1

Phases and Interfaces*

KLEANTHES K. GROHMANN

1.1 Introducing the Volume

The present volume is a collection of carefully chosen contributions with particular attention paid to thematic coherence as well as broad coverage of topics. The overall goal is to present a unique mix of takes on interface properties within the phase-theoretic approach to the grammar. This collection addresses the fundamental issues in the phase-based approach to the mental computation of language that have arisen from recent developments in the Minimalist Program (Chomsky 1993 *et seq.*). Leading linguists and promising young scholars from all over the world focus on two themes that are at the centre of current theorizing in syntax—the interaction of the syntactic computation with the interpretive interfaces (commonly dubbed the conceptual-intentional system and the sensorimotor system) and current formulations of Phase Theory (capitalized to identify a particular strand of current minimalist theorizing).

Phases are a recent way of modeling the *computational system of human language* (C_{HL} or simply the computation) in relation to the interfaces between the syntactic derivation and the *levels of representation*, known as Logical Form (LF, not to be confused with the logical form used in philosophy) and Phonetic Form (PF, sometimes also called Phonological Form). The original formulation of the notion "phase" goes back to Chomsky (2000), circulated in manuscript form since early 1998. It has undergone serious revisions in both Chomsky's own subsequent writings (which appeared as Chomsky 2001,

* This selective collection derives from oral presentations at the *InterPhases* conference, held 18–20 May 2006 in Nicosia as part of the (unofficially titled) *Cyprus Syntaxfest* (see the Preface for more information). Thanks to all the contributing authors for their patience and cooperation, and for accompanying me on the not always easy route to final publication.

Parts of this chapter build on the two introductions written for two *Linguistic Analysis* special double issues, which I guest-edited (vol. 33, issues 1–2 [2003]: *Dynamic Interfaces, Part I* and vol. 33, issues 3–4 [2003]: *Dynamic Interfaces, Part II*; cf. Grohmann 2007*a*, 2007*c*).

2004*a*, 2007*a*, 2008[1]) and many other scholars' contributions (too numerous to mention all[2]). The central idea is that particular substructures of the syntactic computation play an important role in the computational process, also with respect to interpretation at the interfaces.

But in terms of the relation between C_{HL} and the interpretive interfaces, a number of issues remain to be settled. What exactly, for example, does the operation Spell-Out do? How often, and when, does it apply, and to what kind of structures? Where do morphology and phonology kick in? Are the two levels of representation, LF and PF, sufficient, too many, or not enough? How can the interaction between syntax and prosody be formally represented? The contributors to the present volume discuss these and other central questions including the degree to which phases are the right way to think about the dynamic system of language. They consider how far the answers are likely to come from conceptual and theoretical considerations or from experimental and empirical research, which key components might be missing, and how the system can be improved.

Before addressing the main facets of a minimalist approach to linguistic theory as relating to interface issues relevant to the present volume, let us be clear on how the term "interface" is used here. It can be argued, as done somewhat subjectively in Grohmann (2007*a*, 2007*c*), that there are two types of interfaces—*linguistic interfaces* and *modular interfaces*.[3] The latter term was chosen to capture interfaces understood as interactions between separate modules or components of the grammar. For example, there is no shortage of research on the syntax-semantics interface or the syntax-phonology interface, as pretty much all of the subsequent chapters pursue. If LF is the level of representation that sends instructional signals to the systems of thought, which interpret the meaning of a linguistic expression and capture the "meaning side" of language, research in syntax-semantics interactions could thus be considered interface-related. The same goes for syntax-phonology interactions, given that phonology is concerned with the "sound side" of language, the sensorimotor systems, and by extension the level of representation known as PF. The same applies to any number of other combinations, also relating

[1] Subsequently often referred to as "Chomsky (2000 *et seq.*)"—the more technical papers on Phase Theory (but note also the important Chomsky 2005).

[2] Excellent recent dissertations on Phase Theory include Richards (2004), Hiraiwa (2005), and Gallego (2007), to name but a few. For shorter textbook presentations, see e.g. chs. 10 of Adger (2003), Radford (2004), and Hornstein *et al.* (2005) or Lasnik & Uriagereka with Boeckx (2005: sect. 7.4) and Boeckx (2008*a*: sect. 3.2).

[3] See also Chomsky (2008), although with different terminology. In a sense, then, the distinction drawn here relates to the LF/PF vs C-I/SM distinction within Phase Theory starting with Chomsky (2000).

to morphology (including the lexicon), pragmatics (and/or discourse, information structure, etc.), and so on. Such a view of interfaces would concentrate on common properties and divergences between two or more (possibly autonomous) components of grammar. The recent collection of state-of-the-art research compiled in Ramchand & Reiss (2007) provides plenty of further discussion, also investigating interactions between phonetics and phonology, between morphology and syntax, and so on.

However, the study of interfaces need not be concerned with trying to find out something deep about the conceptual-architectural properties of the sound and meaning interface systems, the systems that "translate" linguistic properties into signals to the brain to produce or process language. This is done by the modular interfaces,[4] identified in minimalism as LF and PF.[5] The interface levels LF and PF are systems of representation, in the formal sense of Chomsky (1955); see e.g. Chomsky (1975: 99, 103), and especially Uriagereka (1998, 2008*a*), for valuable discussion. Under this view, the structure assembled in the syntactic component is handed over to the semantic component and to the phonological component, which in turn produce as their output the interface levels LF and PF—steps that are being investigated theoretically and empirically in this volume as well. Standard minimalist assumptions hold that the external systems of thought and the sensorimotor systems read off these levels of representation at the interface.[6]

The following three sections introduce some of the specific questions which can be taken as central to the topic and at the same time mirror the organization of this collection. The twelve contributions have been arranged into three sets of four, fitting the three part titles. Admittedly, this is not, and cannot be, a perfect one-to-one fit, thus some overlap between a particular contribution and the part it has been assigned to may be observed, but by and large the approximation is fittingly close and, it is hoped, transparent. One group largely discusses conceptual issues, sketching the theoretical framework of minimalism and Phase Theory (but often, of course, providing empirical discussion as well); one recurring aspect here is the LF part of interface

[4] This corrects the unfortunate typographical error in Grohmann (2007*a*: 6).

[5] The nature of these signals, and how the brain deals with them, arguably goes beyond the formal study of theoretical linguistics, and also beyond the present volume. The increase in linguistically motivated investigations in areas of neuro- and psycholinguistic research over the past decade, in which linguists participate alongside neurologists, biologists, and other scientists, can, however, be taken as a good sign for interest and progress in this area. This issue is closely related to what Poeppel & Embick (2005) have called the "Granularity Problem" (for further discussion, see also Hornstein forthcoming).

[6] "External" is understood as being outside the faculty of language, whereas the "internal" mechanics are part of our language system. The contributions collected in this volume are for the most part concerned with issues relevant to the faculty of language.

interpretation, the nature of the conceptual-intentional system (Section 1.2). A second bunch explores articulatory issues, focusing on the point(s) of Spell-Out applications and the mapping from syntax to phonology; in this way, the chapters address the PF side of interface interpretation, the nature of the sensorimotor system (Section 1.3). The third part addresses ordering issues at large, in particular linearization and cases of deletion; it deals with other interpretive issues at the interface(s), such as word order and ellipsis phenomena (Section 1.4). The remainder of this introductory chapter thus puts the ensuing discussion, and thereby the articles collected here, into the wider perspective of Chomsky's work on Phase Theory as well as critique, suggestions, and revisions provided elsewhere. The final section of this chapter provides a brief outlook for future investigations, also beyond the concerns addressed here (Section 1.5).

1.2 Conceptual Issues: The Theoretical Framework

Part I contains discussions of largely conceptual issues, thereby sketching the theoretical framework of minimalism in general and Phase Theory specifically. A recurring aspect in all four chapters is the LF part of interface interpretation, that is, the nature of the conceptual-intentional system and how it is fed by the syntactic computation. The Minimalist Program, often simply abbreviated as MP, is the currently prevailing approach to grammar and goes back at least to Chomsky (1993), which circulated in manuscript form and by word of mouth much earlier. The theoretical developments and advances over the past decade and a half fall into two major strands, minimalism as formulated in Chomsky (1995) on the one hand, especially chapter 4 (an expanded version of Chomsky 1994), and in Chomsky (2000) and subsequent work on the other. The former can be classified as embracing at its core *Checking Theory*, the latter as developing *Phase Theory*.

Here the classification is used in this sense, where Checking Theory considers the entire derivation and assumes that movement is feature-driven, triggered by the computational need to check formal features in a specifier-head configuration, or Spec-Head for short. Checking may be source-driven, triggered by the moving element's properties (*Move*, in the sense of Chomsky 1993) or target-driven, where a higher functional element attracts a lower phrase to satisfy feature licensing (*Attract*, in the sense of Chomsky 1995: ch. 4).

Phase Theory, on the other hand, eliminates the structural configuration Spec-Head, which has been a staple property of generative grammar for a very long time, much longer than what can be called "minimalist approaches to the

grammar" in the technical sense. It, and thus Checking Theory as a whole, is replaced by the operation *Agree* which holds between a higher functional head, the *probe* P, and a lower linguistic expression, the *goal* G.[7] The formal relation that must hold for Agree between P and G to take place is c-command: P may enter into an Agree relation with G if P c-commands G. Other relevant aspects involve *feature interpretability* and some notion of locality at large, expressed through the property "active": In order for an element to act as a probe, it must bear an uninterpretable feature that is not yet valued, and in order for an element to be a possible goal it must be active in some sense to be determined. "Uninterpretable" means that the feature needs to get valued and deleted, since it cannot be interpreted at the interfaces; to become a suitable goal, the element must in addition bear an interpretable feature that matches the uninterpretable feature of the probing element. Thus P with an uninterpretable feature [*u*F], in the terminology of Pesetsky & Torrego (2001), must c-command an active G with a matching interpretable feature [F].[8]

The references mentioned in *n*. 2 lay out the basics sketched here in more detail, and for the most part the contributions collected here do not deal with the specifics of the Agree framework to feature licensing, and neither do they directly explore the notion "active"—but indirectly they do. Being active requires the element to be accessible in a particular technical sense, simply put within the same phase.[9] And this leads us to Phase Theory.

The cornerstone of Phase Theory is the hypothesis that the syntactic derivation proceeds phase by phase—by building up a smaller chunk of syntactic structure, evaluating it at several time steps, and then continuing to successively construct the next relevant chunk(s) until the *numeration* or *lexical array* is depleted. In order to demonstrate the rationale behind Phase Theory and address some of the issues that arise, the *architecture of the grammar* needs to be considered in some semi-historical perspective.

For starters, the type of architectural design of the grammar minimalism challenged from the outset is the Government-and-Binding Theory (GB, Chomsky 1981) organization of four levels of representation and their interplay, where each is subject to a number of specific filters and constraints:

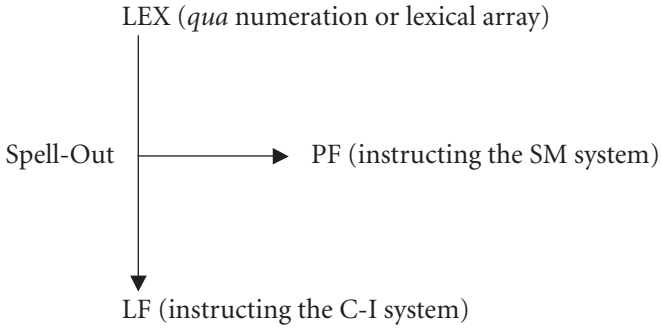
[7] This is a simplified characterization, of course, but it should suffice for present purposes since none of the following chapters deals in any deep sense with Agree and movement issues that bear on the status or replacement of Checking Theory in Phase Theory. It is probably more accurate to say, as Petr Biskup (p.c.) points out, that the Spec-Head configuration is replaced by the operation *Agree* coupled with the (generalized) EPP (Chomsky 2000, 2001) and that Agree replaces F(eature)-movement.

[8] See Adger (2003) for the earliest textbook presentation of this notation and a coherent (if, at times, non-standard) feature-licensing system, ideal as an overview for novice minimalists.

[9] In an earlier formulation, the goal could also be active when in a lower phase (e.g. Chomsky 2001: 14), but this raises the issue of strong vs weak phases, which will be ignored here.

D-structure (Projection Principle) feeds S-structure (Move α) which in turn branches off and leads to the semantic interpretation (LF) and phonetic output (PF). Particular conditions (such as Subjacency or the Extended Projection Principle) apply and individual modules (such as Theta Theory, Case Filter, PRO Theorem, and so on) have to be satisfied at the respective level of representation (see also van Riemsdijk & Williams 1986; for a recent review of subsequent developments, see e.g. Hornstein *et al.* 2005). In contrast, the classic minimalist architecture eliminates the levels of D- and S-structure, as in (1): The Lexicon (LEX) feeds the syntactic derivation directly, which thus allows interspersing of *Merge* and *Move* rather freely (certainly not as constrained as in older models), in accordance with the licensing mechanism of formal properties, as briefly mentioned above (such as Checking Theory vs Agree), and other conditions on interpretation.

(1)



Noteworthy here is the operation *Spell-Out*, which will be addressed in Section 1.3. Other than that, standard minimalist reasoning holds that only such entities should exist in the grammar that either follow from *(virtual) conceptual necessity* or fall into the category *bare output conditions* (Chomsky 1995: 169–71, 219–25), now called *interface conditions* in Phase Theory (Chomsky 2004*a*: 2). LEX, the collection of lexical items and functional elements in the human mind/brain, is arguably conceptually necessary, whereas LF and PF are clearly interface conditions.[10] As just mentioned, these are linguistic levels of representation which the relevant language-external systems read off. These levels, which Chomsky (1995) calls the *conceptual-intentional (C-I) system* and the articulatory-perceptual system, these days more commonly known as the *sensorimotor (SM) system* (Chomsky 2000 *et seq.*), respectively, are clearly

[10] Returning to one of the questions from Section 1.1, note that Uriagereka (1999*a*) makes the interesting case for a revival of DS. He argues that many aspects of DS are essentially still packaged in minimalism as hidden assumptions and carefully teases apart the relevant issues: What is a "level of representation" (as opposed to a "component")? How can we integrate their role in a minimalist approach? The reasoning laid out in more detail in Uriagereka (2008*a*) will probably play an important role in the near future, but not in this volume.

"(virtually) conceptually necessary" if there is anything to the characterization, roughly going back to Aristotle, that language is the pairing of sound and meaning. If language at some level boils down to such a pair—often expressed as the pair $<\pi, \lambda>$, where π is the phonetic output and λ the semantic one or the pair <Phon, Sem> (see below)—then sound and meaning need to be represented somehow, to yield the two objects that make up language.

Or so goes the mainstream view. Two contributions to the present volume deal specifically with the C-I interface system(s). **Wolfram Hinzen** casts some doubt on the characterization of (virtual) conceptual necessity to include the C-I system. When Hinzen asks whether the successor function plus the lexicon equals human language, he not only plays with the title of a workshop recently held in Berlin (cf. Sauerland & Gärtner 2007). Hinzen really asks to what extent the equation in the title is a useful idealization of evolutionary facts. He wants to know what interfaces "motivate" exactly (thereby getting even closer to the title of that particular workshop). And he has some answers, too. He motivates the equation by assuming a radical simplification of the computational system of the language faculty (FL[11]). This explanatory vision operates with a minimal conception of recursive structure-building, modeled on the recursive structure of the natural numbers. The results of the discussion of conceptual and empirical difficulties for the latter may be taken as a reformulation, but not necessarily an abandonment, of the so-called *Strong Minimalist Thesis* (Chomsky 2000 *et seq.*; Lasnik 2002), to be addressed presently, viewed as a guideline of empirical research in the evolution of language.

In contrast, **Takashi Munakata**, working from within the hypothesis that the C-I system is conceptually necessary, argues for a division of the C-I system, into a *Conceptual-System* and an *Intentional-System* as opposed to one unified system, and suggests that both systems interface with the language faculty. He also proposes that the different interface conditions imposed by these systems regulate a number of otherwise unmotivated syntactic properties and mechanisms, such as the A/A′-distinction, the difference between lexical and functional elements, thematic properties, or the dual nature of semantics. Munakata's investigations into the nature of the input within a phase-theoretic approach thus lead to a different perspective from Chomsky's on the output (*vis-à-vis* multiple applications of Transfer; cf. Section 1.3).

To continue with the brief sketch of basic minimalist assumptions and terminology in Phase Theory, C_{HL} thus essentially maps items from the Lexicon

[11] The language faculty is also referred to as the (human) faculty of language, then often abbreviated as FL. Both terms are used in this volume. For a wider discussion of FL issues, including evolutionary speculations and the larger biolinguistic perspective, see Hauser *et al.* (2002) and Chomsky (2005, 2007*b*).

to the LF representation of an expression (Exp)—call this *narrow syntax* (NS). The mapping proceeds from either a unique numeration (as in the earlier minimalist approach of Chomsky 1995) or from several lexical (sub)arrays (as in the current phase-based model of Chomsky 2000 *et seq.*). Spell-Out, or a subapplication of *Transfer* (see Section 1.3), is the operation that applies to the derivation computed within NS, once all uninterpretable features have been licensed (but see the presentation on Spell-Out below). It sends the derivation, or the relevant subpart (the "chunk" called phase), to PF for phonological manipulation in order to obtain a legible, i.e. pronounceable, representation. By assumption, the derivation continues, but without effect on the PF output, in order to obtain a unique LF representation corresponding to the meaning of the linguistic expression computed. The final outcome is a paired expression, namely Exp = <Phon, Sem> (or $<\pi, \lambda>$ in earlier notation).[12] In more recent work, Spell-Out has received a lot of attention, which will be presented briefly in the next section.

Whatever the details, a linguistic theory must above all be able to take care of, and explain, those (unique) properties of human language that make language such a special object to study. Four such properties are (i) the existence of uninterpretable formal features, (ii) dislocation effects, (iii) the cross-linguistic flexibility of morphosyntactic categories, and (iv) the existence of cross-linguistic variation—a wild mix that so far seems to have resisted a clean explanation and has sometimes been characterized as "imperfections" of language. One aspect of the conceptual underpinnings of the Strong(est) Minimalist Thesis (SMT) is the idea that language is, despite appearances, a "perfect" solution to the task of relating sound and meaning.[13] In other words, this perspective takes language to be an optimal solution to conditions that are imposed to FL by the mental modules, the C-I and the SM systems.

However, as **Hedde Zeijlstra** argues, the idea that language is "perfect" in this sense seems to be at odds with several "imperfections" found in grammar, such as those just mentioned. Zeijlstra argues that these four properties are not linguistic imperfections, but are actually predicted by the Perfectness Hypothesis—specifically, that the different conditions imposed by FL are not always compatible to each other, and that therefore FL can offer multiple,

[12] To be more precise, here's the latest formulation in the original (Chomsky 2004*a*: 107):

Assume further that [language] L has three components: *narrow syntax* (NS) maps [the lexical array] LA to a derivation D-NS; the *phonological component* Φ maps D-NS to PHON; the *semantic component* Σ maps D-NS to SEM. Σ is assumed to be uniform for all L; NS is as well, if parameters can be restricted to LEX (as I will assume). Φ, in contrast, is highly variable among Ls. Optimally, mappings will satisfy the *inclusiveness condition*, introducing no new elements but only rearranging those of the domain.

[13] The SMT has undergone some changes in its formulation since Chomsky (1995) but can be summarized as follows: "[L]anguage is an optimal solution to interface conditions that the Faculty of Language (FL) must satisfy" (Chomsky 2005: 3).

equally optimal solutions to these conflicting interface conditions. His contribution thus deals with consequences of conflicting interface conditions: being a perfect solution to one interface condition may imply that another interface condition cannot be maximally solved, and vice versa. Hence perfect solutions to interface conditions, which are in conflict with other interface conditions, can only exist by virtue of less perfect solutions to these other interface conditions. The central claim of this chapter is that the existence of the aforementioned properties are all epiphenomena of the perfectness hypothesis.

A final aspect of interface interpretation relevant for the following chapters concerns binding, captured in earlier theoretical approaches, predominantly in GB, by the Binding Theory which is made up of three binding principles or conditions (Chomsky 1981, 1986*b*): Condition A governing the interpretation of anaphors, Condition B licensing pronouns, and Condition C relating R(eferential)-expressions. Binding is perhaps the interface phenomenon *par excellence*—certainly from a linguistic interface perspective, in the sense understood here. Binding concerns cannot be accommodated without the interplay of at least both syntax (*qua* derivation, yielding the relevant structural configurations) and semantics (*qua* interpretation of individual linguistic expressions, possibly in context). Hornstein *et al.* (2005: ch. 8) provide a larger background of binding issues in a minimalist approach. As for treatments of binding in Phase Theory specifically, not so much work has been done yet. Perhaps Phase Theory has not (yet) much to contribute to standard (minimalist) treatments of binding phenomena in language. One notable exception is work by Uriagereka & Gallego (2006) who propose (multiple) Agree as relating binder (probe) and bindee (goal), where the classic binding domain is recast in terms of the phase (originally suggested in Lasnik & Uriagereka with Boeckx 2005). They thus replace the relation Binding with the operation Agree, develop the notion of multiple Agree to capture Condition A, and derive Condition B from associating subject and object with different probes (Uriagereka & Gallego 2006: 7).

They remain silent, however, on Condition C. **Petr Biskup** pays attention to R-expressions in his contribution and Condition C effects within a phase-based approach to C_{HL}. Concentrating on the role of adjuncts, he revisits the well-known asymmetry between reconstruction and Condition C and the timing question of adding adjuncts to the derivation. Biskup first makes the strong case that there is a need to differentiate between clausal and non-clausal adjuncts with respect to Condition C effects, which only the former can obviate. Condition C effects themselves consequently do not constitute a uniform phenomenon; they can be induced by three different factors (stemming from phrase structure, tripartite quantificational structure, and information structure). He argues further that the Condition C data cannot be accounted

for by acyclic merger of adjuncts or by the special status of (late) adjunct merger, and concludes that all adjuncts are merged cyclically. On the verge of leaving the conceptual part this chapter has been assigned to, Biskup presents a thorough discussion of actual language data and discusses a wealth of relevant data from Czech.

1.3 Articulatory Issues: Points of Spell-Out

Part II explores articulatory issues within Phase Theory with two major focal points—the mapping from syntax to phonology (with a recurring theme of prosodic issues) and further details concerning the operation Spell-Out (such as when and where it applies). In this way, all chapters address the PF side of interface interpretation, the nature of the SM system, from both a linguistic and a modular interface perspective in the sense outlined above.[14] Chomsky (1993, 1995) originally introduced Spell-Out as that kind of operation in NS that replaced the S-structure level of representation. It was assumed to take the final product of the syntactic derivation and send meaning-relevant information to LF and sound-relevant information to PF for interpretation.

The following briefly summarizes the status of Spell-Out in Chomsky's (2000 *et seq.*) more *dynamic model* of Phase Theory (see also the references cited in *n*. 2). It should be prefaced with the observation that many of the properties hold for all recent proposals, to some degree, after the original introduction of multiple Spell-Out by Uriagereka (1999*b*)—which itself picks up on ideas expressed first in Bresnan (1971, 1972). This includes Uriagereka's own explorations of multiple Spell-Out (1998, 2002*c*, 2008*a*, 2008*b*), Chomsky's phase-based model (2000, 2001, 2004*a*, 2005, 2007*a*, 2008), the Spell-Out-as-you-merge approach by Epstein *et al.* (1998) and Epstein & Seely (2002*a*, 2006), the related single-output model of Groat & O'Neil (1996) and others, and Grohmann's (2000, 2003) dynamic spelling out of Prolific Domains, for example, which are briefly summarized in an overview at the end of this section for completeness.

There are at least two major issues concerning the articulatory interface theme in minimalism or, more specifically, some version of multiple Spell-Out and the organization of the grammar—the two issues that connect the chapters in this part (and some others). On the one hand, it needs to be seen empirically whether the notion of multiple Spell-Out has a practical application, and what details of such an application would look like. On the

[14] In this sense, they also contribute to conceptual advances of the framework, of course, but since emphasis is put clearly on Spell-Out effects and phenomena, the four chapters have been included here.

other hand, the terms and conditions relating to multiple Spell-Out have to be made concrete. One exciting aspect of linguistic minimalism (in the sense of Boeckx 2006) is, then, that the study of the linguistic interfaces opens new doors in the large hallway of the architecture of the grammar.

As depicted in (1) above, the so-called Y-model of the grammar, (narrow) syntax feeds the interpretive interface levels LF and PF directly, without assuming additional levels of representation. The operation Spell-Out was originally introduced in Chomsky (2003) to apply at one point and hand the derivation over to the interface levels. With the rise of the Multiple Spell-Out Hypothesis (Uriagereka 1999*b*), however, the conception of this transfer became more "dynamic" in a way (see also Uriagereka 1998, 2002*c*, 2008*a*, 2008*b* as well as the approaches mentioned at the end of this section), while Uriagereka suggested applying Spell-Out to "command paths" with the (simplified) effect of "freezing" left branches of assembled tree structures. Chomsky (2000) picked the idea up and developed a notion of cyclic Spell-Out (other approaches are briefly presented at the end of this section): Spell-Out applies in a cyclic manner over specific subparts of the derivation. These cyclic subparts he called phases, identified on the clausal level as *v*P and CP on the basis of a number of properties (as discussed here by Marušič who provides plenty of references; see also Boeckx & Grohmann 2007 and literature cited for a critical overview). Phases then are the relevant derivational subparts at which Spell-Out applies cyclically.

Since the focus of the chapters contained in this part falls on spelling out to PF, this aspect will be given more emphasis here.[15] More recently, Chomsky (2004*a*) employs the "superoperation" Transfer (Lasnik & Uriagereka with Boeckx 2005: 240), which sends the relevant information (interpretable features) to the interpretive interfaces (LF and PF). Spell-Out, under this view, is the suboperation "Transfer to PF" (as opposed to the alternative, "Transfer to LF"[16]). For the remainder of this chapter, unless otherwise noted, "Spell-Out" is used interchangeably with "Transfer to PF" understood in this sense. And it is this sense that leads to the articulatory issues discussed here.

To start with, **Lanko Marušič** balances his discussion between conceptual and articulatory issues. Following standard assumptions, as laid out in the previous section and continued below, when a phase is completed, the structure is

[15] Note that Nissenbaum (2000)—taking his cue from the single-output models of Brody (1995), Bobaljik (1995), Pesetsky (1998), and Groat & O'Neil (1996)—assumes Spell-Out to apply solely for PF purposes. This single-cycle grammar replicates the effects yielded by the Y-model (cf. (1)) without losing the dynamic character of the phase-based model.

[16] On a par with *Spell-Out* as Transfer to PF, Lasnik & Uriagereka with Boeckx (2005: 240) suggest the term *Interpret* for Transfer at LF.

sent simultaneously to the two interfaces where it gets interpreted. But certain syntactic constituents do not have phasal properties at both interfaces. This suggests that Transfer sometimes occurs to a single interface, that is, to PF but not simultaneously to LF, or vice versa (note the conceptual resemblance to Zeijlstra's suggestion: "Being a perfect solution to one interface condition may imply that another interface condition cannot be maximally solved, and vice versa"). This tool of *non-simultaneous Spell-Out* could place this chapter in the conceptual part of the volume. However, Marušič also provides a host of relevant data from Slovenian, zooming in on both PF- and LF-relevant aspects. Here he finds strong evidence in favor of (non-simultaneous) Spell-Out at both the clausal and the nominal level, i.e. within DP.[17] He further argues that non-simultaneous Spell-Out derives reconstruction effects and covert movement, the two cases where place of interpretation differs from the place of pronunciation.

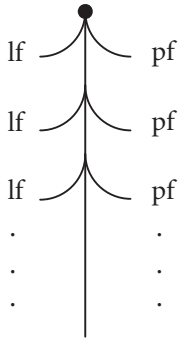
But in "standard" Phase Theory as proposed by Chomsky (2001 *et seq.*), Spell-Out (Transfer to PF) applies at the phase level on a par with Transfer to LF (see also *n*. 15). The phase is thus argued to be an indispensable property of any well-designed language system that conforms to the SMT. In essence, phases are the only relevant units for the mapping from NS to the external systems, the C-I system fed by LF and the SM system fed by PF. This process supposedly allows for optimal computational efficiency, eliminating redundant internal levels and compositional cycles in favor of the generation of a single cycle with periodic transfer to the interfaces. The units sent to Spell-Out are syntactically defined as the locus of uninterpretable features, which need to be eliminated (and whose cyclic valuation ensures Full Interpretation at the interfaces).

As noted above, the assumption that Spell-Out is not an operation fundamentally different from other operations in the grammar in that it applies exactly once in a given derivation leads to more dynamic conceptions (for book-length treatments, see Uriagereka 2002*c*, 2008*b*). Rather, it may apply several times, giving rise to a "multiple Spell-Out" model—and what makes these "several times" of application appropriate is somehow encoded in the dynamics of the syntactic computation. This can be illustrated as below (taken from Boeckx 2008*a*: 45), where LF and PF are assembled cyclically in some fashion (via "mini-interface components" *lf* and *pf*)—leaving out details at this point in the introduction as to how exactly the dynamics of the system is computed. The latter is, of course, identified as the phase, more specifically,

[17] On the phasal status of DP, see Svenonius (2004) as well as Hiraiwa (2005), a possibility acknowledged in Chomsky (2008). Note that Abels (2003*b*) also makes the case for the phase-relevance of PP (by means of a modern twist on van Riemsdijk 1978), but these issues are not discussed in the present volume.

tied to the point at which a phase head is merged into the derivation and ranges over its domain—its complement up to and excluding the next lower phase head and structures c-commanded by it, but including its edge (see below for more).

(2)



Under such an approach, Spell-Out applies several times in the course of the derivation—and the question is to find out which units are the relevant subparts of the derivation at which Spell-Out applies. Chomsky's (2000 *et seq.*) answer is that phases are instrumental; potential alternatives will be briefly presented at the end of this section.

As roughly portrayed in (2), cyclic Spell-Out allows for the dynamic linearization of syntactic structures, where each phase forms a separate linearization domain. If linearization algorithms operate on syntactic information (a reasonable assumption, but see Section 1.4)—such as c-command relations, as under Kayne's (1994) Linear Correspondence Axiom—dynamic linearization is not just a possibility but in fact a necessity in a phase-based system. This is because such information is lost in the course of cyclic computation, which, in accordance with the SMT, leads to minimization of computational complexity, at least by hypothesis, via a reduction in memory load. This property of a phase-based computation yields the strict cyclicity effects captured under the Phase Impenetrability Condition (PIC). The PIC originally proposed in Chomsky (2000) has received some modification, specifically in Chomsky (2001), on the basis of work by Nissenbaum (2000). The latest installment of the PIC is as follows:

(3) At the phase ZP containing phase HP, the domain of H is not accessible to operations, but only the edge of HP. (Chomsky 2004*a*: 108)

For Chomsky, then, the PIC is an inevitable consequence of any "meaningful" system of cyclic computation. In his words, "Φ [the phonological component] is greatly simplified if it can 'forget about' what has been transferred to it at earlier phases; otherwise, the advantages of cyclic computation are lost"

(Chomsky 2004*a*: 107). Most research inspired by Chomsky in this area tends to be done by syntacticians, and thus focus on (syntacticians' conceptions of) the mapping from syntax to PF. But of course, a phonologist's perspective might be equally revealing, if not more (or at least, differently).[18]

A relevant contribution to this aspect is the chapter by **Kayono Shiobara**, who provides a phonological perspective on syntactically derived phases. She thus focuses on the sound side of the two interfaces and considers potential advantages of a phonologically based approach to phases. Shiobara shows that a phonological approach to phases calls for left-to-right, as opposed to the standardly assumed bottom-up, structure-building in C_{HL} and argues that this assumption has independent motivations. First and foremost, left-to-right is the way terminal elements are produced or processed online in performance. In addition, left-to-right structure-building in the computational component is empirically supported by syntactic and phonological facts, and possibly by scope phenomena related to the syntax-LF mapping, for which Shiobara provides evidence. She argues specifically that locality effects captured by the PIC may be reinterpreted in a left-to-right derivation, where it is always the "right" edge of a phase that is accessible to the next computational cycle, without any additional problems.

Current dynamic approaches to the syntactic derivation capitalize on the notion of syntactic cycles, be it in the sense of phases, derivational cascades, or other alternatives. Such models also raise a number of interesting issues regarding the way in which phonology processes the syntactic output. **Anthi Revithiadou & Vassilios Spyropoulos** provide a case study from prosodification of clitic-doubled DP-objects in Greek to implement a dynamic approach to the syntax-phonology interface. They essentially propose that the derivational status of syntactic material is reflected on the way PF organizes the output of syntax into phonological phrases. On the basis of empirical evidence, Revithiadou & Spyropoulos propose that elements which exhibit derivational islandhood form independent phonological phrases and, significantly, are

[18] The subsequent three chapters cite plenty of relevant sources, such as work by Gorka Elordieta, Shinichiro Ishihara, Hubert Truckenbrodt, and, of course, Lisa Selkirk, the pioneer on these issues for the past few decades, who has also worked on Phase Theory in recent years (Selkirk 2006*b*, Kratzer & Selkirk 2007), among many others, naturally including the individual authors' own research. A very recent and highly stimulating piece of research is Chung's (2007) dissertation on the "ecology" of PF. Other relevant research is carried out by Tobias Scheer and colleagues (e.g. Newell & Scheer 2007), who also provide a "little interface library" (http://www.unice.fr/dsl/tobweb/interfacelib.htm). However, the phonology aspect of these chapters will not be discussed in this syntax-orientated introduction (but see the respective chapters of Revithiadou & Spyropoulos, Sato, and Shiobara).

Another perspective comes from morphology, especially the framework of Distributed Morphology (Halle & Marantz 1993); see Embick & Noyer (2001) and Embick (2007) for interesting proposals concerning the "road to PF" (Grohmann 2007*b*).

impervious to PF restructuring mechanisms. They further explore the limits of this isomorphism by investigating the derivational and prosodic status of preverbal Greek subjects and conclude that their syntactic non-islandhood is matched by an analogous behavior at PF since they are subject to restructuring. This particular type of isomorphism provides empirical justification for drawing a distinction between two different implementations of Spell-Out, as originally proposed in Uriagereka (1999*b*).

A comparison, or integration, of the Multiple Spell-Out Hypothesis and Phase Theory is also the concern of **Yosuke Sato**, who provides arguments for multiple Spell-Out through an application to prosodic domains. In this third and final "phonological perspective" on dynamic interfaces and Phase Theory, he proposes a syntax-prosody mapping hypothesis within the recent derivational theory of syntax. This hypothesis yields predictions about possible structural domains for phonological rule application that are indeed borne out by a variety of phonological alternations across languages. The empirical data Sato discusses are rich and varied: Taiwanese tone sandhi, French liaison, Gilyak lenition, Kinyambo high tone deletion, and Welsh consonant mutation are all explored in this chapter.

Expanding on the above presentation and thus going slightly beyond the scope of the present volume, the following list provides a short overview—with no claim to exhaustiveness—of some recent proposals, in chronological order, that are relevant to what has been called here the "dynamic model" (from Grohmann 2007*a*: 11–12):

(i) *Multiple Spell-Out*
Uriagereka (1999*b*), originally circulated in 1996, who proposes multiple Spell-Out every time a 'command path' is formed, which essentially breaks down to left branches (apart from Uriagereka 2002*c*, 2008*a*, 2008*b*, see also his follow-up work with Jairo Nunes and other work inspired by it);

(ii) *Spell-Out-as-you-merge*
Epstein *et al.* (1998), based in part on the previous work of the co-authors, who argue essentially that every application of Merge spells out (see also recent fruitful collaboration of Samuel Epstein and Daniel Seely as well as other scholars' contributions to this line of research);

(iii) *Phase Theory*
Chomsky (2000), originally circulated in 1998, who introduces phases as Spell-Out domains and who refined the notion of phase in Chomsky (2001, 2004*a*, 2008) and other work (see also a lot of recent research within the phase-based approach by a host of different scholars);

(iv) *Prolific Domains*
Grohmann (2003), based on his 2000 dissertation, who suggests Prolific Domains to spell out dynamically (and here too there is much follow-up and related research by Grohmann and co-authors as well as other linguists; see Grohmann, forthcoming).

1.4 Ordering Issues: Linearization and Deletion

Part III addresses ordering at large, in particular how C_{HL} linearizes syntactic constituents and deals with deletion issues; it also deals with other interpretive effects at the LF and PF interfaces, such as word order and ellipsis phenomena. Since linearization must take place in the phonological component (as argued for under minimalist considerations by Chomsky 1995, Uriagereka 1998, Nunes 1999, and many others), dynamic/cyclic linearization goes hand in hand with SMT-conforming dynamic/cyclic Spell-Out. In short, linearization in Phase Theory should take place on a phase-by-phase basis if the phonological component gets constructed piecemeal via phases. The following sketches some issues relevant to linearization and then briefly presents the remaining chapters; deletion and ellipsis will not be discussed here.[19]

In the course of the derivation, "all NS does is to create new objects out of pre-existing morpho-lexical units" (Piattelli-Palmarini & Uriagereka 2004: 355). These new objects are sets which the syntactic operation Merge combines. Merging two items, α and β, thus creates the set $\{\alpha, \beta\}$, in which α and β remain distinct; in natural language, this operation can be reiterated (recursively). This way, the phrase marker is built bottom-up in a recursive manner through the successive application of the operation Merge (but see Shiobara's chapter). The interface with the SM system imposes that the hierarchical structure resulting from merging objects iteratively be linearized. As Uriagereka (1998, 1999*b*) notes, the objects assembled by Merge are (at least) two-dimensional, whereas speech is one-dimensional. Therefore, all the objects NS (or rather D-NS, as per *n*. 12) sends to PF, and ultimately the SM system, must be submitted to some ordering relation—linearization.

However, linearizing the objects in a given phrase marker would, as a consequence, destroy all hierarchical relations, which in turn would result in feeding the C-I system with uninterpretable material. Thus, as Piattelli-Palmarini &

[19] A major concern for deletion relates, of course, to deletion of copies, or whatever multiple occurrences of syntactic constituents be referred to. This is not the right place to open that can of worms, which bears on many issues beyond chain formation (see e.g. Nunes 1995, 2004 and Hornstein 1998, 2001 for extensive discussion).

Uriagereka continue, one of two assumptions must apply. First, one could argue that linear order unambiguously reflects hierarchical structure (as in Kayne 1994, briefly addressed right below). Second—alternatively or in addition—one could capitalize on some marker that the SM system can detect (such as an agreement or Case marker, as Uriagereka 1999*b* suggests) which is attached to one item in the string; according to Uriagereka, this marker corresponds to a marker attached to another item in the string in ways that the C-I system can process, which would suffice to feed the C-I system with specific constructs that can be interpreted there.

One of the most explicit translations from syntactic structure to phonological/phonetic output (i.e. PF) in recent years is however based on some version of Kayne's Linear Correspondence Axiom (LCA). The major insight here (call it the Dominance Hypothesis, with Lechner 2006) is that syntactic relations refer to dominance (via c-command), but not to precedence. Uriagereka (1998, 1999*b*) suggests that the syntactic representation can be likened to a Calder mobile, whose root X is fixed, but whose branches swing freely in a two-dimensional plane—the result of a recursive application of Merge where the output of one application can be the input of the next. But at least at the point at which the product of the completed derivation is submitted to the PF component, an ordering of the two terms has to be specified. That is, the two-dimensional tree has to be mapped onto a one-dimensional phonetic representation. More precisely, it is the two-dimensional circle that results from letting α and β rotate freely which needs to be mapped to a one-dimensional string. Given that this information cannot come from any other source than from LEX and the properties of the syntactic derivation (which are possibly restricted by some kind of IC or "interface readability"), and given that LEX is inherently unordered (which also goes for any implementation of a pre-syntactic numeration or array that enters NS), it follows that the tree somehow must also contain information about order.

For the sake of completeness, and to allow a better processing of the following discussion, (4) reproduces the original formulation of the LCA and (5)-(6), from Uriagereka (2008*b*: ch. 1), illustrate it further (even though it may not bear directly on Phase Theory, at least not in current research[20]):

(4) *Linear Correspondence Axiom* (*LCA*; Kayne 1994: 6)
d(A) is a linear ordering of T.

[20] What may not be so prominent in current phase-based research is Kayne's specific formulation within his Antisymmetry Theory, and Uriagereka provides an interesting alternative formulation. What is prominent, though, is of course the idea that linearization must be captured somehow, and that this is done at PF. Uriagereka's rendering of Kayne's LCA turns out to be a theorem, rather than an axiom. This is surely a step in the right direction, but whether it suffices remains to be seen.

(5) *Linear Correspondence Axiom* (partial statement; Uriagereka 2008*b*: ch. 1)
When x asymmetrically c-commands y, x precedes y.

(6) *Linearization Induction* (Uriagereka 2008*b*: ch. 1)
If a non-terminal X dominates a terminal y, and X is linearized with regards to terminal z, then y is linearized with regards to z.

Aside from transitivity, the LCA is specified through two conditions. First, for each pair of terminals, it must be possible to find two nodes that dominate these terminals and which asymmetrically c-command each other. This condition, the "Totality Clause" of the axiom, requires that all pairs of terminals satisfy this condition. Second, by the "Antisymmetry Clause," there should be no two non-terminals above the terminals that reverse the asymmetrical c-command order. The main objective of the LCA is to derive basic properties of X′-Theory related to generalizations of ordering (specifiers precede heads, complements follow, adjunction is to the left—whether this is to be implemented through Kayne's Universal Base Hypothesis or derived some other way with slight alterations; cf. *n*. 20). A second goal is to find a mapping structure to order. The fact that some terminal α precedes some terminal β in a given structure does not necessarily mean that the two terminals are pronounced in that order.

An alternative to the Dominance Hypothesis would be what Lechner calls the Precedence Hypothesis: hierarchical order (*vis-à-vis* syntactic structure) encodes linear order. This view is espoused in recent work that does not assume the LCA (see Williams 2003, Fox & Pesetsky 2005, and Müller 2007, for example). On analogy with the Dominance Hypothesis, it could be defined in such a way that syntactic principles refer to precedence, not to dominance (c-command). Richards (2007) critically examines this hypothesis and argues against it (at least in the formulation of Fox & Pesetsky 2005).

What is interesting to note at this point is that an adoption of either hypothesis has important repercussions for the theory of syntax. Beyond particular assumptions on phrase structure (an LCA-conforming X′-Theory vs Bare Phrase Structure Theory, for example) and feature checking (see also the discussion of "natural relations" in Grohmann 2003), something has to be said about how unordered items from LEX are arranged in NS in such a way that all relevant hierarchical relations come out (quantifier scope, binding possibilities, and other LF-interpretable properties) and the desired linearized object emerges (the pronounced PF-output).

On the task of linearizing derivational units to comply with observed word order, grammarians have been taxed for a long time by postverbal sentential

complements in German since in all other relevant respects, German seems to be OV. **Jiro Inaba** revisits this puzzle from a phase-theoretical perspective. Based on the concept of postsyntactic linearization and cyclic Spell-Out from the bottom, Inaba proposes (i) that the element spelled out earlier is realized in the phonological component later and (ii) that CPs, as opposed to DPs, constitute an independent Spell-Out domain. This chapter thus contributes to the mechanics of linearization in Phase Theory.

Other complications for linearization are raised by all kinds of deletion phenomena in the grammar. This goes beyond the need to delete "copies" of displaced, or syntactically moved ("internally merged"), material (see *n*. 19). Two such cases are discussed in the present part of the collection, namely, ellipsis in general and a possible subcase, right-node raising.

Turning their attention to the latter special case of deletion, **Asaf Bachrach & Roni Katzir** provide new data showing that right-node raising can feed *wh*-movement and that this movement is exempt from certain locality constraints. They use these observations to argue that right-node raising should be analyzed in terms of multiple-dominance, a concept they put in the right context and provide relevant references for in their chapter. Bachrach & Katzir further discuss the implications of this conclusion for the architecture of grammar, thereby, of course, contributing to the conceptual theme of this volume as well. These include a discussion of the effects of *delayed Spell-Out* at the phonological interface.

Based on Holmberg's (2001) analysis of ellipsis combined with a particular characterization of phase, **Masanori Nakamura** explains a cross-linguistic generalization, which he dubs the *Ellipsis Movement Generalization (EMG)*: If a language allows ellipsis of a particular category in a certain structure, that category cannot undergo movement except when it is phonologically null. Following a discussion of facts from English, Irish, and Japanese, Nakamura puts the EMG in relation to the notion phase. He suggests a modification of the operation Transfer (to PF): "Transfer applies to the complement domain of head H as soon as all of the uninterpretable features of H are eliminated" (cf. Svenonius 2004; Gallego 2006*b*). In other words, in adopting the hypothesis Nakamura holds—very much with Chomsky (1986*a*)—that any projection can in principle be a phase (see also Boeckx & Grohmann 2007). He then modifies it slightly by restricting the relevant domain Transfer to which applies to the Φ-interpretable complement domain of H.

The final contribution to this volume combines investigations relevant to all three parts, and thus relates to much of what has been said above. On a conceptual note, **Howard Lasnik** addresses the organization of the grammar, arguing for *one-cycle syntax*, which has proven very productive with its

concomitant cyclic Spell-Out, but it also raises certain problems. Concerning articulation issues, Lasnik examines what is really meant by "Spell-Out"—at least on the PF side—which he puts in a wider discussion of some of these problems thrown up by one-cycle syntax. It is here that his contribution does fit the ordering part in that Lasnik considers ellipsis phenomena, island constraints, and overt-covert movement asymmetries, and combines the theoretical and empirical concerns just mentioned.

1.5 Outlook and Beyond

The final section of this chapter provides a brief outlook for future investigations and related concerns beyond those addressed here. The following chapters contribute, as outlined above, to the three aspects of *InterPhases*—the relation between the interpretive interfaces and phase-based approaches to minimalist investigations of the grammar. They all explore, to varying individual extent, conceptual, articulatory, and ordering issues within Phase Theory. As regards interface explorations, they also all investigate linguistic and modular interfaces, as the two major types of interface-relevant research have been dubbed here—again to varying individual extent.

And also to varying extent, they all embrace Phase Theory, as laid out in Chomsky (2000 *et seq.*) and other work. While adopting existing notions and hypotheses of Phase Theory, even in detail (and at times even going beyond them), the present collection does not, however, question fundamental assumptions of Phase Theory (as per Chomsky 2000 *et seq.*). Neither do the following chapters deal with certain notions of Phase Theory that might require rethinking or working out of details (as done in Boeckx & Grohmann 2007, for example). And they do not, to end these introductory remarks on a positive note, even address certain aspects of Phase Theory, whether contentious or not (some of which have been raised above)—but the following are aspects of Phase Theory that should be mentioned, if only in passing, even in a sketch as brief as this. So this section completes the rough overview of Phase Theory and interpretive interfaces within linguistic minimalism as relevant to the present volume but also slightly above and beyond, with some pointers to critical or more reflective literature.

Without doubt, the phase-based model of Chomsky (2000 *et seq.*) is an influential approach; however, it is not without its problems, and a number of issues remain to be resolved. For example, to repeat some of the questions posed in Grohmann (2007*a*): What exactly is the relation between phases and Spell-Out—do phases undergo Spell-Out, or just the domain of a phase head, or is the mapping not one-to-one after all? Or to call the relevant interface

operation Transfer, does Transfer take place simultaneously to LF and PF? (Of course, Marušič's contribution bears on this question as well.) Likewise, if phases are domains opaque for further computation once spelled out or transferred to the interfaces, does the Phase Impenetrability Condition apply to all narrow-syntactic operations? What is the relation between Agree and Move (or Merge, if Move boils down to the distinction between Internal and External Merge)? The first question is addressed throughout the following chapters, at least within Phase Theory, at times also incorporating the specific details of Uriagereka's (1999*a*) Multiple Spell-Out Hypothesis, which are not always in line with phase-theoretic assumptions. Alternative approaches were briefly presented towards the end of Section 1.3.

Another very important issue for Phase Theory to be solved satisfactorily, which is here being addressed to some extent by Marušič, concerns the "diagnostics" used to identify phases at the interfaces. Richards (2004, 2007), for example, explores an alternative to purported phonetic independence and isolability at PF and/or propositionality at LF, "standard" tools that have proven quite difficult to ascertain (see e.g. Bošković 2002*c*, Matushansky 2004, and Boeckx & Grohmann 2007 for recent criticism).

Likewise, much more can be said on the issue of intervention, be it expressed through the PIC or some other means, such as integration of optimization procedures in a minimalist computation at large. Research by Gereon Müller may lead the way on this route (among others, Müller 2007 and fruitful collaboration with Fabian Heck), which often incorporates insights from Optimality Theory (Prince & Smolensky 2004 as well as much work of the last decade in phonology, but also increasingly in syntax).

More can, and probably should, be said about feature interpretability. This goes for minimalism in general and is not specific to Phase Theory, but it certainly goes hand in hand with (further) interface-related research. How is the existence of uninterpretable features justified in the grammar? The standard answer Chomsky (1995, 2000) gives relates interpretability of formal properties of the grammar to (im)perfectness issues. In a series of papers, Pesetsky & Torrego (2001, 2006, 2007) offer an alternative conception. See also Roberts & Roussou (2002), Vangsnes (2002), Sigurðsson (2004, forthcoming), Zeijlstra (2008, forthcoming). Svenonius (2007), in particular, offers an interface perspective on features.

Other aspects of the phase-driven grammar that require better answers include the operation Agree (when and how it applies, single vs multiple applications, the definition of "active" goal, and many other issues) and the perennial difficulty of not only describing, but also explaining, islands (Ross 1967)—syntactic or otherwise—and extraction phenomena (both of which

are intimately related to the previously mentioned issues), to mention but a few.

This volume is by no means an exhaustive collection on the topic. This said, however, it will surely not remain the last volume dedicated to the study of *InterPhases*—whether minimalist theorizing will continue and develop in Phase Theory or move on, interface studies will remain an integral part of any future investigations in linguistic theory. Likewise, any continuation and development of Phase Theory will by definition put a strong emphasis on the role of the interpretive interfaces. Phases and interfaces are intricately linked with one another.