Language Evolution as a Constraint on Conceptions of a Minimalist Language Faculty

Andrew Feeney

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The School of English Literature, Language and Linguistics
Newcastle University

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Abstract

Language appears to be special. Well-rehearsed arguments that appeal to aspects of language acquisition, psycholinguistic processing and linguistic universals all suggest that language has certain properties that distinguish it from other domain general capacities. The most widely discussed theory of an innate, modular, domain specific language faculty is Chomskyan generative grammar (CGG) in its various guises. However, an examination of the history and development of CGG reveals a constant tension in the relationship of syntax, phonology and semantics that has endured up to, and fatally undermines, the latest manifestation of the theory: the Minimalist Program.

Evidence from language evolution can be deployed to arrive at a more coherent understanding of the nature of the human faculty for language. I suggest that all current theories can be classed on the basis of two binary distinctions: firstly, that between nativist and non-nativist accounts, and secondly between hypotheses that rely on a sudden explanation for the origins of language and those that rely on a gradual, incremental picture. All four consequent possibilities have serious flaws.

By scrutinising the extant cross-disciplinary data on the evolution of hominins it becomes clear that there were two significant periods of rapid evolutionary change, corresponding to stages of punctuated equilibrium. The first of these occurred approximately two million years ago with the speciation event of *Homo*, saw a doubling in the size, alongside some reorganisation, of hominin brains, and resulted in the first irrefutable evidence of cognitive behaviour that distinguishes the species from that of our last common ancestor with chimpanzees. The second period began seven to eight hundred thousand years ago, again involving reorganisation and growth of the brain with associated behavioural innovations, and gave rise to modern humans by at least two hundred thousand years ago.

I suggest that as a consequence of the first of these evolutionary breakthroughs, the species *Homo erectus* was endowed with a proto-‘language of thought’ (LoT), a development of the cognitive capacity evident in modern chimpanzees, accompanied by a gestural, and then vocal, symbolic protolanguage. The second breakthrough constituted a great leap involving the emergence of advanced theory of mind and a fully recursive, creative LoT. I propose that the theory outlined in the Representational Hypothesis (RH) clarifies an understanding of the nature of language as having evolved to represent externally this wholly internal, universal LoT, and it is the latter which is the sole locus of syntax and semantics. By clearly distinguishing between a phonological system for semiotic representation, and that which it represents, a syntactico-semantic LoT, the RH offers a fully logical and consistent understanding of the human faculty for language. Language may have the appearance of domain specific properties, but this is entirely derived from both the nature of that which it represents, and the natural constraints of symbolic representation.

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Chapter 1: Introduction

1.0 Introduction

There are, undoubtedly, several characteristics of *Homo sapiens* that help to distinguish the species from any other. Nettle (2009) identifies a number of traits including a proportionately smaller gut size in relation to other mammals (almost certainly the consequence of a diet that includes cooked meat); a considerably larger brain in proportion to body size; sophisticated tool use (beyond mode 1); a longer period of ontogeny; and uniquely, finely honed learning skills. However, all of these are a matter of degree in relation other species, particularly primates. Language, on the other hand, appears to be an special. No other species has this potentially infinite creative capacity. The question remains, therefore, why this should be the case.

Explanations for the human faculty for language (FL) fall into two broad camps. In the first there are nativists who believe that language is, like vision or the auditory system, an informationally encapsulated module of the mind, distinct from domain-general cognition (along the lines of Fodor, 1983). Those who oppose this view consider language to be a socio-cultural, learned system much as any other. In this latter group it is common for explanations of FL to treat language as simply another aspect of culture. But language and culture are just too different: three year olds, although linguistic geniuses, are generally incompetent in other components of culture. Even Sapir, whose entire career was devoted to emphasising the cultural nature of language was forced to admit (ironically in language that is culturally unacceptable today) that ‘when it comes to linguistic form, Plato walks with the Macedonian swineherd, Confucius with the head-hunting savage of Assam’ (1921: 234)

One non-nativist argument is founded on the undeniable point that languages must be learnable otherwise they would die out. On this basis, the claim is then extended to maintain that languages have actually evolved in order to be easily acquired. Thus children’s first intuitions about language are likely to be the correct ones because languages have adapted to the way the human brain works. Christiansen and Chater echo this view that language is shaped by the brain in order be learnable and processable: ‘languages have adapted to conform to the most popular guess’ (2008: 507). Although the authors reproach other writers for what they claim is circularity of argument, it is a charge to which they themselves are clearly susceptible. Language, they maintain, is learnable because it conforms to learning biases so it must have evolved to be so, though they do not specify the process by which this could have occurred (or indeed what any alternative scenario might look like). Evidence in support of this position is often drawn from formal, particularly computer, modelling (e.g. Steels, 2003). However, while these simulations are becoming increasingly sophisticated, so far they have failed to have a significant impact on the study of language evolution and Bickerton’s comment that the approach is ‘a classic case of looking for your car-keys where the street lamps are’ (2007: 522) remains pertinent. One other striking problem with an argument based on the evolution of language for learnability is the vast amount of linguistic variation that exists, at least in surface forms. This begs the question why language has not evolved into a single optimal ‘learnable’ form. The answer would seem to be that as an explanation, rather than addressing biological evolution, this falls into the error that Tallerman *et al*. (2009) identify as confusing language evolution and cyclic diachronic change.

1.2 What makes language appear special?

Evidence for an innate language module comes from several areas though none are uncontroversial and all are fiercely contested (for a polemical overview see Sampson, 2005). One characteristic of modularity is double dissociation from the general processor and evidence for this is claimed to be found in individuals with a range of impairments (e.g. Smith and Tsimpli, 1995). Other claims have been made on the basis of psycholinguistic processing, and the existence of language universals. However, the largest body of evidence is founded on child language acquisition. Sometimes referred to as ‘Plato’s problem’ (e.g. Chomsky, 1986), the logical problem of language acquisition concerns the way in which children are able to acquire language based on impoverished primary linguistic data (the ‘poverty of the stimulus’ argument). Not only that, but children appear to acquire their language with remarkable speed and all converge on an approximately identical level of competence (for discussion see e.g. Smith, 2005; Lightfoot, 2005).

One particularly intriguing aspect of research on language acquisition relates to children who are raised in communities in which there is no common mutually intelligible language and the community relies on a pidgin, a much simplified code. Bickerton (1981) noted that such children imposed the morphosyntactic elements of complex language on pidgins and in effect created a new language, a creole. This has been explained in terms of an innate language acquisition device (LAD) specified with the features of a Universal Grammar (UG). More recently research has been carried out on home signers in Nicaragua (Senghas, 2003) who, once brought together as children in deaf schools, created Nicaraguan Sign Language which was modified with each generation. New work is currently underway with Al-Sayyid Bedouin sign language in the Negev desert in Israel (Sandler, *et al.*, 2005) which appears to have emerged in the last 70 years and may confirm some of the general work on the creation of creoles.

While all of the claims for evidence for an innate language faculty are contested, they nevertheless constitute a formidable body of arguments, and a theory that seeks to explain language in these terms needs to be taken seriously. Undoubtedly the most extensively studied of such a model are the various forms of generative grammar put forward by Chomsky and colleagues since the late 1950s (Chomskyan Generative Grammar, CGG) and culminating in its present form as the Minimalist Program (MP, Chomsky, 1995). As with all theories of language, there is a need to account for various constraining factors and these are considered next.

1.3 Constraints on a theory of language

The first major constraint, as noted above, is to account for the process of child language acquisition and this has been a constant theme in CGG. A further constraint is the cross-linguistic variation that is attested in the world (for an overview see Evans and Levinson, 2009; Levinson and Evans, 2010). This has been explained in CGG in various ways including the setting of binary parameters in individual languages, and more recently as the result of features on the various items that constitute the different lexicons of the world. A general constraining principle on any theory is Occam's Razor, the tenet that simplicity and elegance characterise the most feasible account where more than one hypothesis is available. Although CGG became burdened with a vast number of components as the scope of the theory expanded, the MP seeks to reaffirm the notion of economy principles and a minimalist set of procedures. Recently, an additional consideration has been included in the evaluation of theories of language: that of evolution, to which I now turn.

1.3.1 Language Evolution as a constraint on a viable theory of language

It has often been claimed that the human faculty for language (FL) is the only unique ability that distinguishes *Homo sapiens* from all other species. It is therefore not surprising that the origin of language has been the object of fascination throughout history. In the 7th century BCE, the Egyptian King Psamtik I was reported to have isolated two children at birth to discover which language they would spontaneously produce and which, it was concluded, was therefore the 'natural' language of humankind (it was claimed that the first sounds they produced resembled the word 'bread' in Phrygian, a now extinct language that was spoken in parts of what is now modern day Turkey). Along with several other similar 'experiments' there is a tradition of meditation and speculation on the origins of language, from Plato's *Cratylus* dialogue, which discusses the extent to which words have natural or purely arbitrary relationships to their referents, to far less esteemed and wilder speculations in the ensuing centuries, such as claims that language originated out of cries of pain, grunts from heavy lifting, or imitations of sounds in the environment. It was in fact in response to the plethora of such speculations that the Linguistic Society of Paris included article two in its statutes in 1866, which stipulated that 'La Société n'admet aucune communication concernant, soit l'origine du langage, soit la création d'une langue universelle' (The Society does not accept papers on either the origin of language or on the creation of a universal language).

For much of the 20th century, a time when linguistics was anxious to maintain a reputation as a ‘scientific’ discipline, discussion of the origins of language were infrequent and it was not until the 1970s that the topic began to be rehabilitated. Then, seminal papers such as Pinker and Bloom (1990) sparked a renewed, vigorous interest in language evolution which has resulted in a vast output of research in recent years. However, despite (or possibly because of) such an intensity of investigation, there remains much that is either not fully understood or is hotly disputed. Reviewing the field in 2007, Bickerton concludes that there are only four things that people generally agree upon: firstly, language emerged somewhere between 3.5 million years ago (mya) and 50 thousand years ago (kya); secondly, the earliest form of language was a much simpler ‘protolanguage’ than the complex systems of today (though there is much disagreement concerning its nature); thirdly, there was some selective pressure that enabled language to spread – probably social intelligence of some form; and finally there is some relationship between the evolution of language and of cognition more generally. As broad as these tenets are, there is not even acceptance by all researchers of these – Bickerton himself, for example, is adamant that social intelligence was not the adaptive factor in language evolution.

The reasons why there is so much disagreement in the field are not difficult to fathom since they arise from the cross-disciplinary nature of the investigation as well as the paucity of palaeontological evidence and the total absence of any linguistic evidence *per se* from the periods at the heart of the question. Spoken language leaves no fossil trace, and the earliest known writing systems at approximately 6 thousand years old are far too recent to shed light on the origins of language. Furthermore, even the scant fossil record of our ancestors that we do have contains no direct fossils of vital organs involved in speech and language: the brain, the respiratory organs and the vocal apparatus. In addition to this, the study of language evolution involves contributions from disciplines as diverse as evolutionary biology, palaeontology and its subgroup palaeobiology, anthropology, physiology, neuroscience, genetics, primatology and computer science, as well as linguistics. There are disagreements in each of these fields and breakthroughs and discoveries in any one discipline can have a significant knock on effect in the study of language evolution. Consequently, theories of language evolution can best be judged against the criteria of the most plausible ‘abduction’ (C. S. Pierce), that can be made about the nature of the FL which is commensurate with the scarce evolutionary data available. This, then, is the task at hand, and my steps towards dealing with it are outlined in the next section.

1.4 Outline of the Thesis

Chapter 2 reviews the development of CGG from the earliest days through to the most recent developments in the MP. The purpose of this is to identify any conflicts in the theories that motivated their revision. The status of ‘meaning’ is given particular analysis and I conclude by focusing on a number of areas that remain particularly problematic. In chapter 3 I address 3 areas: firstly, theories of evolution; secondly, what is known (or hypothesised) about the nature of hominin evolution; and finally I propose 4 classifications of theories of language evolution and consider each of these 4 in turn. Chapter 4 is concerned with the application of the comparative method to the study of human and nonhuman cognition, including a focus on the structure and evolution of the human brain with particular reference to brain size and what these might mean for a theory of language evolution. In the next chapter I consider the relationship of language and thought, what aspects of cognition are necessary for language and introduce a theory of the FL that best accounts for all the data previously examined. Finally, in chapter 6, I restate more explicitly the conclusions I have drawn and briefly consider further areas for investigation.

Chapter 2. The development of Chomskyan Generative Grammar

2.0 Introduction

In this section I consider the various stages that CGG has passed through in its changing conception of the nature of the language faculty in order to identify tensions that have characterised the enterprise from the start. I begin with Chomsky's earliest publications on language and how, and why, these have metamorphosed into the subsequent models, up to and including the current proposals in the Minimalist Program (MP). Finally, a number of unresolved issues in the MP are highlighted.

2.1 The beginning of transformational generative grammar

The position of meaning has always been problematic in CGG, and was, for the various reasons discussed below, absolutely peripheral to the earliest generative expositions on language:

> 'a great deal of effort has been expanded in attempting to answer the question: 'How can you construct a grammar without an appeal to meaning?' The question itself however, is wrongly put, since the implication that obviously one can construct a grammar with appeal to meaning is totally unsupported. One might with equal justification ask how you can construct a grammar with no knowledge of the hair color of the speaker' (Chomsky, 1957: 93)

While there is general agreement that Chomsky's work has constituted a 'revolution' in the field of linguistics (e.g. Greene, 1972), there are many aspects in which early CGG was rooted in the then current linguistic practices of North America (Kibbee, 2010). Although Chomsky subsequently preferred to see his work as embedded within the tradition of the universal grammarians of the seventeenth century and later writers such as von Humboldt, in fact the work, at least around *Syntactic Structures* (1957), relies far more on aspects of information processing theory and main stream structuralism. From the former of these, Chomsky approaches language as a consideration of an algorithmic generation and distribution of linguistic structures, though he identifies the inadequacy of investigating these in terms of finite state grammars. While the earlier structuralists had almost completely neglected sentential syntax focusing rather on categorisation of phonemes and morphemes, Leonard Bloomfield had already initiated a change of overt emphasis towards sentence structure and this was to be central to Chomsky's endeavour.

One feature that at this stage was inherited from the structuralists was a scepticism towards any investigation of meaning – 'rather pointless' (Chomsky, *ibid*: 100) – the result of the then still dominant paradigm of behaviourist psychology and suspicion of all treatment of meaning as unscientific. For the pre-cognitive (or at least proto-cognitive) Chomsky, the task was to understand language as an independent formalism (not just the development of discovery procedures which had been the focus of many structuralists). Yet, unlike the structuralists, Chomsky was of the view that at the sentence level, the observable data alone was insufficient for the basis of a comprehensive formal theory of syntax. The (potentially infinite) creativity of language could not be accounted for through context free phrase structure rules alone and, developing a notion proposed by Zelig Harris, Chomsky took *transformations* to be central to his theory.

One further early influence, and one that has had a profound impact on the evolution of CGG, is the concern with simplicity and economy principles (see discussion below). This is often suggested to be the result of Chomsky's encounter with philosophers of mathematics and logicians such as Nelson Goodman and Richard Milton Martin, and, as Newmeyer points out, by the early 1950s 'many logicians simply ASSUMED that a natural language was defined by a set of recursive rules', though unlike Chomsky, 'they shrank from the enormity of the task of trying to state them' (1980: 36, emphasis in the original). So while structuralists generally were concerned with developing a theory that could best describe the data, Chomsky introduced a new *desideratum*, that of *explanatory adequacy*, whereby grammars which fulfilled the principles of descriptive adequacy were evaluated against the criteria of economy.

These influences coalesced in the first account of transformational generative grammar in which three sets of rules were proposed. Terminal strings were generated by formal phrase structure rules for a specific language, not qualitatively different from the immediate constituent analyses of the structuralists. The output of these were subjected to two types of transformations. Firstly, obligatory transformations generate the uniclausal, declarative, affirmative *kernel sentences* of a language. These may then be subjected to further optional singular transformations to generate negatives, interrogatives, imperatives, passives etc., or two or more kernel sentences may be coordinated or embedded through *generalised* transformations which are the source of recursion. The final set of rules were the morphophonemics of the language.

2.2 The Standard Theory

Syntactic Structures was largely an outline of work from earlier in the 1950s (later published as *The Logical Structure of Linguistic Theory*, 1975), and by the end of the decade Chomsky's 'cognitive turn' (Swiggers, 2010) was well established. The concern with psychology and epistemology (specifically Cartesian) ensued from early collaborative work with the psychologist George Miller in 1957 and is most famously noted in the 1959 review of Skinner (1957) which fatally undermined the hold of behaviourism in psychology. Chomsky's argument that children could not acquire their language on the basis of the input alone (see discussion in introduction) led him to posit the existence of purely linguistic, innate, mental structures. So by the appearance of Chomsky's next monograph, *Aspects of the Theory of Syntax* (1965), there is a new focus on mental reality and the cognitive processes underlying language, made explicit in the competence / performance distinction. At the same time, the innateness hypothesis gave rise to the question of shared mental content and the term *universal grammar* makes its first appearance.

The 1965 model of CGG became known as the Standard Theory which is represented in figure 2.1 and summarised by Chomsky as follows:

> ‘A grammar contains a syntactic component, a semantic component and a phonological component. The latter two are purely interpretive; they play no part in the recursive generation of sentence structures. The syntactic component consists of a base and a transformational component. The base, in turn, consists of a categorial sub-component and a lexicon. The base generates deep structures. A deep structure enters the semantic component and receives a semantic interpretation; it is mapped by the transformational rules into a surface structure, which is then given a phonetic interpretation by the rules of the phonological component.’ (1965: 141)

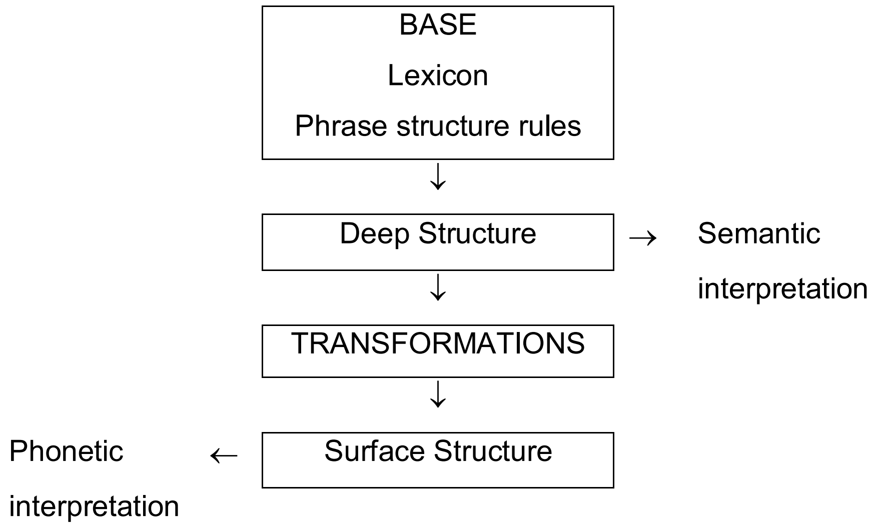

figure 2.1 The Standard Theory

The most striking changes to the 1957 proposal are the acknowledgement of the need for a lexicon, altered roles for transformations and the consideration of a semantic component. Obligatory transformations are replaced with recursive phrase structure rules acting on lexical items which generate the material which is given a semantic interpretation, with transformations only contributing to the surface structure which is only subject to a phonetic interpretation.

The discussion of what a semantic component might look like in a generative theory of grammar had been initiated by Katz and Fodor (1963) but it was the development by Katz and Postal (1964) that is assumed in the Standard Theory. There were two very significant elements adopted from Katz and

Postal's hypothesis. Firstly, transformations are presumed not to affect meaning – all semantic interpretation taking place prior to transformations – so, for example, actives and passives share a common Deep Structure. Secondly, as a consequence of this, nothing that contributes to meaning can be introduced by transformations, only movement and deletion were possible, so Deep Structure had to have a representation of abstract properties such as *Imperative*, *Interrogative*, *Negative* and so on. Thus Chomsky defines the interpretive semantic component in terms of Fregean compositionality as consisting of rules which 'apply cyclically, determining the semantic interpretation of a phrase *X* of the deep structure from the semantic interpretations of the immediate constituents of *X* and the grammatical relation represented in this configuration of *X* and its parts' (2006/1965: 123)

So while in Syntactic Structures the sentence 'Colorless green ideas sleep furiously' was taken as evidence of the autonomy of syntax (1957: 15), by 1965 Chomsky wanted his grammar to generate (his 14 (1)):
1) 'sincerity may frighten the boy'
but not (his 13 (1)):
2) 'the boy may frighten sincerity'
on the basis that the latter was in some way 'deviant', though it is not made clear in exactly what way, and Chomsky concludes that in examples like these (as opposed to uncontroversially 'ungrammatical' sentences such as his 15 (1): 'sincerity frighten may boy the') 'it is much less clear how their aberrant status is to be explained' (1965: 77). The capacity in the generative grammar to avoid generating these 'deviant' sentences was explained through the notion of binary semantic features, similar in many respects to the binary phonetic features that would be presented in Chomsky and Halle (1968). It was posited that items in the lexicon had strict subcategorisation features, such as transitivity on verbs, but also selectional features such as e.g. *animate*, *human* and so on which were factors in the syntactic computation: 'no matter how selectional rules are treated, there is no doubt that such features as [Human] play a role in purely syntactic rules' (1965: 150). However, as *animate*, *human* etc. are clearly semantic rather than syntactic properties, the autonomy of syntax appears to be violated, despite Chomsky's latter protestation in an endnote that there is 'no way to show that semantic features…play a role in the syntactic or phonological

rules' (*ibid*: 226 n15). Thus Newmeyer concludes that the remarks on the relationship of syntax and semantics in *Aspects* is 'vague enough' to be interpreted in any way that you wished to choose (1980: 92) and Chomsky tacitly acknowledges, 'the syntactic and semantic structure of natural languages evidently offers many mysteries, both of fact and principle, and that any attempt to delimit the boundaries of these domains must certainly be quite tentative' (1965: 163).

2.3 The generative semanticists

The consequence of the model of language proposed in the Standard Theory was that the innate, universal aspect of language was in deep structure with individual transformations being language specific. Chomsky argues that the point of departure for modern linguistics should be the insights of the seventeenth and eighteenth century 'universal grammarians' such as the belief that:

> 'The deep structure of a sentence is the abstract underlying form which determines the meaning of the sentence; it is present in the mind but not necessarily represented directly in the signal…The fundamental assumption of the universal grammarians was that languages scarcely differ at the level of deep structure – which reflects the properties of thought and conception – but that they may vary widely at the much less interesting level of surface structure' (1966: 588)

Not surprisingly, this line of thought led many linguists to greater abstraction in considering the nature of deep structure and ultimately to the movement known as 'generative semantics' (henceforth GS) whose acrimonious relationship with mainstream CCG has been discussed at length (e.g. Harris, 1993; Huck and Goldsmith, 1995)

The basic premise of the adherents of GS was that if transformations and surface structure made no contribution to meaning, then all differences and similarities of meaning are differences and similarities of deep structure. In other words deep structure was synonymous with semantic representation. From this it was concluded that two sentences which shared the same truth conditions, such as those below (from Fodor J.D., 1977: 70), had the same deep structure regardless of how much they differed in surface structure, even in terms of number of clauses:

3) Rain may be good for the hair

4) It is possible that rain is good for the hair

it being assumed that the underlying deep structure was closer to a language of logical predicate calculus than surface structure natural language. Such a model was, as Seuren puts it, 'A mediational production grammar (which) is not a sentence *generator* but a sentence *transformer*' (2004: 158, italics in the original) For many psycholinguists and psychologists, the immense attraction of GS was 'the greater plausibility of supposing that a speaker begins by generating the basic semantic component of "what he wants to say", only then going on to cast it in an appropriate syntactic form' (Greene, 1972).

Chomsky dismissed this final argument on the grounds that it mistakenly attributes temporal processing properties to the model of generative grammar (see discussion below of the implications of this for the notion of psychological reality in CCG). That aside, GS ran into a number of problems, particularly in aspects of lexical decomposition (e.g. see Fodor,J. A., 1970) and deep structure became more abstract and complex, as the task of identifying underlying semantic representation was bound to do.

2.4 The Standard Theory revised and extended

Faced with a very popular movement that was taking generative grammar in a direction in conflict with his own goals, Chomsky responded by reverting to the earlier Katz and Fodor hypothesis on the semantic component which did allow for meaning to be changed through transformations.[1] So by the 1967 Beckman lectures at Berkeley, Chomsky was explicitly committed to a position whereby it is a fact 'that surface structure also plays a role in determining semantic interpretation' (2006: 95). At this stage the principal grammatical relations were

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[1] To be fair, Chomsky had always retained a degree a scepticism regarding the claim that all semantic interpretation occurred at deep structure as 'somewhat too strong' (1965: 224 n.9) though these reservations are relegated to an endnote.

still presumed to be interpreted at deep structure, but at least some other aspects of meaning were judged to be determined by surface structure. These included pronominal reference; quantifier scope; presupposition and focus; and topic and comment. With the exception of the first two, these are today understood in CGG to be matters not of syntax and semantics, but of pragmatics and discourse structure.

A further disagreement with the followers of GS that emerged was Chomsky's explanation of some phenomena in non-transformational terms. So while in the standard theory there is a discussion of the treatment of nominalization transformations, and it is thought 'not at all clear that *destruction* or *refusal* should be regarded as Nouns' (1965: 184), Chomsky later (1970) adopts a *lexicalist* analysis of derived nominals whereby nominals such as *happiness* or *construction* are not syntactically derived from underlying adjectives or verbs. The basis for this was that the relationship between (morphologically) derived nominals and their underlying verbs or adjectives was highly irregular and the resulting nominals behaved in all respects like nouns and not at all like verbs or adjectives. On the other hand gerundive nominals have a regular relationship to the underlying verb (from which they *are* assumed to be syntactically derived) and behave like verbs in that they occur with aspectual verbs, and they are modified by adverbs.

Together, these new developments became known as the Extended Standard Theory (EST) and throughout the 1970s and into the 1980s there were many further developments in the theory (which eventually obtained a further title as the Revised Extended Standard Theory – REST) motivated by universalist concerns and the need to constrain the theory, developing the notion introduced in *Syntactic Structures* that only the grammatical structures of any language were generated, and not the ungrammatical ones. This resulted in Principles and Parameters theory in which all languages were assumed to share common principles and a number of binary parameters that needed to be set by the child in the process of acquisition. The most far reaching technical modifications to the syntax were the introduction of X-bar Theory and very precise constraints on transformations, which were ultimately reduced to constrained movement: Move α. The clearest and most exhaustive state of the art account (Chomsky,

1981) included several sub-components or modules: 1) Bounding theory 2) Government theory 3) Theta theory 4) Binding theory 5) Case theory 6) Control theory and 7) X` theory. The consequences for the place of meaning in the grammar were most profound in the addition of the notion of *traces*. If phonetically covert traces of items at the position where they were initially generated were present in the S-Structure (a renaming of surface structure; deep structure becoming D-Structure), then this could be the location of all semantic interpretation including basic grammatical relations, as shown in figure 2.2 below. Surface structure then split, at a point in the derivation called 'spell out' into a component consisting of a set of phonetic instructions (*phonetic form* or PF) that could be read by the articulatory perceptual (AP) system, and another consisting of semantic content (*logical form* or LF) – including phonetically empty categories such as *traces* – that could be read by the conceptual intentional (CI) system. On economy grounds, this was preferable to semantic content being interpreted at different stages in the derivation.

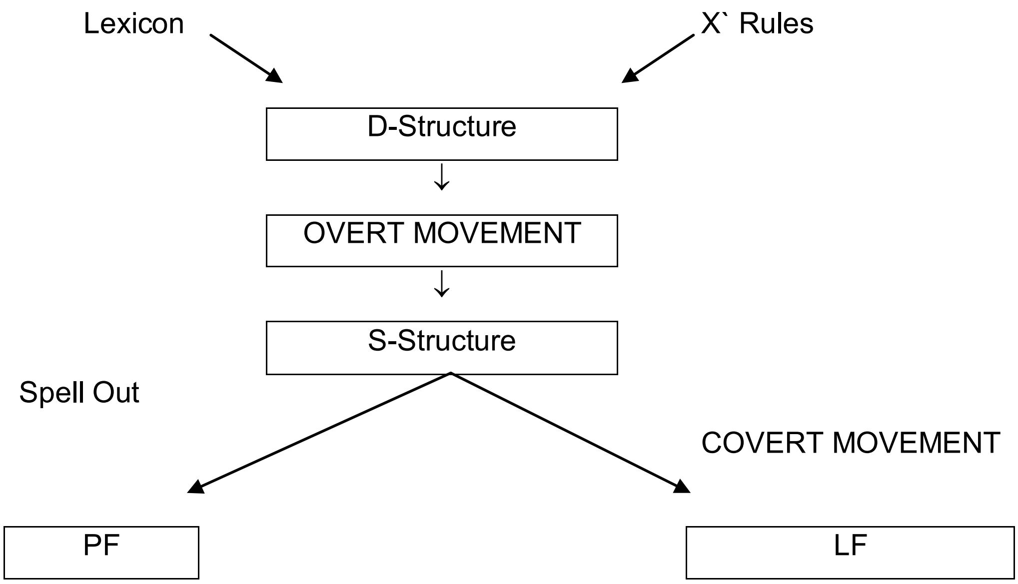

figure 2.2 The Revised Extended Standard Theory

2.5 The Minimalist Program

Economy principles had never been removed from the concerns of CGG, it was just that they seemed to be at best peripheral and at times the direction of research gave the impression of being tangential to stated aims of simplicity; however, as Greene noted early on, ‘despite all appearances to the contrary, the purpose of these theoretical revisions is to make grammars simpler’ (1972: 33). The problem, then, with the way that CGG had developed is that the REST model now consisted of at least four different levels – S-Structure, D-Structure, LF and PF) as well as the numerous sub-components referred to above, it had in effect acquired what Grohmann referred to as the ‘humungous apparatus of Government and Binding’ (2005). Consequently, there was a significant change of direction with the launch of what was described as a ‘research program’ rather than a coherent, fully elaborated theory of language: the Minimalist Program (MP) (Chomsky, 1995).

As with all stages of CGG, the MP is fluid and has evolved substantially from the initial proposals in the early 1990s. What remains more or less constant is a notion of computational efficiency whereby the syntactic component is understood as consisting of operations for linking sound with meaning in the simplest way possible. Mainstream MP (see e.g. Hornstein *et al*., 2005) assumes that lexical items are specified with a number of phonological, semantic, and formal (categorial, Case and Phi) features. A number of lexical items are selected to constitute a *numeration* or *lexical array*. Two of these items are merged to form a third object which is in turn merged with another item from the numeration and so on until a *phase* is complete and the content of the numeration exhausted (e.g. Chomsky, 2008). Uninterpretable (i.e. formal) features are *checked* (eliminated) during the derivation in a probe~goal agreement relationship between the two items being merged. If any uninterpretable features remain, then this triggers further internal merge (also known as *move*) in which a copy is made of the object undergoing movement (the copy remains in the initial position in which it was merged). The Principle of Full Interpretation (PFI) stipulates that no features should be sent to either of the AP or CI interfaces which are not interpretable at that interface. As a result the operation spell out is retained from the REST, and the phonetic (/phon/) features alone are sent as PF to the AP interface and the semantic ([SEM]) features to the CI interface as LF. In order to capture certain scope relationships in LF, there may be further covert movement post spell out, i.e. on objects with only [SEM] features. In theory, the sub-component modules of the syntax have been purged and simplicity restored – the overall architecture of the MP may be seen in figure 2.3 below:

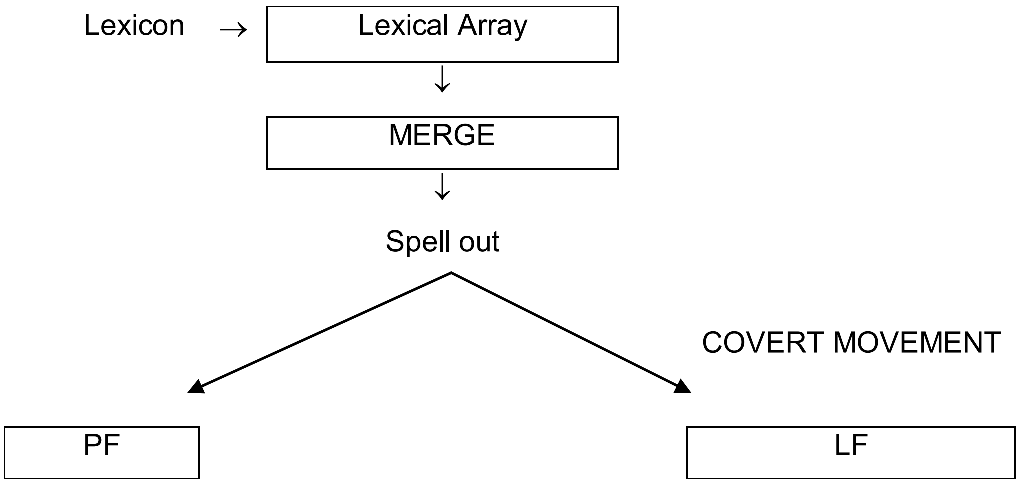

figure 2.3 Derivation in the Minimalist Program

Derivational operations are reduced to a ‘virtual conceptual necessity’ (Chomsky, 1995: 168f) for linking sound with a meaning, and something that is innate and that has evolved to be universal in the species. In the MP it is assumed that ‘parameters of UG relate, not to the computational system, but only to the lexicon…there is only one human language, apart from the lexicon’ (Chomsky, 1995: 131).

What, then, is the status of meaning in the MP? Chomsky in 1995 states that LF is an ‘interface level’ (p.168) though later he claims that the REST postulated ‘three internal linguistic levels *in addition to* the interface levels: D-Structure, S-Structure, and LF’ (2005:11, my emphasis).[2] It appears clear that LF is not semantic representation itself (and certainly not the predicate calculus type envisioned by GS), but its exact nature remains unclear. Seuren concludes that:

> ‘the notion of LF is left without any empirical or formal criteria and without anything approaching a definition…the targets of the movements are determined by what has to be considered a vacuous notion of “logical form”. (2004: 39-40)

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[2] LF is presumably accorded a ‘linguistic’ status here beyond that of PF, as it is the level generated through covert syntax.

2.6 Issues in the current state of CGG

A number of problematic issues that are particularly important for a theory of language evolution and the status of CGG as a real cognitive object arise, or at least become more prominent, in the MP. Four issues are considered below.

2.6.1 Economy principles

Simplicity had been a major concern for Chomsky from the earliest days: ‘Notice that simplicity is a *systematic* measure; the only ultimate criterion in evaluation is the simplicity of the whole system’ (1957: 55-56). Though as Newmeyer notes, ‘since no concrete examples were given in Syntactic Structures of how adequacy correlates with formal simplicity, it was easy for many commentators to draw the conclusion that the simplicity metric was little more than an aesthetic – a matter of personal taste’ (1980: 22)

Within the MP such matters are elevated to play a central role whereby the aim in the description of a theory of language is to go ‘beyond explanatory adequacy’ (Chomsky: 2004) and to understand *why* features of UG are like they are. This is understood to be the result of non-linguistic, ‘third factors’ (Chomsky, 2005) which are part of the biological or even physical/atomic make-up of the world and constitute a ‘perfect’ system. Thus the subjacency principle, for example, ‘follows from some principle of efficient computation…it’s because that’s the way the world works’ (Chomsky, 2012: 61). Fodor and Piatelli-Palmarini similarly argue that much that occurs in nature is not the result of adaptive evolution but rather what they term ‘the laws of form’ which are constraints from above which adhere to abstract ‘mathematical and physico-chemical laws’ (2010: 72). Among the many examples they offer are occurrences of Fibonacci spirals in populations as diverse as droplets in viscous liquid, seashells, leaf alternations and seeds in a sunflower. Further evidence comes from studies such as Hoyt and Taylor (1981) who showed that the gait employed by horses – the changes from walk to trot to gallop – were developmentally acquired energy saving efficiency strategies. Blumberg concludes that land mammals use a diversity of gaits ‘to satisfy the demands of physics and efficiency…These gaits represent universal organisational principles of behaviour. Understand the rules and the behaviour follows naturally' (2009: 118).

Whether spirals in nature or developmental plasticity in animals in such areas as locomotion options (see discussion in the following chapter) are appropriate analogies to an internal, hardwired language faculty is not obvious. Certainly not everyone is convinced by this, and Seuren dismisses discussion of perfection in CGG as 'nothing but the vague idea that it is difficult to imagine that things could be different' (2004: 134). Kinsella discusses the notion of 'perfection' in nature at length and concludes, on the basis of MP architecture, that 'The minimalist is not justified in claiming simplicity and economy for the human language faculty' (2009: 183). The discussion of the role of simplicity in the evolution of the language faculty is taken up below in chapter 3.

2.6.2 The numeration/lexical array

One of the premises of the MP is that a number of lexical items enter a numeration (later called a *lexical array* for reasons that are not of concern here). The No Tampering Condition (NTC) states that no other items may be chosen from the lexicon during a derivation, and that the derivation continues until the numeration is exhausted; this constraint is posited on the grounds of computational efficiency with a claim to extralinguistic generality whereby 'operations forming complex expressions should consist of no more than a rearrangement of the objects to which they apply, not modifying them internally by deletion or insertion of new elements' (Chomsky, 2005:11). The numeration ensures that the syntactic component knows when the derivation is complete, without it a derivation would presumably be concluded every time any fully interpretable linguistic expression was generated.

Two questions arise from the notion of the numeration. First, on what basis are lexical items chosen? Why one particular group of lexical items rather than another? Hornstein *et al*. (2005) declare that the selection of lexical items is a performance issue and outside of the remit of the formally linguistic, while Chomsky claims that 'there is no meaningful question as to why one numeration is formed rather than another – rather than none, so that we have silence… The problem of choice of action is real, and largely mysterious, but does not arise within the narrow study of mechanisms' (1995: 227). But whatever the nature of this 'mysterious' action, it is presumably, as an expression of meaning through sound, a function of the Conceptual-Intentional system. How such an action is possible without an already accessible Logical Form is not clear. Furthermore, if the CI system does play a role then how is it possible that lexical items lacking [SEM] features (such as expletives and complementizers) are chosen when they cannot be 'read' by the system at work in their selection? (see also, for discussion of problems in pronominal selection, Sigurδsson and Maling, 2010: 68, discussed in Chapter 5 below)

The second question is on what basis does the operation 'select' function? That is, why is any particular lexical item to be merged at a particular point in the derivation chosen from the numeration, rather than any other item? Hornstein *et al*. simply say that with a given numeration containing, among other items, *car* and *that*, then 'the computational system may select *car* and then *that*' (*ibid*: 70) but give no indication of on what basis such selection occurs. The selectional features that in the Standard Theory were able to filter out 'the boy may frighten sincerity' have been eliminated so presumably this sentence is just as likely to be generated as 'sincerity may frighten the boy'. Indeed, any and all grammatical structures that can be generated out of a given numeration should be generated. However, given that the numeration was chosen in the first place to generate a specific sound~meaning pairing, this does not seem to be computationally efficient.

2.6.3 Crash-proof grammar versus unbounded merge

Problems become even greater when, on evolutionary grounds, the syntactic component is reduced to recursive, unbounded merge (e.g. Hauser *et al.*, 2002). The earlier writings in the MP had eliminated the sub-components of the REST, but still presumed that their constraining effects were achieved in some other way in the syntax. This was understood as being feature driven, and the multitude of operations (see Hornstein *et al.*, 2005) insured that non-grammatical derivations were avoided – so called 'crash-proof' grammars (Putnam, 2010; Boeckx, 2010). However, in recent years, Chomsky has proposed a Strong Minimalist Thesis (SMT) (e.g. 2004, 2007) which takes 'unbounded' merge (including internal merge or move) as the sole operation in the syntactic component, and that deviant derivations are filtered out by the interface conditions. In this model there is only a single syntactic feature, an edge feature which indicates mergability. The problem for minimalists is that both models bring unwanted consequences. The crash-proof approach requires enormous complexity in the lexicon and numerous feature-driven operations that are entirely unminimalist in character – and highly implausible on evolutionary grounds. As one proponent of the Merge only (Mα) side of the debate notes, '"crash-proof" systems…employ massive stipulations to ensure the 'right' outcome, ending up with an elaborate redescription of the facts (the spectre of GB theory)' (Ott, 2010: 103). On the other hand the Mα approach reduces the syntactic component to what critics may claim is a trivial operation. In addition to there is the less clearly defined operation resulting in projection/labelling which involves the provision of some form of information about the type of syntactic objects being generated, as Chomsky explains, 'we assume, then, that there is a fixed labelling algorithm LA that licenses SOs so that they can be interpreted at the interfaces' (2013: 43). The generation of all possible derivations from a single numeration, all but one of which are then eliminated on legibility grounds is inefficient – 10 lexical items could be merged in 3.6 million different ways (Putnam and Stroik, 2010) – and strips CGG of any pretence at explaining psychologically real processes (see next section). The eradication of theories from earlier CGG that seemed elegant and explanatorily useful, are a classic example of what has been called a 'Kuhn loss' (Ludlow, 2011: 29). It is not even clear on what grounds two competing derivations – both grammatically well-formed but semantically distinct – would be evaluated, the interface conditions not being explicitly stipulated in any way. The development of the MP in the direction of Mα does seem to vindicate Seuren's fierce criticism of the model as 'a "random-generator" view of language' (2004:3)

2.6.4 CGG and the status of psychological reality

The focus on the cognitive aspects of linguistics that emerged in the late 50s promoted the field to what Jackendoff recalls as 'the toast of the intellectual world [as] everyone wanted to know about deep structure and what it showed us about the mind' (2002: xii). It certainly seemed at the time that CGG was concerned with explaining real cognitive processes or 'discovering a mental reality underlying actual behavior' (Chomsky, 1965: 4) and transformational generative grammar was upheld as a necessary contribution to a fully explanatory understanding of speech production and perception (e.g. Chomsky, 1964, 1965). Early psychological experiments were conducted on the basis that the greater the number and complexity of transformations that were involved in any expression would equate to greater processing time – the Derivational Theory of Complexity (DTC). And indeed these first experiments appeared to support this hypothesis, which Chomsky is reported to have taken as a vindication of the theory of transformations within generative grammar (Smith, 2004: 111). However, these investigations were based purely on formal manipulations and once experimenters began to look at meaning-based tasks evidence for DTC proved elusive (for a discussion of these experiments see Greene, 1972 and references therein). As noted above, in the debate with the Generative Semanticists, Chomsky was later adamant that the theory of transformational grammar could not be understood as a temporal cognitive process and that remains the stated position: 'the system implies no temporal dimension. In this respect, generation of expressions is similar to other recursive processes such as construction of formal proofs' (Chomsky, 2007: 6).

This leaves the status of CGG undetermined as to whether it explains a psychologically real process or not. Certainly contemporary advocates of CGG such as Hornstein maintain unequivocally that the 'inventory of rules and principles [in the MP] describe real mechanisms of the mind/brain' (2009: 45f10). And Chomsky states that 'the generative system is something real, as real as the liver' (2002: 110) – and livers, of course, operate in real time. Smith makes the distinction between performance and competence in that the former employs the latter in that 'a parser maps sounds into thoughts by using the grammar' (2004: 112). And presumably a parser is used to map thoughts into sounds which, if it involves movement (internal move), must be temporal, otherwise CGG is simply instrumentalist rather than realist. The distinction is between a weak notion of competence than is purely descriptive of the surface order of language, and a fully explanatory, strong competence than accounts for psychologically real processes. Seuren refers to this as ‘Chomsky’s ambiguous realism’ (2004: 61) which he claims is not realism at all and that *all* CGG is analogous to Fibonacci numbers which can predict natural occurrences such as the number of petals on a flower, but have no ‘reality’ (i.e. are not hard wired) in *plants*. This might seem to accord with the current emphasis on 3rd factors, but leaves little room for the innate aspects that accounted for language acquisition and were the motivation for CGG in the first place. The nature of the psychological reality of CGG is taken up again in chapter 5.

2.7 Conclusion

The relationship between semantics, syntax and phonology in CGG has been constantly shifting. In its current form, with post computational semantic interpretation, the MP is forced to choose between a crash-proof system that is attached to a complex set of operations, dubious on psychological grounds and, as we will see in the next chapter, implausible on evolutionary grounds. Alternatively, the Move α approach reduces syntax to what is arguably a trivial operation, merge, which operates in conjunction with labelling, and fundamentally undermines any claim to being psychologically realist[3]. In chapter 5 I will claim that these problems arise from an inherent property of syntax in CGG: that it is required to simultaneously serve the two masters – LF and PF. The fact that one of these is purely hierarchical, and the other purely linear means that no system is going to be able to operate as this dual function.

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[3] It should be noted that most proponents of CGG, including those who subscribe to the SMT, also assume that there is Agree by which grammatical relations are established through c-command.

Chapter 3. Evolution, hominin phylogeny and the emergence of language

3.0 Introduction

With the exception of those who attribute the existence of the world in its current form to faith-based interventions, evolution by natural selection is one of the most universally accepted theories in science: a point succinctly made by Dobzhansky in the title of his 1973 article, '[n]othing in biology makes sense except in the light of evolution' (p.125). When Darwin published *On the origin of species* in 1859, it had already been noted for many years that living creatures, if not necessarily humans, evolved. Darwin's great contribution was to fuse the notion of evolution with the mechanism of natural selection, a proposal so simple and convincing that the biologist Thomas Huxley felt obliged to reproach himself, reputedly exclaiming "[h]ow stupid of me not to have thought of that". The final part of the theory that is now known as neo-Darwinism or the 'modern synthesis' came with developments in the ensuing 150 years in biological and molecular genetics that provided an explanation of precisely how natural selection operated (for a history see e.g. Ridley, 2004).

This chapter comprises three sections. The first begins with an examination of the nature of neo-Darwinian evolution and the mechanics of the processes which underpin it. This is followed with a consideration of alternative hypotheses for genetic and epigenetic evolution. The second section looks at the evolution of the human species and seeks to identify stages in the physiological, cognitive and cultural history that may aid an understanding of the origins of language. Finally, we look specifically at differences in theoretical perspectives that seek to provide an explanation for language evolution.

3.1 The nature of evolution

Essentially evolution requires imperfect heredity, which leads to variation in a species. This variation enables members of a species to compete for resources and ultimately facilitates the opportunity to replicate themselves. This is the process of natural selection which ensures that those who are more finely adapted to their given environment are more likely to reproduce and consequently the phylogenetic feature that bestowed that advantage will spread through that interbreeding group of the species. Eventually these features become fixed in the species as a homologous adaptation. On the basis that major changes would be deleterious (an often used analogy is making large, random changes to a car engine) and possibly lethal to the individual, they would not spread, so evolution is presumed to be gradual and incremental. Indeed, many writers, especially in inter-disciplinary fields such as language evolution, seem to assume that neo-Darwinian gradualism constitutes the entirety of evolutionary theory. However, while no-one doubts the role of evolution by incremental, advantageous changes, it is by no means the whole picture. Before considering the wider view of evolution, it will be useful to look briefly at the most salient details of the precise mechanics of genetic change prior to further discussion later in this chapter and subsequent ones.

3.1.1 Genes and adaptive evolution

The phenotypic features of any individual are said to be an expression of the genotype of that same individual. Genes are composed of the chemical polymer DNA which itself consists of four bases, (adenine, thymine, cytosine and guanine – often referred to by their initials alone) the first two and last two of which combine against a double helix, sugar-phosphate backbone to form chromosomes which are contained in cell nuclei. Humans have 23 pairs of chromosomes, including a pair of sex chromosomes one of which combines with another parental chromosome in the formation of offspring. In the process of generating new material, the DNA contained in the chromosomes undergoes transcription into mRNA which leaves the nucleus and is transported to another element, or *organelle,* of the cell, the ribosome, where, through the process of translation, its own unique code determines a particular amino acid sequence in the production of proteins. In the case of the 22 non-sex chromosomes, these proteins constitute the phenotypic traits of the individual.

The human genome consists of approximately 25,600 genes comprising roughly 40% of the 3,200 million pairs of bases contained in the chromosomes. Of the genes themselves, only stretches known as exons are translated into proteins (i.e. are *coding*) while other stretches, introns, are deleted after transcription. The function of the remaining non-coding DNA is not clearly understood, but it contains vestigial pseudogenes which were once, but are no longer, coding (and could be susceptible to reactivation) and is certainly functional in some way as damage to non-coding material can be just as harmful to cells as that to coding material, hence the abandonment of the previously common term ‘junk DNA’ (Ecker *et. al*., 2012).

In reproduction of diploid organisms such as humans, in which each cell has two copies of a chromosome, only one, randomly constituted from each of the two in the progenitor stem cell – a process called recombination – appears in the gamete or sex cell. One gamete from each parent fuse to form the embryonic cell (*zygote*) with a full pair of chromosomes. In humans, given our number of genes, this means that a single act of reproduction could produce any one of 64 million possible offspring (Nettle, 2009). Another source of novel traits in a species is gene mutation, in which DNA sequences are altered. Cells reproduce by making copies of the chromosomes and then dividing into two new cells. There are several ways in which mutations can occur, including inserting, deleting and changing base sequences during the copying process, producing an altered gene or *allele*. Mutations in gamete cells may be passed on and, if advantageous, become fixed in the species.

In addition to that contained in the nucleus, there is also a small amount of non-coding DNA that is located in other organelles of the cells known as mitochondria. This mitochondrial DNA (mtDNA) is passed almost exclusively down the female line and, because it is non-coding, mutations have no deleterious effects and are consequently much more tolerated and preserved. As a result, mtDNA is very useful in tracing back lineage in a species.

3.1.2 Genes and non-adaptive evolution

A number of mechanisms, complementary to natural selection, are generally recognised. These include random genetic drift, where alleles that offer no competitive advantage are still likely to be distributed among the population, particularly smaller populations. Furthermore, alleles generally have pleiotropic effects, that is they produce several distinct phenotypic traits. Consequently a particular neutral trait could ‘hitch hike’ alongside an advantageous trait with which it is correlated. There is even the possibility of a ‘trade off’ whereby a negative trait can survive if it is correlated with a sufficiently positive one. Where such a negative trait cannot be easily accommodated, its effect may be modified or eliminated by developments in other genes (modifier genes), a process known as canalizing selection.

Gould and Vrba (1982) emphasise the need to divorce current utility from the initial reasons of origin. Thus features that emerged under one adaptive pressure that may no longer bestow an advantage could be exapted for another purpose. Alternatively, traits that were never functional themselves but rather are the side effects of ones that were – for which Gould and Lewontin (1979) adopted the term ‘spandrels’ – could become utilised.

Saltations – the process whereby a macromutation gives rise to a major phenotypic alteration that is beneficial – are not considered plausible in mainstream evolutionary models. Theories based on sudden great leaps such as Richard Goldschmidt’s ‘hopeful monsters’ hypothesis from the 1940s have not survived (but see Blumberg, 2009, for a sympathetic review), and nor have the genes of Slipjer’s two-legged goat discussed below!

3.1.3 Epigenetic evolution

Fodor and Piattelli-Palmarini (2010) received a large number of very critical reviews for emphasising the internal, endogenous constraints on genotypic and phenotypic variability at the (complete?) expense of exogenous factors. However it *is* the case that a particular gene does not, on the whole, deterministically correlate with any given phenotypic trait (with the exception of monogenetic conditions such as cystic fibrosis). Numerous epigenetic factors influence the way in which a gene is expressed in the phenotype and one of the most significant characteristics of phenotypic development is its plasticity. Development is not pre-determined but rather the direction it takes and the stage at which it ceases are heavily influenced by factors outside of narrow genetic structure. This interaction of development and genetics is sometimes referred to as evolutionary developmental biology, or EvoDevo.

West-Eberhard (2005) argues that contrary to a strong selfish gene hypothesis, evolution operates on phenotypes which are the product of far more than just their genotypes. Indeed, the most successful life forms on earth in terms of an ability to replicate their genes and survive in the greatest variety of environments are non-nucleic, single celled bacteria and archea. Presuming all other life forms evolved from common ancestors with one of these, it is not clear why evolution, if purely propelled by the replication of genes, was ever kick-started in the first place. However, if it is phenotypes that are selected for, and development plays a major role in determining a specific phenotype, then ‘selection can proceed for generations without genetic variation and without an evolutionary effect….Should genetic variation affecting those traits arise, e.g. due to mutation or genetic recombination, it would immediately have an evolutionary effect' (West-Eberhard, *ibid*: 6544). In other words, genes may record adaptive change rather than promote it. She gives the example of the two-legged goat reported by Slipjer of 'phenotypic accommodation'. This animal was born without any forelimbs and yet through anatomical and behavioural developments it was able to move with remarkable agility and speed. It was recorded that the goat had developed the necessary muscular manipulation to enable locomotion in the manner of a kangaroo. It had also developed the necessary bone and tendon shape required for bipedalism. The only two explanations for this phenomena are either due to the reactivation of dormant pseudogenes from an earlier time when the ancestor of goats was bipedal, or, the far more plausible account, that it was the result of developmental adjustment to how the genes were expressed. Being two-legged, however, conferred no adaptive advantage on the goat and it failed to reproduce.

Blumberg (2009) gives numerous other examples of how developmental factors influence phenotypes, and locomotive gait in particular. In the case of rabbits, he reports that locomotion by hopping, far from being genetically determined, is purely a developmental response to the environment. In fact, by severing the spinal cord and subsequently stimulating the appropriate muscles, it was shown that rabbits are hard wired to walk rather than hop. Similarly, a study by Robinson (2005) showed that prenatal experience by a rat foetus had a significant influence on the development of coordinated motor behaviour. Blumberg's conclusion, like that of Hoyt and Taylor (1981) referred to in the previous chapter, is that to 'satisfy the demands of physics and efficiency, land mammals use a diversity of gaits. These gaits represent ‘universal organizational principles of behaviour’ (*ibid*.: 118).

As well as such examples of developmental induction, many species also pass through a sensitive period when they undergo *imprinting*. For example, Spencer *et al*. (2009) refer to ducklings which, immediately after hatching, will follow and form an attachment to the first moving object of the right size that they encounter, whether that is their mother or a red wooden box on wheels. However, ducklings reared in darkness with no appropriate stimuli do not develop such a predisposition. Imprinting, they argue, is not part of an innate, genetically specified endowment, but rather a developmental response to the environment.

3.1.4 Environment and genetic change

While the role of the environment on genetic expression is gaining increasing recognition, it is commonly accepted that development does not impact directly on the genes themselves. However, there are two challenges to this position. Firstly, rather similar to the scenario described by West-Eberhard above, is the process known as the Baldwin effect. In this case, a genetic change that confers an advantage only if conspecifics are able to respond in an appropriate manner, say to a novel warning call, will benefit only those members of the species who can learn the correct reaction. If sufficient numbers do respond correctly and acquire an advantage, then the allele responsible for the behaviour will spread among that group. In time, either the reaction itself or the learning ability may become fixed in the genes through the process of genetic assimilation (Nettle, 2009). This clearly has major implications for possible theories of language evolution (see below).

More controversial are hypotheses that appeal to the long discredited Lamarckian evolutionary theory of soft (acquired) inheritance. However, Spector (2012) discusses the process of ‘methylation’ whereby methyl groups that are free floating in cells attach themselves to points in the DNA (usually c bases) and switch off the gene so that it is no longer coding. Examples of methylated genes that have been passed down generations have been recorded in toadflax plants, water fleas, chickens and mice. There is even evidence that events can change genes and that these changes are inherited by future generations in humans. Spector (*ibid.*) refers to a study of a small, isolated community in Sweden whose ancestors in the 19th century had alternatively gorged themselves in times of good harvests and starved during famines. Those whose parents were born to grandparents during the feasting years had statistically significant increased cardiac disease and diabetes rates indicating that behaviour (in the 19th century) appeared to have had an impact on the third generation nearly a century later. However, the rehabilitation of Lamarck is neither accomplished nor likely to be so and there is only scant evidence available for developments such as these[4].

Even were the existence of acquired inheritance and its mechanisms to be established and given a role in evolution alongside developmental plasticity, the role of genetic change would remain undiminished, particularly in the investigation of different species which is considered in the next section.

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[4] Though see recent research on mice and olfactory memories linked to electric shocks – New Scientist 6/12/13

3.1.5 Speciation

Species is not a straight forward category and depends to some extent on one's philosophical perspective. The two factors usually invoked as criteria for distinguishing between different species are the inability to interbreed, and sufficient morphological dissimilarity. For neo-Darwinists, species has, to some extent, to be a methodological construct as the two criteria are a matter of degree in a gradually changing population. A complementary hypothesis is that of 'punctuated equilibrium' (e.g. Gould and Eldredge, 1993) which the authors describe as 'a novel interpretation for the oldest and most robust of palaeontological observations: the geologically instantaneous origination and subsequent stability (often for millions of years) of paleontological "morphospecies"' (p.223). Punctuated equilibrium is a peripatric theory of speciation, that is, new species are said to appear in geographically isolated, small sub-populations. There are periods of rapid change (adaptive radiations) as the new species emerges and then much longer periods of stasis when there is relatively little significant evolutionary development.

Certainly it is known that sudden and dramatic changes to the environment can have significant effects on genetic expression. The removal of homeostatic constraints on development can lead to many different phenotypes in a population. Blumberg (2009) discusses the example of British grass snakes whose eggs, if incubated above 40 degrees centigrade, tend not to hatch, but those that do invariably form dicephalic (two-headed) snakes. There are various reasons why these creatures are not likely to survive, but, as Blumberg points out ‘if an animal were ever to find itself in an environment that, for whatever reason, did favour the possession of two heads, a dicephalic species could arise very rapidly for one simple reason: *The embryo’s potential to produce two heads is no less ancient, and no less fundamental, than its potential to produce just one*’ (*ibid*.: 95 – italics in original). The gradual evolution and speciation events that have ultimately resulted in modern humans are the subject of the next section.

3.2 Hominin evolution

Of all the disciplines that contribute to the study at hand it is perhaps the field of palaeontology that is most afflicted with controversies, and in which single fossil discoveries can have a significant impact on an understanding of the story of the human species. This is due firstly to the nature of fossilization, in which only hard tissues such as bones and teeth undergo diagenesis, the process by which true fossils are formed, and in pre-burial times the chances of even these materials surviving is extremely small. A second problem is that of dating, of which there are several, rapidly developing techniques, with varying degrees of reliability, and which do not always lead to the same conclusion. The problem of reaching a consensus while utilising multiple methods is further compounded now that it is possible to extract DNA material from fossils for comparative analysis with other fossils as well as the human (and Neanderthal) genomes. Consequently, the outline below, though as close to an orthodoxy as exists, is tentative and several variants on this scenario are possible and have been proposed by researchers in the field; however, for the sake of brevity these will not be addressed in full.

Before looking in more detail at the origin of the species *Homo sapiens*, there are two theoretical points to be clarified. First, as discussed in 3.1.4 above, researchers differ on how they distinguish between different species. Those who tend towards a ‘splitting’ taxonomy will recognise an individuated species on the basis of comparatively fewer unique characteristics, whereas those who favour a ‘lumping’ approach are inclined to demand larger differences before conceding the establishment of a new species. My own position lies midway between both ends of such a continuum as we shall see (despite problems in determining exactly how much variation is ‘normal’ in any give species). Secondly, for most of the twentieth century, it was presumed that modern humans evolved from different ancestors depending on the geographical area they now occupied: the strong multiregional hypothesis. This position is now largely rejected and has been replaced by two competing proposals. Firstly, a weak multiregionalism that still presumes a variety of ancestors but emphasises the sharing of features throughout the human species through interbreeding. Alternatively, examination of mtDNA has suggested a recent out of Africa hypothesis that assumes a single common ancestral group in Africa around 200 kya (Cann *et al*. 1987). As will become clear, I assume a recent African origins for modern humans (for discussion see Mann, 2012).

3.2.1 Possible and probable earliest hominins.

In terms of genes, the closest existing relatives to humans in the animal kingdom are the two members of the *Pan* genus, *Pan troglodytes* (common chimpanzees) and *Pan paniscus* (pygmy chimpanzees, or bonobos). In recent years the estimated date at which hominins shared a last common ancestor (LCA) with chimpanzees has been extended further and further back. Raaum *et al.* (2005) review a variety of evidence and assume a point approximately 6 mya, while Endicott *et al*. (2010) used two methods which produced dates of 6.5 mya and 7 mya, both within a margin of error of plus or minus 0.5 million years. More recently, based on revised rates for *de novo* mutations in humans, Sun *et al*. (2012) have estimated an average date of 7.49 mya.

Research on soil samples (Cerling *et al*. 2011) suggests that environmental changes resulted in deforestation and the beginning of the encroachment of the savannah in East Africa by at least 6 mya, which would seem to confirm the paleaoanthropological and genetic evidence for a speciation event initiated by a change of environment.

The very earliest contenders for membership of the hominin clade include *Sahelanthropus tchadensis* (fossils dated to 6–7 mya) and *Orrorin tugenensis* (6 mya) whose fossils were found in West Central Africa and Kenya respectively. Two possibly better candidates belong to the *Ardipithicus* genus which lived 4.5–5.8 mya in the area of modern Ethiopia. However, while all four specimens show divergence from the assumed morphology of our LCA, especially in terms of increased bipedalism and modifications for a different diet, the changes are too slight and the quantity of fossils discovered too small to confidently classify any of them as hominins (Wood and Bauernfeind, 2012).

The earliest category for which there is a general consensus for classification as hominins are the australopithecines. These archaic hominins include several species that have been found the length of the African continent and whose fossils date from 2.4 to 4.5 mya (though there are claims for a more recent species, *Australopithecus sediba*, Berger *et al*. 2010). They were omnivores who were a little larger than modern chimpanzees, but whose brains remained proportionately the same, varying between 400 – 500 cc. The most significant change was a clear modification for bipedalism, which according to Wheeler (1991) conferred a thermoregulatory advantage for life on the savannah. This view is supported by evidence from the evolution of pubic lice, which took a unique form in hominins some 3 – 4 mya, indicating that some body fur loss would have occurred by this time if the lice were to have a niche to occupy distinct from more general body lice (Reed *et al*., 2007). Whatever the actual advantage was, and regardless of whether it was initially a genetic modification or developmental response, upright walking resulted in a narrowing of the pelvis and accordingly the birth canal in females as well as changes to the thorax and oral tract that were almost certainly beneficial to vocalisation as a subsequent exaptation. It also released the forelimbs from much of the responsibility for locomotion, and this may be related to a greater use of tools. Scarred animal bones found in Ethiopia and dated from 2.5 mya show evidence of having been stripped of meat using ‘Oldowan industry’ (early lower palaeolithic) stone flakes found nearby, and have been associated with *Australopithecus garhi* (de Heinzelin *et al*. 1999; though see Braun, 2010, who suggests an even earlier appearance of stone tools).

3.2.2 Transitional and pre-modern Homo

The first specimen to be generally classified as part of the *Homo* genus and considered by most as a transitional hominin, sharing modern and archaic features, is *Homo habilis,* though some researchers prefer to distinguish a separate transitional, though contemporary species, *H. rudolfensis*, which lived in some of the same locations (e.g. Wood and Bauernfeind, 2012.; Leakey *et al*. 2012). The earliest fossils, dating from approximately 2.4 mya, were discovered in the Olduvai Gorge in modern day Tanzania and indicate complete bipedalism, though otherwise show little change from the australopithecines. Some researchers remain skeptical of the status of a new species and Reader cautions that '*Homo habilis* remains more of an evolutionary idea than an example of anatomical fact linking one species to another' (2011: 332).

Leaving aside the many side branches of the hominin clade (in particular the genera *Kenyanthropus* and *Paranthropus* which some have posited as hominin ancestors), the next major step in a probable human lineage was the appearance of *Homo erectus*. A further species, *Homo ergaster*, is sometimes posited in a strong splitting taxonomy as a stage between the habilines and pre-modern *Homo*, existing between 2 and 1.5 mya. However, it is *H. erectus sensu stricto* that is of most interest in the evolution of modern humans. This species is believed to have first appeared around 1.9 mya in Africa and to have had body morphology very close to modern humans, including smaller teeth and jaw bones that may indicate a diet of cooked food. Brain sizes in the species have been estimated at between 650 cc and 1250 cc with an average of a little under 1000 cc or roughly 60% of that of modern humans. It is generally accepted that

Homo erectus initiated the first migration out of Africa certainly by 1.7 mya and early fossils from this period have been found in China and Indonesia (Mann, 2012; Stringer, 2011).

One puzzle in this scenario was the discovery announced in 2004 of *Homo floresiensis* on a remote Indonesian island. Dubbed ‘the Hobbit’, the species which had survived until only 18 kya was approximately 1 metre tall and had a brain only one third of the size proportionate to modern humans (Reader, 2011). A first account suggested that these were descendants of *H. erectus* who had undergone the generally accepted process of island dwarfing. However, when it emerged that the species shared more characteristics with australopithecines and habilines than more modern hominins, the only explanation seemed to be an earlier migration from Africa, prior to that of *H. erectus*. Alternative theories have been suggested based on pathological conditions affecting a modern human and resulting in microcephaly, but for the moment the debate remains unresolved (for discussion see Aiello, 2010).

As noted earlier, the first evidence of hominin stone and bone tools appears by at least 2.5 mya with the use of unmodified flakes for cutting meat and vegetation. While behaviour of this type may be indicative of a greater manual dexterity, these Mode1 category industries are not substantially different from the employment of available materials by present day chimpanzees, such as stripping tree bark for use as tools for extracting termites from their nests as a food source (though early hominins, unlike chimpanzees, appear to have transported their tools and materials). It is rather the advent of Mode 2, Acheulean (mid-lower palaeolithic) hand-axes at approximately 1.5 mya in

Africa, and subsequently in other parts of the world, that indicates a cognitive breakthrough (Davidson, 2002). These tools, produced by knapping pieces of flint, were mainly of a uniform size and differ in a qualitative sense from preceding hominin and contemporary non-hominin tools (Wynn, 2012). It is no coincidence that the first indication of the use, and possibly creation, of fire is also found at this time, even if not necessarily highly controlled use (Lynch and Granger, 2008).

H. erectus survived probably until 150 kya, but during this time a new species had evolved. Named *Homo heidelbergensis*, the oldest fossils have been found in Zambia and Ethiopia and dated to 600 - 700 kya, with records of the species in areas outside of Africa shortly after this (Mounier *et al*. 2009) *H. heidelbergensis* had an average brain size of 1200cc and demonstrated significant cultural advancement in areas such as shelter, hunting (including the use of wooden spears discovered in Schoningen, Europe and dating from 300 - 400 kya), and the development of full mode 3 type composite tools such as those from 260 kya found at Twin Rivers in Zambia (Stringer, 2011).

3.2.3 *Homo neanderthalensis* and *Homo sapiens*

H. heidelbergensis' reign on earth appears to have been relatively short lived and within 500 thousand years the species had probably disappeared. In a 'recent out of Africa' account, *H. heibelbergensis* gives rise to *Homo sapiens* in Africa while the descendants in Europe and surrounding areas were a different species: *Homo neanderthalensis* (Harvati *et al*. 2004)[5]. Endicott *et al*. (2010)

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[5] Further complexity in recently posited species Denisovans will not concern us here

estimate the most recent common ancestor of both neanderthals and humans to be between 410-440 kya, while the oldest fossils generally recognized as those of Neanderthals have been discovered across Europe and dated to 300-400 kya. Although Neanderthals had large brains (larger even than modern humans) and displayed considerable cultural achievements, e.g. use of Mousterian (middle paleolithic) tool technology (Wynn, 2012), these never reached the stature of that of *H. sapiens*. There is evidence that Neanderthals only ever acquired limited hunting skills, never exceeded *ad hoc*, low temperature hearths (Wynn and Coolidge, 2012) and were generally far less able than contemporary *H. sapiens* at exploiting their environment for nutrients (Stringer, 2011). In terms of symbolic capacity, later Neanderthals engaged in some systematic burial of the dead (d'Errico and Henshilwood, 2011), and while there is some evidence of use of pigments (though it is not clear whether this was for ornamentation or purely utilitarian use e.g. as an adhesive, or a protector from a strong sun), there is certainly no evidence of Neanderthal art (Wynn and Coolidge, *ibid*.).

Meanwhile in Africa, fossils from the Omo and Herto regions of Ethiopia indicate that anatomically fully modern humans were evolving nearly 200 kya (Fleagle *et al*. 2008) with an average brain size of 1350 cc. All modern humans appear to be from one of four major mitochondrial lineages that exist in Africa, yet of these four extant mtDNA haplogroups only one, L3, is found in non-African populations. There appears to have been a population explosion within the L3 group in East Africa around 86 kya and while there may have been several migration events out of Africa (e.g. Templeton, 2002), there is evidence that they were ultimately unsuccessful until an exodus of L3 some time shortly after

65 kya (Mellars, 2006; Atkinson *et al*. 2008). Within 35 thousand years all other members of the *Homo* genus, including Neanderthals, had been replaced. As some 1 – 4% of the genome of everyone not of recent sub-Saharan descent is shared with Neanderthals, it is often assumed that there must have been some degree of interbreeding (Green *et al*. 2010). An alternative explanation (Erikson and Manica, 2012) is that this part of the genome was already in place in the group that constituted the last migration from Africa, and had been inherited from a common ancestor with Neanderthals. This position appears to be confirmed by the examination of mtDNA (Cann, 2012). Whichever is correct, the arrival of humans seems to have been fatal for *H. neanderthalensis,* who were either directly exterminated or simply lost out in the battle for resources and disappeared from the fossil record 30 kya.

3.2.4 Cognitive developments in the hominin lineage

In addition to purely functional tools such as those discussed above, there are other indicators of cognitive developments in recent hominin evolution, including burial, the use of pigment and the appearance of ornamentation and abstract designs. Overall, these advances seem to imply the early stages of a symbolic capacity in hominins.

Pettitt speculates that the fossilized remains of 13 individuals from the species *Australopithecus afarensis* found at Hadar in Ethiopia and dated 3 – 3.5 mya indicate deliberate arrangement of the dead individuals and thus ‘one might see this as relatively simple symbolism’ (2011: 151). A more generally recognized earliest form of mortuary ritual is based on the 400-600 kya *H. heidelbergensis* bodies found at the Sima de los Huesos site in Atapuerca, Spain (Bischoff *et al*. 2003). However, Stringer (2012) has argued that these are in fact early Neanderthals (sometimes classed as a separate species, *Homo antecessor*), actually dating from a much more recent period than initially claimed, and that the status of the site as an intentional mortuary is not confirmed. Endicott *et al*. (2010) have also questioned the dating and suggest 200-400 kya is more likely. The earliest identified human burial sites upon which a majority of researchers agree are the 100-130 kya site at Skhul near modern day Haifa, while the earliest widely recognized in Africa is only 60-76 thousand years old (d'Errico and Henshilwood, 2011).

Evidence for the first use of pigment appears in Kenya at the Twin Rivers site in Zambia 230 kya (McBrearty and Brooks, 2000). However, Pettitt (2011) points out that the simple presence of pigment does not automatically denote symbolic (as opposed to purely functional) use. A stronger case for assuming symbolism is made with the selective use of the most saturated red ochre at Pinnacle Point in South Africa 165 kya (Marean *et al*. 2007). Finally, unambiguous symbolic use is first evident 70-100 kya in the complex geometric patterns painted in ochre at the Blombos Cave also in South Africa (Henshilwood and d'Errico, 2011).

Among the earliest contenders for lithic symbolism are the *pierres figures* from 350-500 kya found in Israel and Morocco. These consist of small cobbles which bear a natural resemblance to a torso and head but appear to have been engraved with a number of grooves (Pettitt, 2011). However, their extreme rarity and unclear status mean they are not good candidates for absolute evidence of symbolic behaviour. More robust assumptions about early symbolism can be made on the basis of marine shells used as beads, some decorated with red ochre, that have been found over North Africa and the Near East, far inland, and dated to 70-100 kya (d’Errico and Vanhearen, 2012). As well as extensive use of ochre decorated marine and ostrich egg shells, there is evidence of sophisticated heat treated stone tools in Southern Africa, at Still Bay by 72 kya (Stringer, 2011) and later, 58-66 kya, at Howieson’s Poort Shelter (Jacobs *et al*. 2008).

The previous sections have discussed the appearance of several aspects of behaviour that characterise humans today including complex tools, formal artefacts, art, structures for living, transportation of valued materials over distances, rituals, migration and adaptation to new environments, and more complex food gathering and processing (Stringer, 2011). Taking all the evidence together, McBrearty and Brooks assume ‘a gradual assembling of the package of modern human behaviors in Africa’ between 250-300 kya (2000: 453) while d’Errico and Henshilwood conclude that there was likely to have been ‘the presence of symbolic material culture in Africa by at least 150 ky[a]’ (2011: 58). Discontinuities in the development of tools and symbolic behaviour (their appearance, disappearance and reappearance) suggest a major role for local conditions, but also one or more significant cognitive breakthroughs for hominins at some points in their history. The nature and likely timing of these are addressed in chapter 4. However, notably absent from this list is language. The evidence for when and why language arose forms the subject of the next section.

3.3 Language evolution

As we will see in the next chapter, even our closest relatives in the animal kingdom do not have anything approximate to language in their natural environment and are unable to acquire it, in any real sense, in artificial settings. Language appears to be a unique, human endowment. Given this lack of continuity with any other known system, the first task of researchers in language evolution is to determine exactly what evolved. In other words, what is the nature of the human FL? Two broad positions can be identified. Firstly, those who propose a view of language that is based on a genetically endowed system of domain-specific linguistic mechanisms, along the lines of a module of the mind as proposed by Fodor (1983). Secondly, even those who reject an explanation of language rooted in modularity of mind still need to account for the evolution of a set of general cognitive capacities that enable the processing of language. As O'Grady acknowledges 'there is general agreement that the acquisition of language is innately guided – this much has been widely acknowledged even by those opposed to the idea of an innate Universal Grammar' (2008: 620). Within each camp there are contrasting views on the initial 'function' of language and how it came to emerge in the species. Consequently, the discussion below will involve a consideration of a number of possible explanations of language evolution. Bickerton (2012) identifies three distinct approaches: language as cultural invention, catastrophic accounts, and adaptive accounts. The discussion below will largely mirror these categories, though with an additional distinction between modular and non-modular catastrophic hypotheses. I suggest that the possible major classifications of theories of language evolution are as outlined in figure 1. The first two, often referred to as ‘nativist’, are: A) a module of the mind/brain for language evolved in a classical neo-Darwinian manner, corresponding to Bickerton’s third category; B) a module of the mind/brain for language emerged suddenly (in evolutionary terms) – a catastrophist account. A range of non-nativist hypotheses are included in the third option: C) language itself evolved as a domain general, socio-cultural system, Bickerton’s first category. The final option D), which has scant support, is another catastrophist account: that language appeared suddenly with no domain specific modification to the brain.

	Gradual	Sudden
Module of the Mind	A	B
Socio-Cultural System	C	D

figure 3.1: possible accounts of language evolution

Before beginning this discussion I will briefly review the genetic evidence that may throw some light on language origins and evolution.

3.3.1 The contribution of genetics

Although humans share around 99% of their genes with chimpanzees, the expression of these genes is radically different and an estimated 80% of proteins are dissimilar in the two species (Glazko *et al*., 2005). Consequently, even very small changes in the human genome can potentially be useful sources of information in understanding aspects of hominin, and language, evolution.

The gene most widely discussed in terms of a relation to the evolution of language is FOXP2. The gene was first reported in 1990 in which a single nucleotide change in the gene sequence was identified as responsible for a condition in some members of the KE family in London (Hurst *et al*., 1990), a condition later characterised as 'orofacial dyspraxia' resulting in problems of motor control and language comprehension, though not non-verbal IQ (Vargha-Khadem *et al*., 1995). FOXP2 is generally a very stable gene, for example there have been no changes in the chimpanzee line since their LCA with rodents some 90 mya. However, two changes have arisen in the hominin line in only the last 7.5 million years. In humans the gene is involved in regulating over 100 other genes – a function lacking in the ancestral form – and Diller and Cann (2012) have suggested that the significant mutations occurred between 1.8 and 1.9 mya shortly after the first *Homo* speciation event (though see Marcus and Fisher, 2003, who had suggested a more recent date). However, sensational press speculation aside, it is generally agreed that while FOXP2 undoubtedly plays a significant role in our ability to speak a language, attempts to characterise this or any other single gene as the 'language gene' are hugely wide of the mark.

Even if searching for a gene ‘for language’ is ruled out, other areas of study have been fruitful, and brain size and structure have been a particular focus of gene research. Several writers have highlighted the correlation between a defect in the genes ASPM and microcephalin and the condition microcephaly in which there is severely reduced brain growth (e.g. Zhang, 2003). There have been substantially accelerated mutations in ASPM, some 15 since the divergence of humans and the LCA with chimpanzees, and Evans *et al*. conclude that ‘ASPM underwent strong adaptive evolution in the descent of *Homo sapiens*, which is consistent with its putative role in the evolutionary enlargement of the human brain’ (2004: 489). However, there is considerable disagreement over this conclusion and the status of ASPM remains unclear (see Diller and Cann, 2012). Other researchers have looked for genetic mutations that might be associated with altered brain structure rather than size *per se*. Eighteen mutations to genes (which in other species are highly conserved) in the Human Accelerated Region (HAR), in particular region 1, appear to be related to greater complexity in cerebral cortex structure and connections (Stringer, 2011).

The period 2-2.8 mya seems to be especially interesting in terms of genetic changes with potential implications for human cognition. Chou *et al*. (2002) identified a mutation occurring 2.7 mya to the gene CMAH, preventing production of a protein that inhibited brain cell growth. While Charrier *et al.* (2012) claim that a duplication of the SRGAP2 gene, variant C, resulted in greater brain connectivity through more compact cellular dendritic spines, and Dennis *et al*. (2012) date this mutation to 2.4 mya. Functional cerebral asymmetry, which is far greater in hominins than other species, compensates for the accompanying reduced degree of redundancy by enabling a concentration of neurons in functional areas and locating areas with inter-related functions adjacent to each other, thus diminishing the ‘connection problem’ of larger brains. Crow (2002) discusses ProtocadherinXY as a gene for lateralisation of function and argues that the significant mutation in the hominin line arose between 2 and 3 mya, and that there was evidence of significant asymmetry in *Homo erectus*. Changes to body morphology, and in particular hominin masticatory muscles, provides further possible evidence for the significance of this period. Stedman *et al*. associate a correlation between smaller jaw muscles as a result of a mutation to MYH16 around 2.4 mya and greater cranial size, concluding that their findings ‘raise the intriguing possibility that the decrement in masticatory muscle size removed an evolutionary constraint on encephalization’ (2004: 418).

A discussion of the role of genetic and developmental factors in the evolution of hominin cognitive abilities will be continued in the next two chapters. Now I will return to the topic of the origins of language *per se*.

3.3.2 Gradualist accounts of language evolution

Gradualists, both nativist and non-nativist, need to provide an explanation for the adaptive pressure that drove language evolution, and the interaction of the composite elements of language, in particular phonology and syntax (‘semantics’ will be considered in the following chapter).

3.3.2.1 Adaptive pressures for language

Positing reasons for why language emerged and the immediate benefit that its users were endowed with is among the most speculative aspect of serious research on language evolution. Although adherents to Chomskyan generative grammar have a tendency to dismiss the various hypotheses as ‘just-so’ stories (e.g. Chomsky and McGilvary, 2012) there are nevertheless a large number of claims made for a dominant adaptive pressure (see Szamado and Szathmary, 2006, for an analysis of the explanatory credibility of 11 competing theories of language evolution). A major distinction can be made between proposals that see the origin of language as a result of purely social pressures and those that emphasize the instrumental. One strongly social hypothesis that has received considerable attention is that language emerged as a method of maintaining social relations in large groups. Dunbar (1996, 2012) points out that the dominant mode of sustaining social bonds in primate groups is through mutual grooming. The other requirements of daily survival limit the maximum time that may be devoted to such activity to 20% of the total time available and this figure is adequate in groups that number up to around 50 – the norm among primates. However, the emergence and evolution of language as a social replacement for manual grooming enabled early hominins to interact with more than one other member of the group at a time, and also to simultaneously engage in other useful activities. As a consequence, the 20% ceiling could be broken and hominin groups could expand to a more efficient size, terminating at around 150 at the time of *Homo heidelbergensis*. Alternative theories emphasizing social interaction include the suggestion that language was initially employed in child rearing. Falk (2012), for example, notes that as hominin forelimbs evolved, babies lost their ancestral ability to cling to their mothers, as a consequence they would have to be put down during foraging. Language, she suggests, could have acted as a soothing influence when physical contact was absent. More instrumentalist perspectives have suggested, amongst others, tool making (Faisal *et al*., 2010), foraging (Gibson, 2012a) and group scavenging for megafauna (Bickerton, 2009), as the initial adaptive pressures. Many researchers though, eschew a single function and adopt the intuitively attractive position that language emerged for the communication of thoughts and would be employed for a range of purposes, as Hurford concludes, ‘(n)o one theory on its own, such as Kin Selection, Reciprocal Altruism, or Sexual Selection, can adequately explain the unique human characteristic of freely giving information in such structurally complex ways as we do every day with language’ (2007, 333).

3.3.2.2 Prerequisites for the evolution of phonology

For non-nativists language is simply another function of the hominin brain and largely inseparable from its externalisation. However, even gradualist nativists must postulate the co-evolution of the mind-internal module and the ability to externalize through some modality (generally agreed as primarily spoken).

Although vocalisations are a common feature of many species including all the primates, the human ability to vocalise is particularly flexible and unique in many respects (see discussion in the following chapter). However, as MacNeilage (2012) emphasises, there is little or no support for an innate concept of a phonological module – there is, for example, no poverty of the stimulus argument in phonology. The limits of human phonological systems are not, he argues, hard-wired as generativists claim is the case with syntax, but rather are a consequence of physiological constraints on the articulatory and perceptual capacities. However, Pinker (e.g. 1994) and Jackendoff (2002) point out the dissimilarity between speech perception and that of sounds more generally and appear to be advocating innateness beyond syntax alone (see discussion below).

In the case of vocalisation there is a clear continuity with other hominids and examination of unique hominin evolutionary adaptations and their estimated dates may enlighten our understanding of the evolution of the capacity for speech. In particular, the anatomy of the human nasopharynx and oropharynx have a significant impact on the range of phonetic phenomena that may be produced. Certain aspects of this physiological form are undoubtedly the consequence of bipedalism and possibly reconfiguration in response to changes in brain morphology, an example of an exaptation, but others may be adaptations specifically for speech. The larynx is particularly interesting in this respect. All other mammals, as a consequence of having a higher larynx, have a two tube aerodigestive tract where the front of the larynx can overlap the soft palate. The advantage of this system is that these species are spared the possibility of choking whereby material intended for the oesophagus becomes blocked in the trachea. This is a potentially fatal condition that results in the death of approximately 300 individuals per year in England and Wales alone.[6] Australopithecines appear to have shared the safer system of other primates and it has been suggested that the larynx descended in early *Homo* to enable an increased air intake which was required to sustain larger brains (Laitman,

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[6] Figures from Office for National Statistics 2008-2010

2010)[7]. Exactly when the descent was complete and whether use in speech was an additional adaptive pressure remain unresolved. While the larynx itself does not fossilize, it is attached to the small hyoid bone but unfortunately this is a free floating bone that does not remain *in situ* after death. Laitman claims that Neanderthals show some evidence of a descended larynx but that they also developed larger nasal passages and sinuses that may have been utilised in warming air. He concludes that on balance if Neanderthals were capable of speech, they were less articulate than modern *H. sapiens*.

Fitch (2002, 2009, 2010) argues that the descended larynx is not unique to hominins and that a permanent descent, approximately half way to the human position, is found in two species of deer, and possibly also koalas. Furthermore, many species, in particular big cats, are capable of a temporary lowering which is exploited in the production of lower formant frequencies to give an exaggerated impression of size for purposes of attracting a mate and defending territory. Fitch maintains that this was the initial adaptive press that resulted in hominin larynx lowering and is still seen in the secondary descent in modern male humans at puberty, although the primary descent is acknowledged to be ‘either an adaptation to speech…or a by-product of some unspecified cranial rearrangements of the face and brainstem’ (2009: 119). However, Tallerman (2013) points out that unlike polygamous deer and territorial cats, there is no obvious advantage for size exaggeration in hominins, and in fact the reduction in sexual dimorphism in the hominin line further undermines the hypothesis.

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[7] Alternative hypotheses include adaptations for endurance running, and cooked food processing (see MacLarnon, 2012)

Two other anatomical traits feature prominently in discussions of hominin adaptations for speech: more sophisticated movement of the articulators and greater control over breathing. The first of these depends on the hypoglossal nerve which innervates the tongue and which was claimed by Kay *et al*. (1998) to be considerably larger in *H. sapiens* and Neanderthals than other primates. More recently however, two of the same authors have recognised that the relative size of both the hypoglossal canal and the nerve itself are not actually larger in humans compared to other primates (Jungers *et al*., 2003). The second modification, enhanced breathing control, is a result of changes to the thoracic region of the spinal cord. Evidence suggests that this adjustment, which is seen in Neanderthals, was not present as far back as 1.6 mya, and it seems likely that it was an evolutionary adaptation that began in *Homo erectus* (Endicott *et al*., 2010; MacLarnon and Hewitt, 2004; Meyer, 2005).

One final modification in the hominin lineage that may be relevant to vocalisation involves the loss of air sacs, small cavities above the vocal folds which are found in all other primates. As these sacs are susceptible to infection it is presumed that they are not purely vestigial but are functional in some sense. While it is not clear whether their primary function is related to breathing or vocalisation (or both) they are known to be capable of being used to give greater resonance to sound. However, it has been argued that the presence of air sacs ‘reduce[s] the perceptual distance between articulations’ (de Boer, 2012) resulting in less clear and distinct vowel patterns. The loss of air sacs may thus be compensated for by greater clarity of vocalisation and possibly enhanced communication. While *A. afarensis* appears to have possessed these sacs, they seem to be absent by the time of *H. heidelbergensis*.

3.3.2.3 Evolution of the lexicon and syntax

Both Burling (2012) and Tallerman (2009) emphasise the unique abilities that are involved in acquiring a massive lexicon (an average of approximately 50,000 items) based on hierarchical ‘semantic’ networks, as opposed to more general memory processing. It is claimed that this ability is the result of phylogenetic learning biases that rely on capacities such as joint attention, imitation and pattern finding that are either lacking or much weaker in other primates. However, as rule-governed vocalisations (such as bird song) and meaningful, if rudimentary, communication are both attested in the animal kingdom, the one unambiguously unique feature of human language is syntax (Tallerman, 2012a[8]) and this is the focus of most work in the study of language evolution. Exactly what is understood by the term ‘syntax’ is largely dependent on one’s theory of language (and indeed language evolution) but there is widespread agreement that language is not mere concatenation of items into linear strings but involves the production of units such as phrases and clauses from items in the lexicon (mainly ‘words’ but also morphemes, larger compounds and formulaic chunks) that are encoded into hierarchical relationships. It is by the parsing of syntax and identifying different hierarchical structures that we are able to disambiguate two sentences with the same linear string:

(1) a. He saw [the man [with the telescope]]
b. He saw [the man] [with the telescope]

In (1a.) the object is the noun phrase ‘the man with the telescope’ while in (1b.) the prepositional phrase ‘with the telescope’ is outside the noun phrase and

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[8] Though Tallerman argues that the uniqueness of the lexicon still stands

modifies the verb as the instrument through which ‘the man’ was seen. Bickerton’s (2012) insistence that syntax must also account for phenomena in terms of CGG, including empty categories, e.g. *PRO*, and operations such as ‘move’, is not shared by non-nativists, and it is the distinction between these two groups that is the subject of later sections.

First, in all proposals for a gradualist account of language evolution, there is a need to explain how the earliest linguistic vocalisations (presuming they existed), non-combinatory units such as ‘ouch’, ‘shh’ and so on (what Jackendoff calls ‘linguistic fossils’, 2002: 240), were replaced by units that could be combined in linear strings and later hierarchical structures, in other words how to account for the development of complex, linguistic syntax from simpler non-hierarchical *protolanguage*.

A number of writers (e.g. Wray, 1998) have argued that early protolanguage was holistic, consisting of fully propositional, non-compositional calls. Over time these are ‘fractionated’ until arbitrary patterns become established as compositional units. Wray (*ibid*. 55) gives the hypothetical examples of ‘mebita’ and ‘kamebi’ which may correspond to ‘give her the food’ and ‘give her the stone’ respectively. There is a purely coincidental occurrence of the sounds ‘me’ and the meaning ‘give her’ in both, but on this basis the two become associated as sound~meaning pairings. Tallerman (2007, 2012b) identifies several flaws in this proposal, including the fact that the trained bonobo Kanzi (see below) appeared to use discrete units (that may be construed to correspond to verbs and nouns). On the basis of this and other arguments presented by Tallerman I will assume that protolanguage was a compositional system.

The earliest protolanguage would be at least as complex as symbolic communication systems that primates are able to acquire. While there is disagreement over the extent to which trained primates are engaging in genuine ostensive intentional communication, rather than conditioned behavioural responses such as the ‘Clever Hans’ effect, the work of Savage-Rumbaugh and others (e.g. Savage-Rumbaugh and Lewin, 1994) with the bonobo Kanzi seems to put beyond doubt the ability of some chimpanzees to acquire and use a fairly large set of symbols (in Kanzi’s case around 250) and display significant comprehension (see full discussion in the next chapter). Crucially, there is (almost) no suggestion that Kanzi nor any other primate subject displayed any aspect of hierarchical syntax. Bickerton (2012) suggests that in addition to trained chimpanzees we have a number of extant human ‘windows’ that may reveal the nature of early protolanguage, such as pidgins and the two word stage in child language, again lacking the features of complex, linguistic syntax. Most writers agree with Jackendoff that the earliest protolanguage consisted of ‘associations of pieces of thought to vocal or gestural expression, without a syntactic component at all’ (1999: 70).

A common claim (e.g. Hurford, 2012) is that a shared lexicon and two word stage gradually evolves into full language by the exaptation of content words for function words that are utilised to represent hierarchical grammatical relations, a process known as grammaticalization (e.g. Heine and Narog, 2010). Bybee argues that:

> ‘The fact that grammaticalization occurs in all languages and at all stages indicates that grammaticalization is the main process by which grammar

> evolves….there is good reason to suppose that whatever the ‘original’ grammar of human language was, it evolved in the same way’ (2012: 533)[9]

The basis of grammaticalization is that a sociolinguistic choice by a group of language users extends the context in which a particular lexical item may be used. This is followed by desemanticization whereby aspects of the meaning of the item that do not fit the new context are semantically bleached. Then the item loses its inflectional and derivational morphology (for example being able to take a plural *–s* or nominal suffix like *–ness*) and ultimately its syntactic autonomy (this is known as decategorization). Finally there is the process of phonetic erosion whereby single phonemes and complete syllables may be lost or simplified. An example is the English indefinite article ‘*a/an*’ as grammaticalization of the numeral ‘one’. There has been semantic bleaching of the numeral meaning, decategorization such that ‘*a/an*’ is no longer able to function as a pronoun without a head noun (*there is a /there is a book), and phonetic erosion such that the vowel is reduced to the most neutral vowel sound in English, schwa [ə], in rapid speech.

For all gradualists, the nature of how and when a protolanguage first emerged and then evolved into fully complex language varies depending on whether the FL is considered innate or not, and these two theoretical perspectives are the subject of the next two sections.

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[9] For an extensive account of how a simple protolanguage of purely content words could have given rise to a complex syntax see Heine and Kuteva, 2007.

3.3.2.4 Option C: Gradual non-nativism

These approaches treat language as domain general and thus consider it as part of the overall cognitive machinery. As discussed in the introduction, it is common in such explanations of FL and evolution to treat language as simply another aspect of culture and appeal to the notion of ‘memes’ as the vehicle for the evolution of language. Memetics (e.g. Dawkins, 1976; Blackmore, 1999) is the theory that cultural artefacts are analogous to genes in that they mutate into competing forms and are selected for under adaptive pressures. Blackmore argues that ‘a spoken grammatical language resulted from the success of copyable sounds that were high in [fidelity, fecundity, and longevity]’ (*ibid*.: 107), and that ‘the function of language is to spread memes’ (93). There are at least two fundamental problems with this as a basis for an explanation of language evolution. Firstly, either the term ‘meme’ is a trivial metaphor or it needs to be clearly defined. Yet as Johansson (2005), who is sympathetic to memetics, acknowledges, the genetic analogy is difficult to sustain given the rapid rate of cultural change, resulting partially from the low fidelity of reproduction compared to genes, and the role of human agency. A second difficulty arises from the fact that a memetic account of language is predicated on imitative behaviourism, as Dawkins explicitly acknowledges, ‘[i]mitation is how a child learns a particular language’ (1999, vii). Yet as Sperber (2000), among many others, points out the acquisition of language is above all concerned with inference and the deduction of ‘rules’ (however defined) rather than simple imitation.

The evidence so far discussed appears to demand an explanation for language evolution that includes abilities unique to humans that have arisen specifically for the acquisition and processing of language. I will return in chapter 5 to theories that account for these capacities in domain general terms, but will next consider the possibility that we have gradually evolved a module of the mind that is exclusively devoted to linguistic matters.

3.3.2.5 Option A: Gradual nativism

Pinker (1994) points out that the chances of 10^{10} neurons which form the average brain being randomly connected and yet generating the properties of UG are vanishingly small. Rather, from the perspective of gradual nativists, language is a complex adaptive system constituting a module of the mind, comparable to other biological systems (the example often given is the human visual system, for example Pinker and Bloom, 1990) that can only be explained in terms of adaptation and natural selection. However, the actual degree of evolutionary change to neural structure since the LCA appears remarkably slight, as Fodor points out:

> ‘our brains are, by any gross measure, very like those of apes. So it looks as though relatively small alterations of brain structure must have produced very large behavioural discontinuities in the transition from the ancestral apes to us. If that’s right, then you don’t have to assume that cognitive complexity is shaped by the gradual action of Darwinian selection on prehuman behavioural phenotypes’ (1998: 4)

As in all gradualist accounts (nativist and non-nativist) there needs to be one or more adaptive pressures that have driven the evolution of the FL. Pinker and Jackendoff argue that the selective advantage that a communication system would bestow is manifest and that in fact ‘the design of language – a mapping between meaning and sound – is precisely what one would expect in a system that evolved for the communication of propositions' (2005: 218). The ability to transmit complex cultural constructions beyond immediate kin constitutes a 'cognitive niche' (Pinker, 2003) in which speakers are able to convey information beneficial to survival – and reciprocate – without the speaker losing that information in the act of transmission.

However, like the argument for the evolution of the FL by neo-Darwinian adaptationism, the notion of communication as the driving pressure is not unproblematic. The benefits to an individual member of a species of a gradually evolving visual system are easy to imagine: greater sensitivity to light could help an organism avoid predators or direct the individual to an area where there were greater resources. The problem with language is that it requires an interlocutor if information is going to be communicated, but evolutionary theory stipulates that coincidental evolution of the same trait in multiple individuals is not feasible. It is not clear what advantages, in terms of communication, an individual with a more highly evolved FL would have. Thus Pinker and Bloom's argument that features of language evolved because they 'defined parts of a standardized communicative code in the brains of some critical mass of speakers' (1990: 718) is explanatorily inadequate. The problem is how any feature could enter the minds of a 'critical mass': traits do not spread unless they bestow an advantage but in terms of the FL it is not clear how they could do this until they had already spread. As an analogy, one could improve inter-connectors between information technology devices by, for example, adding an additional point to a SCART lead enabling it to carry more information. However, if the sockets on the devices remain unchanged then the new lead is of no improved value.

In terms of an actual scenario for gradual nativist evolution of the FL, Jackendoff (1999, 2002) describes in detail one proposed path which bears some similarity to standard grammaticalization processes. It begins with the ability to use symbols (whether initially vocal or gestural) in the absence of their referent. From this we get a dual process with the development of an open set of symbols and the refined phonology (sound patterns) necessary for their discrimination. At the same time occurs the development of the ability to concatenate symbols first randomly and then to represent basic semantic relations such as ‘Agent first’. This protolanguage then evolves to include the syntactic relations of grammatical categories ordered in hierarchical phrase structure, and a method of showing abstract semantic relations, such as through inflectional morphology. This process continues as gradual, incremental parallel evolution of semantic, syntactic and phonological components until we arrive at modern language.

One immediate problem with this picture of a gradual evolution of a modular FL is the question of the time scales. Pinker (1994) estimates that there have been something in the order of 350,000 generations since our LCA with chimpanzees. While at first sight this seems an impressive figure, Worden (1995: 147) examined possible speed rates of evolution and concludes that in the time available the amount of change is ‘certainly not enough to design a complete facility for language learning and use’ (1995:147). Certainly other complex biological systems, such as vision, have evolved over dozens or hundreds of million years rather than the 7.5 maximum available for language.

Christiansen and Chater (2008) and Chater et al. (2009) emphasise that not only is the time factor anomalous, but something which changes as rapidly as a language does (what they describe as ‘a moving target’), does not provide the necessary form of an environment for the coevolution of a biological endowment. They argue that Darwinian evolution requires a relatively stable environment and languages change just too fast for adaptive biological advantages to be selected for. The authors may be confusing individual languages with the ‘language faculty’, however, even if such evolutionary development had occurred in the short period of time available, it is surprising that it ceased at the time of the last migration from Africa. If this were not the case then there would be no Universal Grammar (UG) as nativists assume, but rather the FL would have continued to evolve in different directions in the dispersed population of the species. The common response to this charge is that the amount of time that has passed since the African exodus is not sufficient for evolutionary change to be observable, but this simply brings the argument back to the lack of time for language to have emerged in the first place.

3.3.3 Non-Darwinian accounts

Both nativists and non-nativists have argued for explanations for the origins of language without recourse to neo-Darwinian adaptationism. The most substantial of these is from the nativist camp and these proposals are examined first.

3.3.3.1 Option B: Sudden nativism

If a gradual adaptationist theory of the evolution of a nativist FL is rejected, then an alternative is an appeal to a saltation – an abrupt change resulting from a macromutation in an organism with significant consequences. As a general rule in evolutionary theory, such explanations are excluded when an alternative adaptationist narrative can account for the same phenomena, and both nativist and non-nativist gradualists are quick to argue that the abstract and highly intricate nature of language excludes any such saltationist origins. Pinker likens such explanations to 'the proverbial hurricane that blows through a junkyard and assembles a Boeing 747' (1994: 361). However, even Dawkins (1986) contrasts example of an implausible event an such as the creation of an accidental 747, with a significant leap resulting from a single change to an existing organism, and extends the aeronautical analogy in terms of the creation of the Stretched DC-8 as a modification of the standard DC-8: it is in this latter sense that one can talk of saltationist origins of the FL. Hornstein defends this approach to language origins in terms of random mutation, arguing that such a position 'is not outlandish if what we are talking about is the emergence of one new circuit rather than a highly structured internally modular FL' (2009: 10fn19).

Chomsky is reputed to have been scornful for most of his career of any discussion of language evolution and he maintains that until recently knowledge of the nature of the FL 'made the problem of studying the evolution of language completely hopeless' (2012: 83). This position has now changed somewhat, and in two papers (2002 and 2005, henceforth HCF and FHC respectively) Hauser, Chomsky and Fitch argue that it is the mistake of 'treating "language" as a monolithic whole…[which] confuses discussion of its evolution and blocks the consideration of useful sources of comparative data' (FHC: 181).

Language, these authors argue, needs to be considered in terms a general system (Faculty of Language Broad: FLB) which now includes three components (but see discussion below): first, the conceptual-intentional (CI) system where meaning as logical form (LF) is interpretable and second the sensory-motor (articulatory-perceptual – AP) system where sound or phonetic form (PF) is interpretable. The general conclusion that HCF draw is that all the apparatus of FLB have homologous or analogous counterparts in the animal world. The third component however, is considered to be without any counterpart outside of the human species. This is the narrow syntactic computational module that in HCF is labelled Faculty of Language Narrow (FLN). In both of the papers referred to above, and as often restated by Chomsky, the operations of the computation are considered to consist only of recursive merge, whereby two objects are selected and merged to form a third which can then itself be merged with another object *ad infinitum*. 'Recursion' is not easily defined and there is not universal agreement on what exactly recursive properties consist of (for discussion see Kinsella, 2009). However, there are two generally accepted characteristics. Firstly, that the output of one stage constitutes the input to the next, such as the Fibonacci series and possessives in (3) as opposed to the unordered iterative concatenations in (2):

(2) a) 3 + 5 + 8 + 4 + 6 = 16

b) Karl and his brother and his friend and his uncle

(3) a) 1, 2, 3, 5, 8, 13, 21, 34

b) Karl's brother's friend's uncle

Secondly, and particularly pertinent to linguistics, is the requirement that a recursive operation should enable the embedding of any object of type X into another object of the same type, so that an NP may be embedded in an NP, a clause inside a clause and so on. Merge may conform to the first of these definitions but it does not appear to do so to the second. Tallerman concludes that 'HCF are *not* using 'recursion' to mean self-embedding, but rather, to refer to the formation of hierarchical structure generally: the phrase-building capacity' (2012a: 451, emphasis in original).

The authors, in both these papers and elsewhere (e.g. Chomsky, 2002) stress that they do not consider language (if it includes FLN) to be 'for' communication and that it is in fact poorly equipped for the job, for example in terms of the amount of redundancy, ambiguity and the like inherent in language (see also Carstairs-McCarthy, 2008). FHC argue that communication is only one current use of language (so are private thoughts, problem solving and other functions) and anyway current utility is no indication of 'why' a trait initially emerged or what immediate benefit it bestowed. Furthermore, as FLN is uniquely human, then the comparative approach is redundant in this situation. For Chomsky, FLN appeared as 'a rewiring of the brain' (2010: 59) that provided hierarchical structure and potential infinity to thought through its interface with the CI system in one individual 'who was instantly endowed with intellectual capacities far superior to those of others, transmitted to offspring and coming to predominate' (2006: 184). According to Berwick and Chomsky, only later did the interface with the AP system emerge: 'all recent relevant biological research leads to the conclusion that the process of externalization is secondary' (2011: 32)

FLN, in this view then, could not have evolved through adaptive selection but rather appeared as a single mutation in (evolutionary) recent time as a perfect, optimally designed feature for interfacing with components of FLB which had evolved independently for other reasons. It is clear that HCF are not suggesting a scenario based on punctuated equilibrium and adaptive radiations. Despite an earlier assertion that '[p]lainly, the faculty of language was not instantaneously inserted into a mind/brain with the rest of its architecture fully intact' (1998) this in fact now seems to be Chomsky's position something that he has reaffirmed, commenting that 'there is no empirical or serious conceptual argument' (2006: 184) for positing a gradual evolution of language, but rather the appearance of FLN was a 'great leap' and that 'a more parsimonious speculation is…that the Great Leap was effectively instantaneous, in a single individual (2006: 184).

As discussed in the last chapter, Chomsky frequently expresses the belief that the evolutionary leap that resulted in language (i.e. FLN) produced a 'perfect' system. This raises the question of how perfection should be evaluated. Kinsella (2009) devotes considerable time to arguing that evolution does not favour 'perfect' solutions, preferring the back-up resources made available by redundancy, and constantly being burdened with the vestiges of previous adaptations. However, as Chomsky has made it clear that he does not favour an adaptationist evolutionary account of language, then such criticism is immaterial. For Chomsky, perfection arises from the non-linguistic, 'third factors' which quite simply could not be any other way, as Berwick and Chomsky put it: 'Language is something like a snowflake, assuming its particular form by virtue of laws of nature – in this case principles of computational efficiency' (2011: 30).

The viability of this scenario depends on the degree of mutational change necessary, regardless of the magnitude of the consequence of that change. Any posited modification must be sufficiently minor to be plausible – a stretched fuselage rather than the assembly of a fully operational aircraft from random components. FHC may argue that their proposals regarding the evolution of language are in no way dependent on the explanation of the nature of language inherent in the MP, but this simply will not do. Unless FLN is reducible to absolute minimal operations, e.g. recursive syntax, then their explanation of the origin of FL falls at the first fence, and it is precisely this reduction that the MP seeks to portray (and indeed Chomsky appears at times to imply this e.g. 2005). As Kinsella points out 'the choice appears to be this: show that minimalism is correct, and rule out the gradual adaptationist evolutionary account, or show that gradual adaptationism is correct, and rule out the MP' (2009: 66). As I argue in chapter in 5, these are not in fact the only choices available.

How convincing is it that the theory of language (FLN) as envisioned in the MP arose from a single macromutation, or 'one or two evolutionary innovations' in Boeckx's words (2012: 495)? As discussed in the previous chapter, the MP has to posit either a multitude of features and operations that license merge (see Hornstein *et al.*, 2005) to insure that non-grammatical derivations are avoided – the 'crash-proof' grammars, which fail the test of simplicity and economy demanded by an evolutionary explanation based on saltation. Alternatively, the Strong Minimalist Thesis (SMT), which proposes 'unbounded' merge as the sole operation in the syntactic component, with deviant or unwanted derivations filtered out at the interfaces, reduces the computation to a trivial operation with no psychological grounding. Neither conjecture provides a satisfactory account of the FL evaluated against the criteria of evolutionary plausibility.

An alternative explanation for the emergence of language as a sudden phenomenon makes no appeal to macromutations or indeed any genetic change and is very briefly surveyed in the next section.

3.3.3.2 Option D: Sudden non-nativism

Like HCF, Fauconnier and Turner reject an understanding of the emergence of language based on neo-Darwinian adaptationism, arguing that 'we do not see any gradual path in mammalian history for the development over many generations of ever more complex grammars' (2008a: 136). They maintain that there is no current variation in complexity in the world's languages and indeed that it is a conceptual error to posit intermediate stages in language evolution: 'Language is like flight: an all or nothing behaviour' (*ibid*.: 146). They also share with HCF a belief that minor causes can have exceptional effects, what they term a cause-effect isomorphism fallacy.

Where they diverge from nativists is in also denying any specific genetic basis in the origins of language. According to Fauconnier and Turner, a uniquely complex cognitive apparatus developed in hominins reaching its apex in humans as double-scope conceptual blending (see Fauconnier and Turner, 2003). They argue that there was nothing like protolanguage, but rather that when humans' cognitive capacity had reached a critical level, language arose spontaneously as a natural consequence: 'Once the stage of double-scope blending is achieved, fully complex language comes on like a flood, in cultural rather than in biological time' (2008b: 521).

Clearly their account of language depends partly upon the extent to which the notion of double-scope blending is found convincing, a full discussion is beyond the scope of this chapter but it basically involves partial input from two existing conceptual structures which are then blended to produce a new structure. The theory appears to rely heavily on metaphor theory. However, there is a more obvious flaw in their argument. The evidence the authors present for a rapid materialisation of such a complex system as language is what they claim is the concurrent appearance of art in Europe 50 kya. But as we have seen above, this is a fallacy. There had been a gradual development of cognitive ability and intricate behaviour in Africa over many thousands of years as McBrearty and Brooks demonstrated as far back as 2000.

3.4 Conclusion

We have seen that in addition to the undeniable role of neo-Darwinian adaptation in evolution there are also alternative hypotheses with both genetic and epigenetic foundations. Hominin phylogeny, though the exact path is unsure, appears to show a gradual accumulation of anatomical and cognitive changes resulting in a set of modern abilities and behaviours between 150 and 300 kya. The role of the FL in this picture has been portrayed as an innate module of the mind and also alternatively as an aspect of domain-general cognition. The two answers to the question of whether language emerged slowly as a gradual adaptation or suddenly, have attracted supporters from both sides of the nativist debate. As I have argued all four possible explanations are flawed. The reason for this, I maintain, is identical to the conclusion in the previous chapter: that the lack of a convincing, comprehensive account of the emergence and evolution of language, like the source of the irresolvable problems with ‘meaning’ in CGG, are based on a fundamental misunderstanding of what FL is, a topic I will return to in chapter 5.

Chapter 4. The evolution of the hominin brain and human cognition

4.0 Introduction

In the previous chapter I evaluated four perspectives on language evolution in the light of the most up to date evidence available, focusing primarily on the emergence of linguistic syntax and phonology. Missing from this picture is the third element assumed to be of fundamental importance in most post-behaviourist accounts of language: that of ‘meaning’ or ‘semantics’, however defined. As noted in chapter 2, a generally accepted view of language, in CGG in particular, made explicit by Saussure (1916/1983), is that syntax in some way mediates between the two interface levels of PF and LF. In Chomsky’s own words, ‘[t]his “double interface’ property is one way to express the traditional description of language as sound with a meaning, traceable at least back to Aristotle’ (1995: 2). As will already be apparent (and also see discussion in the next chapter), I believe that there are severe problems with the vague, inconsistent and confused definitions/uses of ‘semantics’ and ‘meaning’ in linguistics (and more widely in the study of language evolution). However, for the purposes here I shall assume that these terms relate to mental content of some sort, whether independent of the mode of its expression or not. This chapter seeks to begin to examine the nature of that mental content or cognition, identify in what ways it differs from that of other species, and understand how and when it evolved – a task that will be continued in the next chapter.

Defining what exactly is meant by mental content or thought is not straightforward. There is, however, a clear distinction between percepts, which are the result of psychological processing of brute causal stimuli from the immediate environment, and thoughts. Thoughts involve concepts. The concept of concept is itself highly problematic, and will be considered further in the next chapter, but for now the definition offered by Medin and Rips will suffice: ‘a concept is a mental representation that picks out a set of entities, or a category….[c]ategory membership is not arbitrary but rather a principled matter' (2005: 37). This non-arbitrary, principled membership depends on an ability to systematically discriminate between two or more potential candidates. It is well established that even simple animals are able to differentiate between different stimuli on the basis of contrasting features (Spence, 1937) and more recently it has become apparent that many animals are able to make sophisticated category judgements, such as pigeons' ability to discriminate between different classes of trees (Herrnstein *et al*., 1976).

Clearly, like percepts, entertaining a concept may have causal effects in that one concept may give rise to another in an individual's mind. The establishment and strengthening of such relationships between concepts is the essence of associative learning. While both humans and other animals are capable of such learning, the question of whether any nonhuman species has the capacity for higher order thinking is far less clear and is considered in the first section below. It is in this area that the comparative method is especially useful, though for the purposes at hand, and the sake of brevity, it is not possible to review all of the vast literature on animal intelligence, and so I focus almost entirely on those species most relevant to an immediate hominin lineage. The first section looks at nonhuman primate thinking in general, before considering in more detail the communicative capacities of these species, both in the wild and in captivity. The subsequent section looks at the structure and function of the human brain, with a particular emphasis on the evolution of brain size. I conclude the chapter with a consideration of gestural and vocal continuity with other hominids, and an examination of two theories of language evolution, both predicated on more general cognitive or neural evolution.

4.1 Comparative approaches to human and nonhuman animal cognition and communication

4.1.1 Nonhuman cognitive capacities

Approaches to explaining nonhuman cognition fall within a broad continuum of traditions. At one end lie anthropomorphic interpretations, more common in the early nineteenth century, which favoured accounts of nonhuman animal behaviour in terms of human-like reasoning. As the field became more scientifically rigorous, writers began to caution against assuming human type cognitive capacities in other animals. Darwin, for example, while stressing the evolutionary continuity of minds in all animal species, insists that '[t]here is no doubt that the difference between the mind of the lowest man and that of the highest animal is immense' (1871/2008: 254). Later, another scientist working early in the field of ethology gave his name to the principle of Morgan's Canon which stipulates that:

> "in no case is an animal activity to be interpreted as the outcome of the exercise of a higher Psychical faculty, if it can be fairly interpreted as the outcome of the exercise of one which stands lower in the psychological scale." (1894: 59)

At its most extreme, this position may be interpreted as constituting a null hypothesis in which all nonhuman vertebrates are presumed to share the same level of intelligence (e.g. Macphail and Bolhuis, 2001[10]). The advent of behaviourism as the dominant paradigm in psychology in the early twentieth century in a sense left the question of comparative cognition in humans and other species redundant, as operative conditioning and associative learning were used to account for *all* behaviour. However, with the emergence of cognitive science since the 1960s, the debate has reignited, with some ethologists (e.g. Pearce, 2008) claiming that all nonhuman animals are incapable of abstract thought, that is entertaining abstract concepts, displaced thought, imagining, counterfactual reasoning and so on. Other researchers (e.g. Shuttleworth, 2012) are more optimistic about discovering mental processes, beyond associative learning, in other species.

Assuming we accept that nonhuman animals are capable of thought of some interesting kind, we face the substantial problem of how to test comparative cognitive abilities, given the impossibility of say a chimpanzee and dolphin performing a similar task; furthermore, unlike humans, no other species can give verbal accounts of their thinking and reasoning. Nevertheless, there have been fruitful areas of enquiry including communication, tool use, social relations, theory of mind and displacement (temporal and spatial) and these will be considered in the following sections. First, though, we will try to consider in

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[10] The writers make a possible exception for rudimentary theory of mind in great apes

more detail that which characterises uniquely human, as opposed to more general animal, cognition.

4.1.1.2 Continuity (and discontinuity) between human and nonhuman cognition.

Penn *et al.* (2008) in a comprehensive review of the literature on mental continuity identify a number of aspects of human cognition that have been subject to comparison with capacities in other species. They conclude that the 'profound biological continuity between human and nonhuman animals masks an equally profound functional discontinuity…between human and nonhuman minds [which] pervades nearly every domain of cognition' (110). Thus they argue that, while other animals have the perceptual capacity to distinguish physical similarity, only humans are able to categorise on the basis of logical, functional or structural similarity. Furthermore, only humans are able to deduce rules and apply them in novel situations, reason about higher-order spatial and hierarchical relations, make transitive inferences and understand the difference between real and spurious causal relations. In respect of each of these, the authors are insistent that '[t]here is not simply a consistent absence of evidence for any of these higher-order relational operations in nonhuman animals; there is compelling evidence of an absence' (110). In accounting for these discontinuities, although Penn *et al*. acknowledge that not all animal cognition can be explained through associative learning alone, they reject any notion that nonhuman animals are capable of abstract, systematic thought (we will return to this hypothesis in the discussion of a language of thought in the following chapter). In the next section we will look at other primates to see to what extent Penn *et al.*'s hypothesis stands up.

4.1.1.3 Evidence for intelligent thought in other primates.

Arguments have been made for evidence of sophisticated intelligence in other species including cetaceans (see Janik, 2012) and various species of birds, including some quite remarkable claims for the mental abilities of Grey parrots (Gibson, 2012b; Pepperberg, 2012). However, as we are interested in the evolution of specifically hominin, and ultimately human, cognition (and language) since our LCA, it is the current capacities of other primates, and chimpanzees in particular, that offer the most informative evidence to indicate what the starting point of that evolutionary process was.

It is well documented that great apes, more so than other species, are able to fashion and manipulate basic tools such as branches for digging out termites, rocks for smashing nuts and so on (Carvalho *et al*., 2009; Sanz *et al*., 2010). However, Penn *et al*. maintain that all nonhuman animals ‘solve tool-use problems based on evolved, domain-specific expectations about what perceptual features are likely to be most salient in a given context’ (2008: 119) coupled with a general ability to reason about concrete, observable causal relations. It is generally claimed that nonhuman animal tool use, including that by all primates, is contingency based and that these animals do not save and transport tools with them in the expectation of later use, indicating a lack of a capacity for planning (though see Mulcahy and Call, 2006, who claim otherwise).

Perhaps the greatest amount of attention in the study of primate thinking has been to social and cultural intelligence with claims of complex social cognition in old world monkeys as well as great apes (Seyfarth and Cheney, 2012). One type of behaviour that has been proposed as evidence of this type of advanced social intelligence is organised multi-participant activity such as that involved in hunting by chimpanzees (Boesch, 2005). However, Tomasello *et al*. (2005) argue that chimpanzees are not taking socially determined roles, but rather spatially placing themselves in the most advantageous position they can occupy in order to catch the object of the hunt, and that this is essentially no different from the hunting strategies of great cats and wolves. As a general rule, many ethologists (e.g. Cheney and Seyfarth, 2005; Wynne and Bolhuis, 2008) caution against the trap of assuming that apparent behavioural similarities across species must imply similarity of cognition (though for a rare alternative view see de Waal e.g. 2012). Tomasello concludes that ‘human-like collaborative activity – group activity with an intentional structure comprising both a joint goal and complementary roles – is something in which great apes do not participate’ (2008: 176) and that even simple tasks such as carrying an item together or working together to fashion a tool is unknown[11]. Confirming this argument, Reader *et al*. (2011) reviewed the research of primate behaviour in the wild, focusing on eight categories of behaviour, and found no evidence of a faculty for social or cultural intelligence distinct from cognition in general.

While there is no doubt that primates have a rich conceptual system and a basic ability to reason based on observable cause and effect relations, the existence has traditionally been assumed of a ‘mental gap’ between humans and chimpanzees, often described as ‘intentionality’, ‘theory of mind’ (Baron-Cohen, 1995) or ‘mentalizing’ (Frith and Frith, 2006). Theory of Mind (ToM) is discussed in detail in the next chapter, and while it is an extremely difficult capacity to identify in non-verbal creatures (Shuttleworth, 2012), at this stage we should note that the theory of complete absence of ToM in chimpanzees has recently been challenged, largely through ingenious experiments typically involving hidden food sources. For example, Schmetz *et al*. (2011) demonstrated that chimpanzees know that conspecifics make inferences, while Burling (2005) reports studies of subordinate chimpanzees who would avoid hidden food in the presence of more dominant ones; similarly Hare *et al*. (2001) showed that chimpanzees acted in accordance with the knowledge they had of what other, more dominant, conspecifics were able to see. Finally, Byrne and Corp (2005) in a study of relative brain size (see section 4.2.3 below) identified occurrences of tactical deception by chimpanzees in the wild, that is, deliberate behaviour which a conspecific is likely to misinterpret to the benefit of the agent.

Nevertheless, the evidence so far reviewed appears to support Penn *et al*.’s view:

> ‘Although there is a profound similarity between human and nonhuman animals’ to learn about and act on the perceptual relations between events, properties and objects in the world, only humans appear capable of reinterpreting the higher-order relation between these perceptual relations in a structurally systematic and inferentially productive fashion’ (2008: 110)

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[11] Though see Gibson (2012c) for discussion of the captive chimpanzees Austin and Sherman and possible examples of cooperation to achieve common goals

However, one aspect of behaviour that has not been considered here yet is communication, both in the wild and in the laboratory, and these topics are addressed in the following sections.

4.1.2 Nonhuman communication

4.1.2.1 Animal communication in the wild

All animals communicate. Even single celled protozoa influence the behaviour of other organisms through chemical secretions, while other modalities for communication include changes of colour, movement, olfactory signals and, as in speech, sound. The content of the message communicated may function to indicate aggression or other mood, sexual attraction, marking territory, and indicating the presence of predators or prey (Pearce, 2008).

Communication may be purely innate – as in the honey bee dance – or learned, like human speech. Hurford claims that '[w]ithout learning, a semantically compositional system cannot evolve beyond the narrowest limits we see in a few insects' (2012: 7). And it would indeed appear that many communication systems are a combination of both inheritance and acquisition, for example bird song (Slater, 2012), dolphin calls (Janik, 2012), and some primate calls such as those of the vervet monkey (Seyfarth and Cheney, 2003). Nevertheless, even in the case of those wild animals who acquire part of their communication system, Hurford maintains that they have no semantically compositional syntax. For example, various bird species may have combinatorial songs consisting of two or more parts, but in no cases do these parts compose to produce a third with a different message: 'whatever syntax can be found in bird repertoires, they do not take advantage of its combinatorial possibilities' (Hurford: 21). Certain nonhuman animal species may acquire the equivalent of the 'vocabulary' of their communicative systems but these systems are limited to the size of that repertoire.

A second factor in classifying communicative systems is to distinguish between displays which clearly lack any intent – such as inherent physical size – and signals which may be intentional. Opinion differs over the degree of intentionality in regard to ape communication. In addition to the evidence cited in the previous section for a basic ToM, Tomasello (2008), who earlier in his career was sceptical about claims that great apes were able to appreciate that others have mental states (e.g. Call and Tomasello, 1999), now ascribes the ability for intentional communication to chimps on the basis of laboratory evidence of their attempts to help humans and conspecifics reach objects out of their grasp, and their ability to differentiate between a refusal and an inability to perform an act such as offering food. As discussed above, Penn *et al*. (2008) are more cautious in assigning human-type intentional behaviour to other species (see also Povinelli and Vonk, 2004; Vonk and Povinelli, 2006).

There is, however, a greater degree of accord in the view that great apes' most sophisticated communicative abilities are not manifest in vocalisations. Seyfarth and Cheney (2012) point out that while there is evidence of some support for the notion that primates are able to learn to respond to new vocal calls (including those of other species), their own production and usage is inflexible, innate and unproductive (see also Zuberbuhler, 2012). Call and Tomasello (2006) contrast ape vocalisation with gestural signals, in which they include bodily posture, facial expression and manual gestures, all of which show significant individual variance within species groups. Gestures are used flexibly; the same one may be utilised for different ends, the same end sought with different gestures, and a new gesture may be employed when a given end has not been achieved. This degree of variety also emphasises the fact that gestures rely to a large extent on iconicity and there is a lack of conventionality and thus symbolic representation in ape gestural communication.

Given that there appears to be a degree of intentional communication among primates in the wild, at least in a gestural if not vocal modality, how complex are the systems employed? Zuberbuler *et al*. (2011) claim that examples such as the *pyow-hack* combinations in Campbell's monkeys, and also song combinations of Lar gibbons are evidence of morpho-syntax in primate calls. However, such calls can be explained as simple concatenations, and Hurford (2012) specifically argues that Campbell's monkeys' ability to combine the five meaningful calls that they possess does not amount to a compositional syntax, and the calls resulting from their combinations are not functions of their parts. Tomasello (2008) acknowledges that ape gesture sequences are equally lacking in compositionality.

The topic of a gestural origin for human language is taken up below in section 4.3.2, but for the moment we can conclude that, although primate gestures in the wild demonstrate a degree of flexibility and productivity, neither they nor vocalisations are truly compositional, and there is no evidence for any apparent hierarchical or recursive structure in either. However, far greater claims have been made for communication with trained apes in captivity and this forms the subject of the next section.

4.1.2.2 Primate communication in captivity

Early modern attempts to train primates to communicate relied on replicating human speech, and these continued as late as the 1950s with the chimp Vicki. Inevitably these enterprises resulted in failure (Vicki only mastered three words ‘mama’, ‘papa’ and ‘cup’), the reason being that despite Vicki’s trainers assertion that there was ‘no doubt that her vocal mechanisms were adequate for producing satisfactory approximations of most of the elements of human speech’ (Hayes and Hayes, 1951: 107), this was simply not the case and primates’ vocal tracts are just too distinct from those of humans (in addition primates lack the degree of neural control over the articulators that humans have, Fitch, 2010) for the production of even a small set of recognizable phones.

Having realised that training in a vocal modality was not going to succeed, researchers began to focus on gestures which, as noted above, are common among primates in the wild. Gardner and Gardner (1969) began training the female chimpanzee Washoe in 1966 in American Sign Language (ASL) and within 22 months reported that she had acquired, and was reliably and consistently able to use, in excess of 30 signs including strings of up to three. Later it was claimed that she mastered in the region of 250 signs and was able to produce strings of up to 5 signs long, with some evidence of novel combinations (see Gibson, 2012c). Project Nim (Terrace, 1979) was a subsequent attempt to replicate the Washoe experiment with the young, male chimpanzee Nim Chimpsky. The stated aim of the project was to collect more rigorous data than the anecdotal evidence which characterised the Gardners' research. Over four years Nim was recorded using 125 signs in more than 20,000 combinations. Although these results are superficially impressive, Terrace, the chief researcher on the project, warns against interpreting them as indicative of complex cognition, and certainly not an indicator of the manifestation of language (see discussion below). Several further signing experiments have been undertaken including, amongst others, those involving a chimp (Lucy), a gorilla (Koko) and an orang-utan (Chantek). Although the data remains controversial, at best these great apes have been reported to use up to 1000 signs, occasionally in spontaneous and novel strings, and possibly to employ signs for deception and displaced reference (for review see Gibson, 2012c).

Alternatives to using sign language have involved training primates with tokens and lexigrams. Premack (1983) trained the mature female chimpanzee Sarah to use tokens, reporting a vocabulary of over 130, with usage that was sensitive to word order and so enabled her to comprehend conditionals. Early attempts had been made to train a chimpanzee, Lana, with lexigrams in the early 1970s, but it was while researchers were attempting to train the adult bonobo Matata that the most famous breakthrough occurred. Although Matata showed no inclination to interact with lexigrams, her adopted male infant who had been present during training sessions, Kanzi, began to spontaneously use them (Savage-Rumbaugh and Lewin, 1994). Kanzi was able to quickly master the initial 256 lexigrams that had been programmed into a computer and went on to respond to spoken English. It is claimed by the authors that he reacted correctly to 445 spoken commands out of a total of 660 consisting of three to five words, including prepositions and alternating agent/theme word order. Training on lexigrams has continued with other bonobos (e.g. Panbanisha) and common chimpanzees (e.g. Panzee) but Kanzi's achievements do not yet appear to have been surpassed.

The data in many early projects is not always reliable, Ristau (1983), for example, notes some researchers' selective reporting of interactions.

Nevertheless, it seems undeniable in later studies, such as Kanzi's, that, regardless of communicative modality, some great apes are able to respond to symbols, both individual and in strings, in a relatively consistent manner. However, there are several problems related to the criteria for judging comprehension; for example, many of these apes required a great deal of training and, where claims of novel interpretation are being made, we should give consideration to the possibility of explanation in terms of simple associative learning. Furthermore, Tomasello (2008) reports a study with chimpanzees which, although they were able to look in the direction in which a human points, appeared unable to understand the purpose behind the pointing – something human children are able to do from age 14 months onwards. As far as production is concerned, even the best performing apes never progressed beyond a mean length of utterance (MLU) of 1.5 (Pearce, 2008), a stage generally achieved by English speaking infants before 22 months. Production is acknowledged to be largely, if not entirely, limited to requests. The evidence for spontaneity and novel utterances remains extremely slight and controversial. Terrace (2005) for example, in a close analysis of the interactions with Nim, suggests that nearly all the signs the chimpanzee produced were nonspontaneous and imitative attempts to obtain rewards that were being withheld by his trainers. Much of what was claimed to be ostensible intentional communication by the chimpanzee could be explained as conditioned behavioural responses, as in the 'Clever Hans' effect where the horse that appeared to be counting was in fact reacting to changes in body language from its trainer. Terrace notes Skinner's (1957) distinction between two types of language use by infants: 'mands' which were demands and requests, and 'tacts' which involved drawing attention to something for no immediate reward. While apes are clearly capable of the former of these in situations in which there is expectation of the reward – perhaps a protoimperative – there is far less evidence of behaviour corresponding to the latter, a protodeclarative (see also Meguerditchian *et al*. [2011] who identify ape pointing as exclusively imperative rather than declarative communication).

There are also grounds for doubting apes' ability to understand combinations of symbols in the sense that we comprehend language. Nim's production of the signs for 'water bird' to identify a swan, for example, was not, maintains Terrace

(2005), the equivalent of a modifier acting on a head item as in language, but rather two signs that Nim associated with the scene and which were employed to achieve a specified end, the result of memory and associative learning.

To account for this, Terrace (*ibid.*) reports a study involving arbitrary, meaningless chains of stimuli (in this case photographs) in which seven items appeared in random order in any one of 16 positions and the subjects (monkeys) were required to repeat the correct order to receive a reward. It was evident that primates had a remarkable ability for memorising and repeating such lists, including relative internal position. While this may be a necessary capacity for language, it is clearly not sufficient. Terrace, while acknowledging that the abilities of an ape such as Kanzi are impressive, concludes that all of the tasks he completed 'can be construed as conditional discrimination problems whose solution is devoid of any intentional meaning' (*ibid.*:100) and there is no basis for ascribing a capacity for language to Kanzi. Finally, it is worth noting that many of these trainers spend several years working with their subjects and undoubtedly form emotional attachments. The potential influence of these relationships on interpretation of data must be significant, as one researcher who worked with Panzee commented:

> 'As to what exactly makes some people believe that Panzee has the same kind of autonoetic, self-knowing consciousness that humans do, and why others will remain sceptical or even scornful of that possibility, one prime variable is assuredly firsthand personal experience: with animals, with Panzee herself' (Menzel, 2005: 219)

In conclusion then, it appears on the basis of studies of animal intelligence, animal communication in the wild, and laboratory based experiments, that chimpanzees have a rich conceptual system, the ability to learn a limited number of symbols for these concepts, and the basic perceptual sensory-motor system necessary to discriminate among these symbols. It is highly likely that these attributes were also shared by our LCA and thus the earliest hominins. However, evidence for cognitive abilities beyond these in other primates is much less conclusive and it is these more complex abilities that are fundamental for language. If we assume little change in the 7-8 million years since our LCA, then in the words of HCF, given the fact that 'animal communication systems lack the rich expressive and open-ended power of human language [...]. The evolutionary puzzle lies in working out how we got from there to here, given this apparent discontinuity' (2002: 1570). While the last chapter looked at aspects of hominin cultural development and touched on the issue of changes to brain size and structure, it is this latter topic which is addressed more fully in the next section

4.2 The human brain

Despite all the modifications to body morphology that have occurred since the hominin line split from the LCA (see previous chapter), it is changes to the brain that are central to our behavioural differences from other primates. As discussed below, the human brain is a very expensive organ, constituting only around 2% of body mass but consuming a massively disproportionate 20 – 25% of all nutrients. In the absence of modern scanning technologies, our early modern knowledge of this organ was sometimes discerned through observation of living individuals such as Phineas Gage who, through accident, lost a large part of his brain, resulting in selective changes in behaviour. However, for the most part, knowledge was largely gained through autopsies, such as those carried out by Broca and Wernicke, when the site of brain damage could be located and examined in individuals who had undergone behavioural changes in their lifetime. In the twentieth century, technology has progressed at such a rate that there are now several varieties of non-invasive techniques for analysing the brain in living beings, and actually observing the brain at work. This section begins with an examination of the overall structure of the human brain, followed by a focus on the evolutionary history of the hominin brain, with particular attention to the issue of brain size.

4.2.1 Human brain structure

Vertebrate brains in general are hugely complex (for an overview see Gazzaniga *et al*., 2013). The human brain at birth consists of 100 billion (10^{11}) nerve cells or neurons of three main functional types: afferent or sensory cells that transmit perceptual information to the brain, efferent or motor cells which transmit commands from the brain to other parts of the body, and interneurons which enable different parts of the nervous system to communicate with each other. Neurons vary in their structure but all possess a cell body (or soma) which contains the nucleus and genome. Information passes through neurons by electro-chemical signals which travel down the cell through the axon, which is attached to the axonal terminals and which, in turn, connect at locations called synapses with the dendrites of other cells (see figure 4.1).

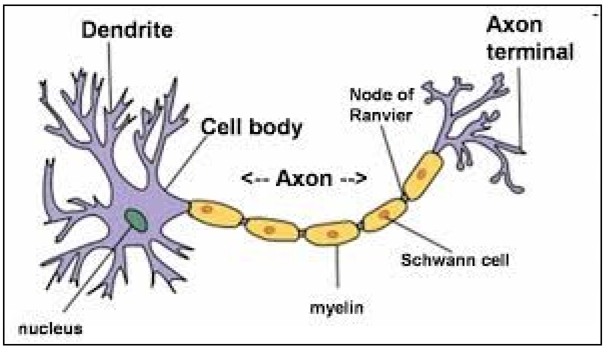

figure 4.1 Diagram of a neuron (from Google Images)

A typical neuron has in the region of 1000 connections so the total number of connections in the human brain is approximately 10^{14}.

The overall structure of the brain consists of two hemispheres with a base of a brain stem and cerebellum. On top of the base sits the cerebrum which is made up of the basal ganglia, limbic system and the cerebral cortex. The cerebral cortex itself is divided into four lobes on the basis of protruding surfaces (gyri) and creases (sulci): the occipital, temporal, parietal and frontal lobes (see figure 4.2).

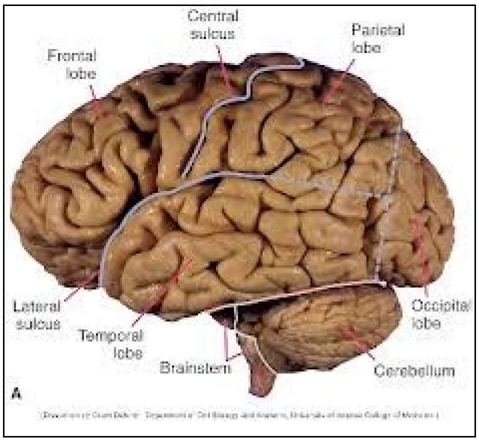

figure 4.2 The structure of the brain (from Google Images)

This cortex is often referred to as grey matter, in contrast to the white matter below, and consists of up to six layers. Areas are functionally specialised, with the regions responsible for the higher functions – primary sensory, motor and association – constituting the six layered neocortex. In mammals, visual processing is associated with the occipital lobe, while the temporal lobe processes auditory information (including speech in humans) and memory. Voluntary movement and spatial orientation are under the control of the parietal lobe, and the anterior parts of the frontal lobes consist of the prefrontal cortex (PFC) which is associated with selective and executive systems (DeSalle and Tattersall, 2012). In terms of Brodmann's cytoarchitectonic map of the brain, based on differences in cell morphology and density, the PFC is usually considered to include parts of Brodmann's areas (BA) 8,9,10,11, 44, 45, 46 and 47 (see figure 4.3)

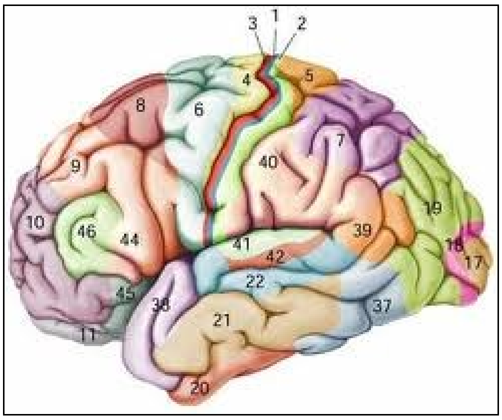

figure 4.3 Brodmann's areas (from Google Images)

Although the two hemispheres share a similar structure, under normal conditions the brain is lateralised for different functions, including language. As discussed in the last chapter (section 3.3.1) there is greater hemispherical asymmetry in the hominin brain, one of the consequences of which is handedness, much less apparent in chimpanzees (Hopkins and Cantelupo, 2003; Hopkins and Vauclair, 2012) and this appears to have begun its evolutionary development between 2 and 3 mya. In the majority of right-handed people, the language functions of the right hemisphere appear to be limited to interpretation of such aspects as voice tone, sarcasm, metaphor and so on (DeSalle and Tattersall, *ibid.*). It is in the left hemisphere that the substantial tasks of language processing are undertaken.

In cases of severe epilepsy a procedure known as a commissurotomy is employed in which the corpus callosum, which joins the two hemispheres together, is severed. Gazzaniga (1983) showed that split-brain patients who were exposed to an image only available to the right hemisphere, and asked to point to an associated image from a selection available, were subsequently unable to explain their choice based on the initial image alone, and relied on the left hemisphere to invent a plausible, though spurious, reason. He concludes that in most right-handed people, the left hemisphere is the locus of language processing and problem solving. However, language processing is not generalised throughout the hemisphere; rather, specific aspects of both speech and language have been associated with specific brain regions. Price (2010) reviewed 100 published papers on functional magnetic resonance imaging (fMRI) studies of language and found that there were around 20 different areas of the left hemisphere involved in speech and language. Grodzinsky agrees, arguing that the data, though complex, is 'stable and clear, parsing the linguistic brain into functionally and anatomically coherent pieces' (2010: 605). The most discussed areas associated with language include Broca's (roughly corresponding to BA 44 and 45) and Wernicke's (around the anterior superior temporal gyrus, or the posterior of BA 22). Certainly, under normal conditions, it seems that Broca's area is involved in the grammatical assembly of words, and increased complexity of sentence structure appears to correlate with greater activity in this region (Caplan *et al*., 2000). Meanwhile, Wernicke's area has traditionally been associated with grammatical comprehension (see Mazoyer *et al*., 1993; Dronkers *et al*., 1994). Brain scans of the KE family referred to in the last chapter indicate that an area of the basal ganglia, the caudate nucleus, may also be involved in language comprehension. Additional regions connected to the production and processing of speech include the auditory cortex for the interpretation of sounds and the motor cortex for the control of the articulators.

The lack of language in our closest relatives among the primate species gives rise to the question of when and why these neural changes evolved. It is this which forms the topic for the next part of this section.

4.2.2 The evolution of the human brain

It has been orthodoxy since the 1960s that human rationality is not the same as logicism, but rather the consequence of a brain that has evolved in a particular direction and brought with it certain non-random biases in deductive reasoning. An example often given is that of the Wason selection task (see figure 4.4) which only 10% of university students are able to solve at first attempt (Evans, 2005). The task involves choosing which cards to turn over in order to verify the truth of a premise such as 'if the card has an odd number on one side then it will have an X on the other'.

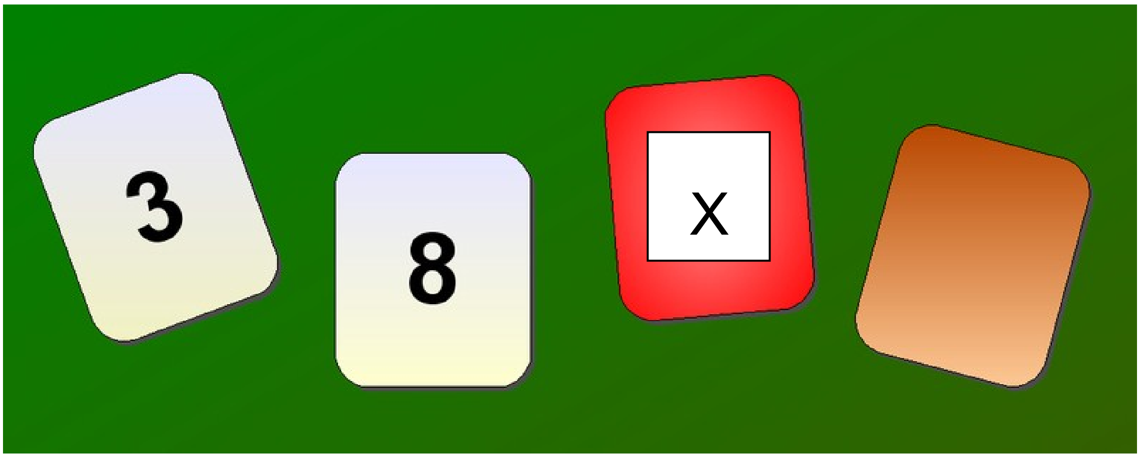

figure 4.4 Wason selection task (adapted from: http://en.m.wikipedia.org/wiki/File:Wason_selection_task_cards.png)

The task requires the participant to identify the premise as being of the form 'if p then q', and the cards in the example above as constituting, from left to right, 'p', 'not p', 'q', and 'not q'. Instead of choosing 'p' and 'not q', the tendency is to choose 'p' and 'q', thus making the error of 'affirming the consequent'.

Cosmides (1989) and Cosmides and Tooby (1992) point out that if the task is framed in terms of social exchange, then the success rate rises to 75%, and this is often used as an argument in evolutionary psychology for 'massive modularity' (Frankenhuis and Ploeger, 2007) in which a large number of domain-specific modules are presumed to have evolved to deal with a range of social situations. However, Evans (2005) points out that attaching social roles to the items in the task changes its nature to one of deontic selection, and that the particular participants relations to the roles in the task has a significant impact on the success rate. Evans concludes that the notion of reasoning biases remains valid. This topic will be resumed in the next chapter, but first I will consider some of the physical changes that the hominin brain has undergone in the time since the LCA.

4.2.2.1 Structural evolution of the hominin brain

The most obvious change in hominin brains is their massively increased size (see section 4.2.3), but there has also been some reorganisation in the cerebral cortex, and the neocortex in particular. For example, Enard *et al*. (2002) showed that while, as a result of genetic similarity, chimpanzees and humans had anatomically more similar organs generally (e.g. livers) than chimpanzees and macaques, the differences in gene expressions resulted in a human PFC that was significantly more distinct from the chimpanzees' than the chimpanzees' was from the macaques'. The exact nature of this difference is disputed: Deacon (1997) claims that the human PFC is on average twice the volume of that expected in a brain of our size, while Semendeferi *et al*. (2002) argue that it is relative sizes of parts that are different, for example human BA 10 is much larger and other areas smaller, and Sherwood *et al*. (2009) suggest the difference lies in greater gyrification in humans[12]. In addition to an increased PFC, other reorganisations include a reduction in the relative size of the primary visual and motor cortices (dated to 3.5 mya), a widening of Broca's area (complete by 1.8 mya) and increased anterior cingulate gyrus (ACC), an area below the frontal cortex (BA 24, 32 and 33) that moderates emotional input into decision making and has been linked with ToM (Holloway *et al*., 2009). Associated with a reduced brain area devoted to visual processing is an increase in the posterior parietal cortex. Wynn *et al*. (2009) have dated this increase to between 700 and 200 kya and claim it plays a vital role in human abstract, conceptual thought (see discussion in the following chapter).

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[12] To a large extent these are methodological differences and depend on which areas are classed as part of the PFC

4.2.2.2 Reasons for changes in the hominin brain

In the last chapter we noted suggestions that genetic changes around 2.4 mya had resulted in reduced jaw muscles, and changes to diet are often suggested as causes for a change in brain size (e.g. Striedter, 2006; Lynch and Granger, 2008; Wrangham, 2009;). As noted above, the basal metabolic rate (BMR) at resting for human brains is 20 – 25%, some 16 times greater than that of muscle tissue and far exceeding the corresponding rate in primates (8 – 13%) and other mammals (3 – 5%) (Leonard *et al*., 2007). Aiello and Wheeler (1995) note that increased brain size has been accompanied with a reduction in the human gastrointestinal tract, which also requires intensive nutrition, to approximately 60% of the expected size. According to their 'expensive tissue hypothesis' the introduction of more animal products into the hominin diet resulted in a more efficient processing of food, which enabled the brain to claim a greater proportion of nutrients and increase its size (though see also Warren and Iglesias, 2012, who argue against the hypothesis). Alternative proposals have suggested genetic changes that facilitated the digestion of tubers, the change to a diet high in fish and shellfish, and the discovery of controlled fire in food preparation (for a discussion see Ragir, 2000).

In the previous chapter there was a brief discussion of genetic changes that have been proposed as linked to brain reorganisation and growth (for a more comprehensive review see Somel *et al*., 2013); however, as earlier noted, epigenetic factors also play a vital role in these processes and it is known that there has been a modest accelerated evolution of brain gene expression on the human lineage, generally assumed to be the result of positive selection, some of which may be as recent as 200 kya (Preuss *et al*., 2004; Khaitovich *et al*., 2006). Whatever the precise combination of genetic and epigenetic factors are, one of the most profound results has been the growth in the volume of hominin brains.

4.2.3 The size of the hominin brain

There is no universal agreement on the significance of brain size in general, and several studies involving bird species have produced conflicting results. Studies on the effect of relative size of the hippocampus in the memory abilities of different bird species proved inconclusive (Hampton and Shuttleworth, 1996), while Spencer *et al*. (2005) showed that overall brain size in canaries, including those with restricted growth as a result of parasitic infestation, did not correlate with song complexity, although simpler songs were associated with a reduced area of the brain labelled the *high vocal centre*. On the other hand Sol *et al*. (2010), while emphasising the evolutionary selection for smaller brain sizes in migratory bird species, acknowledge that larger brains appear to be related to a better ability to adapt to novel environments. However, I argue below that when it comes to primates, Reader *et al.* are correct that a 'volumetric stance' is warranted, and that 'brain component volumes are related to functionally relevant cognitive capacities' (2011: 1024).

4.2.3.1 The evolutionary history of hominin brain size

As would be expected, larger animals tend to have larger gross brain volumes. In order for valid cross-species comparisons to be made, Jerison (1973) proposed the encephalization quotient (EQ) as an allometric measure of brain to body size. EQ can be expressed in a number of ways, but I shall adhere to a homocentric system in which the average human brain is taken as the figure 89.9 (see Holloway *et al*., 2009). Among the mammals, the great apes stand out by virtue of having larger than expected brains, gorillas having an EQ of around 24.7 and chimpanzees 37.5. But the human brain is proportionally, on average, a massive 2.4 times that of chimpanzees (Allen, 2009). It is logical to conclude that this differential has occurred in the process of hominin evolution rather than a loss of brain size in the chimpanzee line, and certainly there is no fossil evidence for this latter explanation. So when and why did this growth ensue?

Comparative data from hominin ancestor species is obtained from endocasts of surviving skull fossils. Relying on such evidence is not unproblematic; there is no absolute correlation between cranial capacity and actual brain volume, and, unfortunately, there are only approximately 160 endocasts of pre *H. sapiens* in existence (Holloway *et al*., 2009). Nevertheless, some clear patterns do emerge. There is no indication of any changes to brain size in any of the candidates for the earliest members of the hominin clade, and, as noted in the previous chapter, little or no evidence of any cultural behaviour to distinguish early hominins from the LCA. The first very minor increases in allometric brain volume, including a gross increase from 400 cc to 500 cc, may have occurred between 3 and 2.5 mya in members of the *Australopithecus* genus, resulting in an EQ of approximately 45. However, major brain growth, both allometric and non-allometric, is first evident in the emergence of the genus *Homo* approximately 2.5 mya, and, rather than having a uniform rate of development over the succeeding two and half million years, occurred predominantly in two rapid spurts in distinct, relatively short periods of time. The consequence of this initial increase was a near doubling in size of the hominin brain to over 800 cc[13], with an EQ in the mid 60s by at least 1.74 mya (Holloway *et al. ibid.*)[14], as Allen observes, '[a] substantial increase in EQ is seen in early *Homo*, but no substantial subsequent increase is observed in *H. erectus*' (2009: 71). This period of relative stability is followed by the final jump beginning roughly 500 kya with the appearance of *Homo heidelbergensis* which, as suggested in the last chapter, ultimately split into two species. By at least 200 kya, modern humans in Africa had evolved brains of an average 1350cc (range 1250 – 1730 cc) (Lynch and Granger, 2008), while Europe saw the evolution of the Neanderthals to which Holloway *et al.* (*ibid.*) attribute a gross brain capacity of up to 1700 cc and an average EQ of 99.14. These figures contrast with those of Kappelman (1996) who assumes a larger body mass for *H. neanderthalensis* and consequently a much smaller EQ than humans. Whichever is the case, there are significant differences in brain morphology between humans and Neanderthals, in particular a larger visual cortex in the latter and a less developed PFC (see e.g. Bookstein, 1999; Lieberman *et al.*, 2002).

In conclusion it appears that, despite Allen's preference to eschew the term 'stasis' (see discussion of Gould and Eldredge, 1993, in the previous chapter), there were two periods in the evolution of the modern brain that correspond to classic cases of punctuated equilibrium. These involved a significant increase in gross volume and EQ, contemporaneous with the first *Homo* speciation event, followed by, as Allen notes, 'a modest increase for the first million years – so modest that its signal is obscured by variation across both time and space –

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[13] At the beginning of the 20th century the anthropologist Arthur Keith proposed the figure of 750cc as the 'cerebral rubicon' for the genus *Homo*.

[14] Though some very late *H. erectus* appear to have brain volumes over 1000cc but with an EQ around 67, a normal figure for the species (Holloway *et al.*, 2009; Allen, 2009)

followed by rapid expansion in the transition from *H. erectus* to *H. heidelbergensis*. The transition from *heidelbergensis* to modern humans is marked less by an increase in cranial capacity but more by a change in cranial (and brain) form' (2009: 64-65).

As noted above, it is well established that as an organ the brain is metabolically disproportionately expensive and, additionally, is vulnerable to, and not efficiently regenerative after, trauma. Increased brain size comes with considerable cost and must have been accompanied by major evolutionary advantages, thus explanations based on diet alone cannot explain the significant increase in size; why, for example, would additional nutrition not be devoted to greater muscular material to enable more effective flight from predators? As an explanation for an adaptive pressure, the 'social brain hypothesis' (e.g. Dunbar, 1998), which links increased EQ to sociability, had been widely held in the field. More recently, however, researchers reviewing the hypothesis have found no evidence for this and rejected such an account in favour of an explanation based on general cognitive capacities (Seyfarth and Cheney, 2002; Finarelli and Flynn, 2009; Reader *et al*., 2011). As Allen concludes, although some studies 'shed doubt on the direct correlation of brain size with cognitive abilities, one group in which this trend is pretty clear is the group to which we humans belong: the primates' (*ibid*.: 212). I will propose in detail in the next chapter one hypothesis to account for this increase in volume in brain size in the hominin lineage, but first we need to consider why, if large brains brought such advantage, there has been no growth for at least 200 thousand years.

Large brains have two negative impacts on survival rates. Firstly, a bigger brain needs a bigger head. As noted above, as a result of body changes necessary for bipedal walking, there was narrowing of the human pelvis (by the time of *H. erectus)* which, along with large headed offspring, entails extended and dangerous childbirth for mothers. In addition, as a result to changes in body morphology, the hominin birth canal had twisted requiring the infant to be partially rotated during birth, increasing the chances of suffocation as a result of becoming entwined with the umbilical cord (Trevathan, 1999). Secondly, the limited size of the birth canal and the need for larger heads means that human babies are more altricial than those of other species, including chimpanzees, and more of the ontogenetic development of an infant takes place after birth, human neonatal brains expanding by a factor of 3.3 compared with 2.5 in chimpanzees (de Leon *et al*., 2008). Consequently, for a longer period, hominin infants are unable to contribute to the group and need substantial care and attention that could otherwise be expended on alternative useful social activities. Nevertheless, the second period of brain growth, unlike the first, continued, despite the concomitant dangers, until it was physically impossible to increase any further; as Allen comments ‘it appears that we have reached an evolutionary equilibrium between neonatal brain size and maternal pelvis size that leaves both mother and child at risk during the birthing process. Obviously the advantages of large brain size have outweighed the considerable costs associated with it at childbirth’ (*ibid*., 72). Thus Uriagereka’s claim, echoed by many others, that as an exaptation, language ‘can certainly emerge as a singular epiphenomenon of a brain that got large enough for some *obscure and/or trivial reason*’ (1998: 67, emphasis added) is not tenable: increased brain size must be the result of one or more selective adaptive pressures, and greater cognitive abilities, including language, appear to be prime candidates. The final section in this chapter looks at the main theories of language origins that are predicated on the evolution of a unique human cognition.

4.3 Neural and cognitive theories of language evolution

To summarise the discussion so far, I have suggested that approaches to the evolution of human language can be grouped into two broad classes: those which propose language as an entirely unique human capacity with no analogue or homologue in the nonhuman animal world, and those who emphasise evolutionary continuity with other animal communication systems. This latter group may be subdivided into vocal or gestural continuity.

Those who adhere to a theory of language with no continuity with any animal system have been dealt with in the last chapter under the heading of ‘sudden’ or ‘catastrophist’ accounts and will not be considered further here. The sections below will look at, first, hypotheses based on vocal continuity, and then at two well-known theories of language evolution based on gestural continuity.

4.3.1 Vocal continuity

The principal group of theories that appeal to vocal continuity may be labelled the 'singing Neanderthal' hypotheses (e.g. Mithen, 2005; Fitch, 2005a) in which language arose out of a musical protolanguage. The idea is not new and Darwin proposed something similar in *The Descent of Man*: 'primeval man, or rather some early progenitor of man, probably used his voice largely, as does one of the gibbon-apes at the present day, in producing true musical cadences, that is in singing' (1871/2008: 239). The adaptive pressure for selection on the basis of singing ability is generally assumed to be sexual selection, with more complex songs engendering greater sexual attraction; though enhanced group cohesion and pair-bonding have also been proposed as potential candidates for selection (Fitch, 2005b). Aside from the gibbons referred to by Darwin, there is no evidence of complex song-like vocalisations among the primates, and researchers have tended to focus instead on birdsongs.

MacNeilage, for example, argues that 'in terms of its organisation in the time domain, speech is more like birdsong than it is like sign language' (2011: 139) and the theory has some support from studies such as Jarvis (2007) who found homologous neural pathways for vocal learning in humans and songbirds. Nevertheless, the complete lack of semantic compositionality in any nonhuman call system as noted by Hurford (2011 – see section 4.1.2.1 above) and weaknesses identified by Tallerman (2013) are sufficient to severely undermine theories of vocal continuity. I shall turn now to the more appealing proposal for a communicative continuity based on gesture.

4.3.2 Gestural continuity

As we saw in section 1 above, there is far stronger evidence for an origin of language in animal gestures which at least share flexibility and a degree of creativity. In this section we shall consider two hypotheses, one based on the evolution of neural structure, and the second focusing on the emergence of cooperation in hominin species.

4.3.2.1 Imitation, gestures and mirror neurons

Tomasello (2008) differentiates between two types of animal gesture. The first are what he calls ‘intention movements’ and these may be purely instinctive (very common in the animal world) or learned. The degree of individual differences within groups suggest that those that are acquired are the result not of imitation but rather associative learning, an example being a chimp raising his arm in order to initiate play. The second, more interesting type, are ‘attention-getters’ which may involve throwing objects, making noises, slapping the ground and so on, with the aim of focusing attention on the subject’s display of intention such as desire to be groomed or sexual arousal. These appear to be unique to great apes or at least the primates, and Tomasello claims that this two-part system (drawing attention and displaying intention) is ‘a genuine evolutionary novelty….and may be considered the closest thing we have to a “missing link” between nonhuman primate communication and…human referential communication’ (*ibid*.: 29). For Tomasello, there is a logical necessity for the coded aspects of language to be preceded by unconventionalised, uncoded communication for which the prime candidate is attention-getting gestures. But are these gestures copied from conspecifics or the result of innovation and association?

Humans have a prodigious capacity for imitation which, as Boyd and Richerson (2002), point out, is a far better tool for dealing with a rapidly changing environment than either innovation or evolution. Pearce (2008) differentiates between mimicry, in which there is no reward, and true imitation for a parallel objective. There is some evidence of mimicry in the animal world, in particular various species of birds including the African grey parrot (see Pepperberg, 2012); however, a capacity for even simple imitation appears to be absent in nonhuman animals, including most primates[15]. Nagall *et al.* looked for evidence of imitation as ‘population specific behavioural traditions’ (1993: 174) which must be acquired, transmitted through generations, and absent in other populations of the same species. They concluded that even chimpanzee tool

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[15] It should be noted, however, that Pepperberg claims that one parrot in particular is capable of cognitive activity far in excess of basic mimicry

use for feeding strategies such as stripping bark and using it to dig for termites was not true imitative learning but rather stimulation enhancement and emulation learning, with the concomitant consequence of lower fidelity. Many other researchers are more inclined to grant simple imitative abilities to great apes (for discussion see Pearce, 2008).

With regards to communication, Arbib (2013) identifies seven genetically inherited cognitive properties that must have evolved prior to fully complex language, the first of which is the recognition and imitation of complex action. Arbib argues that the type of complex imitation necessary for intentional communication requires, in addition to the requisite motor ability, the capacity to differentiate individual actions and to perceive these as combinatorial. Arbib claims that the source of an imitative capacity lies in ‘mirror neurons’. Paukner *et al*. (2005) noted that macaques would give more attention to a human experimenter that was imitating the macaques’ actions than one who was not. It is claimed that ‘mirror neurons’ in these monkeys, who share a last common ancestor with humans approximately 25 mya, fire in the performance and observation of grasping actions. These neurons are found in the region F5 which is architectonically comparable to Brodmann’s area 44, part of Broca’s area, in humans (Rizzolatti et al. 1996; Arbib and Bonaiuto, 2008). It has also been shown that stimulation of this area elicits both hand and orofacial movements in the monkeys (Petrides *et al*. 2005) suggesting a relation between the two forms of action. It has been proposed (Corbalis, 2009; Arbib, 2013) that the mirror system is crucial to the evolution of human language.

Arbib (*ibid*.) suggests that the early stages of language evolution involved iconic pantomiming representing objects, actions or situations. Over time these became conventionalised and formed a system of protosign, a communication system based on manual gestures but lacking hierarchical syntax, that was utilised by hominins from *H. habilis* through to the appearance of *H. sapiens*. The mirror system enabled this conventionalisation by ensuring the necessary ‘parity’ or semanticity, whereby a particular gesture was associated with a specific meaning. This protosign acted as a scaffolding for the emergence of protospeech and the two coevolved with the eventual primacy of protospeech. By 200 kya the genetically specified cognitive properties necessary for language were in place, and with the cultural developments of compositionality of signs, the expression of displacement (given special emphasis by Corballis, *ibid*.), and learnability, complex language materialised between 50 and 90 kya.

There are two major problems with this scenario. First, Arbib's conventionalised pantomiming relies on a notion of holophrastic signs with all the concomitant difficulties this implies, as noted in the previous chapter. Secondly, many writers assume that one of the benefits of bidpedalism was the availability of the hands for tool use, foraging, shelter construction and so on (see Allen, 2009), which would be severely reduced if communication was dependent on gestures. Furthermore, evidence from trained chimpanzees show that they are responsive to human vocalisation and it might be assumed that this modality would become predominant in the early stages given its obvious advantages of greater broadcast reception over distances and in the dark.

We will turn now to an alternative theory that focuses on different changes in hominin cognition as factors in the evolution of language, while still stressing the continuity with gestures.

4.3.2.2 Cooperation

Tomasello (2008) argues that the important cognitive skill that appeared in the human lineage was an understanding of relevance: that is, an appreciation of what is most salient. This is not just in egocentric terms (which characterises behaviour in other primates) but also to sharing content with conspecifics. From this beginning there arose three processes involving cooperation, all of which have consequences for the need to communicate. First, our ancestors became more tolerant of, and generous to, others. There is some evidence of a latent cooperation in chimpanzees which, although rarely, if ever, displayed in the wild, is sometimes seen in interactions with humans, and possibly also each other (Gibson, 2012c). Second, there is indirect reciprocity whereby apparent altruistic behaviour could have helped to build reputation and generate its own rewards. Finally, there is cultural group selection in which imitation serves the social function of increased solidarity.

Like Arbib, Tomasello argues for initial holophrastic pantomimes. He maintains this position because single gesture pointing can have complex meanings, but it is not apparent that this is also true of non-combinatorial pantomiming. The 'drift to the arbitrary' (2008: 219) arose, he claims, through the mis-analysis of complex iconic signs, which, once shared within the group, became conventionalised. Conventionality, being computationally efficient, soon comes to be the dominant form of communication. Again Tomasello shares with Arbib (and Corballis) a belief in the historical dominance of gestural communication with only a recent appearance of speech. However, on the evidence of extant, complex sign languages, Tomasello alone among these researchers insists that 'even when grammar is involved most of this story played out in the gestural modality' (*ibid*.: 245); in other words gestural language evolved beyond proto-sign before the switch to vocalisation.

In Tomasello's theory, of the three aspects of cooperative behaviour listed above, the first, mutualism, requires a relatively simple syntax for a grammar of requesting. This is not significantly beyond the communicative abilities of trained great apes, whose communicative repertoire consists almost entirely of requesting. A sensitivity to word order may be necessary, and, as discussed above, there is some evidence for this in trained apes, though the subject remains controversial. The second process, indirect reciprocity, involves a 'grammar of informing'. This entails a more complex syntax containing elements for the expression of spatial displacement and attitude. Tomasello associates this type of communication with early *sapiens* and likens it to the initial stages of a sign language, in contrast to the stage of communication corresponding to mutualism, which is closer to home sign. The final process of group selection necessitates a grammar for sharing and narrative with temporal displacement and complex reference. These gestural grammars may have become correlated with meaningless vocalisations that 'piggybacked' on the gestures and eventually came to replace them. Grammaticalization and the conventionalisation of all linguistic constructions finally resulted in fully complex, human language.

4.3.2.3 Cognitive or communicative continuity?

The hypotheses considered in this section have sought the origin of human language in the continuity with other animals' communications systems. Alternative theories recognise the uniqueness of human communication but seek to ground this in a development of aspects of animal cognition. Emonds (2011) for example, argues that the labelling of functional items in terms of discrete binary values, for example +/- ANIMATE, is inherited from the only discrete concepts in primate cognition, those connected to vision (see discussion in the next chapter). A more common explanation sees language as emerging from hominin development of simple tools, presuming those used by our LCA, are similar to that of modern great apes. In this scenario there is adaptive selection acting on neural substrates (many of these theories stressing in particular the role of hypertrophy of the left lateralised parietal lobe as discussed in 4.2.2.1 above) that are functionally important in both tool use and language (Bruner, 2004; Faisal *et al*., 2010; Stenning and von Lambalgan, 2012).

4.4 Conclusion

In this chapter I have argued that humans alone are capable of abstract, systematic thought, and only humans engage in communication through a system of semantically compositional symbols. These cognitive abilities are most likely the result of physical changes to the hominin brain during 7-8 million years of evolution. These changes include lateralisation, and reorganisation to areas such as the PFC and the posterior parietal cortex. However, the most striking change is the very great increase in brain size despite the accompanying drawbacks that possessing such a large, expensive organ brings. This growth seems to have occurred in a pattern that resembles classic punctuated equilibrium, with two rapid periods of growth, and relative stasis in between. The first of these periods is associated with the appearance of the *Homo* genus and was completed in the speciation event for *Homo erectus*. The end of the second of these periods, which was accompanied with some brain reorganisation, is contemporaneous with the speciation event of *H. sapiens*.

In terms of communication, primate gestures, and the intention behind them, appear to be far better candidates than vocalisations for an evolutionary precursor for language, and a system based on mirror neurons has been posited as an explanation for this. However, even in the laboratory after many years of training, the communicative abilities of chimpanzees remains slight. In particular they lack the features of human cooperation that enable complex, informative communication and they appear incapable of conveying anything much beyond requests and demands.

In chapter five I consider in more detail those aspects of human cognition that enabled humans to possess language, and suggest an evolutionary scenario for their emergence. There is no doubt that language influences some aspects of thought in the sense that a kind of thinking is involved in how to express thoughts. However, in section 5.1 below, I argue that complex thought must have evolved prior to its external representation in language (whether gestural or spoken). This will involve rejecting the notion of language as a system that acts on double interface objects, an idea that characterises CGG and much contemporary linguistics; and also reconsidering what is understood by ‘meaning’ or ‘semantics’ in relation to language.

Chapter 5. The evolutionary nature of language and thought

5.0 Introduction

In this chapter I intend to consider the most plausible relationship between the evolution of human thought and language, given the evidence discussed earlier. As I noted in the last chapter, chimpanzees, and thus we can assume, our LCA, have concepts and, under training, appear able to label those concepts in various modalities and to combine them into simple strings. However they do this only in very restricted circumstances , for the evidence strongly suggests that chimpanzees will engage in apparent communicative activity solely in order to obtain some form of immediate gratification. Blondin-Masse *et al*. note that 'what is striking is that they never really pick up the linguistic ball and run with it. They just don't seem to be *motivated* to do so, even if they sometimes seem to "get it," locally, for individual cases' (in press, emphasis in original). The reason chimpanzees do not communicate beyond the rudimentary stage of gestures described earlier is, I suggest, because they do not actually have very much worth communicating. At some point in the evolution of hominins this situation changed, our ancestors began to have more interesting thoughts and were aware that their conspecifics had different, possibly also interesting, thoughts. The exact evolutionary relationship between language and thought is addressed in the first section below. The second section focuses on problems in CGG, in the MP in particular, and discusses an alternative view of language, including a reconsideration of the notions of 'meaning' and 'semantics', that resolves these issues. Next I consider the cognitive capacities that evolved to make language possible, before finally presenting a tentative hypothesis of the story of language evolution.

5.1 Clarifying the nature and evolution of human thought

5.1.1 The relationship of language and thought

The notion of linguistic relativity, associated with Whorf (1956), and in particular the stronger version of linguistic determinism, wherein it is believed that the manner in which someone perceives the world is conditioned by the language they speak, had long been discredited. Although controversial again, if there is an orthodox position now, it is that thought exists prior to its external expression, as Penn *et al*. note ‘the adaptive advantages of being able to reason in a relational fashion have a certain primacy over the communicative function of language’ (2008: 123). Moreover, as Schoenemann maintains ‘[symbols] for things must logically be applied to things that in some sense already exist in our own cognitive world. From an evolutionary perspective, there would be no point to communication (and therefore language would not have evolved) if such cognitive categories did not already exist’ (1999: 319). Fodor (1998) points out that expressions in natural language may be ambiguous, including oft cited examples referred to in previous chapters as well as constructions involving quantifiers, such as the English sentence ‘everybody loves somebody’, which does not parse into alternative forms without positing covert move. Examples such as these with ambiguous quantifier scope do not appear be the sort of representations that could be vehicles of thought. In addition, there is the well-documented condition of anomic aphasia in which patients experience severe difficulty in recalling words, while being able to explain the concept itself – not unlike the ‘tip of the tongue’ phenomena that most people occasionally encounter. A similar, frequent occurrence is described by Chomsky in terms of a ‘a very common experience’ whereby one tries ‘to express something, to say it and to realise that is not what [one] meant’ (2000, 76). Thus Saussure’s assertion that: ‘thought is like a swirling cloud, where no shape is intrinsically determinate. No ideas are established in advance, and nothing is distinct, before the introduction of linguistic structure’ (1916/83: 155), seems somewhat problematic. Indeed, only a few pages later (*ibid*.: 160) Saussure discusses differences in the lexicons of English and French and employs the example of the English distinction between *sheep* and *mutton*, in contrast to the single French lexeme *mouton*. Yet surely Saussure does not wish to suggest that, on the basis of having two symbols, speakers of English are able to make a cognitive distinction that French speakers lack? Nor, presumably, that English speakers are unable to differentiate between the concept of *chicken* as a white meat and *chicken* as a domesticated, omnivorous member of the genus *Gallus*.

The well-known case of Genie would appear to support the argument that thought/cognitive structure exists prior to the acquisition of a language. Although lacking all language when rescued from her abusive confinement at the age of 13, she was able to later recall and describe episodes from her younger life suggesting that she had, at the time, constructed and stored memories based on differentiated concepts (see Curtiss, 1977). Nevertheless, we need to be cautious as we do not understand exactly what Genie, nor those similarly lacking complex language in early life (e.g. Nicaraguan home signers, see Senghas, 2003), actually *knew* before the imposition of linguistic structure. Certainly there are testaments from individuals who have acquired language when previously it had been absent that emphasise the dramatic change in awareness. One such famous example is Helen Keller:

> ‘Have you ever been at sea in a dense fog, when it seemed as if a tangible white darkness shut you in, and the great ship, tense and anxious, groped her way toward the shore with plummet and sounding-line, and you waited with beating heart for something to happen? I was like that ship before my education began, only I was without compass or sounding-line, and had no way of knowing how near the harbour was. "Light! give me light!" was the wordless cry of my soul, and the light of love shone on me in that very hour’ (1903/2010: 11)

Advocates of certain schools of linguistic thought, particularly in the broad field known as ‘cognitive linguistics’, remain committed to a form of (sometimes inverted) Whorfism. Pederson *et al*. (1998), for example, argue that the way in which members of a particular culture perceive the world will be reflected in the language they use, and give the example of variation in spatial conceptualization[16]. While rejecting explicit Whorfism, some nativist theories, emphasising the abstract nature of language, also blur the division between language and thought. Jackendoff’s (2002) tripartite parallel architecture for language proposes an informationally encapsulated semantic component, independent from syntax and phonology and he might therefore be expected to

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[16] Li and Gleitman (2002) dispute their findings, based on a critique of the methodology used.

promote a theory of a non-linguistic system of thought. Indeed, he is explicit on occasions in stipulating that a precondition for the emergence of language is ‘a community of individuals who have thoughts worth communicating to each other’ (*ibid*.: 238). However his ‘Unconscious Meaning Hypothesis’ stipulates that ‘if we haven’t yet turned a thought into words, we’re only aware at best of *thinking going on*, not of exactly what the thought *is*’ (2012: 91, emphasis in original). He argues that we can only have unconscious, intuitive states until the substance of that state (which he calls ‘meaning’, see discussion below) is somehow linked to a pronunciation and that languages effectively operate as ‘handles’ for thoughts (2012: 90). Even in mainstream CGG a clear distinction between language and thought is not always present, and it is to this that I turn next.

5.1.1.2 Language and thought in CGG

Chomsky largely avoids discussing the relationship between language and thought and, at least at the level of concepts, the two sometimes seem to be used interchangeably. Berwick and Chomsky, for example, refer to ‘the “atoms” of computation, lexical items/concepts’ (2011: 39), while Chomsky is, at times, even more explicit: ‘the core theory of language—Universal Grammar (UG)—must provide, first, a structured inventory of possible lexical items that are related to *or perhaps identical with* the concepts that are the elements of the ‘‘cognoscitive powers,’’ ’ (2005: 4, emphasis added). Other adherents of CGG, such as Bickerton, are more openly committed to rejecting a system of thought separate from language. He has argued (1995) on parsimony grounds that, as language and thought share the features of being systematic and combinatorial, they should share the same neural resources and he later maintains that ‘without words we’d have never gotten into having concepts’ (2009: 208). However the most explicit treatment of the issue is by Hinzen (2006, 2007, 2011, 2012).

Like Bickerton, Hinzen appeals to the principle of Occam’s Razor for rejecting the concurrent existence of both language and an independent system of thought or mentalese, which, following Fodor (1975, 2008), we will call Language of Thought (LoT). Hinzen (2011), like Chomsky (e.g. 2005), sees the phonetic externalisation of language as a secondary phenomenon which was preceded, in evolutionary terms, by a purely internal language, though not interfacing with the CI system, as in mainstream CGG, but actually constituting that system. Hinzen is a proponent of the 'Great Leap' hypothesis for the origins of language and he sees language as UG, emerging suddenly around 80 kya. For Hinzen, this occurred as 'a neural reorganisation that puts a creative and structured mode of thought into place, and the most plausible cause of this reorganisation is language: what we might call the grammaticalisation of the brain' (2012: 247). The evolution of the species *H. sapiens* corresponded with the appearance of a new type of mind that had a potential for creative thought that could not be realised until the emergence of grammar: early humans had a mind 'of a new and spectacular kind; but they didn't yet know it' (Hinzen and Sheehan, 2013: 259). It should be noted that despite the argument that language is LoT, Hinzen is talking about syntactic computation in the form of UG and not explicitly suggesting any form of linguistic determinism, as he argues 'it is a Whorfianism without the linguistic relativity bit. The structures that language co-opts are universal' (2011: 522); Hinzen and Sheehan thus propose an Un-Cartesian 'unified theory of language and thought' (2013: 7). Hinzen maintains that the productive, generative, recursive, combinatorial nature of language matches precisely those properties that are posited in a LoT. Furthermore, if language was not LoT, then you would not expect to see the alignment of syntax and semantics that he claims is evidenced. Hinzen and Sheehan's proposals involve a good deal of philosophical and technical detail, too much to consider here, and I offer only a brief sketch. Essentially, they argue that sentient beings filter the mass of perceptual data that they are exposed to and in doing so form symbolic mental representations that are common to all animals. Only humans though, deindexicalise these representations in the formation of concepts/lexical roots (lexemes) which enter the computation as grammatical atoms, the *relations* of which constitute grammatical semantics, including reference through reindexicalisation. Truth only exists as predication, a grammatical relation realised in the linguistic sentence:

> 'truth requires predication …, and thus the sentence (viewed as a grammatical object) …. Whatever a Chimpanzee might think, he doesn't think about 'the world' as such, as philosophizing hominins tend to do. The arrival of the sentence, for these reasons, or the transition from a

> perceptually and conceptually given world to one that is grammaticalized, is a truly momentous one. Only in such a world can there be such a thing as a metaphysics, or science' (2013: 84).

In other words, only by 'realising' thought through linguistic form is the nature of referential, truth conditional thought determined. These notions correspond to uniquely human concepts, 'in this sense only where there are lexemes, there is grammar, and there is intentional and intensional reference' (*ibid*.: 54).

However, one major problem with the hypothesis that language equals LoT is the notion of translatable thoughts. If a thought is constituted by the language in which it is expressed then surely translation into another language is not possible. Alternatively, if the same thought can be expressed in two different languages (which appears to be the case) then it must surely be independent of either language. Hinzen and Sheehan explicitly state that the problem to be tackled is 'what is grammar, so that it can be invariant?' (*ibid*.: 76). Their response is that linguistic diversity does not amount to grammatical variation. The former is explained in terms of 'the mapping between syntax and PF, … which must, then, be indirect, in order to capture the fact that languages differ from each other' (p. 180). This suggests that diversity arises from different morphophonological systems while grammatical relations remain universal and invariant. However, it does not appear entirely clear to me how Hinzen and Sheehan see a purely syntactic/semantic derivation prior to the mapping to PF (for example, is it hierarchical, linear or both? See discussion below on the incompatibility of the two). The authors also accept that the lexical inventory of languages vary enormously and are the result of cultural diversity and historical accident. Hinzen and Sheehan acknowledge that differences in lexis will 'necessarily affect the exact thoughts that can be expressed in a given language (simply because the thoughts in question will contain different concepts)' but claim that 'they seem to have no obvious impact on the grammatical semantics available in a given language' (p.180). But while we can be sympathetic with their critique of traditional compositional semantic theory as inadequate in accounting alone for the totality of meaning of a construction, thoughts containing different concepts are surely radically different thoughts. They conclude that 'any human language can create the same *kinds* of thoughts, and not the exact same *set* of thoughts' (p.180, emphasis in original), which may be a weak form of, but nevertheless certainly looks like, Whorfianism of some sort.

Even in mainstream CGG, in which the syntax is explicitly recognised as interacting with the CI system rather than constituting it, as in Hinzen and Sheehan's hypothesis, the problem of the relation of language and thought remains apposite. Two approaches to dealing with the problem can be identified. Firstly, there is the suggestion that all variation arises as a result of externalisation while there remain universal LFs corresponding to individual propositions. A strong version of this proposal would be to posit an extreme version of 'language as abstract'; there is only one language, with some form of 'late' lexical insertion. A position similar to this appears to be adopted by Sigurδsson and Maling (2010). They note that in the two examples (their p.68 (20))

1) a John said to me that he would vote for me
   b John said to me 'I will vote for you'

the choice of pronouns in the second clause depends on the output of the syntax in the first and so could not be selected for a numeration/array[17]. On these grounds (and several others) they argue that the items entering the computation consist solely of features and abstract roots.

Mainstream generative grammar adopts a weaker version of this hypothesis and assumes that lexical items are selected from the lexicon prior to merging in a derivation, yet still maintains that all variation is due to externalisation. As Holmberg and Roberts explain, the 'traditional P&P position…is that there is syntax, deriving LF representations interpreted at the C-I interface, and there are post-syntactic systems deriving PF representations interpreted at the A-P interface' (2014: 72) . Work of this nature represents a significant part of the opus of the generative enterprise, and, on the surface, there would appear to be significant success in divorcing the range of language specific externalisations from invariant LFs. However, there have, for many years, been criticisms for a tendency to Eurocentricism and consequently a focus on languages with

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[17] Though a response could be that these are independent 'phases' with different arrays

relatively recent shared roots (e.g. Epps, 2010). It should be noted, though, that generativists would deny this charge. Chomsky (2013), for example, claims that it is in fact the methodology employed in the generativist or ‘biolinguistic’ framework that ‘allows study of Japanese or English to make use of discoveries about the nature of language unearthed in study of Italian or Mohawk, and of inquiries that go beyond linguistic data narrowly construed’ (2013: 35).

Variation in morphophonology is clearly the least problematic aspect of language to account for purely in terms of externalisation. Even here, though, it is not obvious why the vast differences in, for example, isolating, agglutinating or polysynthetic morphological systems are attested, nor how sentences encoded in these systems could map to identical LFs (for example, embedding of clauses in isolating languages may be replaced with affixation of morphemes in polysyntheic ones – see Evans and Levinson, 2009.). Syntactic structure is more problematic still. Evans and Levinson claim that free word order languages fatally undermine certain principles of CGG, claiming that if ‘constituency is not the universal architecture for sentence structure then the entire generative apparatus of c-command, bounding nodes, subjacency, and so forth collapses, since all are defined in terms of constituency’ (*ibid*: 476). But this misses the fundamental point that in CGG these relations are presumed to exist in LF, while externalisation, whether constrained or random, has no bearing on this. Nevertheless, there are more robust questions arising from the domain of syntax. One example includes the case of propositions that may be encoded in fewer clauses in some languages than in others, such as the question of how epistemic modality is expressed. For example, a language such as Tuyuca (Whaley, 1997) has a set of markers for evidentials which other languages, including English, lack, and therefore need to include additional clauses to express mood. Likewise, while in English it is possible to express change of state in a single clause, other languages, relying on periphrastic causatives, require two or more. One such case is the African language Fongbe (Lefebvre and Brousseau, 2002):

(1)	Àsíbá	blo	bɔ̀	nùsúnû	ɔ́	kpɛ̀n
	Asiba	make	COMP	Sauce	DEF	become.thick

‘Asiba thickened the sauce’

Recursion gives rise to similar questions. Evans and Levinson note ‘how easily a language can dispense with subordination (and hence with the primary type of recursion), by adopting strategies that present a number of syntactically independent propositions whose relations are worked out pragmatically’ (*ibid*.: 442). As well as languages which have little recursion, it has also been claimed that there is at least one language, Piraha, in which recursion is completely absent (Everett, 2005). The problem is how a sentence with multiple embedded clauses in one language could share an invariant LF with propositions encoded in multiple independent sentences in another language.

An alternative, less orthodox, approach accepts that there is variation in the narrow syntax and thus in LFs corresponding to the same thought. Holmberg and Roberts (2014) defend the notion of parameters and argue that they arise as an emergent property of the three factors in language design discussed in Chomsky, 2005. Through a comparative analysis of answers to yes/no questions in English and Finnish they claim that all that is truly invariant is ‘the linguists’ representation of the shared syntactic structure of a particular type of expression, not a representation in the mind of the language user’ (*ibid*.: 80). They note that English yes/no answers consist of a positive or negative particle whereas Finnish licenses an echoing of the finite verb of the question, an option prohibited in English. Structurally these options are in some respects different, involving different forms of movement and ellipsis, and the authors maintain that they cannot be accounted for by variation in selective spell out. Holmberg and Roberts argue that ‘two expressions convey the same thought if they are truth-conditionally equivalent and interchangeable in the same discourse context’ (*ibid.*: 73). Under this definition the two possible responses to yes/no questions are taken to express the same thought, though clearly there is significant pragmatic work to be done in both cases to arrive at any proposition. The authors conclude that ‘the same ‘thought’ can have I-language representations which are different in some respects, although we would still expect them to have the same basic syntactic structure’ (p.72).

As Evans and Levinson have shown (2009; Levinson and Evans, 2010) there is vast variation in the world’s languages and the question endures of how the same thought in all languages (or indeed all individual, internal I-languages –

Chomsky, 1986) corresponds to a single linguistically derived LF (or at least very similar ones in Holmberg and Roberts' hypothesis). It certainly remains difficult to explain in 'minimalist' terms (at the very least a great deal of covert internal merge would appear to be necessary). Further discussion of this topic is resumed below (especially section 5.2), in particular in relation to radically different sentences in the same language, with identical truth values, and the need for pragmatic enrichment of anything that is 'encoded'.

While language is clearly necessary for aspects of those concepts which we only acquire through learning (such as [ATOM], [QUARK] and so on) it also seems obvious that language helps to refine, or to make more precise, more natural concepts. Nevertheless, as many philosophers of mind and cognitive anthropologists point out, humans are endowed with universal, cross-cultural and cross-linguistic modes of thought or 'folk mechanisms' (Wynn *et al*., 2009), as a consequence of which we characterise and think about the world in identical ways. The different languages of the world (including those that are extinct) exist (or existed) to express, and thus are constrained by, this way of thinking, and it is this that will be examined in the next section.

5.1.1.3 The Language of Thought

Amongst others, Jackendoff (2012) comments that even if chimpanzees were suddenly to develop a symbolic communication system, the thoughts expressed would not be comparable to those of humans as we have evolved to entertain different types of concepts and combinations of concepts. One popular proposal to account for these differences, with adherents in 'Cognitive Linguistics', is that humans have evolved an embodied cognition that is situated in interaction with the physical environment. However, this appears to me to be the wrong way round: what humans appear to have evolved is a slower, reflective mode of thought that is *less* embodied, and this is addressed in section 5.3.3 below (for discussion of embodied cognition see Wilson, 2002).

The central tenet of the LoT hypothesis is that humans have concepts and an innate, universal system for combining these concepts into propositions. In these terms concepts are 'mental symbols, the units of thought' (Carey, 2011).

Harnad prefers the term ‘category detectors’ to concepts, and offers the definition that ‘[t]o categorise is to do the right kind of thing with the right kind of thing’ (2010: 213): to eat an apple, to avoid a predator, and so on – though note this says nothing about what the content of [APPLE] actually is. He rejects theories of concepts based on prototypes or exemplars as either inviting an infinite regress or failing to account for category construction, and explains the acquisition of concepts/categories as induction grounded in sensorimotor perceptions (1990)[18]. In addition to this ‘sensorimotor toil’, concepts may be inherited (‘Darwinian theft’) as well as learned through language (‘symbolic theft’) (Harnad, 2003). The notions of inherited concepts and a universal, innate category detector rely on the premise of innate primitives, an idea which is assumed by many writers, and there are presumably some basic concepts shared with other primates (Emonds, 2011; Tomasello, 2008). However, there are good reasons for believing that other innate concepts, and, more obviously, modes of thinking, have evolved since our split with the LCA. Wynn *et al*. (2009) discern three types of universal conceptual thought. The first is grounded in basic ontological categories which, they claim, are uniquely human and innate, and are displayed by preverbal children. These include concepts such as [TOOL] which they associate with an area of the left occipital and temporal lobe (BA 37) and estimate an emergence in early *Homo* around 1.5 mya. The second involves multi-sensory categorisation which constitutes folk biology, a form of essentialism, mirroring Harnad’s rejection of prototype or exemplar based theories. The evidence for this is *pace* Hinzen and Sheehan, who claim that relations of hyponymy and hyperonomy are ‘subject to significant variation across speakers and languages’ (2013: 43), the existence in all cultures of at least three biological ranks or taxons: kingdom (e.g. plant), form (tree) and specific (oak). Given that these ranks are based on the integration of multisensory features, processing must involve the parietal lobe and the appearance of this type of cognition would then be contemporaneous with changes to that particular brain region. The final category is complex, abstract thought, linked to the PFC, and it is this type of thought that a LoT hypothesis is intended to account for.

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[18] See also Fodor’s (1998) argument against prototypes on the grounds that, as prototypes do not compose, they fail to account for complex concepts: the concept [PET-FISH] is neither a prototypical [PET] nor a prototypical [FISH].

However concepts are defined, a LoT hypothesis proposes that they are represented by grounded symbols which are manipulated in the production of propositions as part of a ‘computational theory of mind’ (CTM). Such a theory is founded on the systematicity and combinatoriality which characterise thought and are the foundations of infinite productivity. It is on the basis of these features that CTM is explanatorily more appealing than accounts of thought based on connections in neural networks (see Fodor, 1997). In such a CTM, thoughts are compositionally structured ‘sentences’ in LoT and it is the relation between these sentences that constitutes ‘thinking’. Positing a LoT solves the problem of ambiguity in natural language, indeed LoT is the source of disambiguation. Furthermore, the hypothesis helps explain the acquisition of language, providing an answer to the puzzle of bootstrapping referred to in chapter 1.

Animal minds may be simply sentient and responsive to percepts as qualia, or more advanced and conscious in the sense of processing a greater level of awareness of sensation. Only humans, though, have a yet higher, well developed, reflective, self-consciousness that enables them to have thoughts about things and be aware of those thoughts, and have further thoughts about thoughts (Jacquette, 2009). This is the property of Intentionality and is the result of adopting a propositional attitude, such as believing or wishing, to a LoT sentence[19].

Accepting the notion of a LoT in which thoughts are the result of being in a relation to a generated ‘sentences’ that are independent of their expression has major consequences for a theory of language, and this is examined in the next section.

5.2 Language

If, as I have suggested, there is a LoT that is separate from any system for potentially communicating thoughts, then a theory of the human FL needs to

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[19] Though this is not necessarily the way in which Fodor imagines a LoT

account for this. Consequently, this section introduces the Representational Hypothesis (RH) as an explanation of language in terms of a semiotic system for representing thought (Burton-Roberts, 2000, 2011, 2013; Burton-Roberts and Poole, 2006). In the light of this theory of the relation between language and thought, I also review the relationship between ‘meaning’ and ‘semantics’.

5.2.1 What is necessary in a theory of language?

While I have suggested (chapter 2) that the status of the psychological reality of syntax as it is conceived in the MP (and CGG in general) is problematic, there is nevertheless a general assumption in the field that syntactic operations are real mind/brain processes[20]. Devitt (2006) questions this and distinguishes the psychological processes involved in the execution of speech from linguistic structures as such. The study of one does not necessitate the study of the other except to the extent that any theory of processing must be able to account for the structures of the output, that which he calls ‘The Respect Constraint’. But this does not mean that linguistic rules, constraints on ‘merge’ and ‘move’, are necessarily represented in the mind; when we ride a bike, as with many intricate acquired skills, we need to abide by several complex laws of physics to do with motion and balance, but surely we do not want to say that algorithms embodying these laws are represented in the mind? Language, says Devitt, shares the properties of general cognitive skills in terms of speed and automaticity, and thus is not inevitably represented as either explicit (or implicit) declarative or procedural knowledge (see discussion below of implicit System 1 processing). If the psychological reality of linguistic rules is not a necessary condition for language, then it raises the question of why such a level of representation would exist, and why it would have evolved (either gradually or abruptly). A sentence that a hearer encounters as phonetic material needs ultimately to be translated into mentalese, to have propositional content (semantics), so what value lies in positing an intermediate level of representation? In interpreting the English word ‘cat’ why does the phonological string /kæt/ not lead straight to a mental representation of [CAT], and skip representation as a noun, a syntactic object? On the basis of folk mechanisms, everyone who has encountered cats is aware of the concept and everyone who speaks English recognises the phonetic label, however it is only linguists, those

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[20] See discussion in chapter 2

who created the terms, who are aware of properties of nouns, adjectives, determiners and so on (other than basic distributional patterns). Devitt attributes the thesis that ‘representations are not to be multiplied beyond necessity’ (*ibid*: 51) to Pylyshyn and, borrowing from Occam, terms it “Pylyshyn’s Razor”.

Burton-Roberts and Poole (2006) agree that there is an unnecessary level of representation in CGG and attribute this to a ‘Saussurian legacy’. For Saussure, language consisted of a number of signs that could enter into syntagmatic and paradigmatic relationships in the construction of sentences. The Saussurian notion of the sign involves a signifier (sound image) and a signified (concept) which stand in an asymmetric, semiotic relationship (the signifier represents the signified, but not *vice versa*). Recall from section 5.1.1 above though, that Saussure is firmly committed to the belief that thought requires language and consequently he believes the signifier and signified cannot be separated: ‘[j]ust as it is impossible to take a pair of scissors and cut one side of paper without at the same cutting the other, so it is impossible in a language to isolate sound from thought or thought from sound’ (1916/83: 156). So in addition to the semiotic association these two components are envisaged to also have a symmetric mereological (part~part) relationship in constituting a third entity, the sign (see figure 5.1).

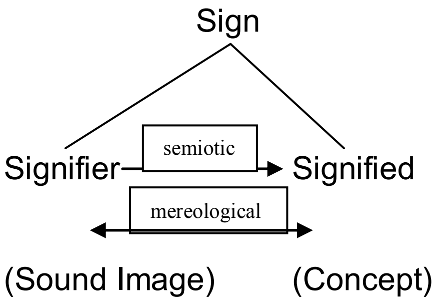

figure 5.1 The Saussurian Sign

A semiotic relationship however, only requires the existence of the signifier and signified, thus there is no necessity for postulating the third entity. Burton-Roberts and Poole further argue that not only is this entity a conceptually unnecessary complexity, it is actually not coherent. They offer instead idea development of the sign as proposed by C.S. Pierce (e.g. 1873) in which the signifier *is* the sign and together with the signified are the only two permissible relata in the semiotic relationship. Pierce identifies three types of sign: natural signs, or indexicals, in which signified and signifier naturally co-occur (e.g. smoke indicating the presence of fire), iconic signs which signify by virtue of resemblance to the signified (e.g. a painting), and finally symbolic signs which represent by convention and in which the relation between the signifier and signified is an arbitrary one (e.g. a road sign such as figure 5.2).

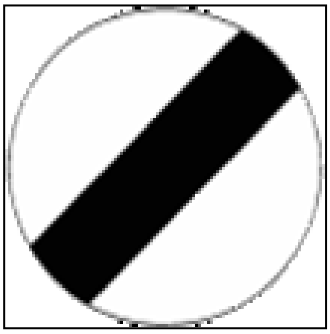

figure 5.2 Sign for UK national speed limit (from Google Images)

In all three cases, Pierce stipulates that it is a 'condition that a Sign must be other than its Object' (1910: 230); signs, by definition, cannot be that which they represent, encapsulated in Burton-Robert's representational axiom (e.g. 2011: 2091):

$$R(x) \neq (x)$$

In order to clearly distinguish semiotic representation from other uses of the term in linguistics and CGG in particular, Burton-Roberts and Poole refer to this as m-representation[21] (2006: 597) in reference to Magritte's *La Trahison des Images* in which the point is made that a painting of a pipe is not a pipe and shares none of its properties other than a physical resemblance *qua* an iconic sign (see figure 5.3)

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[21] Although Pierce refers to all three types of signs as 'representations', Burton-Roberts (2013) distinguishes between non-representational natural signs (indexicals) and signs which are *intended* by someone to represent. Smoke is not a representation of fire in the sense that a portrait *is* a representation of an individual

figure 5.3 Magritte's La Trahison des Images (from Google images)

A further objection to the Saussurean sign with regards to language, is that it is composed of items consisting of a sound image (i.e. something with phonological properties) and a signified with conceptual properties. Burton-Roberts and Poole argue that these are 'SORTALLY distinct…, things whose respective properties are incommensurable' (*ibid*.: 595, small caps in original). It just is the case that things interpretable by the CI system are not interpretable by AP systems and *vice versa*, a fact recognised in CGG (including the MP) in the principle of full interpretation and 'spell out'. Numbers for example do not have phonological properties; the number 7 for example, cannot be bisyllabic. Similarly, sounds do not have inherent conceptual properties, they cannot be prime, or the sum of 4+3 and so on (see discussion below on the distinction between 'semantics' and 'meaning'). In particular, thoughts, objects of the CI system, have purely hierarchical – that is, non-linear – structure; a train of thought may proceed through a linear process in time, but individual thoughts do not. Conversely, language when spoken must be linear with one phone preceding another in real time. The assumption that languages have hierarchical structure is challenged below.

5.2.2 Saussure and CGG

Nevertheless, despite the objections to the Saussurean sign reported in the last section, it has retained a (usually unacknowledged) significant role in much of linguistic theory. In the field of 'Cognitive Linguistics' for example, Evans and Green explain that 'while there are important differences between the Saussurean model and the cognitive model, the cognitive model adopts the idea of the Saussurean symbol' (Evans & Green, 2006: 476), and, writing from a similar perspective, Nerlich & Clarke note that 'at least some cognitive linguists, like Langacker, share with Saussure a concern with the linguistic sign even when this term is not explicitly used' (2007: 598). CGG is far from immune from this. Although Chomsky rarely discusses Saussure, his oft repeated claim that language is a 'system that links sound and meaning' (2005: 10) is clearly potentially Saussurian in character. The view of lexical items in CGG as 'double interface property' (DIP) objects firmly establishes the link with Saussure (see figure 5.4)

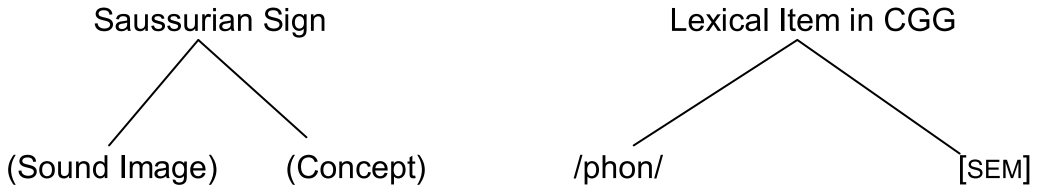

figure 5.4 Saussurean sign and the lexical item in CGG

Evans and Levinson believe that the MP has taken Chomsky in such a direction that the object of his concern now is not language (and certainly not languages) but rather 'the nature of recursive thought' (2009: 477). Certainly Chomsky has made it clear that he considers language to have evolved first as an instrument of thought with externalisation being an epiphenomenon, restricting linearization to 'spell out' and the mapping to the AP interface (e.g. 2005, 2007). This enables Chomsky to maintain the pursuit of perfection in language by conceding that '[o]ne massive case (of imperfection) is the phonological system. The whole phonological system…has every bad property you can think of' (2002:118). The phonological is then relegated to a secondary, peripheral status (see discussion of FLB and FLN in chapters 2 and 3). Sigurðsson and Maling cleanse even more of the 'imperfections' by suggesting that the 'computation proceeds after transfer to PF, that is, much of syntax in the traditional sense is actually morphosyntax or "PF syntax", invisible to the semantic interface' (2010: 64). But if we accept the objections to the Saussurean sign in general, and in particular the 'sortally incoherent' (Burton-Roberts, 2011: 2092) notion of DIP objects composed of phonological and semantic properties, then proposals such as Sigurðsson and Maling still fail to account for the problems of a computation that acts on objects of this type at *any* stage.

5.2.1.3 The Representational Hypothesis explained

The idea of covert syntax, post spell-out, acting on objects with only semantic properties has been a central feature of CGG at least since the Revised Extended Standard Theory. The RH, on the other hand, suggests that *all* semantic structure is the result of a computation operating on concepts with no phonological properties. As the output of the computation is a hierarchical structure, it must by definition have syntax (or at least *a* syntax, that is, a hierarchical structure), as Burton-Roberts argues, 'no-one who admits of LoT would want to deny that it has a generative syntax. Syntax-free (syntax-less, recursion-free – and thus finite) semantics is inconceivable' (2011: 2094). The RH is a development of the Piercian notion of sign in which it is proposed that there is a wholly internal, invariant syntactico-semantic system which generates structured concepts. These structured concepts (*Representatum*) may then be *represented* – not *realised* – externally by speech sounds (*Representans*). As speech sounds must be linear and temporal, they have an arbitrary relationship to the hierarchical, atemporal thoughts they represent: 'nothing non-linear is "linearized"' (Burton-Roberts and Poole, 2006: 603). Particular languages are Conventional (symbolic, semiotic) Systems for the Physical Representation of thought (CSPRs), morphophonologically constituted systems that mediate representationally between sound and semantic properties (see figure 5.5 below). Each CSPR defines what constitutes acceptable, representational, phonetic phenomena differently. Diversity among languages, far from being an 'imperfection', is therefore to be expected.

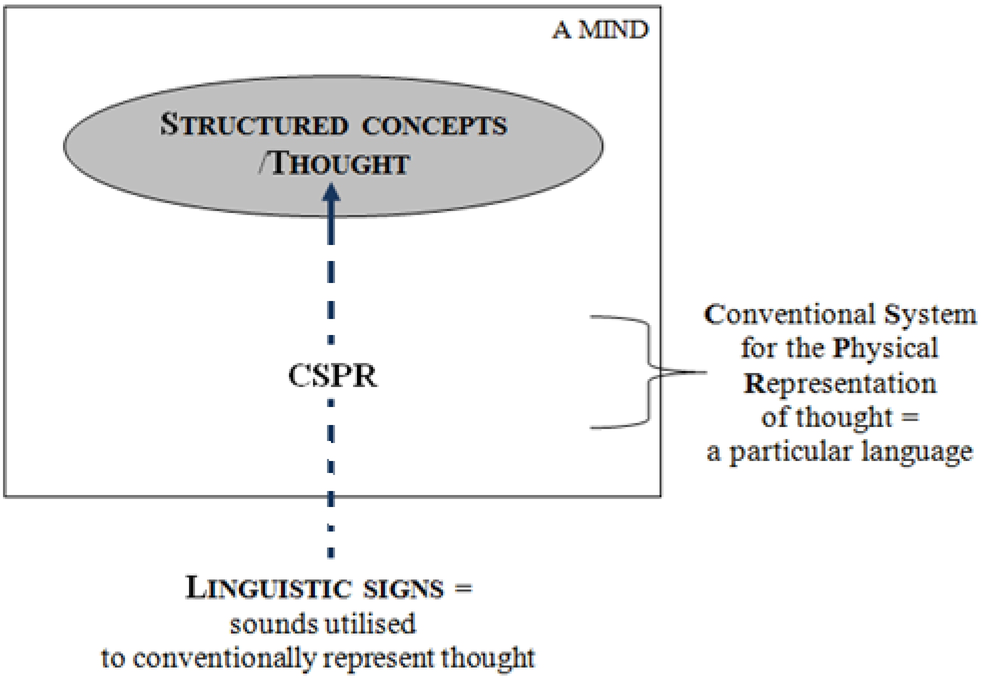

figure 5.5: A model of the Representational Hypothesis (adapted from Stenzel, 2013)

There are significant consequences of this for the ‘division of labour’ as traditionally understood in the study of linguistics. The scope of phonology is vastly increased, becoming a richer ‘representational phonology’ which Burton-Roberts and Poole label ℜ-phonology (2006: 602). The traditional study of (morpho)phonology has included the specification in any particular language of phonetic features, their combination into phonemic segments, the phonotactic constraints on acceptable sequences of segments in syllables, and the arrangement of syllables in the formation of bound morphemes and free words. To these Burton-Roberts adds the stipulation of ‘which sequences of words constitute well-formed (representational) phonetic forms in [any language]’ (2011: 2100). There is no hierarchical structure or syntax in spoken language; speech is, by virtue of being spoken *must* be, entirely linear and thus in the realm of phonology. It is only by parsing speech that we can attribute a hierarchical structure to the thought represented and eradicate any ambiguity. A second consequence involves the area of study in linguistics generally referred to as semantics. As noted above, LoT is a syntactico-semantic system and languages, as understood in RH, lack not only syntactic but also semantic properties. The implications of this are addressed next.

5.2.3 Meaning and Semantics

Chomsky refers to the DIP theory of language as ‘one way to express the traditional description of language as sound with a meaning, traceable at least back to Aristotle’ (1995: 2). However, based on his most explicit writings on language, in *De Interpretatione*, what Aristotle actually meant could be argued to be closer to a semiotic notion of language than that held in traditional CGG:

> ‘Spoken expressions are symbols of mental impressions, and written expressions [are symbols] of spoken expressions. And just as not all men have the same writing, so not all make the same vocal sounds. But the things of which [all] these are primarily signs are the same mental impressions for all men, and the things of which these [mental impressions] are likenesses are ultimately the same’. [22]

The problem in much current linguistics seems to arise with the conflation of the terms ‘meaning’ and ‘semantics’. Jackendoff (2012) for example, explicitly addresses the relationship of language, thought and ‘meaning’ but appears to use the latter term interchangeably with ‘semantics’, thus we get repeated statements that ‘meanings are hidden’ from us (p.49) and discussion of ‘meaning systems’. Von Evkardt clouds the issue further, even distinguishing between ground relations (by which she seems to mean indexical and iconic signs) and symbolic representation e.g. ‘the word “cat” refers to the set of all cats’ (2012: 32) which she labels ‘semantics’. Burton-Roberts seeks to clarify these terms:

> The relation between meaning and semantics… is this. Meaning is a *relation to* semantics – an antisymmetric semiotic relation from α (anything) to conceptual/semantic content. Since semantic content is necessarily one of the terms of the semiotic/meaning relation, it follows that you can’t have meaning without semantics. But it doesn’t follow that meaning *is* semantics; this relational account of meaning distinguishes meaning and semantics’ (2013: 19/20, emphasis in original).

The meaning of any sign (indexical, iconic or symbolic) lies not in the sign itself but the thought it causes an individual to token on any particular occasion. Anything can be ‘meaningful’[23] for someone – smoke, a picture, a string of

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[22] Translation by H. G. Apostle

[23] Although I am insisting that ‘meaning’ is a relation, I adopt common usage of terms such as ‘meaningful’ which denotes a property. Such terms are hard to avoid but should not be taken to suggest that any ‘property’ is being implied.

spoken words – and they can enter into a ‘meaning’ relation, as iconic and symbolic signs do when used intentionally to represent; but they do not have semantic properties. A road sign such as that in figure 5.2 above, stored in a depot does not signify that a particular speed limit must be adhered to on encountering it. On this occasion it has no obvious meaning to me, though it might have a new meaning for a depot worker who sees it and, knowing it has to be on a lorry, had previously assumed that the task of moving it had been undertaken by someone else. Similarly, words as spoken signs do not have any inherent sematic properties, but rather may be used by convention and intention to represent a concept or thought which is the only locus of semantic content.

This distinction appears to be acknowledged by linguists and philosophers of language at various times, but its significance does not seem to have been grasped. Thus Fodor can speculate that ‘[m]aybe all there is to what “cat” means is that it’s the word that English speakers use to say what they are thinking about when they are thinking about cats. That, of course, isn’t semantics’ (1998: 68). But this insight, captured in the RH, is treated as little more than an aside by Fodor. Hinzen and Sheehan are more explicit in their discussion of the topic.

Hinzen and Sheehan claim that:

> ‘[t]he point of language,… is infinity: we can refer to ever new objects, whatever the fancy may be that strikes us. One wouldn’t suppose that, before such a fancy strikes, all of these possible objects of reference already pre-exist our reference to them’ (2013: 95)

However, in the vast majority of cases, relying on folk mechanisms (rather than expertise), I think I *would* suppose that most, if not all, objects of reference pre-exist our labelling them. Furthermore, our modes of classification are not, I suggest, a matter of ‘fancy’ but the result of an inherited (in fact an evolved) mode of classification. Hinzen and Sheehan disagree, arguing that ‘it is *words*, which do not belong to anyone, which are shared between speakers, not concepts, which are in individual speakers heads’ (p. 51, emphasis in original). However, Burton-Roberts (2013:12) cites the example of Mrs Malaprop’s “Sir, you are the pineapple of politeness!” where the very essence of the humour arises from our awareness that are we dealing with a shared concept (for most

English speakers conventionally represented by ‘pinnacle’) and an attempt to represent that concept that fails to utilise the standard convention and instead employs a symbol which for most of us conventionally represents something entirely different. Real life examples of this are common, though generally less amusing, and include the use of terms such as ‘disinterest’, ‘refute’, hopefully’ and so on, all of which so animate prescriptivists.

Hinzen and Sheehan do agree with the premise of the RH that words do not have semantic properties: ‘[t]here is no semantic value that [e.g.] ‘horse’ as such has and that we could insert into the compositional computation of grammatical content’ (Hinzen and Sheehan, 2013: 89). But they claim that it is by virtue of becoming part of a grammatical structure, entering into grammatical relations with other words, that a semantics is created. Yet, as argued above, individual grammars vary, while thought is (species wide) invariant. Not only that, but grammars permit the ‘encoding’ of (potential) meaning in different formats. Burton-Roberts and Poole (2006: 591) give the example of the two English sentences

3) You can’t often bribe officials
4) It is not often possible to bribe officials

both of which represent a proposition with the hierarchical scope relations of

5) [NEG] > [TEMPORAL] >[MODAL]

even though the representations of these are differently ordered in the two sentences (and English is a relatively strict fixed word order language). It could be argued that there are subtle differences in the semantic content represented in 3) and 4), and that strict synonymy across different grammatical constructions does not exist. However, as I briefly discuss below, it is generally recognised that whatever is ‘encoded’ vastly underdetermines the totality of ‘meaning’ that speakers generally intend to communicate (Grice, 1989; Sperber and Wilson, 1986) and the truth conditions of any particular ‘encoded/linguistic’ sentence are radically different from those of the complete, or even its most salient aspect (the full propositional content of any utterance). Pragmatic inference is not just a matter of implicature or an optional appendage, rather it is the case that the linguistic ‘meaning’ of the code is (often) too underdetermined to provide any proposition, but rather acts as input into the pragmatic processor. In the case of one effective approach to pragmatics, Relevance theory, this processor is said to generate the truth-conditional proposition in the form of an *explicature* where ‘the conceptual content of an explicature is an amalgam of decoded linguistic meaning and pragmatically inferred meaning’ (Carston, 2004: 636). Only at this level of explicature can ‘real’ (as opposed to purely formal ‘linguistic’) truth-conditional semantics be engaged. It is important to note that in RT this ‘identification of explicit content is seen as equally inferential… as the recovery of implicatures’ (Wilson and Sperber, 2004: 615).

Languages as viewed from a RH perspective are conventional systems of symbolic signs that are utilised by speakers in a particular context; that is, to represent a thought that is imbued with semantic properties. It is this intentional use of symbolic signs that appears to make human communication unique. Animals do not seem to employ symbols, though some do look as if they are subject to influence by symbolic systems. For example, it has been shown that when offered two varying amounts of food chimpanzees will always choose the larger one even when this is to their disadvantage. However, when the actual food is replaced with a symbol (a number) the chimpanzees will selectively choose the smaller of the two when advantageous (Boyson and Yocum, 2012). An equally intriguing aspect of intentional human communication is why we engage in it at all. The next section will consider the question of what particular properties evolved in our species that gave rise to this ability and propensity for ostensive, representational communication.

5.3 What evolved that made language possible?

In this section I consider in more detail ‘theory of mind’ (ToM) and its evolutionary record in humans. Closely related to this is the notion of recursion and its importance for creative thought. The final part of the section looks at ‘dual processing theory’ as an account of uniquely human cognition.

5.3.1 Theory of Mind

ToM essentially involves the appreciation of other individuals as intentional beings with purposive mental states and independent (and therefore possibly false) belief systems (Call and Tomasello, 1999). These properties are fundamental to language in which ‘communication depends upon the ability of human beings to attribute mental states to others’ (Origgi and Sperber, 2004).

As noted in the previous chapter, ToM is a notoriously difficult trait to identify in nonhuman animals, despite research going back over 30 years (e.g. Premack and Woodruff, 1978). Deliberate deception is taken as one source of evidence of the presence of ToM and I have already referred to a number of experiments involving food sources in which a less dominant primate will not access rewards in the presence of a more dominant conspecific from whom the source is hidden. In addition to these there have also been claims of false indications of predators, hidden grooming and hiding sexual arousal, though none of these claims is conclusive (for discussion see Pearce, 2008). The picture is little clearer with other aspects of knowledge attribution (see previous chapter), though Call and Tomasello’s review identifies evidence that chimpanzees are able to understand each others’ goals and display an awareness of different perception and knowledge held by conspecifics. In the case of false belief tasks, though, chimpanzees appear to be resounding failures. Call and Tomasello’s inconclusive judgement is that:

> ‘[i]n a broad construal of the phrase ‘theory of mind’, then, the answer to Premack and Woodruff’s pregnant question of 30 years ago is a definite yes, chimpanzees do have a theory of mind. But chimpanzees probably do not understand others in terms of a fully human-like belief–desire psychology in which they appreciate that others have mental representations of the world that drive their actions even when those do not correspond to reality. And so in a more narrow definition of theory of mind as an understanding of false beliefs, the answer to Premack and Woodruff’s question might be no, they do not’ (2008: 191).

While Ernst Haeckel’s dictum that ‘ontogeny replicates phylogeny’ is no longer taken as an infallible indication for the point at which any trait appeared in evolutionary history, it is nevertheless interesting to note the very early appearance of aspects of ToM in human infants. As Eagleman notes, human babies ‘pop into the world with neural programs specialized for reasoning about objects, physical causality, numbers, the biological world, the beliefs and motivations of other individuals, and social interactions' (2011: 83). Almost immediately following birth (average 9 minutes) neonates show a greater attraction to face shapes than other types (Goren *et al.*, 1975) and by 8 weeks are able to process features of faces and distinguish between individuals (Morton and Johnson, 1991). Between 11 and 14 months infants are able to engage in coordinated joint attention based on gaze and pointing (Scaife and Bruner, 1975). It was generally thought that the ability to recognise false belief (typically tested in 'Sally-Ann' type experiments) does not emerge until the fourth year, though more recently there have been suggestions for an earlier appearance of this capacity including claims that infants as young as 15 months can pass non-verbal false belief tasks (Onishi and Baillargeon, 2005)[24]. It certainly seems to be the case that, as Shatz puts it, '[a]nimal cognitive sophistication is not qualitively comparable even to toddlers' rudimentary knowledge about imagination and mind' (2008: 146). One of the most important aspects of ToM in relation to the evolution of language is its association with the notion of recursion, and I will briefly consider this next.

5.3.2 Recursion

Recall from chapter 2 that we have defined recursion as consisting of two properties: that the output of one stage constitutes the input to the next, and the ability to embed an object of type X in another object of the same type. A multi-order Intentionality ToM which enables me to have a thought about your belief about someone else's belief and so on, is generally seen as an archetypal example of recursion. As Kinsella points out, this recursive property may be the source for the apparent recursion in language: 'a reasonable evolutionary conjecture is that recursive language was a response to the requirement for an optimal solution to expressing recursive thought' (2009: 152; see also discussion in van der Hulst, 2010). And, as Hurford notes, other animal communication systems lack recursion of the type discussed, '[n]o proper recursion is evident in birdsong or whalesong' (2011: 84 fn.56), and communicative systems such as these can all be accounted for in terms of context free grammars.

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[24] Though it has been claimed that infant ToM is restricted to 'subitizing' limits and System one 'dual-processing' as discussed below (Apperly and Butterfill, 2009)

It has been argued that it is recursion that enables the infinite creative power of human thought. And without it we would be limited to thought processes of a type somewhere between a chimpanzee and human cognition. Hurford discusses ‘the magical number 4’ (2007:90; 2011) as the natural limit at which humans are able to visually keep track, with a high degree of accuracy, of how many items constitute a group, a process called ‘subitizing’, also known as ‘subitization’, distinct from counting. Claims have been made that the limit of subitization is actually 3, others maintain 5 (for discussion see Dehaene, 2011) though the figure 4 plus or minus 1 seems to be the consensus. This is a cognitive feature that has been fixed and not subject to evolutionary change from far back in our history. Hurford reports that 4 is also the average maximum number of objects that can be held in short term memory concluding that the structure of a single thought ‘is derived from the limits of our ancient visual attention system, which only allows us to keep track of a maximum of four separate objects in a given scene’ (*ibid*: 95). Thoughts expressed as propositions through predicate structure in any known language are also limited to three arguments (two internal and one external) and a predicator (Juarros-Daussa, 2010). A non-recursive thought system could conceivably link up to three arguments but no more; events consisting of more participants than this would be beyond the creative power of such a system. Only by recursive embedding are humans able to engage in productive, creative thought limited only by our repertoire of concepts and constraints of working memory. If recursion is a central (or even *the* central) component in the evolution of human thought, and recursive thought in turn gave rise to language, then we need to consider when it emerged in our hominin ancestors and this question is the subject of the next section.

5.3.3 Dual processing and human thought

Unlike other animals, adult humans have numerical capacities far beyond the limits of subitizing. As Apperly and Butterfill note, ‘infants, human adults and nonhuman animals have analogous abilities that enable them to solve number tasks with little or no recourse to general cognitive processes’ (2009: 953). These number tasks involve no figure higher than 4 (though there is disagreement of the exact figure, the consensus if 4 plus or minus one) if an accurate number is required as a solution; for quantities beyond this only comparative judgements can be made. This capacity for subitizing is not, I suggest, analogous but rather a homologous trait that is distinct from adult humans' sophisticated numerical abilities. It has long been established that there are unconscious brain operations that affect our routine perception and thinking. Eagleman (2011) discusses Mariotte's blind spot, a small area in our wider field of vision that neither eye is able to perceive, yet no-one notices this as our brain 'invents' material to occupy this slot. He also refers to Helmholtz's 'unconscious inference' in which the brain creates arbitrary explanations for changes to visual stimuli (see also the reference to split brain patients in the last chapter).

As is well known, nearly 100 years ago Freud developed an elaborate theory of the role of the unconscious in human cognition:

> '[y]ou cannot … get around the fact that acts of a mental nature, and often very complicated ones, can take place in you, of which your consciousness learns nothing and of which you know nothing' (1926/1962: 107)

More recently, dual processing theory (DPT) (two mental systems: one conscious and one unconscious) has arisen as a mainstream theory in psychology based on the premise that 'there is a fundamental duality in human reasoning' (Frankish, 2009: 105). The DPT hypothesis is not a trivial conjecture but rather a substantive claim that humans have two utterly distinct types of mental processing (sometimes in conflict, vividly seen in 'alien hand syndrome' in split brain patients [Eagleman, 2009: 131]) linked to two separate systems, each arising from different architectures of the mind/brain. The evolutionary rationale for maintaining two processing systems is to minimize the effect that, as noted in the last chapter, the brain has as an extremely expensive organ, consuming a far greater proportion of nutrients than its size should entitle it to. Eagleman argues, though, that it is only conscious activity that is high energy, so by allowing much of the function of the brain to remain unconscious and saving on resources, evolution 'has presumably tuned the exact amount of access the conscious mind has [to primarily unconscious processes]: too little and the company [the individual] has no direction; too much and the system gets bogged down in a slow, clunky, energy-inefficient manner' (2011:73). The division of labour is made on the basis of efficiency and speed versus reflective control. The advantage of a self-conscious, reflective system is that it enables the species to deal with novelty, anticipate the future and make complex inferences, while at the same time overriding potentially harmful intuitions from an unconscious processing system (Sloman, 1996)

5.3.3.1 An overview of dual-processing theory

Exponents of DPT are explicit in the distinction between the modern school of thought and Freudian dual-processing. DPT has no role for repressed impulses, or ‘pleasure principles’, nor is the role of the ‘unconscious’ restricted to exerting an influence on the ‘conscious’, rather than directly controlling motor mechanisms itself (Frankish and Evans, 2009). Modern DPT posits two systems of learning, reasoning and decision making: System 1 and System 2[25]. System 1 is the evolutionarily older of the two and is shared, at least to some extent (see discussion below) with other species. System 2 is an evolutionarily recent development that is unique to humans[26]. It is System 2 that most people imagine to be ‘in control’ and is responsible for deliberate, reflective thought that functions on the basis of rule-based logical relations. However, an intuitive, fast, unconscious System 1 is also at work and may be responsible for much more of an individual’s actions than the controlled, conscious system; as Eagleman observes, ‘[o]ur brains run mostly on autopilot, and the conscious mind has little access to the giant and mysterious factory that runs below it’ (2011: 5). However, if time and conditions allow, then (conscious) System 2 can override System 1; this is seen in the Stroop Effect where subjects are asked to give the name of the colour that words are written in. When the word refers to a colour that contrasts with that in which it is printed (e.g. the word ‘green’ in red ink), subjects often give the name of the word rather than the colour (an automatic, System 1 reaction), though if they produce the correct answer the response time is significantly longer, indicating a conflict between the two systems at work. A typical contrast of the features of the two systems is given by Frankish and Evans (2009) and is reproduced as table 5.1 below.

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[25] Eagleman (2009) adopts the term ‘emotional/zombie’ for System 1 (and suggests there may be many such systems at work) and ‘rational’ for System 2. Bickerton (1995) uses the terms ‘on-line’ (System 1) and ‘off-line’ (System 2) thinking

[26] Though Evans argues that System 2 processing is not strictly exclusive to humans but is ‘uniquely developed’ in our species (2009: 38).

System 1	System 2
Evolutionarily old	Evolutionarily recent
Unconscious, preconscious	Conscious
Shared with animals	Uniquely (distinctly) human
Implicit knowledge	Explicit knowledge
Automatic	Controlled
Fast	Slow
Parallel	Sequential
High capacity	Low capacity
Intuitive	Reflective
Contextualised	Abstract
Pragmatic	Logical
Associative	Rule-based
Independent of general intelligence	Linked to general intelligence

table 5.1: from Frankish and Evans (2009) p.15

Frankish and Evans make no explicit reference to the place of language in this schema, but language use (as a means of representation) clearly corresponds to the properties of system 1; it is fast, automatic and high capacity. On the other hand, complex thought (in the LoT), characterised by the property of recursion, is, as noted in section 5.1.1.3 above, abstract, reflective and logical. In other words, it belongs to system 2. However, as also previously noted (see section 5.3.3), system 1 is far more efficient in terms of energy consumption, and processes that may initially be under the control of system 2 may become automated and subsumed under system 1; successful (i.e. bilingual) learning of a second language in adulthood would seem to be a clear example of this (see also brief reference to movement from system 2 to system 1 in conclusion in the final chapter).

5.3.3.2 Evidence for DPT

Much of the research into DPT focuses on reasoning biases, such as that in the Wason Selection Task discussed in the last chapter. Another classic example of System 2 logical reasoning is the syllogism of the type:

6) All men are mortal
Socrates is a man
Socrates is mortal

However, even in cases such as these it has been shown that there may be a belief bias effect whereby subjects are more likely to accept a conclusion if it is intuitively believable, even if it does not follow from one of the premises such as (example from Klauer *et al*., 2000: 875):

7) Some fish are not acquerites.
All acquerites are trout.
Therefore, some fish are not trout.

Similar belief bias effects have been recorded in valid (*modus ponens*; *modus tollens*) and invalid (denial of the antecedent; affirmation of the consequent) arguments (Evans *et al*., 2010). The effects of such belief biases are believed to be increased where there is lower general intelligence (though this seems to be a highly circular argument as syllogisms and similar reasoning tasks are generally used as measures of intelligence), and when there are additional strains on System 2, such as supplementary concurrent working memory tasks and time constraints.

Other biases are clearly seen in different task types such as the Monty Hall problem in which subjects are offered three doors behind one of which there is a reward. Having chosen a door, subjects are then told that one of the two unchosen doors can be excluded, and they are given the choice of remaining with their chosen door or swapping to the other one. Despite that fact that swapping doubles their odds of winning, from 1:3 in to 2:3, the vast majority of subjects remain with their initial choice (Franco-Watkins *et al*., 2003). It seems that repeated exposure to the outcomes of such tasks does little to mitigate the influence of System 1. Evans notes that even when subjects are exposed to repeated failures they still react to choices on the basis of the same intuitions. This is the source of the ‘gambler’s fallacy’ in which subjects overwhelmingly opt to bet on outcomes that have not occurred recently, e.g. if tossing a coin has resulted in 5 consecutive heads, there is a strong temptation to bet on tails, although the actual odds remain at 50:50. As Evans remarks, examples such as these suggest that humans are susceptible to a ‘fast and frugal heuristic that makes us dumb rather than smart’ (2010: 104).

5.3.3.3 What are System 1 and System 2 like?

DeSalle and Tattersall observe that we make many decisions in a fast and efficient manner using evolutionary older parts of our brains, and conclude that human brains ‘are still operating under all the same constraints that have governed brain evolution in other organisms’ (2012: 240). However, this does not mean that System 1 processes have no uniquely human features. Although Jackendoff rejects a DPT of the human mind of the exact kind proposed here, he does recognise a distinction between a System 1 type of thought (which he labels ‘intuitive thought’) and a System 2 type (‘rational thought’). He is clear, though, that it is his belief that it is not just one of these systems that is exclusively human, rather, he speculates, it is the case that our ‘System 1 is doubtless more sophisticated than that of chimps’ (2009: 214 fn.3).

One popular explanation for the difference in human and other animal System1 types is offered in terms of ‘massive modularity’ (Frankenhuis and Ploeger, 2007) briefly referred to in the last chapter. Mithen (1996) for example, suggests that the evolutionarily significant development in hominin cognition was the emergence of modules and a system of ‘cognitive fluidity’ that enables output from different modules to be combined. Similarly, Stanovich (2009) proposes ‘The Autonomous Set of Systems’ (TASS) as a collection of modules that have evolved to process inputs from the environment and feed into an ‘analytic processing’ System 2. There have even been suggestions that System 2 processing is itself a form of massive modularity, with no domain general cognition of any sort (Mercier and Sperber, 2009). However, unless the explanation of the mind in terms of massive modularity is restricted to a useful, if limited, metaphor, then numerous problems arise if you exclude the existence of any central control system. In order to recognise that our visual system is modular and that we are deceived by illusions such as the Müller-Lyer surely relies on some form of overall processing. Furthermore, it has been argued that any account of massive modularity in evolutionary terms is highly implausible, both in terms of time scales and the nature of evolutionary change (see Fodor e.g. 1998, chapter 13). A more parsimonious explanation in DPT is the proposal that there are only two systems, though outputs from System 1 may have an immediate impact on motor activity, or may be the 'preattentive' input to options for reflection by an analytic System 2, as in figure 5.6 below.

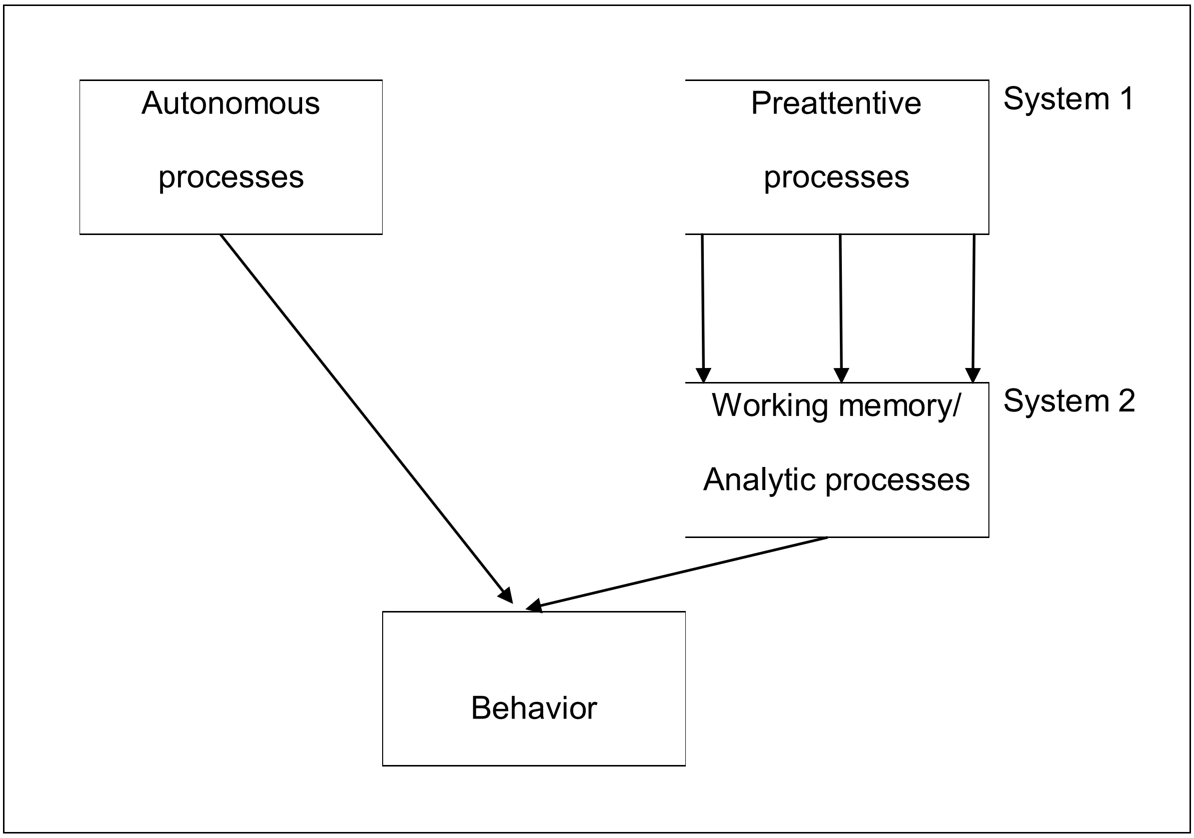

figure 5.6: adapted from Frankish and Evans (2009) p.43

5.3.3.4 Neural correlates of dual processing

For over 30 years it has been known that subjects demonstrate an unconscious 'readiness-potential' to act, up to as much as a full second prior to subjective awareness of intention to carry out any operation (Libet *et. al*., 1983). Much of the research in this area has been based on fMRI scans and recently there has been some criticism of findings, focusing on the tendency to have used small sample sizes and noise effects arising from a failure to triangulate analyses (Vul *et al*., 2009; Kriegeskorte *et al*., 2009; Button *et al*., 2013). Nevertheless, a substantial body of evidence has been built up, using a variety of techniques, that indicates that an unconscious predisposition to behave in a certain way can be detected before the individual is cognisant of the intent (e.g. Haggard and Elmer, 1999; Blankertz *et al*., 2003). Furthermore, the actual brain areas involved have been identified to a remarkable degree of precision. For example, Haynes *et al*. (2007) were able to locate an area of the medial PFC which was activated in deciding which of two simple mathematical tasks (addition or subtraction) to perform, analysis were able to predict with 71% accuracy which of the two a subject had chosen. Lieberman (2009) identifies areas of the brain which correspond to the two systems, which he terms, on the basis of what he maintains is the most relevant distinction, the X (reflexive) and the C (reflective) systems (see table 5.2).

X System	C System
Ventromedial PFC	Lateral PFC
Ventrial striatum	Medial PFC
Amygdala	Lateral Posterior parietal cortex (PPC)
Lateral temporal cortex	Medial PPC
Dorsal ACC	Rostral ACC
	Medial PFC
	Medial temporal lobe

table 5.2: adapted from Lieberman (2009) p.294

Much recent research has focused on even more precise regions of the brain and in the light of this the correlation between single concepts and identifiable, localised neural activity has been established. Such work had been largely dismissed since Sherrington's (1940) theory of a 'millionfold democracy' model of the mind/brain in which vast populations of neurons are presumed to be involved in coding concepts. However the proposal was resurrected in the late 1960s in the theoretical ideas of Konorski's 'gnostic cells' and Lettvin's 'grandmother cells' (for discussion see Gross, 2002). In recent years, with more advanced technology working with patients undergoing treatment for intractable epileptic conditions, Quiroga *et al*. (2005) have observed that so-called 'Jennifer Anniston' neurons fire in the inferior temporal cortex and the hippocampus in the presence of pictures and other representations of the actress, but not other figures of a similar status (e.g. not Oprah Winfrey). Similarly, other ensembles of neurons are activated in response to other concepts. It is not that specific neuronal activity is shared across individuals, but in any one subject a unique group of sparse (perhaps as little as a few thousand) concept cells can be reliably identified as correlates of particular concepts: 'the presence of the [concept] can, in principle, be reliably decoded from a very small number of neurons' (Quiroga *et al*., 2005: 435). The chances of finding the only neurons that fire in relation to a particular concept are unrealistically small, and we know that neurons die while memories may be retained so there must be a degree of plasticity. Nevertheless the correlation of particular neuronal activity in the presence of specific concepts seems to have been established (Quiroga, 2012; Suthana and Fried, 2012).

5.4 A theory of language evolution

I have argued that Penn et al. are correct in their conclusion that

> 'the functional discontinuity between human and nonhuman minds pervades nearly every domain of cognition – from reasoning about spatial relations to deceiving conspecifics – and runs much deeper than even the spectacular scaffolding provided by language or culture alone can explain' (2008: 110)

While we share with nonhuman animals a similar, though not identical, system of fast, intuitive cognitive processing based on evolutionarily older brain systems, we have also, at some point in the last 7.5 million years, evolved a capacity for systematic, computational thought that enables us to be logical and reflective and on occasions to override instinctive, associative reactions. The remaining questions are: when did these developments occur and what is the relation to language? I suggest that there were two significant periods in the evolution of human cognition, at least one of which is worthy of the often used epithet 'great leap'. These are the topics that will be addressed in the final section of this chapter

5.4.1 Language, cognition and Homo erectus

As we saw in chapter 3, there were numerous genetic mutations in the hominin species in the period running up to the speciation event of *Homo* and the appearance of *H. erectus*. The most striking physiological change associated with these genetic and epigenetic alterations in the new species was the evolutionarily rapid doubling in brain size, an alteration that carried such deleterious effects that it must have been the result of a significant adaptive pressure. The cultural advancements that accompanied this period of punctuated equilibrium included the first creation of mode 2 stone axes and the first migration out of Africa. The former of these involves mental rehearsal, taking a large lump of rock and, from this, imagining a finished tool, and so repeatedly knapping the rock until the desired shape is achieved. Travelling out of Africa indicates a capacity for innovation and accommodation to new environments, far quicker than evolutionary change could accomplish. There are also suggestions that *H. erectus* made use of fire and engaged in coordinated hunting and scavenging. So was this the result of an enhanced System 1, the emergence of System 2, or aspects of both and their interaction?

Our System 1 is clearly different to that of chimpanzees. We may be prone to costly, instinctive errors in Monty Hall type reasoning but we are at least capable of undertaking such tasks. However, just as there are claims for a basic first order ToM in chimpanzees, some authorities on DPT maintain that there is a rudimentary System 2 in great apes (Carruthers, 2009; Evans, 2009 – see footnote 9 above) and that it is this system that enables trained primates to communicate with humans. If we suggest that *H. erectus* had acquired a protolanguage then that would imply a more developed System 2. In the opinion of Holloway *et al*., a ‘reorganizational pattern, involving Broca’s region, cerebral asymmetries of a modern human type and perhaps prefrontal lobe enlargement, strongly suggests selection operating on a more cohesive and cooperative social behavioural repertoire, with primitive language a clear possibility’ (2009: 1333). Brain growth and reorganisation may have bestowed a proto-LoT on hominins some time before 1.5 mya. Greater cognitive capacity led to an awareness of the value of cooperation and consequently the appreciation of conspecifics as Intentional beings. The proto-symbolic capacity that appears to be evident in trained primates could then be harnessed to intentional communication, very possibly as an exaptation of existing mirror neurons as discussed in the previous chapter. Prior to the existence of any shared conventional system, the earliest communication will have consisted of iconic gestures, including pantomiming. However, in contrast to the gestural theories discussed in the last chapter, I believe the advantages of vocalisation would have become manifest early on and a spoken protolanguage emerge as a Baldwin effect (see chapter 3) with epigenetic consequences and possibly genetic assimilation later.

Many writers (certainly all gradual nativists, see chapter 3) agree with Levinson and Evans that ‘there can be no doubt that premodern humans were talking’ (2010: 2742) but what was that talking like? As Sperber and Origgi (2010) point out, there is very little that actually needs to be in a shared code, complex codes being neither necessary nor sufficient for simple communication. All that is required is enough to kick start pragmatic inference. As more complex communicative needs and desires arise, then simple concatenation can be employed for functions such as modification of heads and proto-predicates, in order to trigger more precise inferences.

And yet the period after the emergence of *H. erectus* does seem to be characterised by a long period of stasis. As Stringer recalls, in response to the point that Acheulean hand axes were so sophisticated that they indicated the presence of language in the species who were responsible for them, the archaeologist Desmond Clark pointed out that as the axes ‘had hardly changed shape through a million years…and across three continents’, then if these hominins had language ‘these ancient people were saying the same thing to each other, over and over and over again’ (2011: 125). If the minds of these early Homo lacked recursion and were limited to simple thoughts constrained by the limits of subitizing then it would account for the lack of cultural development (and complex language) for this long period. So, contrary to those theorists (principally gradual nativists) who claim that protolanguage was limited by the lack of a linguistic syntactic modular component in the brain, it is more likely that ancestors of modern humans just did not have much that was very interesting to say; more interesting than chimpanzees, but still very restricted and of limited instrumental use to conspecifics. The crucial deficiency in comparison to *Homo sapiens* was not *linguistic* but *cognitive* recursion. As Blondin-Masses *et al*. note in relation to the notion of a protolanguage, ‘[a] language is just a set of symbols with which we can say anything and everything, whether in gestures or in speech, whether quickly or slowly, and whether with a vocabulary of many symbols or few’ (in press). The issue of just when we started to use many more symbols, and use them very quickly, is the issue addressed in the next section.

5.4.2 The emergence of complex thought

Although brain size had doubled in *H. erectus*, it stopped at an average of just under 1000 cc. As this is significantly below the maximum size that the species could anatomically tolerate, presumably the adaptive advantages (greater cognition, innovation, cooperation and communication) were increasingly no longer sufficient to offset the disadvantages (metabolic consumption, increased danger in child birth). Thus when the brain again began to demonstrate reorganisation and further growth some million years later, increasing the deleterious effects, there must have been a further adaptive pressure. I suggest that this is the second period of cognitive advancement and the true 'great leap'.

One of the distinguishing characteristics of human thought is its recursive hierarchical structure . It is recursion that enables us to move beyond the magical number 4 of subitizing, and embed propositions inside each other, theoretically *ad infinitum*, constrained only by the limits of working memory. It is recursion that underpins a multi-order Intentionality ToM. Given that recursion is a rather simple process in itself, regardless of the immense consequences it has for our power of thought, it is clearly possible to associate the emergence of a recursive LoT with relatively minor mutations and changes to gene expression. If recursion really is present in some form in non-humans then a single mutation or two could enable it to be exapted from a domain specific System 1 function (e.g. navigation) to a domain general System 2 one. Alternatively, if not present in non-humans then it is the result of unique evolutionary development, again the consequence of a small but significant rewiring of our brains. Sommel *et al*. concur that the 'second phase, which led to the emergence of the cognitive traits that produced the human cultural explosion ~200,000 years ago, may have been driven by only a few mutations that affected the expression and/or primary structure of developmental regulators' (2013: 124) and they note that there have been 10 or fewer mutations related to cognition since our split with the last common ancestor with Neanderthals. It is therefore not implausible that at a point in history an individual was born with a greater, recursive cognitive machinery than other conspecifics, an internal, recursive LoT. It is interesting to note that recent research has suggested that the rapid nature of the second phase of cognitive evolution was not without cost, and links have been made with reduced methylation levels in the human PFC, allowing greater gene expression, but showing links with a variety of psychological disorders (Sommel *et al. ibid*.; Zeng *et al*., 2012)

5.4.3 The emergence of complex language

Given a new, recursive system of thinking, the protolanguage that had already evolved would be harnessed for the expression of more complex thought. The demands of both the more complex cognitive capacity and the need for a more intricate linguistic (i.e. phonological) system in which to express those thoughts would themselves become adaptive pressures on brain evolution. As the semantic content became more complex so the means of representation – the CSPR consisting of a $\mathfrak{R}$-phonology – similarly increased in complexity, a process we might characterise as the ‘evolution of a representational capacity’. Language, understood in this sense, requires a finely tuned pattern finding ability and the memory capacity to cope with a substantial lexicon. Landauer (2008) discusses various computer modelling techniques and concludes that the ability to acquire a large vocabulary such as we have today would require a brain the size of modern humans. Furthermore, language use entails a high level of awareness of intentionality and relevance for which our species seems particularly well adapted.

So, the emerging language was constrained by the need to represent a recursive LoT (hence the *appearance* of recursion in language), and by both the articulatory-perceptual and pragmatic capacities of the organism. These constraints on all languages require the hierarchically structured semantic content to be represented in a linear string. Word order, agreement marking and case marking are all tools that can be deployed to indicate relative positions and relations in a hierarchical semantic structure. As Burton-Roberts and Poole note with regards to the first of these, languages ‘that have conventions constraining word order do so as a way of harnessing linearity to the m-representation of structural relations in the C-I (conceptual-intentional) system’ (2006: 605). Deacon has argued for an additional constraint that arises from the existence of symbolic systems that must conform to various universals that are inherent in the nature of symbolic representation and that the human brain has evolved to cope with such systems:

> ‘Semiotic universals are emergent constraints, like the emergence of symbolic reference itself. But even though they need not be biologically pre-specified, the evolution of human brains may also have been influenced by the presence of these semiotic selection pressures so as to make discovery of these constraints easier. Despite their abstract nature, these constraints create ‘adaptation demands’ that may have selected for functional differences in hominid brains that ease their discovery’ (2003: 138)

Rather than any specific ‘module of the mind’ for language, humans evolved the capacity for creative, recursive thought, and the ability to *represent* this, in a variety of ways, to conspecifics. Features which are shared across all languages, may be features of a truly universal grammar, and an indication of the admittedly very difficult problem of what exactly LoT is like. As Burton-Roberts points out, there is already progress in this area and the sceptic ‘seriously under-estimates the extent to which discoveries hitherto regarded as discoveries specifically about FL structure are in fact discoveries about LOT structure’ (2011: 2095).

The precise consequences for the arguments made in this chapter, and the preceding ones, are dealt with in the final chapter.

Chapter 6: Conclusion

6.0 Introduction

I have argued that the logical problem of language evolution requires a reassessment of the nature of FL. Just as addressing ‘Plato’s problem’ was a major motivating factor in the foundation and advancement of generative grammar (which has certainly provided numerous indispensable insights into language) so solving ‘Darwin’s problem’ (Boeckx, 2009) requires a revision to that understanding of FL which is inherent in the current generative enterprise.

Despite all appearances to the contrary, language is *not*, I claim, special in the sense of being a hardwired module of the mind. What *is* special, and what evolved in our species as the FL, is primarily the capacity for generating complex recursive thought, and then being able to represent those thoughts within the constraints of symbolic systems. Languages have the appearance of hierarchy and recursion by virtue of representing a system that is truly hierarchical and recursive.

6.1 Evolution as a constraint on conceptions of the FL

Of the four classes of theories of language evolution considered above (gradual and sudden; nativist and non-nativist) I believe significant problems have been identified in each. This is because of a misunderstanding of what evolved, and at what stage. Hominins have gradually evolved unique physiological features over a period of million years since our split with the LCA, and significant, though limited, cognitive changes in a period of punctuated equilibrium around 2 mya. However, somewhere after 700 kya there was a second, dramatic period of change: a rewiring of the brain that resulted in a unique, internal syntactic system of thought. Extant physiological and cognitive developments – our ability to articulate, our short and long term memory, our basic theory of mind and more general pragmatic competence – which were already utilised in protolanguage, were employed to far greater effect for the purposes of expressing vastly more complex internal thoughts, and in themselves evolved further as this function was refined. I propose that by clearly differentiating these two systems (thought and its mode of representation) we allow two different evolutionary scenarios which best accord with the known, and hypothesised, story of hominin evolution and a more elegant and logically coherent explanation of the human faculty for language than is currently offered.

6.1.1 Language Evolution and the MP

Despite Chomsky's first major intervention into the debate on language evolution, and all the work since then, the state of the relationship between language and thought in CGG remains unclear. If, as Chomsky claims, language first appeared with only a mapping to the CI system, and yet gave an enormous adaptive advantage to those who were endowed with it, then it seems, as Hinzen and Sheehan (2013) argue, that language was the medium in which thought was carried out. Its subsequent externalisation does not change that. Hinzen and Sheehan might claim that rejecting the 'language equals LoT' hypothesis would deprive us of the best prospect for explaining semantic structure. However, this does not mean that the hypothesis is correct, and, as noted at the end of the last chapter, there are grounds for optimism that a reanalysis of linguistic findings may result in a greater understanding of LoT. On the other hand, as Chomsky sometimes claims, if there is a separate LoT, then it is more parsimonious to see 'languages' representing thought rather than the external 'realisation' of a system whose function (neither thought nor its representation) is not entirely clear. As I have argued above, I favour the explanation based on an independent LoT for all the reasons outlined.

Proposals here, and in the RH, are sympathetic to Chomsky's stated minimalism. However, while language is understood as acting on DIP objects it is always going to be problematic, hence the tension between 'crash-proof' and 'merge only' versions of the MP. It is because in the MP language simultaneously derives hierarchical, semantic LF at the same time as a purely linear PF that complexities are unavoidable. On the other hand, as a truly minimalist theory of FL, the RH is concerned only with the linear. There is neither 'move', nor 'features', nor operations such as 'procrastinate'. Burton-

Roberts and Poole posit a far more minimalist conception of the ‘signing theorum’ in which ‘there is no criterion for structural C-I position other than Interpretation in the C-I system and no criterion for linear position other than temporal succession of hearable events’ (2006: 607). Thus the variation in word order in examples such as 3) and 4) in Chapter 5 is not the result of complex derivations producing different PFs with an identical LF, but a consequence of the fact that a phonetic sign ‘just is – and will be interpreted as - the sign of a C-I property’ (*ibid*., 606) regardless of the linear position of the former, or the hierarchical position of the latter. There are conventions adopted in different languages to aid such interpretation, but, as with all conventions, they can be overridden and our general cognitive and pragmatic capacities will prevent a breakdown in communication.

6.2 Final thoughts

Christiansen and Kirby may be accused of hyperbole in claiming that the study of language evolution is ‘the hardest problem in science’ (2003). Nevertheless, the cross-disciplinary nature of the endeavour, and the difficulty in researching occurrences from hundreds of thousands, if not millions of years ago, as well as the rapid developments in research techniques across the subject areas does make the topic a challenging one to keep abreast of. The ‘abduction’ I have presented here does, I believe, accord with the vast majority of the amount of evidence. It is also clearly falsifiable (in the Popperian sense) and new data from any one of a number of disciplines could potentially undermine the overall thrust of the argument.

There is of course further work to do in the area of linguistics; I will mention just two. Burton-Roberts and Poole (2006) make some tentative suggestions as to how languages might be seen in terms of default conventions and how and why these might be overridden. The RH presents a major challenge to conventional linguistics (the eradication of notions of hierarchy and focus on linear representation) and is an important and challenging area to explore, especially in relation to insights it might offer to the nature of LoT. Secondly, there is the position of language in a DPT theory of cognition. Complex motor acts, such as riding a bike, are under the responsibility of System 1 and are guided by an implicit procedural memory that is doubly dissociated from explicit memory (Cohen *et al.*, 1985). The act of acquiring such skills involves the development of automaticity which is the transfer from explicit (System 2) to implicit (System 1) memory. Language appears to require similar processes. It is perhaps the interaction between System 1 and System 2 that is uniquely human, and language may be a window into how the systems operate and relate to each other. Both of these research areas have the potential to recreate the anticipation that the study of language will reveal insights into the characteristics of the mind that Jackendoff (2002) referred to in chapter 2 above.

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