Categorial Minimalism: Syntax, Semantics and the Language of Thought

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Chapter 1 – Preliminaries

This is a draft of the first chapter of a book in preparation. The second chapter on LoT and NL, with an introduction to combinatorial syntax, is available at lingbuzz/002265*, the third chapter on 'head movement' is at* lingbuzz/001615*, and the fourth chapter on phrasal displacement within the clause at* lingbuzz/001992*. Comments welcome.*

1 Introduction

Our aim in this book is to propose, illustrate and justify a theory of the interrelations among all of syntax, semantics, pragmatics and conceptual structure, where the central interest is in the syntax of natural language and of language-related internal representations. We do not wish to deny the existence of cognitive processes which are not language-like – some aspects of spatial cognition (e.g. Pacer et al, 2012), of music, and some forms of association for instance – but these fall outside the purview of this book.

We will proceed by presenting a series of linguistic examples which demonstrate the methods and results that become available within the theory. Although obviously subject to revision, we hope that these exemplars and their analyses show the descriptive and explanatory advantages of the theory. There are of course many open questions within the framework we advocate, and we have indicated alternatives where these seem important.

In this opening chapter we set the scene by positioning ourselves in the intellectual landscape and spelling out our background presuppositions about language and the mind. After specifying what we mean by the language faculty, we outline our various commitments: to Internalism, Modularity, Minimalism, and Compositionality (section 2). In sections 3 and 4 we then motivate and sketch the outline of a linguistic theory that satisfies these requirements, arguing in particular for a modular specification, based on a modified Combinatory Categorial Grammar (CCG hereafter) with a merge-based morphosyntax. The aim is to show that under this form of grammar, the syntactic insights of Minimalism and Principles & Parameters theory can be obtained in more restrictive and more explanatory fashion. In particular, we hope that the re-distribution of 'displacement' effects between the combinatorial system and the morphosyntactic system will provide both a simpler overall system, and new insights into human language.

2 Language and the human mind

2.1 The Faculty of Language

We begin with the framework of Hauser et al (2002) who draw a distinction between the Faculty of Language in a 'narrow' sense (FLN), and the Faculty of Language in a 'broad' sense (FLB), where FLB includes FLN as a proper sub-part. FLB encompasses all aspects of our linguistic and communicative abilities, including not only a grammar in the traditional sense, but a language of thought, parsing and production mechanisms, links to memory and encyclopaedic knowledge, relations to Theory of Mind and so on. Many of these components are shared with at least some other vertebrates, suggesting a common evolutionary history. Human linguistic ability, however, seems to be qualitatively different from the abilities of other species, and Hauser et al suggest that FLN represents what is both unique to language and unique to humans, speculating that this might be restricted to recursion[1] (cf. also Fitch et al, 2005; Chomsky et al, 2005; Pinker & Jackendoff, 2005; Jackendoff & Pinker 2005; Smith & Law, 2007, 2013; Spelke & Tsivkin, 2001; and de Vos, 2014; but see Steedman 2014a). Our interests encompass all of FLB, but our evidence will come mainly from what Chomsky elsewhere (e.g. 2004) calls 'narrow syntax'. Accordingly, we shall be looking at the inter-relationships among several of the components of FLB; in particular we shall investigate the relation between Natural Language (NL) and the Language of Thought (LoT) (see Gleitman & Papafragou 2005, Fodor 1983, 2008; Chomsky 2007 for general discussion of the issues).

2.2 Natural Language and the Language of Thought

We take it, following Fodor (1975, 2008), that the representational system for our cognitive activities: for problem-solving, for inference, for the fixation of belief, and for our model of the world is an internal 'Language of Thought' (also known as 'Mentalese'). This presumably

[1] This would put the lexicon and indeed much of the machinery of linguistics outside FLN (see Jackendoff & Pinker 2005).

emerged in the species about 100,000 years ago by processes of evolution, (cf. Tattersall, 2004: 25; Hauser et al, 2014: 6) with immediate advantages for those newly endowed with powers of thought superior to those which had gone before. We further assume that at some evolutionary stage, parts of this LoT were 'externalised' (see e.g. Chomsky 2010), eventually as NLs. That is, natural language evolved from a system which was available first for thought, still its prime function, and only secondarily – and subsequently – for communication. There have in fact been several suggestions that the medium of thought is either natural language (e.g. Smith, 1983; Carruthers, 1996) or some system homomorphic to natural language, so that the role of LoT has been taken over by NL. More accurately, the suggestion was that thinking exploits language shorn of the properties of its physical instantiation such as the sound system: hence some extension of Logical Form. This cannot be completely accurate as natural languages have properties that are irrelevant or even inimical to thought. For instance, all languages allow phenomena like ellipsis that have no equivalents in the LoT, and that would in fact be unhelpful because of the problem of retrieving from memory propositions expressed with them. Comparable remarks pertain to pronouns like *he* and/or *she* used referentially, which need to be replaced in LoT by a unique identifier relating to the relevant encyclopaedic information for the individual in question. More interestingly, and as discussed in detail in chapter 3, natural languages exploit 'dummy' elements – items with identity semantics – which could play no role in LoT. Conversely, the LoT deploys constructs alien to natural language. It is reasonably clear that we can include images of friends, evocations of sensations, or gestalt properties of individuals in our thoughts, and submit them to mental operations such as comparison, or evaluation for some purpose. For instance, bird-watchers may identify similar looking birds on the basis of traits that they not only *do* not verbalise, but often *could* not verbalise. Comparable remarks pertain to thinking about music or swathes of colour or emotions. One may bring to mind a scene including roses whose (particular red) colour is explicit without this being represented verbally. These imagistic evocations can play the same kind of role as lexical items: they may be embedded in a thought whose structure is language-like (e.g. linear, having a fixed syntax and a fixed semantics), or they may not. These examples suggest that the relation between LoT and the LF (Logical Form) of a natural language is an overlapping one, but where the overlap contains the vast majority of possible LF structures. Accordingly we will generally use the term 'LoT' to refer to any LoT representation which has language-like properties, taking it as a working hypothesis that, despite the kind of phenomena illustrated above by pronouns and dummies, the compositional structure given by the syntax of a natural language sentence is the same as that of structures in this subpart of LoT.[2]

A further issue arises with regard to the conscious accessibility of our thought processes. Even where representations in LoT and at LF are isomorphic, it might be the case that only

[2] Lurz, 2007, discusses the 'wordless thoughts' of creatures with no NL (higher primates). Although we find his arguments intriguing, we are concerned exclusively with humans endowed with a NL, and with those thoughts that can be mapped onto NL The main relevance of his paper to our current concerns is the distinction he draws between 'thoughts' and their 'vehicles of representation'.

externalised forms are available to conscious introspection and deliberate manipulation. As Chomsky put it:

> 'Now what seems to me obvious by introspection is that I can think without language. In fact, very often, I seem to be thinking and finding it hard to articulate what I am thinking. It is a very common experience at least for me and I suppose for everybody to try to express something, to say it and to realize that is not what I meant... it is pretty hard to make sense of that experience without assuming that you think without language. You think and then you try to find a way to articulate what you think and sometimes you can't do it at all;... Experiences like that seem to indicate that we can and do think without language and, if you are thinking, then presumably there's some kind of conceptual structure there.' (Chomsky, 2000c:76).

Work summarised in Dehaene 2014 makes it clear that the treatment above is somewhat simplistic. For instance, he cites well-known cases such as 'blindsight' (Weiskrantz 1986) in which someone who has been rendered consciously blind by a lesion in the primary visual cortex can nonetheless point accurately to the source of a flash of light. Equally remarkable is the case of DF (Dehaene 2014:54f.) who suffered carbon monoxide poisoning with consequent visual form agnosia, but who "when asked to post a card through a slanted slit, whose orientation she consistently failed to perceive, her hand behaved with perfect accuracy". Examples could be multiplied indefinitely. For further discussion see also Burton-Roberts 2011.

Accordingly, despite the differences we have identified, we largely reject the list of discrepancies between the structure of NL and LoT put forward by Collins (2007:422). He suggests that "linguistic structure does not match the apparent structure of 'thought', as witnessed by raising/control pairs, c-selection, lexicalisation, ambiguity, passivization, island phenomena, 'illusions', case, etc." In the absence of any explicit hypothesis about the syntax of LoT and hence about which of these constructs can map on to structures in LoT we find the assertion too pessimistic. Our stance is supported both by the necessity for the acquisition of NL from a prior basis of the Language of Thought, and by facts of elementary inference. Just as the English sentence *roses are red* is structurally related in different ways to *delphiniums are blue*, *roses were red*, and *roses are pink*,[3] so is the thought that roses are red related to a number of other thoughts: that flowers have colour, that roses have physically observable properties, and so on. The validity of the conclusion stated as *flowers are coloured* from the thought, taken as true, that roses are red is parasitic on the relation between LoT and language, and on the logic of LoT (where this logic sanctions inferential processes over representations). In the present case, we assume an LoT item ROSE linked in the English NL lexicon via the LF *ROSE* to the morphosyntactic feature <NOUN: *ROSE*>, which in turn is

[3] We assume some version of Evans' (1982) 'Generality constraint', which was intended to capture the structure that there is in thought. He illustrates with examples comparable to those above.

mapped together with number information onto *rose* or *roses* or the appropriate sounds or signs in externalisation.

With this background we assume as a summary first approximation that a natural language grammar defines a mapping between LF as above and some representation interpretable at the Sensory-Motor interface, standardly 'Phonetic Form'. Even if we ignored the discussion above suggesting an occasional mismatch between 'LF' representations and 'LoT' representations, it would be exegetically helpful to retain the notational distinction. In the usual case, for any LF of an item of NL (a word, phrase, or sentence) there is a corresponding well-formed item (a word, phrase or sentence) in LoT. Thus, in simple cases if a speaker has in mind the message he intends to convey to the hearer, he selects a version of this for the target LoT of the utterance he wishes to produce in some NL. The aim is to produce a well-formed structure whose LF is equivalent to the desired LoT and which, together with its associated PF, will have appropriate pragmatic effects.

Because of externalisation, while the syntax of LoT needs only recursion and types, NL needs in addition a means of mapping representations to the relevant motor system. In fact, there is an interesting issue concerning the status – phonetic or phonological[4] – of the output at the Sensory Motor interfaces, as the phonetic detail is arguably not 'represented' at all (for discussion see Smith 2010). Additionally, to achieve observational adequacy there must also be further features to account for language variation, for example in morphology and word order[5]. What is not yet clear is the extent to which these properties fall in or out of FLN (see Steedman 2002). We return to the issue at the end of the book, when we have more evidence for what we have to postulate.

LoT plays a crucial role in the storing and retrieval of memories and in online processing. Other components of the mind are responsible for providing an immediate analysis of incoming stimuli (see 'Modularity' below) but these are integrated and amalgamated with encyclopaedic information using LoT. Further, there is evidence from evolution, from computational efficiency and a variety of other considerations that the LF part of a natural language, with its direct link to constructs of LoT, has logical priority over the PF part (for discussion, see Chomsky 2010). One reflex of this priority is our decision to assign LF pre-eminent status in the syntax while maintaining a grammar which is neutral as between speaker and hearer. A precursor to this position can be seen in Lakoff's 1963 paper "Towards generative semantics" which postulates the rule:

T → s. pred., s. subj. (s. obj.)

[4] The output may of course be either spoken or signed.

[5] For example, some morphological features can be read off in toto from the lexical entry; others are dependent on the interaction of features associated with the lexical entry and features introduced into the syntax elsewhere. An example of the former would be *only*, examples of the latter would include some displacement, and overt forms such as *kissed* or *went.*

where 'T' = 'thought' and the rule says "every thought must have a semantic predicate and a semantic subject, but need not have a semantic object" (simplified and corrected from Harris 1993:107).[6]

2.3 Internalism

Initial concentration on thought rather than communication entails that we are internalist in our philosophical commitments. "Internal" means that our focus is on I-language rather than E-language (Chomsky, 1986, 2003), where 'I' is mnemonic for 'internal', 'individual' and 'intensional' (for discussion, see Smith, 2004; Smith & Allott, 2016). What we are studying is a domain that is internal to the mind–brain of particular speakers and hearers, rather than one expressing a relation between the mind and the outside world. If the subject matter of the discipline is about (internal) mental representations, it follows that these are properties of 'individuals' on the uncontroversial assumption that mental events (ultimately brain states) are individual rather than collective. The third 'I', 'intensional', means that it is "a function specified in intension, not extension" (Chomsky, 1995a:15) implying that the internal system of rules and principles that constitutes our grammar are such that their formal properties, as well as their output, are important.

The I-language strongly generates well-formed expressions with a particular structure and meaning. The individual can use his I-language to produce NL expressions for a subset of LoT representations, and to induce LoT representation corresponding to a subset of NL representations produced by other individuals. A listener can be expected to construct the LoT intended by a speaker only if the speaker deploys a subset of his I-language which corresponds relevantly to that of the listener. In cases where the listener infers discrepancies, because the LoT obtained is incomplete, inadequate or implausible, he has various options open. If enough of the structure is even partially interpretable, he may successfully use pragmatics to infer the intended meaning, and then decide whether or not the speaker simply made an error which can be ignored or queried. If he does not posit an error, he may perhaps add new lexical entries to his I-language, or infer that the speaker has an I-language differing from his with respect to the syntactic features of certain lexical entries. In the latter case, he may tentatively add information to his grammar, perhaps as a more specific override to an entry he already has. These additions or alterations, of which further examples are cited in section 2.6, may be stored with or without annotation as to register or speaker. It follows that the internal grammar, in conjunction with principles of pragmatics, will give some

[6] Generative semantics never followed up this early suggestion formally, but taking the grammar to start from semantics, implicitly from (a language of) thought, was central to much work in the paradigm. Basic statements of their varying positions can be found in Lakoff 1971 and 1972, and McCawley 1972. For discussion see Lasnik & Lohndal 2013

interpretation to isolated words and phrases, and even to many ill-formed structures, as well as to fully grammatical sentences.[7]

Three further points follow. First, our internalism pertains not just to the natural language which Chomsky is explicitly discussing, but also to the LoT. That is, it covers inference and general representations as well as (natural language) syntax. We return below to the inferential manipulation of representations in our discussion of pragmatics and relevance theory. Second, the relation between the word and the world – the philosopher's traditional relation of Reference – is indirect and must be mediated by the acts of individuals who use utterances referentially (Chomsky, 1995b). Our treatment here relies on the postulation of mental models of parts of the world, or of hypothetical worlds, and the notion of truth with respect to such models. It is this that allows LoT to be representational in a coherent internalist sense. Given that the models are internal, the possibility of reference, and the communication of reference, is licensed provided that the relevant portions of the internal models of speaker and hearer match appropriately and the matching notions are referred to with the same NL vocabulary. It must be emphasised that these models are themselves internal: we are studying and comparing idiolects and there is no linguistically useful sense of 'public language'.[8] It should be obvious that much of the evidence for constructing such internal models — both ontogenetically and subsequently — comes initially from our experience of the external world, notably from public tokens of the ambient language or languages, though some must be innate. Hence there is a crucial social (external) aspect to the development of the models. Third, despite huge advances over the last two decades, the mind-brain relation is still poorly understood. Fortunately, this doesn't matter for us. We need to appeal to 'stored representations' and 'inferential processes' carried out over such representations independently of the neural instantiation of such constructs. Much recent experimental work[9] gives increasingly sophisticated evidence for the relation, but it is largely of only indirect relevance to our programme.

2.4 Modularity

It is uncontroversial that the mind is complex and is structured. As a working hypothesis we accordingly assume that the structure of the mind is at least partially 'modular'. As the term is used in a variety of ways it is necessary to spell out our own particular interpretation:

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[7] This interpretation of 'generate' avoids the strictures of Pullum (2013) who argues that under a GES (Generative-Enumerative-Syntax) account such examples have no syntactic properties.

[8] But see Lassiter (2008) for cogent arguments that "community language" is a theoretically useful notion.

[9] E.g. Brown & Hagoort, 1999; Banich & Mack, 2003; Ingram, 2007. Contributions to the journal *Brain & Language* provide a representative sample. The explosion in neurolinguistic work in the last few years means that that situation may change. See for example the papers by Dehaene-Lambertz, Friederici, Hagoort, Moro, and Yang at the colloquium on the Biology of Language in Amsterdam (December 2014).

essentially an amalgam of Chomsky (1975, 2013) and Fodor (1983). We begin with the most basic difference, and one that separates Chomsky and Fodor: the contrast between modules as processing constructs (Fodor's position) and modules as being or including knowledge structures (Chomsky's position). Since processing implies some data to process and a knowledge of how to process it, we do not see any problem in a model that includes both sorts of module. It is also crucial to make explicit whether the focus of attention is the mind or the brain. The different accounts of modularity all tend to refer to the 'mind-brain'. The implication is that the claims being made are pre-eminently psychological — pertaining to the mind, but are in principle neurological — pertaining to the brain. In early discussion there was simply the assumption that mind-states are underlain by brain-states, but with the remarkable advances in imaging technology of the last decade or so the result has been that more and more evidence about the structure of the mind is derived from experiments on the brain.

Although Chomsky's (1975) discussion predates Fodor's (1983) and was a major influence on it, we start with a summary overview of Fodor's now classical position, as put forward in *The Modularity of Mind*. Fodor differentiates the central system, which is responsible for higher cognitive activities, such as general problem solving and the fixation of belief, from the input systems, which provide grist for the central mill. He then argues that these input systems, which correspond in the first instance to the sensorium, but crucially also include the language faculty, share a number of further properties, and any component with these properties is then, by definition, a module. For instance, modules are domain specific, they operate fast and mandatorily, they are ontogenetically deterministic, they are subject to idiosyncratic pathological breakdown, they are subserved by specific neural architecture, and they are informationally encapsulated. All of these properties pertain to processing. It is also worth noting Fodor's (1983) claim that the central system is largely inaccessible to scientific investigation, hence he attributes it virtually no internal structure (but see Fodor, 1992, 2000, 2008 for slight revisions of this position where he does attribute some putative structure to it).

Evidence for informational encapsulation in the linguistic domain comes from lexical retrieval, as elegantly demonstrated by Swinney's (1979) experiments. He showed that when you are confronted with sentences like *The spy hid the bug in the hotel room* and *The hygiene inspector found the bug in the kitchen,* then, independent of context, **both** meanings of an ambiguous word like *bug* are initially accessed, and (since both are well-formed syntactically) the irrelevant one is subsequently dismissed by the central system, utilising pragmatic processing. Evidence that this last is not mandatory is provided by our ability to detect unintended and pragmatically inappropriate puns.

A potential challenge to claims of informational encapsulation is provided by 'Embodied cognition' (see e.g. Glenberg and colleagues,[10] Andy Clark, 2008; Nazir et al 2008a, b). For instance, as Nazir et al, 2008b put it: "Perception of words or objects that index tactile, gustatory, auditory, and visual knowledge activate brain regions associated with encoding

[10] *https://psychology.clas.asu.edu/**glenberg***

these sensory experiences ... whereas those that index action-related associations involve motor areas". A striking example of this relation is provided by Boulenger et al (2008) who were able to show that "the receptivity of PD [Parkinson's Disease] patients is conditional on word meaning: their ability to capture information from the prime was impaired for words that described actions but not for concrete nouns. This selective deficit for action word priming disappeared when patients were on dopaminergic treatment that restored their motor function, testifying to a subtle but close link between language processing and motor systems" (Nazir et al, 2008b:2).

Further interesting experimental evidence for the tight relation between the language module and neural architecture comes from Glenberg et al's (2008a, b) work showing that the processing of language – both literal and relatively abstract – may modulate brain activity otherwise related to the motor system. There is a clear tension between such work in embodied cognition which claims that cognition, including language use, is grounded in sensorimotor activity and the Fodorian claim of informational encapsulation. For instance, the 'Action-sentence Compatibility Effect' correctly predicts that response times will be faster for action-compatible responses (such as moving the hand forward while comprehending the sentence "Close the drawer") than for action-incompatible responses (see e.g. Guan et al 2013). Despite this striking effect, it is worth emphasising two points. First, informational encapsulation needs to be relativized to the kind of representation under discussion: the 'grounding' of embodied cognition is distinct from the representations characteristic of central processes. Second, the theoretical claims of modularity and their putative neural implementation in the brain are conceptually independent. On Fodor's (1983) account the property of being "subserved by specific neural architecture" is only one of eight or nine possible identity criteria for a 'module'. There is overwhelming evidence that, despite a degree of plasticity seen in pathology, particular functions — linguistic, visual, affective, etc. — do indeed have the same neural underpinning across the species. This is usually taken as evidence for a modular position but while it is compatible with and perhaps supportive of modularity, the theory is a psychological one not a physiological or neurological one.[11] It is also important to note that much of what is said to be evidence about semantic deficits in brain damage cannot be distinguished from evidence about deficits in LoT or pragmatics, or at best evidence about the lexicon (Marantz et al 2000, Kent 2003, Pulvermüller 2003, Ingram 2007). Perhaps the most striking examples come from dissociations where, for instance, patients lose the ability to name or state the use of particular classes of object while retaining the ability to use them appropriately (Warrington & Shallice 1984, Saffran 2003).

Be that as it may, for Chomsky, the language faculty (FLB) cannot be a Fodorian module for two reasons.[12] First, we use language to speak as well as to understand, and as Fodor

[11] An externalist, avowedly non-psychological construal of generative grammar is provided by Devitt 2006. Collins 2007 makes a strong case against any such position.

[12] A useful succinct summary of his and Fodor's positions is provided by Chomsky (forthcoming).

identifies modules with 'input systems', then language, which normally includes an output system, cannot be simply a module. Second, and more importantly, the 'language faculty' must partly fall within the central system to accommodate the basic fact that it includes a system of acquired knowledge (e.g. vocabulary). Further its deployment exploits knowledge in the form of representations of beliefs about the world as internally modelled, so cannot be encapsulated. Moreover, this knowledge constitutes a common store which is neutral as between the individual acting as speaker or hearer. That is, we draw on largely the same knowledge whether we are producing an utterance of our own or interpreting that of someone addressing us. Only the innate subset of FLN given by UG could be a Fodorian module.

We will use the term 'module' to indicate either a body of information and/or the processing of that information that is relatively self-contained in the sense of being 'informationally encapsulated'. Each of the modules of this general form may itself have modular structure. For instance, the vision module has separate components dedicated to processing colour, motion and form. These may dissociate in certain pathologies so that one patient may be able to identify colour correctly but not shape, another shape but not colour, and so on (see Campbell 2007). In the case of the language faculty there are many suggestions regarding the internal structure of modules. It is relatively (though not entirely) uncontroversial that there is a modular distinction between the lexicon and the computational system — the syntax. Government-Binding theory (Chomsky 1981) posited as an explanatory device a large number of modules: Binding theory, Bounding theory, Case theory, etc. which jointly conspired to account for the status, well-formed or ill-formed, of sentences. Whether or not there are such modules in the grammar has to be determined from the evidence, not *a priori*, and more recent work has seen their gradual elimination from the theory, largely because of the need to account for the evolution of language (see e.g. Hornstein 2013). Despite this anti-modular tendency, we do find some autonomous systems — for example LF, Narrow Syntax (in the sense of Chomsky 2000a) and PF. We return to the issue in chapter 3.

Assuming that the various components of the mind are neurologically instantiated, the claim of modularity entails the possible dissociation of the abilities represented by the various modules (see Shallice and Cooper 2011, Dehaene 2014, Smith 2003, for discussion), so one expects to find the kind of attested situation in which one faculty is spared and another impaired, as in Down syndrome, Williams Syndrome and Specific Language Impairment (SLI)[13]. Moreover, each of these pathological conditions has a (partly) genetic aetiology, providing more evidence for the innate basis of the language faculty, with evolutionary implications. More generally, it is clear from considerations of universality and uniformity that much of our linguistic ability is genetically determined, but it is equally clear from the range of linguistic variation that much is due to environmental considerations and some to epigenetic factors (see e.g. Mayberry & Lock 2003, Sloman & Chappell 2007, Vercelli & Piattelli-Palmarini 2009).

[13] See e.g. Perovic 2006, Perovic et al 2013b, Sanoudaki and Varlokosta 2014; Riches et al 2010; Garraffa et al 2015; Ring and Clahsen 2005; Stavrakaki 2015.

Our working assumption of a modular theory within the language faculty is motivated by at least three considerations: the existence of different kinds of generalisation — lexical, syntactic, semantic, pragmatic, phonological, and so on; the independence of such generalisations, with the consequence that it is defensible to prescind away from phonetics when considering syntax; and the kind of pathological dissociations mentioned above, where one faculty is spared or impaired independently of another (see Smith, 2002, ch.7; 2003, for discussion). Additionally, there are considerations of an evolutionary nature: for instance Chomsky (cf. Sperber and Origgi 2010) has argued that some internal recursive 'language of thought' preceded any externalisation of syntactically complex thoughts. Additionally, there seems to be (controversial) evidence of at least some pragmatic (second order) processing by non-humans (see e.g. Clatterbuck 2015.)

2.5 Semantics and Pragmatics

We draw a distinction between semantics and pragmatics which is largely compatible with the claims of Relevance Theory (Sperber & Wilson, 1995; Wilson & Sperber, 2012; Carston, 2002, 2008). From the point of view of the hearer, the distinction reduces, to a first approximation, to that between decoding and inference. If you hear *He complimented her on her new hat* you can decode on the basis of the syntax, the compositional semantics, and the meanings of the individual words as given in your lexicon, that some male person expressed his appreciation to some female person of that latter person's novel head-dress. You also know that the speaker used each pronoun either referentially or as a bound variable. So much is automatic and essentially inescapable and is (part of) the task of semantics. You then work out by a process of 'inference to the best explanation' (more specifically to the most relevant explanation) that *he* is intended to refer to the person you identify as 'Harold', that *she* is intended to refer to Margaret, and so on.[14] This inferential process is based on your background knowledge of the speaker and any mutual acquaintances, on your encyclopaedic information about hats and the people tentatively identified, and a host of other material. The interpretation may of course be wrong: it may be that Fred was intended, not Harold. Such examples are not restricted to identifying referents. The errant student's assertion that *I haven't finished my essay yet* is intended to invite the (deniable) inference that the assignment has at least been begun. 'Finishing' suggests a stage in which a start has been made, but the suggestion goes beyond what is strictly said. Further, even if the hearer's interpretation is correct it still leaves a lot to be done: Was the utterance intended ironically? Why should I care? Such further inferencing is far from essential and may involve noticeable effort. All this falls under pragmatics.

The immediate conclusion to draw is the 'underdetermination thesis': that information presented in a natural language underdetermines the 'explicature', that is the intended LoT representation of the thought expressed by a disambiguated utterance. Underdetermination is

[14] Following the usual shortcut, we proceed to give names to the individuals serving the relevantly same function in the mental models of speaker and hearer.

unavoidable, except perhaps for statements of mathematical truths. (For detailed discussion and justification, see Carston, 2002, ch.1). This prompts the question whether representations in the LoT may similarly be underdetermined. At first blush the answer has to be negative. If one takes a natural language sentence like *This fish tastes better than this fish* (pointing to each of two different fishes in turn) it must be the case on pain of incoherence that the LoT items represented by the NL expression *this fish* have different content on each occurrence. However, there may be some residual role for indeterminacy in an LoT for at least two kinds of example. First is the case of indexicals, as in my expressed thought that '*that* was wonderful' where *that* may refer to an episode that I have not bothered to demarcate even to myself; second is the related case of vague predicates such as *My life is a mess*, where the predicate expressed by *a mess* is again likely to be too vague even in the speaker's mind to be truth-evaluable. We assume, following Fine, that "Any (extensionally) vague sentence is neither true nor false" (Fine 1975:266). This discussion also implicitly distinguishes 'underdetermination' (a relation between expressions in NL and representations in LoT) from 'indeterminacy' (a relation between representations in the speaker-hearer's model of the world and the LoT chosen).

This leads immediately into three further concerns: the notion of truth and truth-evaluability; the definition and role of relevance, and the nature of 'background' or context. We look at each in turn but before doing so we should make explicit that we take the (pragmatic) problems confronting the speaker to mirror those confronting the hearer. Linguistic pragmatics is frequently defined from the point of view of the hearer as a theory of utterance interpretation. However, in couching their utterances in such a way as to optimise communication, speakers have to project their perception of the hearer's pragmatic processing, so their task, although necessarily second order (see Sperber and Wilson, 1995) , calls on the same communicative and cognitive principles. A difficulty with this speaker/ hearer neutrality can be illustrated with the following example. Suppose someone says *I parked the car near the bank.* Presumably she had in mind the particular bank near which the car was parked, with the appropriate semantic representation, either financial or riparian as part of the LF of the sentence uttered. For the hearer the situation is not so simple and one of his first tasks is to disambiguate the utterance and come up with his own representation of it. This, of course, may differ from that of the speaker – e.g. by including the wrong kind of *bank*. When talking about the representation of an utterance it is therefore important to remember that any uttered PF may be the PF of more than one LF and LoTF. It is part of the speaker's task to ensure that the hearer is in a position to work out the appropriate (intended) LoTF on any occasion.[15]

2.6 Semantics and 'truth with respect to a model'

Language is frequently used to convey information about the external world but, as should be clear from the brief discussion of internalism, it does not follow that an utterance has a

[15] For general discussion of ambiguity and the relation between 'sentence' and 'utterance', see Burton-Roberts, 1994.

semantic interpretation with respect to the external world. Rather, there has to be an internal model of the world, or rather some relevant part of the world, which may differ from person to person, and an internal semantics relating the internal representation of the language to the model. Of course, even in the simplest cases, for information about the external world to be successfully communicated, there must be a number of local alignments between speaker and hearer. Ideally, they have models of the world which are equivalent for relevant entities and states, so that they can be described as 'sharing' a local model and, on pain of extinction, that shared model must usually be compatible with the important properties of the relevant portion of the real world (see Cormack 1982b). At a minimum, speaker and hearer must have NL lexicons which map phonological words onto relations which are isomorphic with respect to the relevant local model, and in particular, with respect to the inferences which can be drawn over that model. It is important to keep the two kinds of alignment apart. Someone who is red/green colour blind does not have a model which matches that of the majority of the population with respect to colour relations. Similarly, someone who thinks that Hesperus (the evening star) and Phosphorus (the morning star) are two distinct entities has a different model from someone who thinks that they are the same entity, the planet Venus, visible at sunset or sunrise. On the other hand, if two people disagree as to whether some object is green or blue, they most probably have differing denotations for the LoT colour words corresponding to English *green* and *blue*, as assessed in models which do correspond in the relevant respects. With respect to both sorts of alignment, speakers may adjust their internal representations to accommodate to others, or may simply represent the differences within their internal model. If your ailing friend complains of arthritis in the thigh (Burge, 1979) you will probably not change your own conception of 'arthritis' (which excludes the possibility of having arthritis in the thigh by current medical definition) but you will annotate your encyclopaedic information about your friend to indicate this divergence in your denotations for what appears to be the same word. Similarly, in the case of our colour-blind friend, it is appropriate for me to represent in my model of the world this quirk in her model. More generally, one person may represent another as having a distinct model, idiolect or dialect or, alternatively, he may accommodate pragmatically to unexpected discrepancies without adjusting his own internal representations. You may say *elevator* while I refer to the *lift* or use *disinterested* the way I use *uninterested*, but nothing much hangs on this and neither of us needs to do more than annotate our respective lexical entries with information about the differences in usage. It also bears mentioning that usages may change both over the generations and even in the space of a single generation. We (the authors) no longer use *gay* in the merry sense it had in our childhood, still less in the sense of 'prostitute' that was common in the nineteenth century. (It is salutary to recall that once upon a time *girl* could be used to refer to a child of either sex). It is important to note that such idiolectal differences extend to syntax. For instance, most of the younger generation don't allow the use of *promise* as a subject-control verb as in *John promised his mother to mow the lawn* where it is *John* who is to do the mowing. For us the construction is perfectly normal, but even we have systematic differences as illustrated by properties of sequence of tense phenomena.[16]

[16] For example AC rejects as ungrammatical NS's 2005 title *Did you know that the*

All theories of pragmatics rely on inference about the local model, where this model includes representations of utterances. The internal language, LoT, is then used both to represent items of NL (so that NL words which have many meanings can be distinguished, for instance), and for inference. In order to relate to NL, LoT must have a syntax with recursion. In order to be usable for inference it must have certain further properties. Inference is essentially a meaning-blind manipulation of symbols, so LoT must deploy at least one inference rule, which maps premises onto conclusions in such a way that true premises lead only to true conclusions.[17] Given the requirements of recursion and truth-preservation, the language must be capable of supporting a compositional semantics with respect to a model, where the internalist position demands that each such model is mental.

2.7 Relevance and the two principles of relevance

Our commitment to the centrality of inference reinforces our appeal to Relevance theory (RT), the most fully worked-out and successful inferential theory of pragmatics. RT is particularly apposite for our purposes as it is both a theory of cognition and a theory of communication dedicated to the interpretation of utterances. Both CCG and RT are fundamentally about knowledge *and* use of language and their potential integration provides mutual support for each. The core of RT is the first 'cognitive principle of relevance' which says that human[18] cognition is geared to the maximisation of relevance, where this is a joint function of cognitive (contextual) effects and the effort expended in deriving them.

A simple example can be provided from the field of visual processing. For instance, it is well-known (cf. Bar, 2004, 2007) that the same entity will be seen as either a hair-dryer or as a power drill depending on whether it is displayed in the context of a dressing-table or a work-bench. In this case, as in many instances of visual or verbal priming, relevance correlates with frequency of association. The reason for this correlation is that frequency associates with probability, resulting, more often than not, in correct decisions: an evolutionary advantage. That this is not a necessary condition can be seen from an example such as that where travellers see a predator in every shadow, even though such predators are only known to them by hearsay. Here appreciating the degree of danger is more important than getting the right answer, implying some systematic cost-benefit analysis underlying decision making.

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[17] This is, of course, an idealisation. It has been known since Wason's (1966) selection task that normal human beings operate less rigorous constraints than simple truth preservation. See Sperber et al (1995) for discussion and a relevance-theoretic account which is compatible with our assumptions.

[18] The claim should probably be generalised to other primates (see Clatterbuck 2015) and even some birds (see Ostojić et al, 2013), though in neither case is there anything like the complexity of the ostensive communication characteristic of humans. A useful overview of (the implications of) the mind-reading abilities of chimpanzees is provided by Scott-Phillips (2014).

The relative unimportance of frequency is confirmed when we turn to the special case provided by acts of ostensive communication which fall under the second 'communicative principle of relevance'. This principle, stated as "Every act of inferential communication conveys a presumption of its own optimal relevance" (Sperber & Wilson, 2006:179) gives rise to an expectation that what the speaker is saying will be worth the hearer's attention and, to the extent that the speaker is competent, will put him or her to no undue processing effort. If the speaker is malicious, or momentarily or habitually incompetent, or not addressing the hearer, the expectation may on occasion not be fulfilled, or the level of relevance expected may be lowered by the hearer.

For instance, consider an artificially simplified scenario in which the only salient information is that you know that John is allergic to shellfish. In this context the utterance *John has just had a crab sandwich* will be relevant to you because it enables you to draw certain inferences – i.e. it has "cognitive effects". The same example is more relevant than any of the plausible alternatives *John has just had a plate of chips and a crab sandwich* and *John has just had a sandwich*, or *John would like a banana*. It is more relevant than the former because this puts you to more effort in processing the extra constituent (*a plate of chips*); it is more relevant than the latter because it allows the crucial inference about John's allergy that the *sandwich* and *banana* examples do not: that is, it has more cognitive effects.

It is important to be explicit about the level(s) of representation that are involved in the kind of example just cited. The propositions communicated fall into two classes: 'explicatures' and 'implicatures'[19]. Explicatures are those propositions intentionally communicated by means of "a development of a logical form encoded by an utterance" (Sperber & Wilson, 1995:182). The notion 'development' allows *inter alia* for the possibility that an utterance may (but need not) convey more than the PF selected by the speaker to represent the intended LF explicitly encodes. This is most obvious in cases where enrichment or ellipsis-resolution is expected. The former is illustrated by examples such as *Freddy insulted the class bully and got beaten up*, where the relation between the two events is interpreted not just as truth-functional conjunction as given by *and*, but as 'and as a result'. The latter is exemplified by the reply *Me* or *I did* to the question *Who ate my chocolates?* An explicature of either response is that 'I ate your chocolates', not just that 'I did something or other' or 'Look at me'. More interestingly, if the earlier example *John has just had a crab sandwich* is uttered with manifest glee, the speaker would be conveying not only the explicature that *John has just had a crab sandwich* but also that he is sadistically pleased at the possible implications. Such 'higher-level explicatures' are characteristically, but not necessarily, introduced by adverbials such as *frankly, happily, evidently,* and so on, though they may equally well be communicated by intonation, facial expression and other

[19] Note that what is 'ostensively communicated' must be intended by the speaker and excludes things which are 'covertly communicated' (e.g. when a speaker deceptively tries to inform the hearer of her state of mind but without that intention being itself communicated) or 'inadvertently transmitted' (e.g. a speaker is trying, but failing, to hide her feelings) (see Wilson & Sperber, 1993).

paralinguistic features. That is, the evidence for a higher-level explicature may be partly non-linguistic. Conversely, the proposition expressed by an utterance need not be an explicature of the utterance, as in the case, for instance, of a metaphorical or ironic utterance. In general, the content of an explicature is obtained from a combination of parsing and pragmatic inference, exploiting both the LF of the sentence underlying the utterance and the context. It is important to note that context is not just derivable from the situation in which the utterance is made, but may include any other propositions that the speaker deems the hearer to have access to.

The other class of proposition communicated by an utterance are 'implicatures', defined as anything in addition to the explicature which is inferred, and intended by the speaker to be inferred, from the utterance and its context. In the *crab sandwich* example this would include such conclusions as that one should call an ambulance or make sure John uses his medication. It would exclude propositions inferred on the basis of contextual information not salient to both speaker and hearer, such as the hearer's later conclusion that she should label all the dishes of food.

A further distinction drawn by Relevance Theory which is germane to our programme is the distinction between 'procedural meaning' and 'conceptual meaning' (Blakemore, 1987, 2007; Carston, 2002; Bezuidenhout, 2004; Hall, 2007a, b). The distinction involves the contrast between expressions which "encode information about the conceptual representations which take part in inferential computations (conceptual meaning)" and those which "encode information about the inferential procedures which yield conceptual representations (procedural meaning)" (Blakemore, 2007:58). The conceptual content of a lexical item such as *tree* or *persevere* is familiar and relatively straightforward, even if not always easy to pin down explicitly. The same is not true for the procedural meaning associated with items like *so, after all* or *anyway* in examples such as *Gladys is insufferable; after all she's a linguist* or *Gladys is insufferable — anyway she's not coming.* Rather than add to the content of the proposition it introduces, *after all* has the effect of instructing the hearer to interpret what follows as a piece of evidence for the preceding statement; *anyway* indicates that the preceding statement is irrelevant because of what follows. A further mark of the contrast resides in the fact that "conceptual representations can be brought to consciousness: procedures cannot" (Wilson & Sperber, 1993:16). Other examples of procedural meaning include the choice of imperative mood, of intonation, of 'tone of voice', and more (see Carston, 2002 for discussion). Moreover, some items may embody elements of both procedural and conceptual meaning: for example, a pronoun such as *she* in *She hasn't come yet* encodes the conceptual content that the referent is female, while – as a pronominal – simultaneously provides "a procedural indication to the pragmatic processor of the sort of entity being referred to" (Carston 2002:60). Other cases where procedural and conceptual meaning are both relevant include 'evidentials' such as *evidently* (see e.g. Rooryck, 2001a, 2001b; Papafragou et al, 2007) and demonstratives such as *this* and *that.*

The cognitive effects of an utterance include more than the accessing and processing of the propositions inferred as explicatures or implicatures. All processing is potentially done in parallel, and there may be simultaneous aesthetic or emotional effects, with which we will not

be concerned, and also effects on conceptual salience and accessibility, engendered by the occurrence of lexical items, phrases, or propositions and their order. The manipulation of accessibility is one means of controlling Context, to which we turn now.

Within the framework of Relevance Theory, 'context' refers not just to the non-linguistic physical environment - where it might, for instance, limit interlocutors' access to individuals in the world: ensuring that *There's no-one here yet* is correctly interpreted as meaning *in the library* rather than the whole of London, but much more widely. Thus it may refer additionally to the previous utterances in the conversation and to "a subset of the hearer's assumptions about the world" including "expectations about the future, scientific hypotheses or religious beliefs, anecdotal memories, general cultural assumptions, beliefs about the mental state of the speaker" (Sperber & Wilson, 1986/95:15-16) and so on. That is, context is characterised as a set of propositions that each interlocutor automatically constructs in order to facilitate the interpretive process.

It follows, of course, that speakers and hearers may misinterpret each other, with the concomitant need for accommodation of the kind discussed in 2.6 above.

2.8 Inferential processing in Grammar and Pragmatics

It is necessary to distinguish the mode of operation of (processing) rules internal to the grammar from the mode of operation of inferential (pragmatic) rules operating on the output of the grammar, where these in turn may lead to reasoning carried out in conscious thought using LoT representations. We may then look at the extent to which they are alike, and how they differ. We set aside any inferential processes that cannot helpfully be seen as operating over language-like symbolic representations. The null (and minimalist) hypothesis is that the same processes are used in all reasoning.

The first type of reasoning, internal to the grammar, but not necessarily restricted to the linguistic domain, is illustrated by 'blocking' or the 'elsewhere condition' of Pāṇini, c. 450 BC; see Kiparsky, 1973, 2005), which states that where there are two alternative possibilities the one which must be chosen is that meeting the more highly specified antecedent condition (or, for identical antecedent conditions, that with a more highly specified consequent). The simplest kind of example comes from irregular morphology. The usual way to form plurals in English is to add an *–s* (or one of its morphophonemic alternants) to the singular. A regular example, like LF CAT will have its singular *cat* listed, but not its plural form (*cats*), and the general rule operates. But an irregular item will need to have both singular and plural listed — like *foot*, *feet*, for LF FOOT. This extra information makes the condition on using the entry more finely specified and the Blocking Principle then implements the irregular specification, inhibiting the operation of the regular rule. We use the principle extensively within the narrow syntax module. For example, English has a rule stipulating that noun phrase arguments follow the selecting verb, while another rule stipulates that subject noun phrase arguments precede the verb. Blocking ensures that the latter, the more highly specified, will apply. For both these examples, the reality of the process can be seen from application to novel examples.

The inference of standard logic, has already been illustrated by the 'crab sandwich' example. Within pragmatics, it operates on a complex output: a lexically rich syntactic representation, produced in conjunction with a set of semantic meaning postulates and encyclopaedic information. This complex whole forms the basis of pragmatic interpretation. It must also be the basis for parsing and production more generally.

2.8 Information structure

As a bridge to the syntax we appeal to the notion of 'Information structure' as most clearly elaborated in Steedman's work (e.g. 2000a, 2000b, 2002, 2014b). He argues persuasively for a theory of (categorical) grammar in which "intonation helps to determine which of the many possible bracketings permitted by the combinatory syntax of English is intended, and that the interpretations of the constituents that arise from these derivations … are related to distinctions of Information Structure" (Steedman 2000a:109). A characteristic example is provided by his pair of sentences in (a) and (b):

a) Q: I know who proved soundness. But who proved COMPLETENESS?
A: (MARCEL) (proved COMPLETENESS).
H* L L+H* LH%

b) Q: I know which result Marcel PREDICTED. But which result did Marcel PROVE?
A: (Marcel PROVED) (COMPLETENESS).
L+H*LH% H* LL%

for which he provides simultaneously a syntactic structure, a compositional semantic structure, an intonational structure (indicated here using Pierrehumbert's 1980 notation) and an information structure. We shall not in general pursue the last two in the detail Steedman does, but it is necessary that our treatment be compatible with his or with some equally rich variant.

3 The Syntactic framework: The Minimalist strategy

We are "minimalist" in the sense of Chomsky (1995b); that is, we limit ourselves to using those constructs which are conceptually necessary or empirically unavoidable. Moreover, the technical machinery we posit must allow adequate descriptive coverage and underpin language acquisition, while simultaneously maintaining theoretical elegance and computational tractability compatible with the limitations of human short-term memory (see among many others Miller and Chomsky 1963, van Rooij 2008, Marcus 2013). Accordingly, we assume the standard position on UG (Universal Grammar) which specifies that narrow syntax requires a lexicon and a computational system (the computation for human language, C_{HL} of Chomsky, 1995b:170; cf. 2000b:49). The minimal requirement is that there be two interface representations, PF and LF, which are required under any theory.[20] These are linked

[20] Chomsky (2008) has suggested that the representations at the interfaces are outside the grammar, making the faculty of language stricto sensu even more meagre. A further possible exception is provided by Hinzen's (2006) theory.

by the computational system which relates (representations of) sounds to (representations of) meanings. In each case we assume that these representations are symbolic, whether or not they may additionally be mapped onto sub-symbolic elements in a neural network. Chomsky (2013:36; cf. 2011c) suggests a reversal of the usual formulation, saying that "language is not sound with meaning, but rather meaning with sound (or some other externalization), a very different concept", with "many consequences concerning cognitive architecture and its evolution." This implicit assignment of priority to the 'conceptual-intentional' is a strategy we have been pursuing since Cormack & Smith 1998, where we endorse the priority of LF, and accordingly construct syntactic representations that map LF (which is largely isomorphic to a subpart of LoT) to PF. That is, we hypothesise that a NL grammar framed as a mapping from LF to PF will be simpler than one framed as a mapping from PF to LF or as an interface neutral one. Accordingly, in the Chapters that follow we apply this approach systematically to a variety of structures, aiming inter alia to identify the further formal additions required. The latter should constitute UG. In performance, of course, humans need to be able to make the mappings in both directions.

For a linguistic representation to be well-formed it must be 'interpretable' at both of these 'interface' levels. LF is the interface with the conceptual-intentional (C-I) system, essentially our LoT, i.e. where the language faculty connects with the representation of thought and inference and, as seen pre-eminently in paralinguistics, with the emotions (Poyatos, 1993). PF is the representation which interfaces with the sensori-motor (S-M) system where the language faculty connects with systems of audition and externalisation (speech, sign, writing). We argue that the two are only indirectly connected. Under our analysis, LF and morphosyntax share an integrated structural representation, with recursion, so that Narrow Syntax is essentially monostratal. Every lexical item must have an LF-interpretable part (though this may in some cases be the identity function) or it is unable to enter into LoT merge, and a morphosyntactic part, where the latter as it comes from the lexicon may be partially underdetermined. The morphosyntactic features become fully determined during merge, giving a structured 'MSyn' representation in parallel to the LF. The PF is obtained by a mapping from MSyn using morphological specifications from the lexicon, with some appeal to structure to accommodate stress and intonation. Both systems exploit generalisations over the lexicon.

We also argue that LoT, and hence LF, is linearised, even though Natural Languages manifestly do not all exhibit the same PF ordering for comparable items. We have suggested (Cormack & Smith 2012) that a general assumption of 'Functor First' gives an appropriate fixed order for LF, and also has other advantages. Where the PF order fails to reflect the LF order, relatively superficial operations cause the apparent 'displacement' (Chapters 3 and 4).

A natural language can be seen as a solution to the 'legibility conditions' imposed by the interfaces at PF and LF and by the computational system, (Chomsky, 2000a, 2002). Chomsky suggests that the solution is optimal; it must at least be adequate, where the metric for 'adequacy' includes providing the means for the effective communication of those thoughts, couched in LoT, that contribute to the aims of the individual, the cohesion of society, and the

preservation of the species. To be optimal a language would have also to conform to external desiderata of physical and computational practicability, and compatibility with the requirements of acquisition and learnability. Since these desiderata conflict, we should not be surprised that Natural Languages provide more than one solution, though we subscribe to Chomsky's (2001) "Uniformity Principle" that "in the absence of compelling evidence to the contrary, assume languages to be uniform, with variety restricted to easily detectable properties of utterances."

The minimalist imperative instructs one to assign as little as possible to any NL-specific system, deriving its properties where possible from other, independently needed constructs, physiological or conceptual. This entails that the default hypothesis is that the computational system is that already required by LoT, which has conceptual and evolutionary priority (cf. Sloman & Chappell 2007,[21] Sperber & Origgi, 2010). Any extra hypotheses and apparatus must be subject to scrutiny, to see if they are superfluous.

In order to carry through this program, we need a hypothesis about the syntax of UG such that it provides a basis for inference, and can provide a suitable basis for NL. In 1970, David Lewis discussed the limitations of categorical grammar in the sense of Ajdukiewicz 1935 for describing any language except symbolic logic in Polish notation, and suggested that "The time therefore seems ripe to explore *categorically based transformational grammars*, obtained by taking an Ajdukiewicz categorical grammar as base, and adding a transformational component." Since 1970, 'transformational' grammars have been transformed into 'Principles and Parameters' grammars, now guided by the Minimalist Program where even 'Move' has been replaced by 'Agree'; and categorial grammars have also developed, in particular into Combinatorial Categorial Grammars. The time seems once again ripe, this time to explore in some detail a *combinatory minimalist grammar*. This is our plan here. We will be urging that LoT, and concomitantly LF, are in fact just 'symbolic logic in Polish notation' (chapter 2), and that the only 'transformation' required is displacement that affects PF (taken to be phonological form) but not LF (chapters 3, 4).

We take it that in the default case the LF (of a NL item) and its LoT will be identical. The simplest situation would then be to assign a single phonological representation to each LoT item on a one-to-one basis, and to preserve LoT syntax. However, properties of the computational system and the communicative principle of relevance appear to militate against this maximally simple position. For example, it seems to be the case that humans prefer to re-use a phonological form for distinct meanings, related or not (leading to lexical ambiguity, and local uncertainties during parsing). This may be partly due to storage problems in the computational system; but the fact that we manage with such a system is due to the power of the pragmatics of processing. The pragmatic system makes its own demands: some of the 'displacement' exhibited by NL is most naturally explained by the desideratum of indicating the discourse status of certain items by putting them in a peripheral position in the sentence (for example by displacing topics to a sentence-initial position, or foci to a sentence-final

[21] Who suggest (p.375) "that language first evolved for 'internal' use".

position). Further, the existence of morphological agreement and the existence of words with null phonological content may each be motivated by processing considerations, despite the fact that the one introduces some redundancy in information at PF, and the other, suppression of such information. Each of these desiderata produces deviations from the simplest system, where these vary from one language to another.

Minimalist assumptions entail that any further specification of the properties of NL inheres in the lexicon, and more specifically, in the set of 'features' associated with a particular lexical item; where, moreover, the choice and distribution of such features is the locus of parametric or micro-parametric variation.

Some features are simple and traditional: e.g. those specifying the word-class of an item, such as ADV (adverb) or COMP (complementiser). Others are of a traditional kind, such as category, but here the notation is different, as we use the categorial grammar format, which encodes selections in the category name (e.g. V/D/D for a transitive verb, where the '/D' correlates with a selection for a determiner-headed argument). In general, we use word-class in an <attribute: value> format, such as <VERB: *HOIST*>, and in particular configurations where they interact via 'Agree'.

A significant innovation — and a central part of our theory — is that, unlike mainstream minimalist work, we exploit the category notation and the combinators of Combinatory Categorial Grammar. Inter alia, this enables us to merge in situ certain sorts of phrases that in standard Minimalism must have their position accounted for by Move (for example in Raising, as in Cormack 2006). A further innovation in our system — and a deviation from most standard minimalism — is our claim that any remaining discrepancies between the position of elements at LF and PF, standardly treated as the 'displacement' of PF realisations with respect to the position of their LF congeners, are mediated **solely** by the features entering into Agree. We implement this compositionally, in such a way as to obtain a monostratal Narrow Syntax.

4 Implementation

4.1 Merge

We begin with those properties of our system which are in agreement with standard Minimalism, and continue with those aspects where we diverge. Like everyone else we need to assume some process which combines items from the lexicon to form larger constituents: Merge or its equivalent (Chomsky, 1995a:226). Merge recursively creates structures, and is licensed only by the discharge of some selection feature, as has long been assumed in Categorial grammar. It is binary and asymmetric, it applies 'to the edge' – Chomsky, 2008:138; it obeys 'No-Tampering' – Chomsky, 2010:52, and 'inclusiveness'[22] – Chomsky,

[22] There is one principled exception to this claim: generalisations over the lexicon which are triggered by semantic features, not syntactic ones, and may pertain to phrases. See for instance example (1) below, and the discussion of resultatives in Chapter 5.

1995a:228. We look at each of these properties in turn. Given that s-selection is required for compositionality, it is s-selection that licenses merge in LoT, but we shall argue that we also need c-selection, where this is in principle independent of s-selection, to account inter alia for the syntactic differences between the LoT-identical *likely* and *probable,* or the status of a probability operator as an adverb or a modal or a verb. The recursive nature of Merge is required to account for the possibility of both the production and the parsability of novel sentences, and for the intuitive acceptance of arbitrarily deep levels of embedding (despite processing problems) Chomsky (1955/1975), Smith and Wilson (1979). Our system, however, requires no separate stipulation to ensure this. In a model which obeys compositionality and has only two levels of representation – LF and PF – it is necessary that merge give rise to LF directly and to PF concomitantly. An important part of our position is that we add the combinators of CCG to the lexicon both of LoT and of natural languages. This allows, for example, for the sort of non-standard constituents required to align constituency with information structure phrases and intonation; it also allows the LoT and LF string to be unambiguous with respect to structure.

Given the standard Categorial Grammar assumption that merge must be licensed by the discharge of a selection feature (see also Chomsky, 1995a pp. 226ff.), the simplest implementation is to assume that selection features are discharged one at a time, leading to binary merge (see Rizzi 2013a:6, fn.10), which produces a more restrictive system than if one allows n-ary merge (n > 2). The asymmetry of merge follows directly from the assumption of binary merge and licensing by selection discharge. However, the results here are different from those in standard Minimalist accounts, and unproblematically include adjuncts (see the discussion of linearisation (word-order) by Functor First in Chapter 2).

The "No-tampering condition"[23] specifies that merging two constituents X and Y leaves each of them unchanged. We find that features of one element of the merge (e.g. an agreement feature) might be instantiated as a result of the merge. If this is by unification, instantiating an existing underdetermined feature, we take it that this does not fall under "tampering". The requirement that "all merge be to the edge" ensures that one constituent cannot be merged inside another. This is a desirable restriction on learning or constructing grammars. In addition, it is hard to see how LoT could be usable for inference if its representations did not conform to this desideratum. It can hardly be the case that an LoT representation has to be 'parsed' in order to be interpreted and used, so inference must operate directly on the strings of symbols representing a proposition in LoT. This rules out infixing constituents one inside another at Merge of LoT items. Given that NL items normally include an LF part which is an LoT item, Merge at least of LF parts in NL must merge to the edge.

Like 'No-Tampering', 'Inclusiveness' is "a natural principle of efficient computation" (Chomsky 2007: 4) specifying that "No new information can be introduced in the course of the syntactic computation". The adoption of this principle resulted for example in the

[23] Described by Chomsky (2009a:26) as "a natural principle of efficient computation, perhaps a special case of laws of nature".

replacement of X-bar theory with its different phrase levels by 'bare phrase structure' (Chomsky, 1995c); and the replacement of 'traces' by Copy Theory. The borrowing of mechanisms from CCG allows different and, we claim, better, ways of eliminating the suspect nature of these and some other constructs of earlier Principles and Parameters theory.

In standard Minimalism, Merge is manifest in two forms – 'external' and 'internal', where 'internal merge' replaces the earlier 'Move'. Internal merge seems to us to violate the essence of the 'No Tampering' desideratum, in that there are now linked copies where before there was a single item. An important part of our programme is that there is no movement (cf. Brody, 2006). The effects of apparent movement are achieved by the use of combinators during merge, or of 'PF displacement', which appears as a by-product of morphosyntactic feature checking and copy deletion.

We claim that all 'displacement' of PF (relative to the congeneric LF) is to some existing LF position; that every displacement is licensed by morphosyntactic specifications relating the two positions, with one of the duplicated specifications left unpronounced; and that well-formed displacements satisfy locality conditions arising from the way features may interact under Merge. A corollary of this position is that we have a monostratal (representationalist) narrow syntax.

In sum we would emphasize that we are not advocating a standard (Combinatory) Categorial Grammar, although we believe that what we put forward is capable of being interpreted as a categorial grammar. Not only do we treat the combinators as elements of LF (and LoT), but we admit a form of 'Move' (displacement), determined by morphosyntactic features — though this affects only the PF realisation of the associated LF.

4.1.1 The lexicon

The lexicon is the repository of all language-particular facts. It contains information of broadly two kinds: information relating to particular items (which may be unitary or phrasal), and generalisations over items, where these generalisations aid acquisition and economical storage, impose well-formedness conditions on new lexical items, and may apply also to phrases constructed during a derivations. This last is a simple consequence of the CCG notation for a category — a phrase and a lexical item may bear the same category — but its consequences are important. A phrase, whether learned as a whole, (by rote, or as an idiom) or constructed by Merge, may be considered as a lexical entry, even if sometimes one which is ephemeral. It will have an LF, and a set of morphosyntactic features, and a category, though not a unitary word-name. We will see this in operation in pseudo-serial structures. For instance, in (1) below neither *sing* (in the required sense) nor *hoarse* is compatible with an overt direct object, but the complex predicate formed from the two by means of covert conjunction ('∧ SING HOARSE') has all the relevant properties of a transitive verb, and so is compatible with a direct object: [24]

[24] Such examples are discussed in more detail in Chapter 5 §5.

(1) Maria sang herself hoarse

The lexicon is usually conceived of as divided into a 'functional' component, where this refers to that subset of the whole which deals with functional categories such as Tense, Complementisers and Determiners, and a 'lexical' component which deals with 'substantive' categories such as Noun, Verb, Adjective and some Prepositions. For reasons which will become clear, we will usually refer to what are often confusingly called the 'lexical' items, on which we focus here, as 'relational' items.

Minimal items are 'lexemes' (in the sense of Matthews, 1972, Aronoff, 1994, Stump, 2001). A lexeme is a bundle of information associated with an LF item (possibly internally phrasal). Typically, it includes an LoT representation of its meaning, a type, a category, a word-class and a word-name, and a set of morphosyntactic features, relating for example to agreement or inflection, which will incorporate the word name and word-class as an 'attribute: value' pair.[25] We simply exemplify here, leaving the justification to later chapters.

Consider the LoT item CAT (the domestic feline quadruped), which has type <e, t>. There is a matching LF CAT, which is associated in the English lexicon with two distinct items of word-class NOUN, distinguished by their word-names, *CAT*, and *PUSS*, of which *PUSS* will be annotated as for use with children. For word-names we use italic small capital letters relating to the LF where possible, for mnemonic reasons. These word-names are new items of LoT — one can think about 'words'. The LoT and LF item which we give as 'FELINE' with type <e, t> is associated with several lexemes: two have word-name *FELINE*, but one has word-class NOUN, and the other, word-class ADJ (for adjective). Another has word-class NOUN and word-name *CAT*. The two distinct lexemes associated with word-class NOUN and word-name *CAT* have distinct LFs (say CAT1 and CAT2 for domestic and 'big' cats respectively) but identical morphosyntactic properties; and they will map onto /kæt/ in the singular, and, by a morphological generalisation over the lexicon, onto /kæts/ in the plural.

LF-related features are LoT items, which link to related Meaning Postulates, and also potentially to associated encyclopaedic and procedural information. It is plausible that each lexical item also needs an LoT name, which is the name of the triple of information just indicated. The majority of 'functional' items have non-trivial LoT entries, contrary to what is sometimes assumed, though some may have only an identity function as their entry, so that their contribution to the semantics of any larger unit is trivial.

It is necessary to postulate a richer ontology of syntactic categories than the simple lexical/functional divide – to accommodate such phenomena as conjunctions and quantifiers – but for present purposes we limit ourselves to lexical and functional, which correspond to the traditional open and closed class respectively. Our underlying motivation is that the set of functional items (including negation, etc.) are in some sense 'known in advance' and hence raise different problems of learnability than do lexical items. An additional consideration is

[25] A morphophonologist requires only a stripped down version of a 'lexeme': word-class and word-name.

that the Borer/Chomsky conjecture (see e.g. Baker, 2008:3) claims that those features which generate parametric variation between languages are associated only with functional items.

A peripheral issue in relation to semantics and the content of the lexicon is 'lexical decomposition'. Is *kill* a PF related to KILL and *KILL*, or related to [CAUSE [BECOME DEAD]] (the 'cause to die' discussed and dismissed in Fodor 1970)? We take it that the default assumption should be the first one. Only if there can be found evidence that parts of the whole can be active in distinct positions in the representation, should decomposition in the syntax be considered. Examples are Larson's 2011 decomposition of intensional verbs like *want*, or von Stechow's (1996) treatment of the operands of restitutive *again*).

4.1.2 Principles and Parameters

In pre-Minimalist syntax, the strictly syntactic part of the language faculty which is characterised by UG specifies not only a lexicon and a computational system, but a set of universal principles and parameters. Universal principles are constraints such as structure dependence (Chomsky, 1971), (strict) cyclicity (Freidin, 1999; Chomsky, 2002), or the Extended Projection Principle (Chomsky, 1995a), which constrain both the operation of the computations carried out by a competent speaker, and the child's hypothesis space in first language acquisition. Structure dependence is a principle which states that all grammatical operations – phonological morphological and syntactic – have to be defined in all languages over structures rather than simple linear sequences of elements.[26], That is, the possibility of counting the number of words or constituents is excluded *a priori*. This follows without stipulation from a recursive definition of a well-formed unit in terms of bottom up Merge, which we assume. Minimalist principles require that other 'Principles' are equally explained by more primitive requirements — or shown rather to fall under parameters.

Parameters were represented as choice points by reference to which languages can differ and which jointly define the limits of variation. Apart from unifying language typology and (first) language acquisition, the theory of parametric variation purports to solve 'Plato's problem': the problem of accounting for how it is that humans know so much on the basis of such meagre evidence (the poverty of the stimulus argument). The idea was that the child comes to the task of first language acquisition already endowed with knowledge of the possibilities represented by parametric choices and learning the first language consists simply in setting a small finite number of 'switches'. An immediate implication of this view was that, aside from lexical variation, "there is only one computational system" (Chomsky, 1995b:170). Chomsky's more recent approach rejects the idea of parameters built into the human brain as being implausible given evolutionary considerations. The 'parameters', then, must be learnable in toto, rather than being given as properties ('features') of lexical items, and by hypothesis, just of the 'functional' items of the lexicon. That is, languages really are cut from

[26] Neeleman & van de Koot, 2006 point out that the case of phonology is somewhat different in that it is adequately described not in terms of trees but in terms of strings. Structure dependence emerges nonetheless in our framework because all processes are merge-based.

the same cloth and the only substantive tasks are learning the language-specific properties of individual lexical items, and establishing generalisations over the lexicon. This is, of course, an empirical claim, as is the distribution of phenomena as between 'principles' and 'parameters' (if any), or macro- vs. micro-parameters. For discussion see Evans & Levinson 2009, Rooryck et al 2010, Pearl & Lidz 2013. For us a parameter always accounts for one of the ways in which an expression of a NL deviates from the expected expression, given the underlying LF – and the lexicon and the parameters so far utilised.

A requirement of attempting to substantiate such a claim within a Minimalist framework is that we produce a reasonably varied and explicit sample of the lexicon, together with a description of what is needed in addition to enable such a lexicon to generate well-formed NL structures for a particular language. This is what we have tried to do in the following chapters, arguing that the required 'features' for lexical items include category as in CCG, and structured morphosyntactic features, both of which are deployed only as determined by Merge. Features may be allotted by generalisations over the lexicon (macro-parameters), or lexeme by lexeme (micro-parameters). All features are in principle defeasible, but the necessities of learnability often result in generalisations that are exceptionless.[27]

5 Fragestellung

Given our commitment to CCG, it is incumbent upon us to spell out our presuppositions about the properties of UG that underpin explanations within that framework. Relevant phenomena must include Natural Language (NL) compositionality, such principles as structure dependence, the inclusion of combinators as part of the syntax as well as of the semantics, and the status of morphosyntax (MSyn) as the locus of all further generalizations and variation in the mapping from LF to PF in Natural Languages.

To begin, we raise and provisionally answer four related questions. The first is why we adopt a (bottom-up) Categorial Grammar rather than any of the alternatives: a top-down, Phrase Structure Grammar, or some different dependency format, or a Spec/Head/Complement based structure. The second is why we adopt and adapt Combinatory Categorial Grammar (CCG) rather than relying on the traditional standard variety. The third is how and why we adopt a unidirectional CCG (i.e. one with no ordering parameters expressible) rather than a standard bidirectional one. The fourth is why combinators are part of the lexicon, rather than distinct forms of composition.

We do not attempt to justify our decisions in this brief preamble which is intended merely to provide an initial rationale for what follows. Detailed justification will appear in the text.

[27] In English, internal arguments follow the head for verbs, nouns, adjectives and adpositions. But there are a few exceptional postpositions such as *hence* in *three years hence*; and if *notwithstanding* is a present participle, this too is exceptional in formal registers in allowing a preceding internal argument (*your protests notwithstanding*).

Q1. *Why Categorial Grammar for Narrow Syntax?*

We have a number of reasons, listed from A1 to A6 below:[28]

A 1. It unifies the Syntax and Semantics

Each syntactic category corresponds to a semantic type with respect to the number of arguments or operands it selects. Merge is simply function-argument application, operating in parallel in all of: the Language of Thought type system, the syntactic category system and the semantics. That is, this syntax is purely applicative, embodying a uniform computational system. This guarantees compositionality and should be attractive to philosophers and logicians as well as linguists.

A2. It is lexically based in that CG reduces the syntax to the manipulation of lexical features under Merge.

There is a converging view that all linguistic variation is lexical, and that most of the functions previously described by PS rules should be captured in the lexicon. Crucially, the lexicon, including morphosyntactic features, encodes both UG facts and language-particular specifications.

A3. It is radically minimalist in the set of (primitive) categories postulated.

A4. It is monotonic. Although a phrase may be unpronounced, as in ellipsis, there is no deletion of LF interpretable material, and no movement, nor any syntactic 'internal merge'.

A5 It is monostratal. LF and MSyn are the interface representations, derived directly by Merge, ultimately of items from the appropriate lexicon. LF is mapped almost 1:1 onto LoT at the CI interface. MSyn is mapped onto sound, sign or writing at the S-M interface, via appropriate mapping rules.

A6. It is empirically superior. Evidence appears throughout the book, but a simple example is provided by the unproblematic characterization of 'adjunct' that the system offers.

Q2. *Why Combinatory Categorial Grammar?*

Again we have a number of reasons, listed from A7 to A12 below:

[28] By 'Narrow Syntax' we mean those structure-based components that are required for LF and for the morphosyntactic interface representation of a particular natural language. We will argue that the latter is input to a 'morphology to phonology' mapping (e.g. via morphological generalizations and paradigms).

A7. According to Steedman (2000a:202) combinators have the advantage of being 'cognitively primitive'. This hypothesized meta-theoretical advantage is supplemented by a number of empirical bonuses:

A8. It provides for non-standard constituents with appropriate prosodic properties, as required for example for non-constituent conjunction and final contrastive focus.

A9. It can provide directly structures such as scope-affecting scrambling that would otherwise require LF displacement.

A10. '*Wh*-movement' can be eliminated.

A11. It allows the description of 'A-movement' without the need for movement as such.

A12. It avoids the problems of bound variables, and allows for the elimination of variables from the grammar altogether. Moreover, in conjunction with the restriction for NL whereby only a subset of the logically possible combinators can be exploited, the elimination of variables also leads to a simpler and non-stipulative account of *wh*-island phenomena.

Q3 *Why a unidirectional CCG with morphosyntactically driven displacement?*

Again we have a number of reasons, listed from A13 to A15 below:

A13. It gives conceptual priority to LF. This allows LF to be directly syntactically generated and isomorphic to LoT representations with universal syntax.

A14. A unidirectional CCG allows the simplest Natural Language linearization, with at most a single choice: Functor First or Functor last. These alternatives do not have the linearization problems of analyses based on Kayne 1994.

A15. Aside from the lexical inventory, that part of parametric and microparametric variation among languages not accounted for by combinator choices or Functor First/Last is reduced to the morphosyntactic component of the lexicon. This includes 'displacement' ('head movement', phrasal movement) not accounted for with combinators. The parameters are cast as syntactically active default specifications; for example a verb in English is required to be in a checking relation with some head providing inflection.

Q4 *Why are combinators lexical items and hence part of the representation of syntax?*

Again we have a number of reasons, listed from A16 to A21below:

A16. Combinators are required in LoT to ensure adequate expressive power without ambiguity. Having the combinators appear in the syntax of NL as well ensures that it is unambiguous as to its structure and interpretation in LoT.

A17. As lexical items, combinators may be associated with morphosyntactic features, contributing inter alia to the elimination of the notion 'Specifier'

A18. The Polish notation associated with combinators allows the tree structure for an LoT expression induced by Merge to be represented unambiguously as a linear string, without the need to introduce brackets. This allows a simple mapping to a linearized LF.

A19. Some of the parametric variation in a language is mediated by means of the combinators, requiring their presence in the syntactic representation (e.g. to allow for checking for the appropriate combinator by a Raising head).

A20 They explicitly represent a particular structure and all the information relating to its well-formedness within a linear representation, including some non-standard constituents, so that processes depending on such constituency (e.g. ellipsis or some 'displacement') can be morphosyntactically characterised.

A21 The restrictive theory of NL and LoT combinators required to give a bracket-free notation automatically explains the existence of 'strong' extraction islands.

We return to all these putative advantages below and in the chapters to follow. Importantly, all of the properties in these answers should simplify the acquisition process. Concomitantly, if this is the right approach, the specifications required to characterise a given language should be simpler than those of alternatives. This assumption is of course modulated not only by the small amount we discuss, but by the usual caveats about the correctness of our intuitive notions of simplicity in relation to what is required in the brain

There are, of course, potential problems: the psychological plausibility of the constructs of CCG, the learnability of the postulated morphosyntactic features, the empirical validity of particular analyses, but these problems are not unique to us and we leave discussion of them to the relevant chapters.

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