

The Minimalist Impulse¹

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1. The explanatory limits of syntax

Recent years have seen a striking trend in the direction of "minimalist" syntax, an approach to syntactic theory that eliminates many of the elaborated formal devices of earlier versions of the theory of autonomous syntax. There appears to be widespread acceptance of the minimalist approach, even among linguists formerly predisposed towards classical syntactic formalisms.² Keeping in mind the theme of this book, "the limits of syntax," it is possible to interpret this minimalist impulse as an implicit recognition that syntactic theory, as represented in works such as Chomsky's *Lectures on Government and Binding* (1981) and *Barriers* (1986) has substantially exceeded its limits.

We can understand this notion of "limits" in two ways, descriptive and explanatory. The **descriptive** limits of syntax pertain to the correct characterization of linguistic phenomena. E.g., Ray Jackendoff and I have argued (Culicover and Jackendoff 1995a) that important aspects of Binding theory properly reside in semantics, not in syntax (i.e. S-structure or LF). If we are correct, much of the Binding theory is not a syntactic theory at all, in the usual sense of Asyntactic as pertaining to the structure of the sentence itself, as contrasted with its sound or its meaning.

I will focus here, rather, on the **explanatory** limits of syntactic theory. The explanatory limits of syntactic theory concern the extent to which a syntactic theory is capable of truly explaining the observed necessary and possible properties of natural language.

As a part of the theory of generative grammar, a syntactic theory is by definition an idealized characterization of linguistic competence. One problem with this general approach, which has been recognized by non-linguists from the very inception of generative grammar, is that the particular idealization adopted by generative grammar strips away the dynamical character of language, eliminating from consideration such time-bound factors as language acquisition, language processing, and language change. The idealization in turn raises the question of what a syntactic theory is about, given that it is in principle impossible to account for the dynamical properties of language within the theory itself. The answer to this question is, typically, that a syntactic theory is about the knowledge itself. However, it is natural to wonder whether it might not be possible to develop a dynamical theory that **embodies** knowledge of language without actually representing it as a distinct object of cognition.

An interesting consequence of the idealization is that the explanatory power of syntactic theory *per se* is relatively shallow, even with respect to linguistic competence. Universal properties of language are attributed to universal properties of the language faculty, as implemented in the language acquisition mechanism, and language variation is attributed to the fact that certain universals incorporate parameters that range over a fixed set of possible values. There are certain restricted possibilities available to the language learner in formulating or choosing a grammar for a language based on primary linguistic experience; the form that the grammar takes, and its content, can be directly attributed to the fact that they are in a sense a direct projection of the language faculty onto the linguistic competence of the native speaker.

Chomsky has argued consistently that this perspective about linguistic theory is rational and scientific, virtually indisputable. In fact, it cannot reasonably be disputed, given the presumptions that: (i) a language faculty exists that contains specific syntactic knowledge and (ii) what is left after stripping away the dynamical aspects of language is something that really exists, in some sense, in the mind/brain. What I wish to explore is the question of whether these two presumptions are themselves correct. An alternative view is one that does not eliminate the dynamical properties of language from consideration. I.e., it assumes that the aspects of language that we describe in symbolical terms when we construct grammars are in reality distinguishable time-bound events in the mind/brain. On such a view, there is something in the mind/brain that behaves in a way that can be roughly described by a generative grammar. But

what resides in the language faculty is not linguistic competence **as conceived of by generative grammar**. A generative grammar is not a theory of something that really exists in the mind/brain, but an idealized description of its behavior. A fortiori, the theory of grammar that provides a set of generative grammars as a characterization of the notion "possible human language" is not a theory about the language faculty *per se* and hence not a theory about the mind/brain, except in a very indirect sense as a theory about the kind of behaviors that what is in the mind/brain may produce.

The crucial term in this discussion is "generative grammar," which I understand here to be a formal, symbolic, static characterization of linguistic competence, i.e. an algorithm. The alternative that I will propose does not deny that there is a language faculty, but it holds that what resides in the language faculty is a mechanism of a different sort that **inherently reflects** the dynamical character of language. In particular, it is acquired over time, it is a psychological mechanism used for speaking and understanding, and it undergoes change, both in individuals and in communities. Again, on this view, a generative grammar is an idealized description of how the language faculty behaves, but not a description of the language faculty itself.

By distinguishing between the dynamical language processing mechanism that is in the head and the description of the content of this mechanism, I am recasting the familiar competence-performance distinction. I am suggesting, however, that because it is a complete idealization away from the dynamical properties of this mechanism, our usual account of competence fails to tell us what the language faculty is actually like. The challenge, it seems to me, is to develop an account of this mechanism that is more faithful to the dynamics and at the same time provides an adequate account of linguistic competence.

In the remainder of this paper I sketch out an alternative construal of syntactic theory that is responsive to the dynamical issues. I will suggest that such a theory is "concrete minimalist", in the sense that it eschews formal devices and representations that do not correspond to perceptual and cognitive distinctions available to a plausible learner.³ An unarticulated variant of this intuition may in part be behind the recent minimalist impulse, and I will try to show, in '2, that current Chomskian minimalism may converge in part to concrete minimalism when various empirical requirements are taken fully into account. In '3 I outline the concrete minimalist approach in more detail, and consider its actual implementation. In '4 I propose that something like Jackendoff=s Conceptual Structure (CS) as discussed in this volume and elsewhere forms the universal basis for the learning of syntax. In '5 I explore some of the implications of this approach for the analysis of the syntax of natural language.

I should note that much of what I suggest here is not new; various aspects have either been explicitly proposed and pursued by others, or explicitly considered and rejected. What may be novel, besides some of the details of the concrete minimalist proposal, is the suggestion that we return to issues that were active during the *Aspects* Theory (Chomsky 1965), but set aside in the development of Principles and Parameters, and reconsider them from a broader perspective.

2. Abstract and concrete minimalism

There are several ways in which a minimalist theory can be elaborated. Because space is limited, I will restrict myself to Chomsky's Minimalist Program, which is probably the most widely known at this point.

Chomsky (1995) assumes that there is an abstract, autonomous syntactic component that contains the minimally necessary principles and primitives for descriptive adequacy. I will call this "abstract minimalism". There is a terminological issue lurking here, because what constitutes "syntax" as opposed to some other formal representation (e.g. "semantics" or "LF" or "morphology" or "phonology") is not independently established on Chomsky=s approach. However, I will assume that investigation of the descriptive "limits of syntax" can resolve this

issue satisfactorily.

Abstract minimalism attributes minimal formal machinery to the syntactic theory, and derives predictions from this restrictiveness, in principle at least. What is crucial in this approach is that the computation of every syntactic derivation of a sentence must be minimized with respect to possible alternatives. In addition, the syntactic analysis of an expression incorporates the smallest amount of necessary structure, consistent with the assumptions of the syntactic theory. Such an analysis might actually be quite complex and abstract, in an intuitive sense, if the syntactic theory requires that the syntactic structure satisfy certain formal conditions. In contrast, the syntactic analysis of an expression in concrete minimalism simply incorporates the smallest amount of structure that a learner needs to assume in order to account for the sound/meaning correspondence, no additional presumptions about structure enter in. Assuming that the structure of the meaning is directly available to the learner (it is *Concrete*), the learner minimizes as much as possible the mismatch between sound and meaning.⁴ I will provide elaboration as we proceed.

2.1. Abstract minimalism

In *The Minimalist Program* (Chomsky 1995), syntactic theory has a certain form and a certain content that are dictated by considerations of abstract computational simplicity. In the ideal case, the notion of computational simplicity is independent of the empirical details. The computational system is the simplest system that can be envisioned that can in principle characterize the sound-meaning correspondence. In this sense the computational system approaches "perfection", as well as "virtual conceptual necessity."

The baseline empirical framework is the Principles and Parameters theory, e.g. as summarized in Chomsky and Lasnik 1991. The challenge is to eliminate as much formal machinery as possible while still capturing, in some way, the correct results of earlier syntactic research.

Chomsky's approach is a radical one, in that he eliminates virtually all the formal machinery of the earlier theory. He assumes that there are just two basic operations that together characterize all linguistic objects: Merge, which combines two objects into a single object, and Move, which combines part of an object with the object itself, extending the object. Random composition of two words or phrases will only sometimes yield a well-formed expression; many illegitimate cases will be ruled out by the fact that the result lacks an interpretation at LF. Other illegitimate derivations that cannot be ruled out on semantic grounds are assumed to be ruled out by PF, although how this is accomplished is not entirely clear.

Chomsky's earlier conception of Move (Chomsky 1993) was that alternative derivations competed with one another, the most "economical" blocking the alternatives. Recognizing the computational intractability of this approach, in Chomsky 1995 (Chapter Four) he proposes instead that Move by definition incorporates the following properties:

- (1) a. (Last Resort and Greed) Move a feature to target K iff
 - i. F is an unchecked feature.
 - ii. F enters into a checking relation with the head of K as a result of the operation.
- b. (Minimal Link Condition) \hat{a} can raise to target K only if there is no legitimate operation Move \hat{a} targeting K, where \hat{a} is closer to K [than \hat{a} is].

As seen here, a key component of Chomsky's approach is that movement is formulated as the checking of a strong feature. Consider a strong feature fF_{strong} . When an element \hat{a} with the feature fF_{strong} is introduced into the derivation, by assumption it must be immediately checked and erased by adjoining to its projection a constituent \hat{a} with the feature [F]. Hence movement is

Attraction of $\hat{a}[F]$ by $\acute{a}fF_{,,}$. To the extent that movement correlates with surface order, introduction of $\acute{a}fF_{,,}$ into the derivation is the way to derive a specific word order, in this approach. Crucially, if the feature is purely a formal one, with no morphological or semantic correlate in a given language, then the introduction of $\acute{a}fF_{,,}$ into the derivation is nothing other than a way of saying what the surface word order is. For example, in order to derive the fact that English must have a surface subject, Chomsky proposes that Infl possesses the strong categorial feature $fD_{,,}$, which attracts a DP. This derives the so-called Extended Projection Principle.⁵

On this approach, empirical phenomena that do not conform to the strongest and most restrictive interpretation of what is computationally simple must fall outside of the scope of the theory. This general approach is entirely natural from the perspective of sound scientific method; the question is of course what empirical phenomena are explained and what are not.⁶ There is no obvious way on this approach of accounting for much of what appears in the lexicon (see Jackendoff's article in this volume). Well-known locality conditions such as Subjacency (especially CED and CNPC) and ECP do not follow in any obvious way from his minimalist assumptions (see the paper by Manzini in this volume, but see also Kluender=s paper in this volume); only Relativized Minimality (the Minimal Link Condition) does (but again see Kluender=s paper). Familiar reordering operations such as English Heavy NP Shift and extraposition constructions fall outside of the scope of the theory; Chomsky proposes that they are part of the PF component. Moreover, such phenomena as anaphora, binding, ellipsis, word order and control are not characterizable within this minimalist theory and therefore must fall under LF or PF. Thus this theory is minimalist both in its formal properties and in its descriptive scope.⁷

If this interpretation of Chomsky's Minimalist Program is correct, then it is reasonable to conclude that it does not actually derive much of the Principles and Parameters theory from more basic primitives. Rather, it is equivalent to a very small proper subset of the P&P approach. The introduction of strong features on heads, along with the assumption that underlying branching is always to the right, is equivalent to the parameterization of the directionality of government. The requirement that when \acute{a} and \hat{a} form a phrase one of the two determines the type of the projection effectively captures a core notion of X-bar theory, that of endocentricity (cf. Speas 1990). The rest of X-bar theory presumably falls under LF and the requirement that all derivations be interpretable "at the interface".

According to the approach of Chomsky's abstract minimalism, the scope of "syntax" is highly restricted, and much of what appears to be uncontroversially syntactic turns out not to be syntactic at all. While it is certainly true that this framework can and will be further elaborated, the extremely restrictive formal mechanisms and the failure to accommodate many of the well-substantiated generalizations of earlier research suggest that a different sort of minimalism may be better able to deal with the empirical demands placed on any syntactic theory.

2.2. Concrete minimalism

2.2.1. The role of learning

The basic difference between abstract and concrete minimalism is the domain over which computational complexity is defined. In abstract minimalism, computational complexity is defined over the set of syntactic derivations. The explanation for why syntax is the way it is is thus an *a priori* one: syntax is the way it is because it is computationally as simple as can be imagined and still characterize a minimal part of the sound-meaning correspondence. Why syntax should be computationally simple in this way is not clear.⁸

Abstract minimalism derives the elimination of unnecessary structure from the principle that language approaches a "perfect" system that is imperfect because it is spoken, i.e. that it has dynamical properties. Concrete minimalism derives the elimination of unnecessary structure from the principle that a learner will fail to hypothesize a structure in the absence of concrete

evidence that supports it. The grammar according to concrete minimalism is actually what is in the head, a performance mechanism that embodies knowledge of language. The grammar according to abstract minimalism is also what is in the head, but in this case it is the native speaker's linguistic competence, the internal state of the native speaker's language faculty (Chomsky 1995:15)

In some cases the two approaches may arrive at the same or similar conclusions, but for different reasons. For example, under abstract minimalism, there have been proposals to "avoid structure"⁹ that is not associated with morphology, on the grounds that positing such structure violates minimalist principles. Concrete minimalism provides a computational foundation for such minimalist principles, to the extent that they are correct, by taking the maxim "avoid structure" to be a fundamental, architectural property of the computational mechanism that engages in language acquisition. That is, it is not simply that such a principle is **observed** by the learning mechanism, rather the learning mechanism is a device which **by its very nature** will postulate the minimal structure consistent with any given sound-meaning correspondence. As I suggest in '3, an adaptive dynamical system has just this architecture.

2.2.2. Dynamical properties of language

When we take seriously the notion that a language is learned, we must deal with the fact that learning, along with language change and language processing, is dynamical; that is, it occurs in time. The classical formulation of a generative grammar as a set of relations on symbols takes its purest form in abstract minimalism, which thus becomes singularly unsuitable as a basis for accounting for dynamical aspects of language.

It is typically argued (e.g. Chomsky 1995:19-20) that the idealization away from such factors is a sensible one in that it allows us to focus on the core properties of language by abstracting away from peripheral phenomena that arise out of historical accident, dialect mixture, personal idiosyncracies, and the like. While such idealization is of course plausible, and cannot be argued against in principle, the possibility exists that at some point what remains in the execution is no longer about human language. This possibility can arise if the idealization abstracts so much from accidental factors that it cannot **explain why** natural language is the way it is, how it is acquired, why it changes, and how it is used by native speakers.

It is of course possible to import dynamical considerations back into the framework of generative grammar. The standard approach to language acquisition in theoretical linguistics, for example, is to assume that a learner constructs a sequence of generative grammars on the basis of "triggering" experiences, perhaps with a maturational component that produces the appearance of development over time in the absence of concrete experience. Similarly, language processing is conceived of as the province of processing mechanisms that are constructed in the mind on the basis of the content of the formal grammar. Such mechanisms assign to linguistic representations the structural descriptions stipulated by the generative grammar, and may be constrained by principles that are incorporated into the grammar as a consequence of the theory of grammar. However, such dynamical overlays do not provide an **explanation** for the dynamical properties of language, but simply augment the static description of a generative grammar with dynamical mechanisms.

Moreover, there are serious problems with the classical view that all of the possible alternative generative grammars for natural languages are wired into the learner, waiting to be triggered by the appropriate experience, as discussed in Culicover (1995). Unfortunately, space limitations prevent me from elaborating at length here. Briefly, the main puzzle concerns the course of language acquisition, which appears to have no basis in the classical architecture of triggering.¹⁰ The main paradox is that triggering requires prior sentence processing ability to allow for the analysis of sentence structure; given this ability, it is not clear what is to be learned, but everything that is actually learned cannot realistically be considered to be wired in. A

plausible conclusion is that there are learning mechanisms for aspects of language that do not require triggering and that such mechanisms can in principle be extended to account for language acquisition in general.

2.2.3. Correspondences

Let us assume that there is in the human brain a region that has evolved for the purpose of mapping the sound-meaning correspondences (SMC). This is what corresponds in the concrete minimalist approach to Universal Grammar. Extending the familiar notion somewhat, I will take the lexicon to be the repository of all of these SMCs, following essentially the work of Jackendoff (1990) in this regard.¹¹ The following three types of SMCs are represented in the lexicon.

(2)

Lexical entry	Conceptual structure	Relation
Single word	Simple concept	Atomic concept (e.g. GO)
Single word	Complex concept	Complex concept (e.g. <i>assassinate</i>)
String of words	Single or complex concept	Idiom

In addition, there are productive and quasi-productive correspondences between sound and meaning. Productive relationships are said to be "compositional", although compositionality is a somewhat more restrictive notion than productivity. Quasi-productive SMCs are those that are partly idiomatic, such as idioms with internal arguments, e.g. *sell NP down the river*. Finally, as Ray Jackendoff and I have argued (Culicover and Jackendoff 1995b) there are paratactic constructions where the precise description of the syntax-meaning correspondence is *sui generis*. An example is the construction *the more ... the more* in English and similar constructions in other languages. (3) summarizes.

(3)

Syntactic structure	Interpretation	Relation
Idiom/variable	Idiomatic	Quasi-productive (e.g. <i>sell NP down the river</i>)
Parataxis	Quasi-idiomatic	Productive but idiomatic at the locus of parataxis (e.g. <i>the more.. the more...</i>)
Phrase structure	Compositional	Productive (e.g. V NP)

While the lexicon is responsible for the SMCs in (2), it is the role of syntax to express the productive SMCs and the productive part of the quasi-productive SMCs.¹²

Let us compare this perspective with that in an abstract minimalist approach. Recognizing the fundamental primitive character of the head/complement relation in determining

interpretations, Chomsky's Merge operation allows for the composition of any two arbitrary words and phrases; only those for which there is an interpretation.

- (4) a. Merge: link \acute{a} and \hat{a} , i.e., form $\langle \acute{a}, \hat{a} \rangle$ or $\langle \hat{a}, \acute{a} \rangle$.
b. $\langle \acute{a}, \hat{a} \rangle$ must be interpretable (Chomsky's Full Interpretation).

Chomsky's formulation of minimalism omits the specification of constituent order from syntax, relocating it into Morphology/PF. Under a concrete minimalist approach, however, linear order paired with conceptual structure, and not syntactic structure, is the most salient information for the learner.¹³ Reduced to its fundamentals, the task for the learner is to acquire the correspondence rules that will generate the full set of such pairings.

So, let us take $\langle \acute{a}, \hat{a} \rangle$ to be the relation of linear precedence such that there is a dependence of \hat{a} on a head \acute{a} , as in Manzini's work (this volume). What emerges is a theory in which the pair $\{\acute{a}, \hat{a}\}$ is assigned an interpretation $\mathbf{M}(\acute{a}, \hat{a})$ on the basis of the semantic properties of \acute{a} and \hat{a} , and is assigned a linear precedence, either $\langle \acute{a}, \hat{a} \rangle$ or $\langle \hat{a}, \acute{a} \rangle$ depending on the evidence. There is not enough space here to pursue a multitude of issues that are important in such a "linearization" account, including whether linearization is capable of "wrapping" the daughters of one constituent around another that is semantically external to it; I see no reason in principle to exclude such a possibility. Crucially, orders that cannot be incorporated directly into a correspondence rule will thereby become the province of transformations (or the equivalent) between discontinuous parts of a phrase marker.¹⁴ The key point here is that the correspondence rule incorporates the linear precedence; it is not a product of some operation on phrase markers.

What is it about \acute{a} and \hat{a} that determines the assignment of linear precedence? What in fact occurs, I suggest, is that autonomous syntactic categories form as a consequence of the following sequence of events in the course of language acquisition.

- (5) Stage 1: Linear precedence relations are represented as orderings between individual lexical items.
Stage 2: Lexical items of the same semantic type that bear the same ordering with respect to other lexical items are reorganized into syntactic categories.
Stage 3: Morphological properties of lexical items are associated with the particular categories.
Stage 4: Strings of words headed by an element of a particular category (phrasal projections) are analyzed as being members of the same category as the head.
Stage 5: Linear precedence relations are reconstrued as orderings between morphologically determined syntactic categories.

The sequence of events summarized here recalls the notion of bootstrapping (especially Pinker 1984, but see also Lebeaux 1988 and Gleitman 1990) where the category is established on a core semantic basis and then generalized to the point that it becomes syntactic.

A crucial aspect of this approach is that the initial choice of syntactic category in the course of learning is determined by a universal semantic basis, e.g. CS (Jackendoff 1983; 1990). But syntactic categories in natural language do not have a unique CS characterization; for example, not all nouns denote concrete objects. For the further development of syntactic categories, there are essentially two options. First, we could assume that there is a universal inventory of syntactic categories from which the learner chooses, and second, we could assume that the development of a syntactic category is determined by the specific properties of the language, that is, of the input to the learner. I will suggest that the latter option is the correct one, as I sketch out the properties of the language acquisition mechanism that constitutes the

foundation of the concrete minimalist approach.

3. An adaptive dynamical approach to syntax

In order to develop the ideas of concrete minimalism I will now explore a non-standard but not entirely unfamiliar way of thinking about the acquisition knowledge of language sketched out in (5), one that may be called "adaptive." Since the particular adaptive theory that I will be proposing is a dynamical theory, I will refer to this approach as "A-theory"¹⁵. The proposal that an adaptive approach is in general a more satisfactory way of accounting for the representation of linguistic competence, and of cognition in general, is familiar from connectionism, but the basic idea is independent of any particular computational implementation.¹⁶ Connectionist approaches are attractive from the perspective of language acquisition because they appear to approximate in a more or less natural way the growth of complex knowledge on the basis of experience. However, a standard criticism of many connectionist proposals regarding language is that while they may show how a **language** as a set of sentences can be acquired by some device, at best they display "nothing more than a superficial fidelity to some first-order regularities of language" (Pinker and Prince 1989; see also Lachter and Bever 1989). According to this critique, a connectionist learning model that employs distributed "sub-symbolic" representations does not explain why a **grammar** takes the form that it does. Presumably such a model would be able to identify regularities in a body of data that were not representative of natural languages as easily as it accommodates real natural language phenomena. Moreover, it has been suggested that there are severe limitations on the representational capacity of connectionism that are significant in regard to language.¹⁷

The adaptive view is of course by no means widely accepted in linguistics, however, and bears further elaboration, particularly in regards to the relationship between the acquisition of knowledge and the particular formal organization of this knowledge in the mind/brain. Moreover, the particular characterization that I will propose here differs in certain respects from many of those in the literature.¹⁸ And connectionist approaches have been notably deficient in failing to address, for whatever reason, the rich array of phenomena unearthed by linguistic theory in the past forty years. The descriptive successes of modern linguistic theory constitute a minimum criterion of success for any alternative (including, it should be stressed, minimalist proposals).

On the A-theoretic approach we use the metaphor of a *Aspace@*, which we will call Syntactic Space, in which individual lexical items occupy particular positions.¹⁹ The organization of this space reflects the syntactic, semantic and morphological similarities and differences between items. On the grossest scale, all nouns will be located in one distinguishable region, while all verbs will be located in another. Within each region there will be further organization reflecting subcategories and idiosyncracies of individual items. Since the space is multidimensional, proximity on one dimension does not entail proximity on any other dimension.

To extend the spatial metaphor to acquisition, we imagine that Syntactic Space is composed of a soft material that undergoes deformation as a product of experience. The more a particular item is encountered and processed, the greater the deformation of the corresponding region of the space. In this way, the space retains a memory for past experience that reflects both qualitative and quantitative aspects of the experience.

As a first approximation, we may think of exposure to individual instances of a linguistic expression to be equivalent to a drop of liquid from above dripping onto a particular point in the soft material; this produces a small depression. Greater exposure to a particular element or pattern corresponds to greater dripping in the relevant region of the space, hence a deeper and wider depression in that region. Intuitively, phrases are represented by the passage of the liquid between regions of this space and recursion by linkages from regions directly or indirectly back to themselves.

Next, suppose that the representation of linguistic expressions in Syntactic Space is

dynamic, in the sense that what corresponds to a linguistic expression is a **trajectory** with extent and direction, not just a set of linked regions (see Elman 1995). Understanding or producing a sentence then involves traversing a particular path through the space; thus there is activation of different regions (in fact, points) of the space in some time sequence. By assumption, if a particular trajectory has been traversed, subsequent traversal of it requires less energy; the system is in this sense adaptive. Syntactic generalizations (such as phrase structure rules) correspond to regions of uniform flow within this space; that is, sets of trajectories that more or less parallel one another, that link neighboring points in some region.

On this view, a flow is like a trough, or a rut, in Syntactic Space. If such a flow exists, this does not mean that every trajectory within the region of flow has been traversed as a consequence of experience. But traversing a new trajectory within the region of flow requires relatively little energy, as does traversing a previously laid down trajectory. We assume that a sentence is judged grammatical if traversing its trajectory requires little energy.²⁰ In effect we have the core of a solution here to the so-called Projection Problem (Peters 1972), the problem of how one goes from finite experience to an infinite grammar. The lowering of the energy level for numerous closely related trajectories (e.g., those corresponding to verb-NP sequences) produces a lowering of the energy level for all trajectories within the same region of flow, even those that have not been encountered through direct experience. That is, the architecture of the system is such that there is **local** generalization as a consequence of the establishment of regions of flow.

Now comes a key point. This architecture does not produce **maximal** generalization. For example repeated experience of *wh*-fronting of direct objects of simple sentences does not generalize to unconditional Move \acute{a} (Chomsky 1981). Taking the regions of flow to correspond to the expressions of the language that are judged grammatical, it follows that all expressions corresponding to trajectories through areas **outside** of the region of flow will be judged ungrammatical, even in the absence of direct or inferred negative evidence. Thus the poverty of the stimulus produces specific knowledge after a period of learning, without any additional computation.²¹

To understand this notion more fully, imagine the cross-section of a region of this space. Prior to the establishment of a flow, the region is flat, and the cross-section is a horizontal line. A single trajectory produces a small depression, a channel with sloping sides; closely related trajectories produce a larger depression in the same region. As the depression deepens, the walls of the depression become higher, and it becomes more difficult to move outside of the region of flow from a point within the flow. In effect, learning a language involves getting into a rut (or series of ruts). The more of our language we learn, and the more we learn our language, the more difficult it is to get out of these ruts.²²

A common view of adaptive approaches, and the basis for a fundamental criticism, is that they are essentially associationistic (Bever 1992). But the approach that I am suggesting is not strictly associationistic, to the extent that it permits self-organization and local generalization. Imagine that there are isolated cases that are not as strongly supported by experience as the vast majority. We may hypothesize, not implausibly, that such isolated cases are eliminated through self-organization of the region, essentially a local generalization process. The assumption of local generalization produces interesting implications that I will turn to in the next section.

Learning on this model does not proceed by triggering, but by accretion, self-organization and local generalization. A mistaken hypothesis, should it arise on the basis of particular experience, will not be sustained by future experience; the region of space that it occupies will eventually be absorbed by the "correct" cases. With sufficient experience, an idiom will produce a stable but restricted region of the space that is outside of the general region of flow. A subregularity will occupy a well-defined subregion, its boundaries may be somewhat ill-defined, but it will be able to coexist peacefully and stably with other general patterns. In effect, the size and stability of a region of this space corresponds initially to the statistical

properties of the input, prior to self-organization.²³

So it is natural to interpret the A-theoretic model in the following way: if every trajectory in a region of flow were realized, the result would be (more or less) equivalent **in content** to the linguist's idealized grammatical description of the knowledge of the native speaker. Such a configuration would be the result of exposing the learner to infinite experience of the language to be learned over infinite time, effectively idealizing away from dynamical considerations.

4. Minimal Conceptual Structure

As noted, a standard criticism of the A-theoretic approach to language is that it may show how a **language** as a set of sentences can be acquired, but it does not explain why a **grammar** takes the form that it does. On the standard view in linguistic theory, the explanation resides in a syntactically specified Universal Grammar, which A-theory lacks. For example, UG contains a specification of what the possible lexical categories are, and the learner simply determines the best match to the input data.

The question naturally arises, if there is no UG with a universal inventory of syntactic categories, how does the learner figure out which words belong with which in the first place? The answer must be that those strings that exemplify genuine syntactic categories must correspond or be systematically related to elements in a representation that is external to linguistic form. Just as we correlate particular patterns in various areas of our visual cortex with particular patterns on our retina, so must we correlate particular patterns in Syntactic Space with particular patterns in some other domain. An obvious choice for this other domain is something along the lines of Conceptual Structure (CS; see Jackendoff 1990). CS posits a language-independent inventory of conceptual categories (e.g. object, place, time, property, etc.) and expresses knowledge of the world as a set of representations of the individual's experience in these terms. Human children must have CS representations in order to maneuver around the world and to manipulate it, and non-linguistic animals must have similar (although less complex) representations for the same purpose.²⁴

As a first approximation, I will assume that CS has representations for physical objects corresponding to nouns, for concrete actions corresponding to verbs, for predication and the subject-predicate relation, and for operator-variable binding structures.²⁵ I hypothesize that the connection with CS is sufficient to bootstrap the syntax;²⁶ once the sentential core is up and running, there can be significant divergences between CS and syntax.²⁷ For example, while recognition of physical objects establishes the syntactic category of NP, not all NPs refer to physical objects. Their NP-hood is morphologically marked, however. On the other hand, while verbs and adjectives express relations, not all languages distinguish them morphosyntactically. The general idea is that CS gets the syntactic categories off the ground, while morphology and semantics together do the rest.

On this view, it is possible for the learner to establish the structure of VP only after it has firmly established the categories V and (simple) NP.²⁸ The structure of S (or IP) can be determined only after the structure of VP has been established. Without a prewired X' theory and without explicit maturational principles for syntax, the general pattern of development that we would expect is that phrase structure develops from the bottom up, which appears to be more or less attested by the empirical studies (e.g. Radford 1990, Wexler 1994, Rizzi 1993, although with somewhat different theoretical interpretations).

The fact that the growth of mean length of utterance in learners follows the degree of exposure to the basic vocabulary (Bloom 1970) and rises dramatically at around age 3 is an immediate consequence. The learners must first establish basic properties and meanings for individual verbs and nouns, then they must learn the correct way to link them (e.g. linear precedence). After sufficient experience with individual items and phrases, categories and flows begin to develop and local generalization occurs.²⁹ At this point we move from individual cases

to an approximation of phrase structure.

Moreover, the assumption that the mental representation is essentially a record of the experience, prior to local generalization, and that this record forms the sole basis for subsequent linguistic behavior, provides us with a preliminary way of explaining why it is that children behave as though they are setting parameters instantaneously on the basis of a single experience and never produce the full array of logically possible syntactic structures in the course of learning.³⁰ In effect, the knowledge that e.g. the verb precedes the noun phrase in English or that Italian has pro-drop is exemplified in the earliest experience and is overwhelmingly supported by the evidence. The intriguing cases are, of course, those where what appears to be learned is not so exemplified or supported, and for such cases we will need to understand the intricacies of conflicting or interacting local generalizations.³¹

5. Syntactic theory

5.1. General consequences

Let us contrast the A-theoretic perspective with the more traditional one within linguistic theory. Elsewhere (Culicover 1995) I have called the classical approach "Triggering-theory" or "T-theory" in order to highlight its reliance on the notion that the learner makes a choice of grammar that is triggered by exposure to specific linguistic input. In T-theory, the grammar is a characterization of the possible structures of a language; the grammar is translated into mechanisms for speaking and understanding that implement the knowledge expressed in the grammar. In A-theory, on the other hand, the grammar is embodied in the performance mechanism that resides in Syntactic Space, through the particular flows that are established.

Another difference between classical T-theory and A-theory concerns the character and content of Universal Grammar. In T-theory, UG is a set of principles that determine possible grammars. UG is a specifically **syntactic** theory. In A-theory, the core of the grammar is determined by Conceptual Structure and is projected into Syntactic Space. Thus, "core grammar" in the classical sense is not syntactic but essentially semantic. It does not follow that development is thereby "essentially uninteresting for a theoretical linguist" (Rizzi's 1993). This is because, unlike Rizzi, I would take the adult system to be a more elaborated version of the developing system of the learner, not a radical departure from it (as would be a shift from a "semantic" to a "syntactic" grammar, for example).

This characterization of core grammar recalls Chomsky's early distinction between the core and the periphery, more or less overlooked in recent work. In fact, as I noted earlier, Chomsky (1995) explicitly excludes certain peripheral constructions from the domain of syntax. On the current view, the core is determined by Conceptual Structure; the periphery, on the other hand, is strictly syntactic and in fact forms the "core" of autonomous syntax for a given language. Autonomous syntax is everything syntactic that cannot be explicated purely in terms of CS, i.e. the unpredictable sound-meaning correspondences in (3) that fall within the domain of the correspondence rules, as well as the word order and case marking phenomena that designate particular expressions as bearing certain grammatical roles (f-structure in LFG; see Bresnan 1982).³²

The resulting theory differs in significant respects from recent proposals; here are some of the obvious differences, many of which are far from innocuous in the context of much current thinking about grammar.

- (6) a. Apparent constraints on movement or on representations are the consequence of syntactic complexity or processing considerations, and are not an explicit part of the language faculty.³³
- b. The universal core of the syntax is a projection from CS, and what remains can

- vary unboundedly, subject to independent conditions of interpretability and complexity.
- c. There is no bound on the possible syntactic categories. What can be a subcategory in one language can be a distinct category in another language.³⁴
 - d. Semantic interpretation of syntactic structure is not uniformly compositional; there can be complex syntactic structures with particular idiomatic interpretations (Jackendoff 1990; Culicover and Jackendoff 1995a,b;1996; Goldberg 1995).
 - e. Binding theory properly resides in CS (Culicover and Jackendoff 1995a) and is therefore resident at the earliest stages (Crain 1991).³⁵
 - f. There are no substantive parameters, that is, no abstract grammatical parameters whose settings produce clusters of superficial grammatical differences between languages, and no strong and weak morphology.³⁶
 - g. There is no syntactic level LF and no LF movements.³⁷
 - h. The notion of competence *per se* is absorbed by performance in the A-theory, since the generalizations and exceptions that constitute the native speaker's knowledge of language are entirely incorporated into a computational mechanism for assigning interpretations to linguistic input.
 - i. Movement need not be and perhaps is never triggered by morphosyntactic agreement, but by the need to articulate with information structure.³⁸

Space limitations preclude the discussion all of these consequences here. I will discuss in detail just the first.³⁹

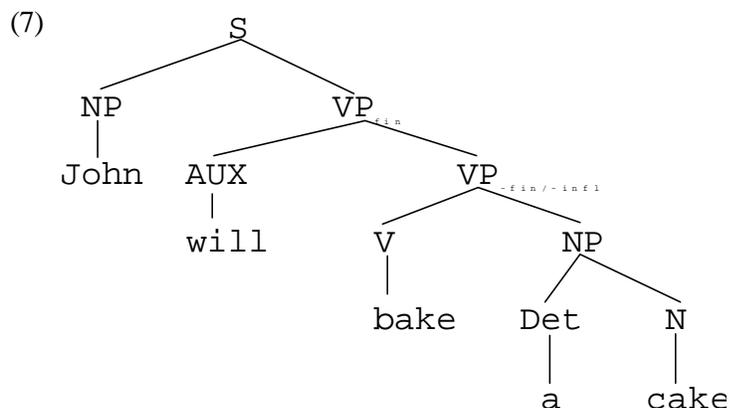
5.3. Constraints on extraction

It should be clear that on the A-theoretic approach, a constraint cannot be motivated as it was on the T-theoretic approach (see Wexler and Culicover 1980), that is, on the grounds that it restricts the space of hypotheses. In fact, on the A-theoretic approach the learner does not formulate hypotheses in an interesting sense, since every experience is encoded as a trajectory in Syntactic Space that is linked to some CS representation. To the extent that there is generalization (a form of hypothesis), it is very local, and occurs only after experience has substantiated the limits of a construction. For example, after encountering numerous V-NP sequences, the learner may generalize the flow of trajectories from the entire region V to the region NP.⁴⁰

On the A-theoretic approach, apparent constraints must come from one of two sources: either they correspond to regions of Syntactic Space that are relatively difficult to traverse as a consequence of lack of experience, or they are reflections of processing limitations.⁴¹ I will only try to give an example of the first type of explanation here. An argument that ECP *that-t* effects are of the second type is given in Culicover and Levine (1995).

I will appeal to a notion of relative complexity defined over syntactic structures. The basic idea is that the possibility of a movement chain in a simple structure does **not** generalize globally to more complex domains. The idea of global generalization is a natural one if we think of linguistic knowledge as a grammar that contains something of the form Move α , but not if we think of it as a set of dense flows in Syntactic Space.

We can actually use traditional phrase structure trees to represent trajectories, if we are careful to keep in mind that these trees have an interpretation in A-theory that is different from the usual one. For example, consider the following Standard-Theory-type structure for the sentence *John will bake a cake*.



Our interpretation of this structure as a trajectory for a canonical sentence is that the trajectory begins at the NP-region and specifically the noun *John*, then visits the VP_{fin} subregion of the region VP. In this subregion the trajectory visits *will* and then recurses back into VP, but this time it visits the nonfinite uninflected region of VP. And so on.

On this approach, one way to represent the trajectory for a *wh*-question, such as *what will John bake*, would be as in (8).⁴²

(8)

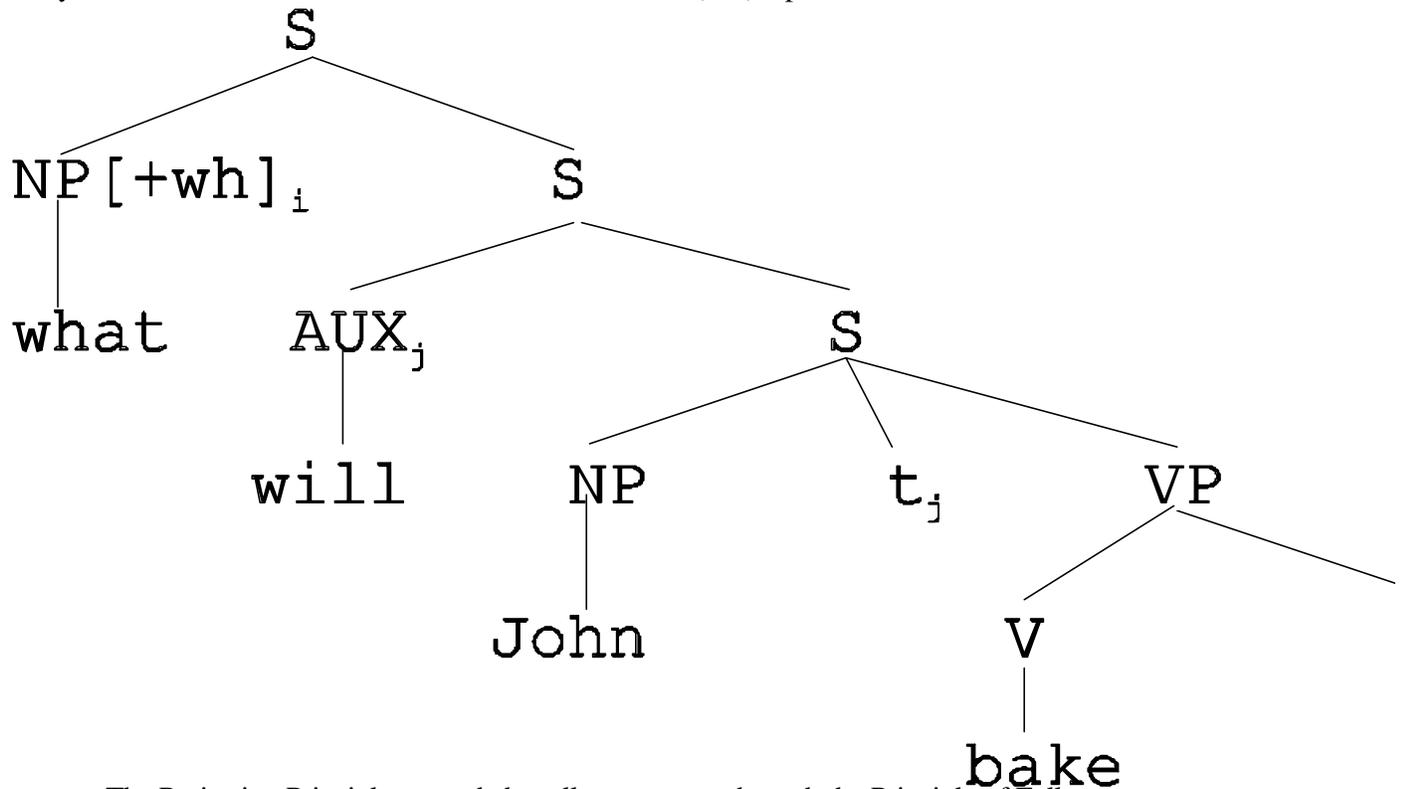
Here, the *wh*-question is viewed as Aparasitic@ on the declarative, in that the basic trajectory of the declarative is shared with the *wh*-question. The coindexing of traces and antecedents would represent the fact that the grammatical functions of the displaced elements *what* and *will* are determined by the positions of the traces. On the other hand, we could simply say that the structure of *what will John bake* has no traces and that the overlap in grammatical functions is a product of the rules of interpretation.⁴³ This latter approach is an entirely natural one in an approach in which the formulation of correspondence rules is sensitive to the linear precedence order of elements.

These approaches are of course both well-attested in the transformational and non-transformational literature, and I see no reason why they cannot equally well be translated into a theory in which trajectories replace structures. However, I would like to offer still another possible view here that is not a reformalization of a traditional approach. Let us suppose that the dislocation of elements in Amovement@ constructions involves relocation not of the **constituent** in the structure/trajectory, but simply of the **phonological content** of the constituent. In effect, the **structure** of *what will John bake* will be exactly the same as that of *John will bake a cake*. The trajectory will be the same, as well, except that it enters the sentence not at NP, but at *what*, where the phonological processing is initiated, and then visits NP as the initial constituent in S. The phonological processing of the *wh*-phrase is in a sense a Adown payment⁴⁴ on the direct object, which is otherwise processed *in situ*. This picture contrasts sharply with that proposed by Chomsky (1995), in which movement dislocates all features, including the phonological ones.⁴⁵

We can make the following sense of the Projection Principle in these terms. Suppose that the learner has established a strong link between V and NP regions corresponding to the set

of predicates in CS. The introduction of dislocation, e.g. through *wh*-Movement, can be dealt with by the learner by linking the dislocated *wh*-phrase to the canonical argument position, effectively a trace or copy. Similarly for other displacements from the canonical order, including SAI, topicalization, and focus movement. We presume, of course, that it is a property of the architecture of the system that it will seek to reduce novel trajectories to existing trajectories wherever possible. Possibly the operator-variable interpretation of a *wh*-question at the level of CS will facilitate this step.⁴⁶

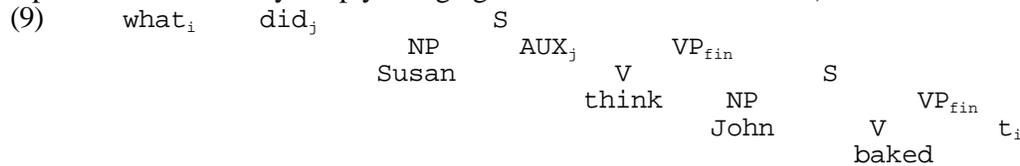
For each case of putative movement it is an empirical question, it seems to me, whether to treat it as a case of displacement from a canonical structure, or to treat it as a distinct construction. In the case of V-raising and similar obligatory movements that produce Aabsolute neutralization@, it is difficult to argue for movement on a concrete minimalist basis unless we can argue that the independently available CS representation is not isomorphic to the surface representation. When there are phonologically overt alternations, an argument can be made for dislocation from a canonical structure only if an argument can be made that one structure is canonical while the other is not. That there are canonical structures in some languages, at least, has been the intuition of many linguists for many years. Whether we can find an empirical basis to substantiate this intuition is not clear, although it is reasonable to speculate that the order in which particular constructions emerge in the course of language acquisition would constitute evidence along these lines. The fact that *wh*-questions and subject-aux inversion are acquired later by children learning English than the standard S-(AUX)-V-O construction suggests that the analysis in terms of dislocations of canonical structures is (still) a plausible one.



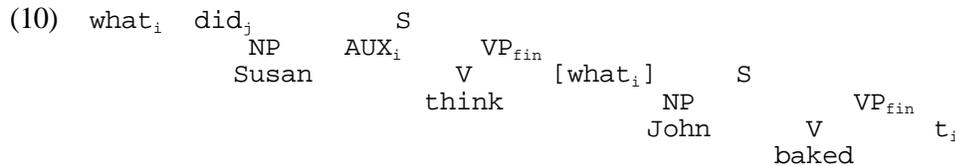
The Projection Principle, extended to all movements through the Principle of Full Interpretation (Chomsky 1986), is a natural stipulation in Principles and Parameters theory and the Minimalist Program, along with the very existence of traces and their particular properties. On the current approach we can provide a foundation to these aspects of syntactic theory in

terms of a learning mechanism that builds minimally on previously established canonical structures. Crucially, these results can be made to follow from an A-theoretic architecture, one in which canonical structures establish themselves early in the course of acquisition. Furthermore, this approach entails that there is no movement in subject *wh*-questions such as *who called?*, a conclusion shared by many.⁴⁷

Consider now an embedded sentence. The trajectory must be newly learned; it does not follow from the trajectory of the simple sentence since the simple sentence does not involve recursion through S. By assumption, generalization is local and does not extend to novel structure, so there is no way to generalize from the pattern in (8) to the pattern in (9). (Here I represent dislocation by simply stringing the elements out to the left.)



A similar argument holds of course for extraction from relative clauses, adjuncts, and so on. In fact, the natural generalization of the simple *wh*-question to extraction from a complement would involve the trajectory in (8) as a subtrajectory. The way to achieve this result is to link the pattern in the higher clause through the initial position of the lower clause; effectively an intermediate trace, as in (10).



What needs to be learned for (10) is that, for certain verbs, dislocation can be extended from a lower clause to a higher clause. In structural terms, there can be a trace in complement-initial position linked to a higher antecedent. The trajectory within the complement is already acquired; it corresponds to (7)/(8). Thus this representation embodies successive cyclic movement in the "Conditions" framework of Chomsky (1973), and more recent instantiations of the same idea (such as the copy theory of movement). The minimalist picture that we arrive at is similar in respects to that of Chomsky (1995, especially chapter 4), but it is much closer to the classical GB/P&P account in that it does not (in fact, cannot) use the presence of a functional head to trigger each step in the movement.

We can also see in the use of (8) to construct (10) a possible basis for the phenomenon of partial *wh*-Movement and copying discussed by de Villiers, Roeper and Vainikka (Roeper 1990; de Villiers, Roeper and Vainikka 1990), and Thornton and Crain (Crain 1991, Thornton 1990; Crain and Thornton 1994, forthcoming).

Recapitulating, the idea is that the regions of Syntactic Space corresponding to more complex extractions are attainable, but only on the basis of positive experience. Failure to experience more complex extractions leads to a state of affairs in which such extractions are judged to be ungrammatical, in the sense introduced earlier; the corresponding regions of Syntactic Space cannot be easily traversed. Locality constraints such as Subjacency follow, then, not from learnability considerations but from the relative complexity and accessibility of structures.

On this view, violations of Subjacency are possible, but less highly valued by the learning mechanism, other things being equal. We thus allow for languages like Italian, Swedish

and Hebrew, where extractions from *wh*-islands and relative clauses are possible.⁴⁸

If a learner is exposed only to examples that satisfy Subjacency, after sufficient experience violations of Subjacency will be relatively inaccessible. It will therefore appear to be the case that in the absence of positive evidence, the learner "knows" that Subjacency cannot be violated. But if the learner is exposed to "violations" of Subjacency in sufficient quantity, the learner will come to "know" that Subjacency can be "violated", albeit under certain conditions. Given that there is some type of independent complexity metric, it will be computationally more costly to do so, but not impossible.⁴⁹

In this way, the A-theory eliminates the argument from the poverty of the stimulus so often cited as evidence for innate knowledge specific to language, without requiring direct negative evidence in exchange.⁵⁰ What is wired into the system is not that Subjacency is a constraint, but a complexity metric that renders violation of Subjacency less highly valued. We have thus returned to the perspective of Chomsky (1964; 1965; 1981), where a more "marked" alternative is possible if there is specific evidence to support it. A-theory provides us with a natural way of capturing the markedness phenomenon.⁵¹

Notice that this approach will account not only for Subjacency phenomena, but might allow us to induce a more extensive hierarchy of extraction possibilities. Suppose we take the subject/predicate split to be a fundamental feature of CS, and in fact ontogenetically prior to all properties of CS representations. Let us assume, crucially, that subjects are thereby prototypical arguments in CS, in the sense that any property of *Aargument@* will be a property of subjects, other things being equal. Given the centrality of the lexicon, arguments governed by verbs are the next most prototypical, and after them come adjuncts. Let us combine this hierarchy with that associated with the complexity of sentences due to embedding of clauses

- (11) a. SUBJECT > OBJECT > PREPOSITIONAL OBJECT > ADJUNCT
b. SIMPLE > FROM SENTENTIAL COMPLEMENT > FROM SENTENTIAL ADJUNCT (CED)

Suppose that this hierarchy determines the direction in which the system generalizes. That is, extraction of an argument entails extraction of a subject, but not vice versa, and so on. The accessibility of extraction then appears to be more or less determined by (11), where the subject is immediately accessible, the arguments of the predicate next, and so on. Also, extraction within a simple clause is more accessible than long extraction. This formulation appears more or less consistent with the work of Keenan and Comrie (1977) on NP accessibility, and with the fact that there are languages (like Russian and varieties of German) that allow simple *wh*-movement but not extraction from sentential complements. Moreover, such a hierarchy recalls the notion of *o*-command used in the analysis of binding in HPSG (Pollard and Sag 1992), and may prove to be a partial foundation for such hierarchical generalizations.⁵²

6. Summary

In summary, I have proposed that the foundations of minimalist syntax ultimately reside in the theory of language acquisition, and that the proper way to view the language learner is in terms of adaptive learning. On this view, the grammar is the embodiment of the knowledge that the learner has about the language, as realized as patterns in the learner's experience. This approach, if successful, would account for the full range of linguistic knowledge in relatively uniform terms, as opposed to other minimalist approaches, which tend to exclude certain phenomena on principled, but weakly motivated, grounds. I suggest that Conceptual Structure may provide the universal basis for the construction of the core of syntax, but that beyond the core, syntax is autonomous and can vary in idiosyncratic ways from language to language. The variations are expressed in terms of correspondence rules in the sense of Jackendoff (this volume). I speculate that *Amovement@* involves simply the dislocation of phonological material, the syntactic

structure remaining unchanged, and that there can correspondence rules that deal with such relations, as well. Apparent constraints on movement are the product of a principled notion of computational complexity governing the formation of this latter type of correspondence rule, and arise from the architecture of the adaptive dynamical system.

1. I owe many of the ideas in this paper directly or indirectly to my collaboration with Andrzej Nowak. For helpful discussion and clarification of many of the issues, I wish to thank the participants in the 1996 Summer Syntax Seminar at Ohio State: Richard Danforth, Karin Golde, Robert Kasper, Robert Levine, and Tara Norcross. I am particularly grateful to Andreas Kathol and Louise McNally for their extremely helpful comments, criticisms and suggestions.
2. Such as myself.
3. As Andreas Kathol (p.c.) points out, much turns on what we take to be Aplausable@.
4. Thus, the concrete minimalist analysis and the abstract minimalist analysis will be the same if the former takes as the representation of meaning what the latter takes to be D-structure or the equivalent. Hence much turns on how we represent meaning. For example, if the meaning of a simple sentence like *Chris ate the cake* has an analysis part of which is isomorphic to the Aexploded@ Infl analysis of GB theory and later work, this structure will be available to the learner and will drive the learner=s hypothesis about syntactic structure. I assume, however, that the analysis of meaning is formulated in terms of semantic categories that in general do not correspond to morphosyntactic categories or classical syntactic structures (for discussion, see Jackendoff 1983;1990). Thanks to Andreas Kathol for raising this point.
5. Space limitations do not allow me to pursue in detail the empirical consequences of Chomsky's proposal. I note in passing that there is abundant evidence that in the English Stylistic Inversion construction the [Spec,IP] position is occupied not by DP, but by PP, AP or possibly even VP (see Stowell 1981, Bresnan 1994, Coopmans 1987, Hoekstra and Mulder 1990, Culicover and Levine 1995). If this is correct then Chomsky=s account of the Extended Projection Principle in categorial terms cannot be correct.
6. Thanks to Louise McNally for helping to clarify this point.
7. Of course, to say that extraposition is part of PF rather than syntax does not change any of the properties of extraposition, only what we understand APF@ and Asyntax@ to consist of. Extraposition is still syntactic in the naive sense, in that it involves the arrangement of constituents in a sentence. Its properties must still be acquired by a language learner, to the extent that they are not universal.
8. For discussion, see Johnson and Lappin (1996).
9. Rizzi (1995); see Rizzi (1988, chapter 3) for a precursor.
10. This is not a new criticism of the triggering perspective; it has been standard ever since its inception.
11. The general perspective taken here is shared with that of Construction Grammar; see Goldberg (1995).
12. It would appear to be natural to extend the chart in (3) to sentence mood but I will not pursue the matter here.
13. Chomsky (1981:10) writes AIt would, for example, be reasonable to suppose that such

concepts as >precedes= or >is voiced= enter into the primitive basis [for UG], and perhaps such notions as >agent-of-action= if one believes, say, that the human conceptual system permits analysis of events in these terms independently of acquired language. But it would be unreasonable to incorporate, for example, such notions as >subject of a sentence=, or other grammatical relations, ...=.

14. Thanks to Andreas Kathol for emphasizing this point. For the case in which two sisters are adjacent in the sentence, there have been a number of proposals in the literature, including standard HPSG (Pollard and Sag 1994) and categorial grammar (Dowty (to appear)). Kathol (1995) proposes a linearization theory that allows for binary combination without strict adjacency.

15. After much consideration I have concluded that the terms "A-theory" and "A-theoretic" are most appropriate, in spite of the unfortunate overlap with the term "atheoretic."

16. For some precedents, see for example Elman (1995), Smolensky (1991), Smolensky et al. (1992), Plunkett and Marchman (1993) and the papers in Touretsky (1991), Sharkey (1992) and Reilly and Sharkey (1992).

17. For example, Pollack (ms.) shows that there are problems getting a neural network to incorporate recursion. Birnbaum (1991), Maskara and Noetzel (1993). For some recent attempts to resolve these difficulties, see Kwasny and Faisal (1992), Dyer et al. (1992). See Reilly and Sharkey (1992) for a range of views on the suitability of connectionist architectures for the study of language and language processing.

18. The closest antecedents appear to be those of Elman (1991;1992) and Pollack (1991). Neither has fully explored the linguistic implications, however.

19. Syntactic Space is actually Linguistic Space when viewed at a particular level of resolution. A finer grained view would reveal morphological, phonological and phonetic structure, for example.

20. See Kluender (this volume) for a very similar idea, which he traces back to Ross (1987) and Fodor (1983).

21. This formulation concerns only constraints on structures for which there is no negative evidence; it says nothing about cases in which the learner acquires specific structures for which there is no positive evidence. It is not clear to me that the latter sort of cases exists.

22. So we can see how it is that the better we know our native language, the more difficult it becomes to learn a second language.

23. For a related view, see Goldberg (1995).

24. Crucially, only humans have the means for recursively representing the sound/meaning correspondences - syntax or, more specifically, Syntactic Space.

25. On the question of the subject-predicate relation, I believe that I part company with Jackendoff, and certainly Chomsky (1981); see footnote ?. At this point I see no way to explain the subject-predicate relation except to assume that it exists independently and *a priori*. On the concrete minimalist approach, the fact that the subject-predicate relation holds at CS means that

it may, but need not, be realized syntactically, an interesting consequence.

26. Pinker 1984; Lebeaux 1988; Gleitman 1990.

27. As suggested by Culicover and Jackendoff (1995a,b; 1996).

28. Here and throughout, I am using the traditional grammatical terms such as VP and IP to refer to whatever knowledge it is that the learner acquires that corresponds to what has classically been described in these terms. Whether expressions of the form V-NP actually occupy a region of Syntactic Space in the learner's mental representation of English is, in principle at least, an empirical question that may be decided by the usual linguistic criteria (e.g. grammaticality judgments) or perhaps by other means, such as psychophysiological evidence and studies of the course of language acquisition. I am assuming here that in at least some languages, syntactic VP exists. It may turn out that in a language in which the verb and the direct object are never adjacent to one another and the verb always precedes the subject there is a different grammatical representation, one that does not involve VP. In such languages, the correspondence between nonadjacent V and NP on the one hand and the CS predicate is implicit in a more complex correspondence rule.

29. Of course without an implementation we cannot predict the exact statistics of vocabulary growth.

30. See, for example, the papers in Hoekstra and Schwartz (1994).

31. The question of verb placement in German is such a case; for discussion see Poeppel and Wexler (1993).

32. It would thus appear that the basis for the true generalizations of XN theory, e.g. endocentricity, would be a semantic one, to the extent that syntactic form is isomorphic to semantic structure, as in Montague grammar; see Montague 1973; Partee 1976; Dowty 1979.

33. This is by no means an original notion. For some representative work along these lines, see Fodor (1978;1983), Chomsky and Lasnik (1977), Berwick and Weinberg (1984), Hawkins (1988;1990;1994) Kluender (this volume), among many others.

34. Recall that on the current view, a category is simply a region of Syntactic Space containing closely related items.

35. Binding theory may be subject to syntactic conditions, but the binding relation holds at CS.

36. Substantive parameters are those whose values do not correspond to superficial descriptive properties of sentences. The parameter *Averb precedes/follows direct object@* is a superficial, not a substantive parameter. The parameter *AV governs to the right/left@* is substantive. Using the setting of a superficial parameter as an *Aexplanation@* for why a language has a particular property *Aconfuses explanation with description@*, to use Anderson's (1987) apt phrase.

37. Consequently, it will be necessary to find non-LF substitutes for the most well-motivated LF explanations, e.g. LF wh-movement (Huang 1983) and antecedent contained deletion

(Hornstein 1994), and quantifier scope (May 1985).

38. Here I am using the term *Amovement@* to refer to those grammatical constructions that have conventionally been analyzed in terms of the dislocation of a constituent from some canonical position. For discussion of the articulation between syntactic structure and discourse structure, see the papers in this volume by McNally, Prince, Roberts, and Vallduvi.

39. Work in progress (Culicover and Nowak, in preparation a and b) deals with these and other consequences.

40. A more refined development of this example would have the generalization of flow be sensitive to the thematic properties of the verbs and other selectional factors. These factors would establish subflows within the broader region of flow.

41. Of course, difficulty of processing may underlie the fact that a particular structure is infrequently or never experienced, as Fodor (1978) observed.

42. For simplicity of exposition I omit representation of SAI.

43. Such a view is in fact taken by Pollard and Sag (1994) for subject-aux inversion, and by Kathol (1995) for a range of *Amovement@* phenomena in German.

44. I am indebted to Robert Levine for suggesting this term to me.

45. An obvious advantage of this approach is that it immediately yields all reconstruction effects. On the other hand, it is not immediately obvious how to handle anti-reconstruction. I will leave this question for another occasion.

46. This is by no means a trivial matter and I gloss over it here only because of lack of space. Note that on the view that both PF and CS are concrete input to the learner, either the PF order or the CS scope can provide a basis for generalizing *wh*-questions to existing trajectories. The first appears to be the case in languages like Chinese, and the latter in languages like English.

47. This is a central claim of GPSG (Gazdar, Klein, Pullum, and Sag 1985) and HPSG (Pollard and Sag 1987), and has even been arrived at by Chomsky (1995) on independent grounds. See Grimshaw (1996) for a related view. For some empirical evidence that this is the correct analysis, see Culicover (1991).

48. Andreas Kathol (p.c.) observes that extraction from islands composed out of simple extraction and extraction from sentential complements. Hence the learner must establish distinct trajectories for these cases, crossing the NP boundary. This is exactly the right result, given that extraction from sentential complements does not entail extraction from relative clauses, for example. Kathol also notes that the learner has the ability to establish distinct trajectories for long movement that do not involve intermediate traces, again a correct result, if the analysis of Cinque (1990) is on the right track, as I believe it is. It is entirely natural that extraction in simple sentences and extraction from complements, while learned independently, can fall together under a later generalization.

49. Relative complexity can be formulated in terms of Complete Functional Complexes, at least as a first approximation; I will not pursue the point here. Notice also that this approach

suggests a possible account for the fact that linguists who work on Subjacency phenomena in English find certain extractions to be better over time, as they encounter them more frequently. Thanks to Carl Pollard for the term "life-long learning" to describe this phenomenon.

50. Chomsky (1981) suggests that if certain structures or rules fail to be exemplified in relatively simple expressions, where they would be expected to be found, then a (possibly marked) option is selected excluding them in the grammar, so that a kind of "negative evidence" can be available even without corrections, adverse reactions, etc. The current approach takes "negative evidence" to be operate generally and uniformly and not to incorporate notions such as "relatively simple expression" or "expected to be found".

51. Pinker (1989) and Fodor (1989) both appeal to markedness as the basis for accounting for aspects of the developmental pattern. A notion of formal complexity is also found in the work of Slobin (1985).

52. The notion of o-command is somewhat less comprehensive than the hierarchy suggested here, since it does not rank extraction of or from adjuncts against extraction of or from arguments.

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