

## **Chapter 6**

### **Third factor explanations and Universal Grammar**

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#### 6.1 Introduction<sup>1</sup>

The biolinguistic approach to generative grammar has in recent years emphasized the relevance of principles that are not specific to the Faculty of Language. These are taken to work together with both genetic endowment and experience to determine relevant I-languages. Chomsky (2005) labels these non-language-specific principles ‘third factors’, and argues that computational efficiency is a core example of the notion.

Although the study of third factors is novel to the Principles and Parameters Approach, we show below that this perspective has historical antecedents in generative grammar. Nonetheless, it is only now that we are beginning to know enough about the structure of Universal Grammar to be able to ask real questions about what third factors might amount to. This perspective is in our view fruitful not just within linguistics, but more generally within (molecular) biology. At the same time, we will argue that we are far from having offered real third factor explanations for linguistic phenomena.

This chapter is structured as follows. In section 2, we discuss the three factors that enter into the design of I-language(s) and discuss the historical roots of this viewpoint. We also situate the perspective within the Principles and Parameters approach. Section 3 offers examples of third factors suggested in the recent literature. We evaluate these critically, and argue that although they are suggestive, more work is needed to understand

them fully. In section 4, we warn against overusing third factors. Conclusions are presented in section 5.

## 6.2 Three factors in biology, and three factors in I-language

Chomsky's perspective on generative grammar has always been biological. Since language is something humans have tacit knowledge of, Cartesian mentalism is immediately relevant (Chomsky 1966). In turn, individual humans are taken to carry an I-language in their minds (Chomsky 1986b), which virtually entails a biological component. Universal Grammar only appears to exist in the human species, so something about the (epi-)genetics of humans must be enabling the linguistic procedure. The classical poverty of the stimulus argument argues for this approach, even if much work lies ahead in understanding the bona fide mechanisms underlying language.<sup>2</sup>

However, given that language is biological in nature, already in Chomsky (1965) we find a remark that suggests something even deeper may be at work (pp. 58-59) (see also Freidin and Vergnaud 2001 for extensive discussion):

It is clear why the view that all knowledge derives solely from the senses by elementary operations of association and generalization should have had much appeal in the context of eighteenth-century struggles for scientific naturalism. However, there is surely no reason today for taking seriously a position that attributes a complex human achievement entirely to months (or at most years) of experience, rather than to millions of years of evolution or to principles of neural organization that may be even more deeply grounded in physical law.

As Freidin and Lasnik (2011) point out, the traditional evolutionary approach is being compared here with non-biological principles of natural law. In fact present-day conjectures on the evolution of language, or anatomically modern humans more generally, situate the emergence within the last couple of hundred thousand years at most (see Fitch 2010 and references therein). This strongly suggests that general principles of nature may be even more important than the (epi-)genetic component, as Chomsky (2007a) hints (see also Sigurdsson 2011).

While these sorts of considerations have been around for decades, it is only within the Minimalist Program that it has been possible to speculate about what ‘principles non-specific to language’ might amount to, and how they determine linguistic structure in language. By the time Government and Binding (GB) theory had been fully developed at the end of the 1980s, linguists had a sufficiently well-understood set of principles to ask how these could reduce to their essentials. The theory of phrase structure presents a good example of reduction to the barest essentials (see Lasnik and Lohndal 2013 for discussion; see also Lohndal 2014). Once we have accomplished this for a number of principles or structures, the goal becomes to *understand* why these conditions are they way they are. In Chomsky’s (2004a: 105) words: ‘In principle, then, we can seek a level of explanation deeper than explanatory adequacy, asking not only *what* the properties of language are but also *why* they are that way.’ The desideratum, of course, is not unique to linguistics, as physicist Steven Weinberg reminds us:

In all branches of science we try to discover generalizations about nature, and having discovered them we always ask why they are true. [...] Why is nature that

way? When we answer this question the answer is always found partly in contingencies, [...] but partly in other generalizations. And so there is a sense of direction in science, that some generalizations are 'explained' by others (quoted in Boeckx 2006: 114-115).

The Minimalist Program has attempted to enable the formulation of these *why*-questions. Whereas Chomsky (1965) was concerned with explanatory adequacy (to what extent the theory offers an account of how the child can acquire a language in the absence of sufficient evidence), Chomsky (2004) wants to go *beyond* explanatory adequacy in the way the quote above outlines. The goal is ambitious, leading us into uncharted territory for linguistic theory: the laws of natural science. As we will see next, it is hard to come up with ideas as to what these laws might be, as applied to the computational system of language as a model of knowledge of language.

Chomsky (2004a, 2005) argues that three factors condition I-language design: Assuming that the faculty of language has the general properties of other biological systems, we should, therefore, be seeking three factors that enter into the growth of language in the individual (Chomsky 2005: 6).

These three factors are outlined in (1).

- (1) a. Genetic endowment
- b. Experience
- c. Principles not specific to the faculty of language

Based on Chomsky (2005: 6), the genetic endowment is assumed to be more or less uniform for the species.<sup>3</sup> This hard-wired structure presumably shapes the acquisition

of language helping the human child in the task. Thereby it presumably also imposes constraints on the kind of I-languages that can be acquired.

Of course, without experience, the genetic component cannot do much. This is what determines that a child growing up in Japan will learn Japanese and a child growing up in Oslo, Norwegian, under normal circumstances.

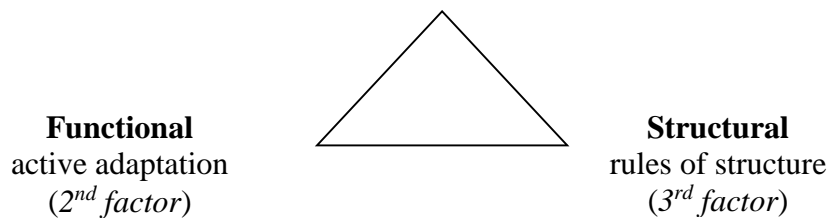
Finally the 3rd factor consists of principles that are not specific to the computational system underlying I-language(s) (Universal Grammar). Rather, these conditions are more general, reaching beyond human language, but can be employed by the language faculty. Chomsky argues that there are several subtypes of these general principles. The first consists of principles of data analysis that might be used in language acquisition and other domains. Another subtype consists of:

. . . principles of structural architecture and developmental constraints that enter into canalization, organic form, and action over a wide range, including principles of efficient computation, which would be expected to be of particular significance for computational systems such as language (Chomsky 2005: 6).

For this reason, the third factor has also been characterized as ‘general properties of organic systems’ (Chomsky 2004a: 105). Chomsky (2005: 6) suggests that these properties ‘should be of particular significance in determining the nature of attainable languages’.<sup>4</sup>

The three factors are more general than they might appear. Gould (2002) discusses three similar factors that hold for organisms more generally. Gould provides the ‘adaptive triangle’ in (2) (Gould 2002: 259):

(2) **Historical**  
contingencies of phylogeny  
(1<sup>st</sup> factor)



Gould says that a current trait may arise from adaptation to whatever environment surrounds the organism, from a constraint that is not particular to the development of this organism ('architectural or structural principles, correlations to current adaptations'), or by inheritance of an ancestral form – a historical or a phylogenetic constraint. This sort of constraint is part of the genetic endowment of the organism.

These three factors are argued to express the major influences on the genesis of form (Gould 2002: 259). While most contemporary scientists accept Dobzhansky's dictum that 'nothing in biology makes sense except in the light of evolution', the issue is to what extent this amounts *just to natural selection*. In Gould's triangle this notion constitutes the second factor, since it involves adaptation to the environment. But a growing literature, summarized in Hoelzer, Smith and Pepper (2006), emphasizes the role of principles of self-organization. This is part of Gould's third factor. Alas, it has proven difficult to clarify what *specific* laws self-organization obeys and what role they play in shaping matter, life or mind. Chomsky (1968/1972/2006: 180) outlines the linguist's take on these issues:

The third factor includes principles of structural architecture that restrict outcomes, including principles of efficient computation, which would be expected to be of particular significance for computational systems such as language, determining the general character of attainable languages.

However, this raises the question: What kind of *efficient computation* is Chomsky talking about here? We discuss the matter in section 3.1.

In summary, the biolinguistic enterprise raises the question of the role of third factors, which Thompson (1942) pointed out provide some fundamental explanations for the growth and form of biological entities (see Freidin and Vergnaud 2001 for detailed discussion). Next we consider some examples of third factor considerations that have been suggested in the literature.

### 6.3 Examples of the third factor

The goal of this section is to discuss a few examples of third factor conditions offered in the literature. The list is not long yet, perhaps because of the novelty of these ideas, the relatively small number of those actively researching them, or the difficulty in identifying substantive hypotheses.

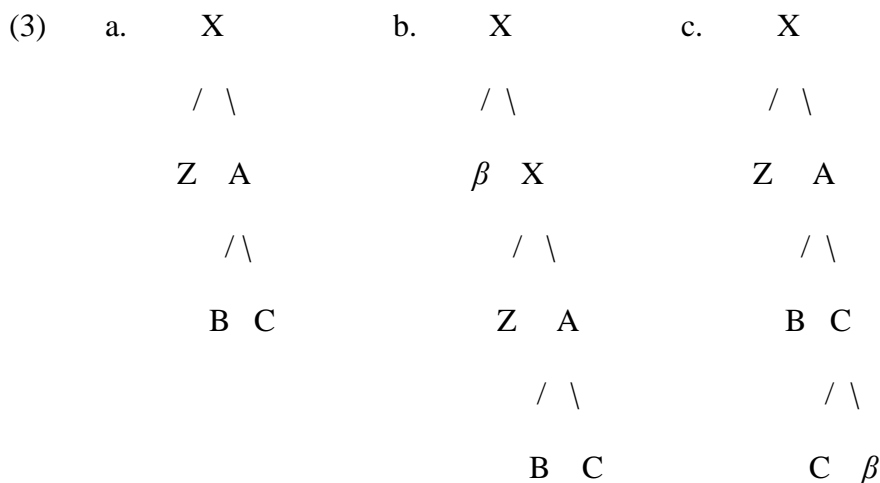
There are various ways to study third factors. One approach is to look for general principles that appear across various domains in nature. This assumes that there are more general principles governing the creation of form, and that these can be recruited by various general cognitive computations. Another way is to look at linguistic units and see if we find them in non-human species. If we find that principles of, for instance, human

phonology appear in different animal species, that strongly suggests that the phonological operations are not unique to the Faculty of Language. This is the approach taken by Samuels (2009, 2011), and in Chapter 21 of this handbook for phonology. In the remainder of this section, we concentrate on the first approach.

### 6.3.1 Computational efficiency

As we saw in section 2, Chomsky takes ‘computational efficiency’ to be the hallmark of a third factor effect. The implicit assumption is that computations in general should be as efficient as possible, and that this is a property that all computations share, regardless of what is being computed. There are not that many examples of efficient computation in the literature when it comes to I-language; but Chomsky (2008) mentions cyclicity considerations as an example.

The Extension Condition states that (External and Internal) Merge of a new object targets the top of the tree.<sup>5</sup> In order to see this, consider the trees in (3a)-(3c).



(3a) is the original tree. (3b) shows a derivation that obeys the Extension Condition because the new element  $\beta$  is merged at the top of the tree. The derivation in (3c) does



not obey Extension because  $\beta$  is merged at the bottom of the tree. A related cyclicity condition is the No Tampering Condition. The No Tampering Condition states that merge of X and Y leaves the two syntactic objects X and Y unchanged.<sup>6</sup> The set {X, Y} created by Merge cannot be broken up and new features cannot be added (Chomsky 2008). So on this view, (3b) involves no tampering, since the old tree in (3a) still exists as a subtree of (3b), whereas (3c) involves tampering with the original structure. Chomsky (2008: 138) sees the No Tampering Condition as a ‘natural requirement for efficient computation’. This is an economy condition, as argued by Lasnik and Lohndal (2012): It is more economical to expand a structure than to go back and change a structure that has already been built.

Yet another example is what Rizzi (1990) called Relativized Minimality. Chomsky (1993) reinterpreted Rizzi’s groundbreaking work in terms of least effort. Let us illustrate that here by way of a phenomenon called Superiority, which has often been analyzed as a Relativized Minimality effect. Consider:

- (4) a. Guess who bought what?  
 b. \*Guess what who bought?

In this situation, there might seem to be the option to either front *who* or *what*. As (4a) and (4b) show, only the former is licit. In such a situation, the *wh*-element closest to the target of movement is picked, as first observed by Chomsky (1973: 246). Rizzi (2001: 89) states Relativized Minimality as follows:

- (5) In the configuration  
 ... X ... Z ... Y ...

Y cannot be related to X if Z intervenes and Z has certain characteristics in common with X. So, in order to be related to X, Y must be in a minimal configuration with X, where Minimality is relativized to the nature of the structural relation to be established.

Put differently, one should minimize the ‘distance traveled’ by the moving element, an instance of economy of derivation.

Once again, economy conditions are supposed to be quite general, as argued, for instance, by Fukui (1996) or Uriagereka (1998). However, in this case, the notion of ‘distance’ is certainly not trivial. This is captured in the name of the condition itself: distance is somehow *relativized* to the units across the path being considered. In this regard the following remark in Fukui (1996: 61) seems quite relevant:

We are of course not suggesting that the economy principles of language are ‘reducible’ to the Principle of Least Action. The actual formulation of the principles appears to be highly specific to language. Nevertheless, the fundamental similarity between language and the inorganic world in this respect is so striking that it suggests that there is something deep in common between the two areas of inquiry.

In other words, we still want to understand why distance should matter – as it does in other realms of nature. In all languages that have been studied in this regard, some notion of distance, very much something along the lines Rizzi and others unearthed, is certainly at work. Therefore it is important to investigate what distance reduces to – what are the basic properties of distance and why do those particular properties matter, as opposed to other conceivable conditions.

One proposal in the literature is that distance is limited because the derivation only happens ‘in chunks’. That is, during the derivation various parts of the syntactic structure are shipped off to the interfaces (Uriagereka 1999, Chomsky 2000). These units, called phases or cycles, are among others motivated on grounds of computational efficiency. Here is a relevant quote:

Suppose we select  $L[\text{exical}]A[\text{rray}]$  as before [...]; the computation need no longer access the lexicon. Suppose further that at each state of the derivation a subset  $LA_i$  is extracted, placed in active memory (the workspace), and submitted to the procedure  $L$ . When  $LA_i$  is exhausted, the computation may proceed if possible; or it may return to  $LA$  and extract  $LA_j$ , proceeding as before. The process continues until it terminates. Operative complexity in some natural sense is reduced, with each stage of the derivation accessing only part of  $LA$  (Chomsky 2000: 106).

Put differently, phases reduce the computational complexity of a derivation. One question that immediately comes up is what phases are.

Phases are defined by stipulating the phase heads:  $C$  and  $v$ . Chomsky (2000b) argues that these are the phase heads because they are propositional and they yield convergent derivations. In later work, unvalued features have been the defining properties of phase heads (Chomsky 2008, Richards 2007). Regardless of what the relevant property is, though, as long as phases are meant to reduce computational complexity it would be nice to see at least a correlation between how computational complexity works and how the phase heads are defined. Put differently, we would expect that the phase heads fall out from properties that are independently known to relate to computation, whatever these

may be. Whereas it is somewhat easier to imagine how this would work for the C head,<sup>7</sup> it is unclear how the v phase would fall out. Further problems arise if DPs too induce phases, as argued by Svenonius (2004).

Evidently it would be a welcome result if phases fall out from natural constraints on computational complexity, as these units remain a stipulation – much in the sense bounding nodes were in earlier theories (see Boeckx and Grohmann 2007 for discussion). If cyclicity, in a broad sense, is a deep property of the computational system, we would expect it to have a deep rationalization as well (see Freidin 1978, 1999). Attempting to provide one turns out to require revisions of several standard assumptions (see e.g. Uriagereka (2011)).

Another example of a third factor comes from Freidin and Lasnik (2011). They argue that interface constraints fall under the rubric of principles of efficient computation, providing the following argument for this view. Interface conditions (*bare output constraints*) are taken to be imposed on the grammar by other cognitive components. In particular, Freidin and Lasnik interpret the principle Full Interpretation as a legibility requirement banning superfluous symbols in representations, assuming meaning and sound interfaces cannot interpret relevant structures. As such, the principle contributes to efficiency: The computation need not compute symbols that turn out to be superfluous. Freidin and Lasnik go on to argue that the Theta Criterion can be made to follow from the principle of Full Interpretation.<sup>8</sup> This is taken to account for the data in (6).

- (6) a. \*John seems that Mary is happy.  
b. \*John gave Mary a book to Bill.

An argument that does not have a theta role is uninterpretable at the semantic interface – hence superfluous, cf. (7) where *like* only has two theta roles, but there are three nominal constituents. If these data violate Full Interpretation, portions of the Theta Criterion are therefore redundant. The Case Filter can be analyzed in the same way if Case features are uninterpretable at the interfaces.

(7) \*John likes Mary Peter

As Freidin and Lasnik argue, this approach progressively eliminates principles whose nature was taken to be part of the first factor (the genetic endowment), in favor of conditions that are outside of the Faculty of Language.<sup>9</sup>

Now, for perspective, computational efficiency need not be a third factor. The following is a case that may at first glance appear to be a third factor, but which was actually argued to be what we are now calling a first factor, as it involves the computational efficiency of parsers.<sup>10</sup>

Berwick and Weinberg (1984) argue that cycles described by syntacticians constitute optimal units of parsing. Observe:

(8) [Who<sub>i</sub> did [John say [t<sub>i</sub> that [Peter believed t<sub>i</sub> that ... [Mary sent t<sub>i</sub> flowers/to Bill ]]]]]

The parser that Berwick and Weinberg are working with constructs one phrase marker and a discourse file that corresponds to it. The usual filler-gap problem emerges in a case like (8), where there is a *wh*-phrase. However, in the case of (8), the predicate *send* is syntactically ambiguous. It can be parsed with a different number of arguments. It is necessary for the parser to have access to the relevant predicate and its immediate context, plus the left-edge context. The latter provides information about the antecedent

*wh*-phrase of the gap. But as the example in (8) indicates, the antecedent can be arbitrarily far removed from the variable that it binds. In order to account for this, Berwick and Weinberg suggest that the left context is present at every derivational cycle. Intermediate traces enable this.

An immediate question is why the cyclic nodes that Berwick and Weinberg assume are the ones that coincide with those discovered in the past – as opposed to others that would seem equally plausible, parsing-wise. Why, for instance, can the next phrasal projection not constitute a cyclic node (Fodor 1985, van de Koot 1987)? Berwick and Weinberg did not attempt to answer that question; they simply argued that the parser works well if it is structured this way, even though it does not solve all cases of parsing ambiguity. Fodor (1985) criticizes this on evolutionary grounds, and Berwick and Weinberg (1985) counter by citing Gould's (1983) criticism of perfect design. So their approach is very much a *first* factor approach: the parsing mechanisms are specific to the Faculty of Language, and the computational efficiency comes from adaptation; it is therefore species-specific.<sup>11</sup>

Let us now return briefly to computational efficiency from a third factor perspective. Even though it is pretty obvious that something like computational efficiency is a general property of computations, stating that does not answer the deeper question that one can ask: Why is computational efficiency what it is?<sup>12</sup> What properties of the structure of computations make them efficient?

### 6.3.2 The Fibonacci sequence

A different, though ultimately related, argument for third factors stems from Fibonacci patterns of the sort seen in natural phenomena. Uriagereka (1998: 485 ff.) sketched an argument that we find Fibonacci growth patterns also in language, and thereafter some researchers have begun to produce specific results in this regard. Before we outline this sort of argument, consider Fibonacci sequences.<sup>13</sup>

Relevant structures manifest themselves either as a number of features falling into the series 0, 1, 1, 2, 3, 5, 8, ... or as a logarithmic growth based on the limit of the ratio between successive terms in the Fibonacci series (1.618..., the so-called golden expression  $\phi$ ). The majority of plants that have been studied have been shown to follow Fibonacci growth patterns, and we see them also from the organization of skin pores (in tetrapods) to the way in which shells grow (in mollusks), among scores of other examples. In addition, the pattern has been recreated in controlled lab situations (Douady and Couder 1992). Consider the latter case in a bit of detail, since it shows that the structure can emerge under purely physical conditions, and not only under 'Darwinian conditions'.

Douady and Couder slowly dropped a magnetized ferro-fluid on the center of a flat, rotating oil dish. The drops repel each other, but are constrained in velocity by the oil's viscosity. As the dropping rate increases, a characteristic Fibonacci pattern emerges. The relevant equilibrium can be conceptualized as involving a local and a global force pulling in opposite directions, and the issue is how these opposing forces balance each other out, such that the largest number of repelling droplets can fit within the plate at any given time, as they fall onto it. It turns out that an angle  $\phi$  of divergence between each drop and the next achieves this dynamic equilibrium.<sup>14</sup>

The first example of the Fibonacci pattern in language was proposed for the structure of syllables (Uriagereka 1998: chapter 6). We won't review that now, but rather point to another result from phonology involving metrical feet.<sup>15</sup> Idsardi (2008) proves that the number of possible metrical parsings into feet for a string of  $n$  elements is  $Fib(2n)$ , where  $Fib(n)$  is the  $n$ th Fibonacci number. In particular he observes that, if we disregard prominence relations within the feet,<sup>16</sup> the possible footings for strings up to a length of three elements are as in (9) (Idsardi 2008: 233). Below, matching parentheses indicate feet, and elements that are not contained within parentheses are unfooted ('unparsed' in Optimality Theory terminology).

- (9) a. 1 element, 2 possible parsings: (x), x  
 b. 2 elements, 5 possible parsings: (xx), (x)(x), (x)x, x(x), xx  
 c. 3 elements, 13 possible parsings: (xxx), (xx)(x), (xx)x, (x)(xx), x(xx),  
 (x)(x)(x), (x)(x)x, (x)x(x), x(x)(x),  
 (x)xx, x(x)x, xx(x), xxx

As Idsardi (2008: 234) observes, the number of possible footings is equal to every other member of the Fibonacci sequence (relevant parsings as in (9) boldfaced in (10)):

- (10) Fibonacci sequence: **1**, 1, **2**, 3, **5**, 8, **13**, 21, ...

Intensionally: for  $n > 1$ , where  $Fib(n)$  is the  $n$ th number in the Fibonacci series,

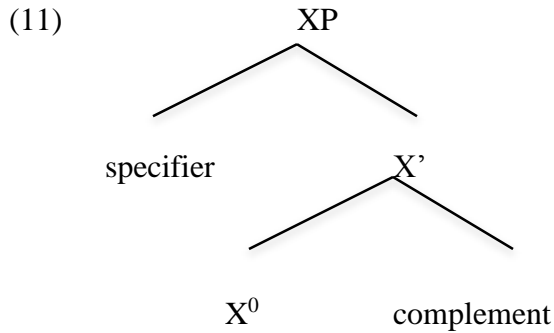
$$Fib(n) = Fib(n-1) + Fib(n-2)$$

Idsardi then provides a proof for this result, which we will not go into now. In a follow-up paper, Idsardi and Uriagereka (2008) provide some rationale for why half of the Fibonacci sequence is involved in these phonological parsings.

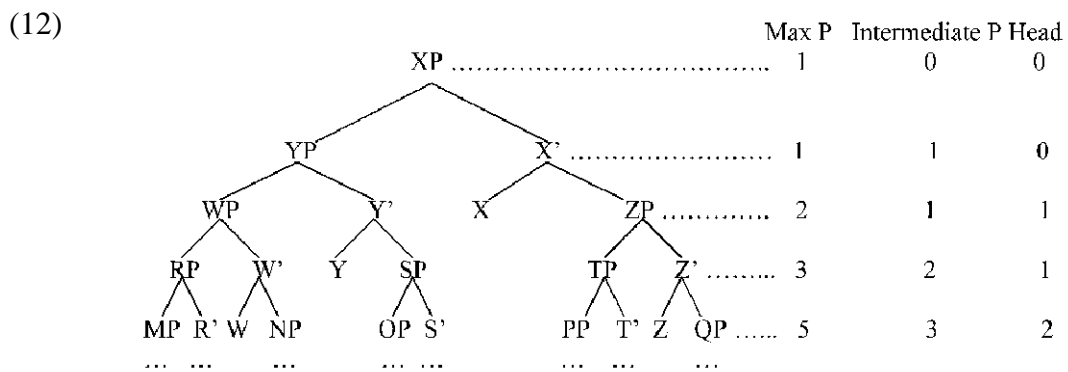


Uriagereka (1998: chapter 6) also indicated that we should expect conditions such as these in other parts of the grammar. Boeckx, Carnie and Medeiros (2005), Medeiros (2008, 2012) and Soschen (2008) have argued that this is the case. We will here focus on Medeiros' work.

Medeiros takes standard X-bar theory (Chomsky 1986a) as a point of departure.



He then investigates maximal expansions of (11), as in (12), which observes binary branching (Kayne 1984, Chomsky 2000). The expansion is optimal in the sense that the basic X-bar structure is present in all branchings, although of course that maximality is not necessary in linguistic representations.



At each successive full expansion of the tree in (11), there are Fibonacci numbers of maximal projections, intermediate projections and heads. Medeiros further shows how the Fibonacci patterns force deeper phrasal embedding in the relevant cases.

Medeiros then goes on to claim that the formation of linguistic tree structures is related to structural optimization: Merge makes the full spectrum of binary branching forms available. Medeiros argues that there is a computational burden associated with establishing relations based on containment and c-command (2008: 189). This entails that some derivational choices are better than others, and he argues that the form that is closest to the X-bar schema in (9) is the computationally most optimal. This then coincides with the Fibonacci pattern as seen in (10). Computational efficiency and Fibonacci therefore seem to be related at a fairly deep and structural level, where one may suggest that, in some sense to be understood, the Fibonacci structuring is constraining the nature of the computation.

If the above turns out to be on the right track, it immediately raises the following question: What is the connection between the Fibonacci patterns for syllables and the Fibonacci patterns for phrase structures? Carstairs-McCarthy (2000) explicitly argues that there is one such connection when he claims that phrasal structure is a biological exaptation, in evolutionary terms, of earlier syllabification conditions. Such an idea is not entirely new; among others, Kaye, Lowenstamm and Vergnaud (1985) and Levin (1985) argue for a close link between phrasal and syllabic structures. However, as Piattelli-Palmarini and Uriagereka (2008) emphasize, it remains to be seen why a structural translation – ultimately going from the realm of sound to that of structured meaning – is in the nature of language.

There are also many unanswered questions that should be acknowledged. Even if Fibonacci patterns do occur in linguistic representations (a difficult empirical matter to ascertain one way or the other), that does not answer *why* such patterns should occur in the relevant representations. Piattelli-Palmarini and Uriagereka (2008: 223) address this very issue when asking:

What does it mean for linguistic forms to obey those conditions of growth, including such nuanced asymmetrical organizations as we have studied here? Why has natural law carved this particular niche among logically imaginable ones, thus yielding the attested sub-case, throughout the world languages? What in the evolution of the species directed the emergence of these forms, and how was that evolutionary path even possible, and in the end, successful? The biolinguistics take that we assume attempts to address these matters from the perspective of coupling results within contemporary linguistic theorizing with machinery from systems biology and bio-physics more generally. Again, we do not fully understand the ‘embodiment’ of any of the F[ibonacci] patterns in living creatures. But the program seems clear: proceeding with hypothetical models based on various theoretical angles, from physical and bio-molecular ones, to grammatical studies isolating abstract patterns in the linguistic phenotype. A synthesis proceeding this way seems viable in the not so distant future, at the rate that new discoveries march.

#### 6.3.4 Summary

We have looked at a few examples of third factor proposals in the literature: Efficient computation and Fibonacci patterns. In both cases, they invoke principles that are assumed to be non-specific to language. In the case of Fibonacci patterns, it is obvious that they exist in many different domains of nature. It seems plausible to argue that there are laws of nature that yield Fibonacci sequences, since these sequences appear in the organic and inorganic world alike. We have also mentioned how Medeiros (2008, 2012) presents a close link between efficient or optimal computation and Fibonacci patterns. One may speculate that the principles underlying the Fibonacci patterns somehow are structuring the computation. Or it may be that the computation is simply structured so that such patterns appear based on this structure, more or less as an epiphenomenon (cf. Uriagereka 2011). Work of the sort that we have reviewed here has made it possible to ask new questions, even if definitive answers are still missing. Future work will hopefully enable us to delve deeper into these issues, and it may turn out that our understanding of the basic computation of language has to be modified in order to truly rationalize third factors (see Uriagereka (2011) in this regard).

#### 6.4 Studying third factors

We would like to end this chapter with some reflection on the complex task of determining whether a given linguistic condition might be a third factor.

On the PHON side of the interface, one can argue that none of the observable computational operations are human-specific (see Samuels (2009, 2011) and Chapter 21). One may also argue that the computational operations on the phonological side are grounded in phonetic constraints. Perhaps these constraints are the way they are because

of physio-anatomical considerations; for instance, phonetic patterns across languages that involve ease of articulation and perception (Blevins 2004, Hayes, Kirchner and Steriade 2004). Couldn't one then argue that the phonetic grounding of phonology is a third factor, human physiology constraining possible phonological patterns?

Since the foundations of human physiology presumably have little to do with how language is structured, in that view phonetic patterns are not specific to language.

Whether an argument along these lines, then, determines the validity of this condition as a third factor depends on whether there is independent validity to the claim that phonetics is the way it is because of human physiology. For starters, such a claim requires a serious, and difficult, look at the relevant neurobiology, as Poeppel, Idsardi and van Wassenhove (2008) emphasize for speech perception.<sup>17</sup>

Now while on the PHON side of things one at least has the advantage of relatively straightforward observables and decades upon decades of tradition to gear research, on the SEM side the task seems much harder. There are, no doubt, familiar arguments for relevant syntactic structures, and we know also that we understand meanings associated to those structures. However, little else is known, or directly observable, or even up for clever testing. One could certainly claim – on analogy with arguments about human physiology constraining possible phonological patterns – that human *psychology* constrains possible semantic patterns. However, it is far from obvious that the foundations of human psychology are totally independent of how language is structured, or that such a would-be claim is even testable with other animals. So it is not altogether clear what it would, then, mean to say that some third factor grounds SEM the way it might PHON.<sup>18</sup>

This, of course, does not mean that there could not be third factors on the semantic side – just that it is hard to make the case. Let us discuss a possible third factor effect exclusively for illustrative purposes. For Neo-Davidsonian approaches that assume conjunction to be the basic semantic composition principle (Schein 1993, Herburger 2000, Pietroski 2005, 2011), one could ask whether conjunction is, in fact, specific to language. Suppose it isn't, and its essentials can be demonstrated for other species.<sup>19</sup> We would still need to understand why, in the case of human language, not just anything gets conjoined for semantic composition; rather, in this view of things, *predicates* of a specific type are what conjoins, as shown in (13):

- (13) a. Brutus stabbed Caesar quickly.  
b.  $\exists e[\text{Agent}(e, \text{Brutus}) \ \& \ \text{Theme}(e, \text{Caesar}) \ \& \ \text{stab}(e) \ \& \ \text{quickly}(e)]$

Different proposals about how the syntax delivers the logical form in (13b) have been explored in Borer (2005), Hinzen (2006), Uriagereka (2008) or Lohndal (2012, 2014). These are hypotheses – among others possible – on concretely how conjunction is actually employed depending on language-specific computations. Suppose a method is found to empirically validate one of these different theories, or some alternative. Would this then mean ipso facto that the psychology of conjunction is a third factor?

Again, as in the case of phonetics, the answer to that question would depend on whether there is independent validity to the claim that semantics is the way it is because of human psychology. Very clearly a serious evaluation of such a claim would depend on matters of neurobiology for which, at present, there is effectively no understanding. Circumstances may change as discoveries bring us new insight into the brain. That being said, for evaluating whether a given semantic condition is a third factor, attitudes in that

area of study will need to change. At present answers in this realm are often descriptive, and even questions of the sort we are now sketching are met with skepticism. But the main point of this section is to argue that, difficult as determining what a third factor is, in our view it won't do to just *claim* such a thing on essentially eliminative grounds.<sup>20</sup>

## 6.5 Conclusions

In recent years, the study of I-language has been divided into three factors: genetic endowment, experience, and principles of nature that are not specific to language. This chapter has outlined these three factors, discussing some possible third factor approaches.

There are not many third factors suggested in the literature. This is not surprising, as the concept has not been around for that long in linguistics. Future research should be able to take us further, providing more detailed accounts of how principles that are not specific to the Faculty of Language apply to it (or not).

In closing, we would again like to emphasize how challenging the third factor approach is. It also shows us how difficult it is to provide principled explanations. It should be clear that empirical generalizations such as cyclicity constitute the foundation of the third factor approach – but this perspective forces us to go beyond that unavoidable empirical step.

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<sup>1</sup> We are grateful to Robert Freidin, Ian Roberts, Bridget Samuels and T. Daniel Seely for comments on a previous version of this chapter.

<sup>2</sup> See Berwick et al. (2011) for comprehensive discussion of several unsuccessful attempts at getting machines to learn significant linguistic structures.

<sup>3</sup> Of course, the matter is debatable for epigenetic conditions, but we may set these aside, supposing that they too are uniform in human societies.

<sup>4</sup> Although the Minimalist Program has centered around these concerns, Freidin and Lasnik (2011) point out that the reduction of the genetic factor is consistent with Chomsky's earlier view on language evolution. They point at the following quote:

It does seem very hard to believe that the specific character of organisms can be accounted for purely in terms of random mutation and selectional controls. I would imagine that biology of 100 years from now is going to deal with evolution of organisms the way it now deals with evolution of amino acids, assuming that there is just a fairly small space of physically possible systems that can realize complicated structures (Chomsky 1982b: 23).

<sup>5</sup> See Richards (2001) for arguments that this condition does not always hold.

<sup>6</sup> Uriagereka (1998: 264) calls it the Ban Against Overwriting.

<sup>7</sup> This is assuming that something like a sentence is an independent computational unit.

<sup>8</sup> This condition prohibits an argument that does not get a theta role and multiple theta roles being assigned to the same argument.



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<sup>9</sup> It remains to be seen in which sense relics of Full Interpretation are found in other domains of cognition, be it in humans or in non-humans, or in other areas of nature.

<sup>10</sup> For more discussion of this case, see Uriagereka (2011).

<sup>11</sup> In fact, there is no deep reason to assume that the parser works in exactly the same way across all languages, or that the cyclic nodes are universal (see Rizzi 1978).

<sup>12</sup> Recall Fukui's (1996) suggestion that economy principles within linguistics resemble the Principle of Least Action in physics, suggesting a deeper physical basis behind computational efficiency.

<sup>13</sup> What follows relies on material that is discussed in more detail in Piattelli-Palmarini and Uriagereka (2008).

<sup>14</sup> We need not discuss the technical details of the experiment here, but the following link presents a curious video of the actual experiment:

<http://www.sciencenews.org/view/generic/id/8479>.

<sup>15</sup> For discussion of other third factors in phonology see Samuels (2009, 2011) and Chapter 8.

<sup>16</sup> With Halle and Idsardi (1995: 440), Idsardi does not assume an exhaustive parsing of phonological elements, pace Halle and Vergnaud's (1987) Exhaustivity Condition.

<sup>17</sup> Albeit not with the goal of reducing phonology to phonetics, a matter orthogonal to that paper.

<sup>18</sup> Imagine, for the sake of argument, that the best theory for semantics is model-theoretic. To appropriately make the case for such a condition being a third factor, one would have to demonstrate its independence from language, for instance in terms of other organisms

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making use of this system in ways similar to those in which humans use said mechanics for language.

<sup>19</sup> We are not making any specific claim in this regard, but it wouldn't strike us as implausible that basic animal psychology should be conjunctive. After all, most roughly iterative animal tasks one can think of (e.g. building a nest or a dam, or plotting a path to some goal and back home) would seem to entail at the very least some elementary conjunctive semantics associated to the iteration.

<sup>20</sup> To paraphrase Sherlock Holmes: 'When you have eliminated the second factor, whatever remains, *however improbable*, must be a third factor.' The fallacy is based on the fact that, for starters, the hypothesized condition may be a total mirage – and blaming it on the third factor won't give it more ontological bite, on the sheer basis of the claim.