probably not all logically possible ones: Podos et al. 2004), and there is no obvious reason
why what we find in the only species of language learners available should be any less a contingent outcome of the evolutionary history of that species.

Against this background, let us consider the basic goal of linguistic research. The object of inquiry in the field, the language faculty, supports the rapid and efficient acquisition and use of natural language, is a consequence of our biological nature as humans, and probably arose through natural selection. While much is often made of the extent to which aspects of this faculty overlap with other aspects of human cognition, the faculty as a whole is unique to humans, and investigating it is in principle independent of whether the relevant cognitive ability is based wholly, partially, or not at all on capacities domain-specific to language. But how do we infer the contents of this faculty, in order that we might ask how it arose in our evolutionary history?

The primary source of evidence comes from examination of the grammars of particular languages, considered as systems of knowledge that arise in the minds of speakers in interaction with their early linguistic experience. Whenever we can argue for the presence of some specific content in a grammar, it must have as its source one or another of the following (or their interaction):

- Input data: only systems corresponding to the evidence can be acquired.
- Learning process: only systems accessible through the available mechanisms of learning can be acquired.
- Language faculty [narrow sense]: only cognitively possible systems can be acquired.

The combination of the last two, the learning algorithm and the set of constraints on possible systems imposed by the overall nature of the mind and brain, is what is commonly described as the ‘language faculty’ (in a broad sense). The difference is significant: some cognitively possible systems might be inaccessible to the mechanisms by which language is acquired, and some of the outputs of the learning algorithm might be inconsistent with the way the mind is organized. We will not be concerned with this distinction here, however. What we wish to contrast is the contribution to the content of our knowledge of language that is due to properties of the input data, and the contribution made by the cognitive system(s) we call the language faculty.

In particular, an important strategy in the field is to argue that some of what we find in speakers’ knowledge of language is not attributable simply to regularities in the ‘primary linguistic data’ on the basis of which that knowledge arose. Arguments of this sort are known as arguments from the ‘poverty of the stimulus,’ and would appear to provide a direct pathway to the structure of the language faculty. After all, if speakers come to know something for which the evidence in the data is not sufficient, it must be due to the properties of the system itself.

A number of arguments of this form have been offered, of which the argument from English auxiliary fronting (claiming that grammatical regularities are grounded in constituent structure rather than simple linear concatenations of
words) is in some sense the poster child. Analysing specific examples would take us beyond the scope of this chapter, but the problem raised is that of proving a negative: how can we show that there is no possible way of deducing the property in question from regularities in the data?

Those who reject such arguments sometimes refer to them as arguments from the ‘poverty of the imagination’ instead. In the case of the structure-based nature of syntactic regularities, rejecting the claim that this is a property of the language faculty and assuming it could be learned from the data would make it remarkable that children always get it right, and we never find rules in any language that reflect an analysis of sentences simply as strings of words. Thus, even though it might be possible to learn that grammatical rules are structure-sensitive, it seems much more plausible to attribute this to the language faculty: learners only entertain structure-based hypotheses. But we cannot show that this must be the case, because of the difficulty of establishing that learning is absolutely excluded.

In spite of this problem, many linguists accept (and offer) arguments following the ‘poverty of the stimulus’ logic for the content of the language faculty. Much more general, however, are arguments of a different sort. When something appears to be true of all (or nearly all) languages, it is tempting to attribute it to the language faculty: either it is something assumed by the learning algorithm, or it is a characteristic of the space of cognitively possible grammars. In this case, however, it is even more important to bear in mind that the regularity we find might simply be a consequence of regularities in input data.

Of course, a property found in all languages could logically just be the residue of some contingent property of ‘proto-World,’ assuming human language originated only once in our history (see Nichols, this volume). To the extent such a universal is also characteristic of signed languages (Sandler and Lillo-Martin 2006), this is unlikely, since no existing signed languages have an origin in common with spoken languages.

More plausibly, a property found in all languages might be due to the constitutive characteristics of the language faculty; or else it might be due to (externally imposed) regularities in the input data available to learners around the world, and thus learnable. The tension between these accounts is roughly that between ‘formalist’ and ‘functionalist’ views of linguistic universals, and the two are generally posed as incompatible alternatives. The logical possibility also exists, however, that both might be true in a given case, if properties of the language faculty reflect recurrent regularities in the data. Looking at language from the perspective of evolution, in fact, it can be argued that this duplication is exactly what we should expect.

Arguments for the origin of universals in externally imposed properties of the data available to learners can be found in a number of domains. Blevins (2004) argues, for instance, that most if not all substantive universals in phonology are the product of independent mechanisms of linguistic change: the phonologies of languages are as they are not because they must be, but because linguistic change
channels them into these patterns and not others. Mielke (2008) makes similar arguments about the most basic characteristics of phonological systems, the set of distinctive features defining dimensions of contrast and natural groupings of sounds. On this view, the Neogrammarians were right: the only way to understand why languages are as they are is to understand how they developed. In consequence, the regularities we find are regularities of the input data, and tell us nothing about the structure of the language faculty.

A similar result is suggested in syntax by Newmeyer (2005) on the basis of work by Hawkins (1994, 2004). On this picture, functional motivations lead speakers to choose particular structures whenever possible; later learners interpret the predominance of these structures in the data as a grammatical rule. When regularities become entrenched across languages, it is not because the language faculty requires them, but because external (functional) effects have conspired to make them properties of the available data.

We are left with a problem: on the one hand, there is reason to believe that a rich cognitive capacity for language is species-specific. But when we try to determine the substance of that capacity, there are alternatives to attributing specific aspects of linguistic structure to the language faculty. At least a possible hypothesis is that the two converge, and that attributing something to the language faculty and finding an external basis for it are not mutually exclusive.

To make sense of this, let us ask how the specific properties of the language faculty might have arisen, as part of our genetic endowment as humans. It is implausible to say that all the details have arisen through natural selection because they are adaptive: it is difficult to imagine how conforming to the principle of subjacency might have enhanced reproductive success in human history (Lightfoot 1991, this volume). But there is an alternative: that the genetic fixing of the properties of the language faculty came about through Baldwin effects.

The evolutionary effect associated with James Mark Baldwin has been given a variety of formulations and elicited a variety of reactions: for a survey and a spectrum of opinions, see Weber and Depew (2003). The logic involved can be outlined as follows. Certain behaviour that is learned (or culturally transmitted) may be selectionally advantageous under the conditions in which the organism finds itself. Selection may then operate to favour individuals who are able to learn the advantageous behaviour rapidly and efficiently. The learned behaviour may itself alter the characteristics of the environment within which selection occurs (‘niche construction’: Odling-Smee et al. 2003), favouring its acquisition even more. The eventual result may be to make the learning of such behaviour hard-wired (the fastest and surest way to learn it). In these terms, there is nothing mystical (or Lamarckian) about the Baldwin effect: it is simply normal natural selection operating to favour learning mechanisms that contribute to enhanced fitness. Since the language faculty is a capacity to learn certain sorts of systems, this is just where we might expect such a principle to operate. Looking at language in
this way, we expect the language faculty to favour the acquisition of grammars that have the properties most likely to characterize the ambient languages of learners. Arguments such as those of Blevins and Mielke (for phonology) and Hawkins and Newmeyer (for syntax) show that historical change, based on auditory and other effects and functional pressures, is likely to converge on corpora of speech data that display certain recurrent properties. Computer simulations have suggested that structure sensitivity can plausibly be expected to arise in communication. But then the Baldwin effect should lead to the incorporation into the language faculty of these recurring regularities, so they don’t have to be learned de novo by each new generation of speakers. If this reasoning is correct, properties of the language faculty are likely to duplicate, or at least closely reflect, regularities for which we can also find alternative explanations. The availability of those explanations is thus not mutually exclusive with attributing the properties in question to the language faculty. On the other hand, this often leaves us without a way to show that something that is true of all—or most—languages is in fact constitutive of language as a cognitive system.

The central task for linguistics is to devise ways to infer the properties of the language faculty from the available data. But in fact, very few aspects of language can be attributed necessarily to the biologically based language faculty. Some would argue that this shows there is not really much content to a species-specific language faculty. But that seems contrary to the available evidence for our capacity, unique in the animal world, to acquire and use systems with the properties of natural languages.

The human language faculty, like any complex biological system, has surely been shaped through evolution by natural selection. While directly adaptive explanations for the specific properties of natural language are not generally available, Baldwin effects in the context of the human cognitive ‘niche’ can be much more successful. This makes it possible to restore language to its place in the natural, biological world, but it makes our task as linguists much harder, because of the convergence of properties of the language faculty with ones for which external explanations are available.

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