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Tobias Scheer

DIRECT INTERFACE AND ONE-CHANNEL TRANSLATION

A NON-DIACRITIC THEORY OF THE MORPHOSYNTAX-PHONOLOGY INTERFACE

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Editors

Henk van Riemsdijk
Harry van der Hulst
Jan Koster

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and One-Channel Translation

A Non-Diacritic Theory
of the Morphosyntax-Phonology Interface

Volume 2 of A Lateral Theory of Phonology

by

Tobias Scheer

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Abbreviations used

(cross-)references

Vol.1	Scheer (2004)
BlueVol	Scheer (2011a)
§79	the running number in the page margins are paragraphs. Cross-references in this book are only to these paragraphs, number 79 in this example. *Beware*: reference to a § that identifies the beginning of a chapter or a section refers to this chapter or section *and to all of its sub-sections*.
§§45-48	reference to paragraphs 45, 46, 47 and 48.
§§45,48	reference to paragraphs 45 and 48.
§§45f	reference to paragraph 45 and the following paragraph.

general

#	beginning of the word
##	beginning of the utterance
arch.	archaic
BC	Before Christ
DM	Distributed Morphology
FEN	final empty nucleus
GB	Government and Binding
HPSG	Head-drive Phrase Structure Grammar
LA	lexical array
LCA	Linear Correspondence Axiom (Kayne 1994)
LF	Logical Form
Lin	linearisation function (Embick & Noyer 2007)
OT	Optimality Theory
PF	Phonological (Phonetic) From
PIC	Phase Impenetrability Condition
SOV	Subject-Object-Verb
SPE	Sound Pattern of English (Chomsky & Halle 1968)
SVO	Subject-Verb-Object
UG	Universal Grammar

types of segments

V	any vowel / nucleus
C	any consonant / onset
T	any obstruent
R	any sonorant
N	any nasal
TR	obstruent-sonorant cluster

types of segments

RT	sonorant-obstruent cluster
TT	obstruent-obstruent cluster
RR	sonorant-sonorant cluster
etc.	

syntactic phrases

AgrP	Agreement Phrase
AspP	Aspectual Phrase
CP	Complementizer Phrase
DP	Determiner Phrase
NP	Nominal Phrase
PP	Prepositional Phrase
TP	Temporal Phrase
VP, vP	Verbal Phrase

in representations

Gvt	government
Lic	licensing
IG	Infrasegmental Government
<==	relation of Infrasegmental Government
barred arrow	the lateral relation at hand is not effective

grammatical symbols

pf., ipf.	perfective aspect, imperfective aspect
√	root
dim.	diminutive
sg., pl.	singular, plural
masc., fem.	masculine, feminine
2sg., 3pl. etc.	second person singular, third person plural etc.
3m sg., 3f pl. etc.	third person masculine singular, third person feminine plural etc.
act., pass.	active, passive voice
N, V, G, D, A, L, I	nominative, vocative, genitive, dative
A, L, I	accusative, locative, instrumental
Nsg, Gpl etc.	nominative singular, genitive plural etc.
ø	null set (not the vowel [ø], unless explicitly specified)

languages

arab.	Arabic	lat.	Latin
att.	Attic (Greek)	lesb.	Lesbian (Greek)
av.	Avestan	LSo	Lower Sorbian
BCS	Bosno-Croato-Serbian	Ma	Macedonian
Bru	Belarusian	MHG	Middle High German
Bu	Bulgarian	NHG	New High German
cr.	Croatian	OCS	Old Church Slavonic
CS	Common Slavic	OHG	Old High German
Cz, cz.	Czech	Po, po.	Polish
fr.	French	Ru	Russian
goth.	Gothic	Sk	Slovak
gr.	Greek	skr.	Sanskrit
IE	Indo-European	srb.	Serbian
it.	Italian	toch. A	Tocharian A
Ka	Kashubian	Uk	Ukrainian
ko.	Koine (Greek)	USo	Upper Sorbian

Table of graphic illustrations

All graphic illustrations are drawn from Wikipedia (August 2010).

1 Editorial note

This book is the third (and final) piece of a project that I have been working on since 2001.

1.	Scheer (2004) Vol.1	A Lateral Theory of Phonology Vol.1: What is CVCV, and why should it be?
2.	Scheer (2011a) BlueVol	A Guide to Morphosyntax-Phonology Interface Theories. How Extra-Phonological Information is Treated in Phonology since Trubetzkoy's Grenzsignale
3.	this book Vol.2	Direct Interface (and One-Channel Translation) Vol. 2 of A Lateral Theory of Phonology

The first book (Scheer 2004, called Vol.1 for citation purposes below) lays out a development of Government Phonology called CVCV (or strict CV) that was initiated by Jean Lowenstamm. The central idea, also of Government Phonology as such when looked at from hindsight, is that syllable structure is the result of a network of lateral (or dependency) relations among constituents (government and licensing), rather than of a tree-type structure. While Standard Government Phonology introduced the lateral idea, it ran out of breath half way and ended up with a hybrid arboreal-lateral theory. CVCV goes all the way down by eliminating arboreal structure altogether, and shifting all labour regarding the definition of syllabic patterns to lateral relations. The result is an entirely flat constituent structure (see §§10f below).

This alternative to the traditional representation of syllabic patterns is worked out in Vol.1 on domestic phonological grounds. The result for the broader architecture of grammar is the claim that phonology is a computational module that lacks the ability to build trees. This is in line with current minimalist assumptions in syntax where tree structure is the result of one single operation, Merge, which of course is absent in phonology (and semantics) since these modules do not concatenate anything: they merely interpret what was concatenated elsewhere (in morpho-syntax). The inability of phonological computation to create tree structure also explains a long-standing observation, i.e. the fact that there is no recursion in phonology (and semantics): recursion supposes domination (the argument is developed at greater length in §14 below).

The second volume was originally planned to extend this flat perspective to the other major area of phonology where trees are traditionally assumed since the 80s, i.e. the representational interface with morpho-syntax. The goal was to show that the Prosodic Hierarchy is inaccurate and needs to be abandoned (see §9 below on deforestation).

The work on this project constantly integrated other aspects of interface theory, and in the end, after many more years than were originally planned, produced a book on (the history of) the interface with morpho-syntax. This is Scheer (2011a), called BlueVol for citation purposes below. It does *not* include my own view on the representational side of the interface, i.e. its original purpose, for two reasons. For one thing, the manuscript that was circulated since October 2008 and which included both the BlueVol and the present book, was much too big: BlueVol alone is over 900 pages from cover to cover. But also, BlueVol is a stand-alone volume because it has a different audience (beyond generative thinking: the history begins with Trubetzkoy), because it is thematically independent, historically oriented and has handbook qualities (hence the title "A Guide to…"): it is written from an neutral observer's perspective (journalistic style), and is therefore theory-unspecific. These are also the reasons why BlueVol did not appear in the SGG series (Studies in Generative Grammar).

The book that the reader holds in hands is the piece that could not be included in Scheer (2011a) because it is all the contrary of a theory-neutral and journalistic enterprise: it introduces my own view on (the representational side of) the interface. In order to make it a stand-alone volume, some pieces of BlueVol had to be included: without them the motivation for Direct Interface and its location in the general landscape would have remained obscure. Part I of the book does this job: it introduces to the central issues of representational interface management. Special attention is paid to Cognitive Science and modularity, which place specific constraints on what a linguistic interface theory can and must not look like (for example, domain specificity imposes translation and rules out diacritic outputs thereof).

Finally, the reader is referred to §9 for the understanding of how the (admittedly rather meandering) partition of the original project into three separate volumes makes sense: the present book completes the deforestation of phonology by doing away with the last piece of arboreal structure that is traditionally found in phonological representations.

Unlike BlueVol (from which CVCV is absent), the present book qualifies as Vol.2 of Scheer (2004) because it develops CVCV at the interface: after having made broad choices in the general interface landscape (Part I), after having introduced Direct Interface and One-Channel Translation (Part II), the remainder of the book is concerned with the behaviour of CVCV in the environment defined, as well as with the predictions that are made (Part III). While Scheer (2004) thus works out CVCV at the syllabic level, the present book applies it to the interface.

2
Foreword
What the book is about, and how to use it

This book is about the way morpho-syntax talks to phonology (this direction, the other is only touched on in passing, see §127). Or rather, it is only about one of the two means that allow morpho-syntax to bear on phonology: the representational side of the coin (as opposed to its procedural side, i.e. cyclic derivation, today phase theory, see §§5f). The critical questions that define all theories of the representational side of the interface, and which the pages below attempt to answer, are the following: in case morpho-syntax impacts phonology by inserting an object into phonological representations,

– which morpho-syntactic information exactly is translated (all or just a subset of the whole)?
– what kind of object is inserted into phonological representations (diacritics such as #, ω or items of the truly phonological vocabulary)?
– how exactly is the output of translation inserted into the linear string (non-locally in forms of autosegmental domains or locally, i.e. with a left and a right neighbour)?

At variance with probably all other theories on the market, and especially with Prosodic Phonology which was the dominant framework in the past 30 years, Direct Interface holds that

– only phonologically relevant information is transmitted (privative translation): irrelevant noise that does not impact phonology is not shipped through translation and hence never reaches phonology,
– diacritics cannot be the output of translation: hash marks, omegas, bananas and the like do not qualify, and
– insertion is strictly local: rather than being autosegmental domains, items inserted have a right and a left neighbour; that is, they are non-diacritic boundaries (sic).

Direct Interface is an application of the minimalist philosophy to phonology in the sense that it shapes the theory of a particular linguistic module according to the requirements of the interface. Since its inception in the 50s, generative linguistics is an application of the modular theory of the mind (Fodor 1983 and following) to language. Modularity imposes translation for the purpose of intermodular communication because different modules do not speak the same language (of the mind). For the same reason (domain specificity), it also imposes non-diacritic translation, i.e. the ban on diacritics (#, ω, bananas etc.) as carriers of morpho-syntactic information in phonology.

The theory that is laid out also follows the minimalist track in two other respects: privativity of translation and chunk definition. Privativity is the aforementioned issue regarding the translation of everything (including irrelevant noise), or only of phonologically relevant morpho-syntactic information. While (quite surprisingly) all theories on the market, and namely Prosodic Phonology, translate all kind of irrelevant noise, translation is privative in Direct Interface, and this is a minimalist requirement: structure is only built in case it is needed (Merge in syntax today, as opposed to GB where the full tree was always built no matter what).

Finally, everybody agrees that there is a (non-phonological) mechanism that defines which are the phonologically relevant chunks of the linear string, i.e. the domains that constitute the (successive) input to phonological computation. There are two competitors, representational and procedural: Prosodic Phonology holds that chunks are defined by the output of translation, i.e. the constituents of the Prosodic Hierarchy, while cyclic derivation, today phase theory, defines chunks that are sent to phonology without reference to translation. Since prosodic constituents are diacritics and therefore out of business, Direct Interface works with the minimalist way of defining chunks: phase theory.

This is not to say, however, that all minimalist orientations are shared. Some versions of the biolinguistic programme for example place PF, and hence phonology (which today is not the same thing anymore, see BlueVol §726), outside of grammar, claiming that phonology could well be shared with (some) animals (Hauser *et al.* 2002, Samuels 2009a,b). It is certainly true that there is no recursion in phonology, and this has indeed important consequences: there is no tree-building device in phonology (§14). But this does not mean that the phonological computational system does not have a domain-specific vocabulary, or that it is not a module: phonological computation is modular computation, which therefore is based on a domain-specific vocabulary that nobody has ever observed to be active elsewhere in the cognitive system, or in cute animals, however skilful they may be, however extraordinary things they may be able to do, and whatever their "intelligence". The vocabulary in question includes things like stopness, labiality, nasality and so on.

In sum, Direct Interface sets a frame that is neutral with respect to individual *phonological* theories – but this frame restricts possible properties of these theories, and it makes their competition refereeable according to their behaviour at the interface. This is something that no other interface theory affords since, at variance with Direct Interface, all other theories impose a uniform interface vocabulary that is supposed to carry morpho-syntactic information in all competing phonological theories: juncture phonemes, hash marks or the Prosodic Hierarchy. Since in Direct Interface, however, diacritics do not qualify, valid carriers of morpho-syntactic information are the genuine units of whatever vocabulary is proposed by individual phonological theories: nuclei, moras, x-slots etc. When used as carriers of morpho-syntactic information, they will then make different predictions as to what are possible interface phenomena, and how precisely they impact phonology.

Practically speaking, Part I of the book is a kind of toolbox for Part II: basic assumptions, technologies and (historical) surveys of a number of issues are introduced. They represent a digest of relevant topics that are covered in Scheer (2011a), and they do not need to be read through from cover to cover. The information just sits there in order to make the book a stand-alone volume (see the description of its history in the editorial note); it may be accessed like a dictionary, or through the developed cross-reference system of the book. Readers who are familiar with the issues at hand should directly start reading Part II where the core of Direct Interface is introduced. Finally, Part III works out the consequences (or the implementation) of Direct Interface for one particular phonological theory, CVCV (or strict CV: Lowenstamm 1996).[1] Since it is concluded in Part II that the only possible carrier of morpho-syntactic information in phonology is syllabic space, Part III especially inquires on the expression of this idea in CVCV, where the insertion of empty CV units plays a critical role in the communication with morpho-syntax for about a decade (Lowenstamm 1999). This is also the place in the book where original empirical material is discussed.

The practical design of the book is as for the two preceding volumes: reading from cover to cover is probably not the best way to go. The organi-

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[1] The lateral project and CVCV are introduced at greater length in §§10f. The reader should be aware that there are a number of different implementations of CVCV (Cyran 2010, Szigetvári 2001, 2008, Rowicka 1999, Polgárdi 2003, Scheer 2004), and that the one that is referred to in Part III and elsewhere in the book revolves around Scheer (2004) and the Coda Mirror (Ségéral & Scheer 2008b, Scheer & Ziková 2010a).

sation being thematic, a dictionary-like access is more promising. Look-up access is supported by a detailed table of contents, a fairly fine-grained subject index and ample cross-reference. As before, this design generates some redundancy, and I apologize beforehand for repetitions and summaries that get on the nerves of cover-to-cover readers.

While writing the book and preparing the manuscript for print, a number of pieces have been published in form of articles (or are underway). The reader may find it useful to rely on them in parallel since they condense this or that aspect of the book in a reasonably sized stand-alone item. Scheer (2008a), is about the diacritic issue: the Prosodic Hierarchy is as much a diacritic as hash marks (if in an autosegmental guise) and therefore has to go (see §93). The issue of chunk definition, i.e. how phonologically relevant chunks (computational domains) are identified, is addressed in Scheer (forth a) (see §99). Scheer (2009a,c) concern external sandhi (in Corsican and Belarusian, respectively), the *phonological* motivation of phases above the word level and the question of how the beginning of the word is represented (the initial CV is phase-initial, rather than word-initial) (§260). Finally, the predictions made by the initial CV (concomitance of three typological properties) are made explicit in the two articles on Corsican and Belarusian, but also in Ségéral & Scheer (2008b).

A number of people have helped while writing, and have commented on earlier drafts: I would namely like to thank two true cover-to-cover readers and page-by-page commenters: Marc van Oostendorp and Diana Passino. Other people have provided precious feedback on selected pieces of the book: this is the case of Eugeniusz Cyran, Michal Starke, Gaston Kočkour, Grzegorz Michalski, Katalin Balogné-Bérces and lately also Kočička Châtaigne.

Châteauneuf de Grasse and Lantosque, December 2011

3 Introduction

4 1. Scope of the book: the identity and management of objects that carry morpho-syntactic information in phonology

5 1.1. Procedural and representational communication with phonology

Scheer (2011a) (which is also called BlueVol in this book) discusses how morpho-syntactic information is shipped to and processed by phonology. The history of the morpho-syntax - phonology interface shows, and everybody agrees,[2] that there are two quite different means, and two means only, for morpho-syntax to bear on phonology: one is procedural (derivational), the other representational.

The former is a genuinely generative invention that has come into being in Chomsky *et al.* (1956:75) and was successively known as the transformational cycle, the phonological cycle, interactionism, cyclic derivation and finally today as derivation by phase (in syntactic quarters). It embodies the insight that (phonological and semantic) interpretation applies successively from the most to the least embedded piece. It is therefore referred to as inside-out interpretation in Scheer (2011a).

The other means by which morpho-syntax can influence phonology is through the insertion of a representational object into the linear string that is submitted to phonological computation. Based on morpho-syntactic structure, all theories (syntactic, interface, phonological etc.) provide for a spell-out mechanism that pieces together a linear string of morphemes, i.e. of minimal phonological items that are stored as such in the lexicon (and which are called Vocabulary Items in Distributed Morphology). This string is then augmented by additional objects that do not represent morphemic information but rather carry morpho-syntactic information.

This is the traditional interface management that is practised (at least) since the 19th century, and which in any case is shared by structuralist and generative thinking: non-morphemic carriers of extra-phonological information in phonology have successively incarnated as juncture phonemes, SPE-type diacritics (# and the like) and the Prosodic Hierarchy, each being the representative of its time. That is, carriers of morpho-

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2 At least in generative quarters, but also beyond: see BlueVol §§6f for discussion of the broader interface landscape.

syntactic information were (juncture) phonemes when phonemes were the basic currency in phonological theory, they were made segments in SPE (# was supposed to be a [-segment] segment) where the basic phonological units were segments, and finally became autosegmental domains (the Prosodic Hierarchy) in the early 80s when all areas of phonology were autosegmentalised (BlueVol §694).

Scheer (2011a) argues for Interface Dualism, i.e. the idea that natural language provides for and uses both means of communication: theories that try to reduce interface activity to either are on the wrong track. The interface landscape as it stands today is structured along this fraction line anyway: roughly speaking, Lexical Phonology (and its modern offspring: DOT, Stratal OT, phase theory that continues interactionism) is *the* procedural theory of the interface, while Prosodic Phonology (and its modern offspring) is *the* representational theory of the interface.

6 1.2. Focus on the representational side of the interface

This book is exclusively concerned with the representational side of the interface. It is organized into three major divisions. Part I lays out the desiderata for a non-diacritic theory of the interface. Part II is about the general properties of Direct Interface as a theory of the representational side of the interface, which however is neutral with respect to individual phonological theories: any phonological theory can be run in Direct Interface, and different theories will make different predictions at the interface. Finally, Part III describes the behaviour of one specific phonological theory, CVCV (or strict CV), in this environment.

7 1.3. A theory-neutral frame for non-diacritic translation (Parts I and II)

Part I bridges back to Scheer (2011a), recalling the foundational issues related to modularity and its consequence, translation (chapter 2),[3] to dia-

[3] Translation, i.e. the transformation of morpho-syntactic structure into information that is legible by the phonology, was called mapping in the 80s and especially in Prosodic Phonology. In the broader Cognitive Science literature that talks about intermodular communication, it is sometimes called transduction (also by Hale & Reiss 2008:105ff in linguistics). In this book I only use the former vocabulary item because it is not theory-laden: *translation* refers to the

critics and local vs. non-local insertion (chapter 4). Chapter three is about the *identity* of the objects that are inserted into the phonological string. It fleshes out what it means to eliminate the mediating buffer (i.e. diacritics) between the morpho-syntactic origin of translation and its output, i.e. the object that is inserted into the phonological string. Finally, chapter four discusses how exactly the output of translation is inserted: insertion may or may not be local.

In practice, the discussion is organised around five foundational questions (see chapter 1, §18) that define the design properties of any interface theory. Part I works them out in order to decide which options are correct. The result is then the input to Part II where they are condensed into the theory of Direct Interface.

Direct Interface is a theory of the interface where specific claims are made – but it is not a theory of phonology. As was mentioned, therefore, any phonological theory can be run in the frame for translation that is set by Direct Interface: the only requirement is that whatever vocabulary a particular phonological theory proposes, carriers of morpho-syntactic information must be recruited among this vocabulary (chapter one of Part II).

Chapter two is about the *management* of the objects that are inserted into the phonological string: it discusses another constraint on translation, which comes from the translational mechanism itself, rather than from the items that translation manipulates. The question is whether translation is done by a specific computation, or through a lexical access. The former solution is the classical assumption of Prosodic Phonology (the Translator's Office, where mapping rules do the labour, see §84). In a broader cognitive environment that goes beyond language, it is also promoted in Jackendoff's (1997 and following) work (correspondence rules, see §172). The alternative where translation does not involve any computation is sketched by Michal Starke in unpublished work, on which the book draws: the carriers of morpho-syntactic information in phonology originate in a (or rather: in the) lexicon, which on the non-phonological side of lexical entries is accessed by the spell-out mechanism that transforms morpho-syntactic into phonological items (morphemic information).

The translational labour, then, is done by a strictly lexical and hence hard-wired term-to-term relation. In this perspective, *all* objects that reach phonology originate in the lexicon: those that represent morphemic information (through lexical insertion) as much as those that carry non-

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process as such, whether occurring in structuralist thinking or in any of the generative theories.

morphemic morpho-syntactic information (i.e. the output of translation). As a result, there is only one channel through which phonological objects can transit: the lexicon (rather than two, i.e. the lexicon for morphemic, against the Translator's Office for non-morphemic information).

The lexical perspective on translation enforces additional constraints on how (truly) non-diacritic translation works: only objects that can be stored in the lexicon qualify for the output of translation.

8 1.4. Minimalism in phonology: shaping phonological theory according to the requirements of the interface (Part III)

Part III sets out with a chapter that evaluates the effect of the combined requirements of Direct Interface and One-Channel Translation on a particular phonological theory, CVCV (or strict CV). The idea is that the properties of the theory (as much as of all other phonological theories) must be compatible with non-phonological requirements that are issued by the interface. Shaping a linguistic theory according to what the interface dictates is certainly a received attitude in minimalist times. Chapter one may be understood as an application of this philosophy to phonology.

Chapter two then shows the interface-readjusted system at work: the initial CV has been around in Government Phonology and CVCV for quite some time now (Lowenstamm 1999), and it has produced a reasonable amount of empirical work. It is shown that only syllabic space passes all filters that are set by Direct Interface and One-Channel Translation. In CVCV, syllabic space reduces to CV units, which are thus the only possible carriers of (non-morphemic) morpho-syntactic information.

Finally, a number of case studies are presented that review empirical evidence for the initial CV and inquire on the modalities of its management. Chapter three discusses the distribution of the initial CV in external sandhi (i.e. in languages where phonology applies across word boundaries), while chapter four focuses on the restrictions on word-initial clusters.

9 2. Deforestation: the lateral project, no trees in phonology and hence the issue with Prosodic Phonology

10 2.1. The core of Government Phonology: lateral, rather than arboreal syllable structure

It was explained in the editorial note (§1) in which way the book may be considered to be the volume 2 of Scheer (2004) (the latter is also referred to as Vol.1 in this book). The project of Vol.1 is to build a lateral alternative to the traditional arboreal conception of syllable structure: Vol.1 §165 explains at length in which way replacing arboreal structure by lateral relations (government and licensing) is the core of the research programme of Government Phonology. In a nutshell, the idea is that the syllabic position of a segment is not defined by the constituent to which it belongs (and whose status is itself defined by the arboreal relations that it entertains with other constituents), but by lateral relations that hold among constituents.

For example, a consonant does not show characteristic coda behaviour because it belongs to a constituent "coda" whose mother is the rhyme; rather, coda behaviour is due to the fact that relevant consonants occur before a governed empty nucleus which is unable to provide support (licensing). This explains why coda consonants are weak, rather than strong (while the weakness of the coda constituent does not follow from anything). In sum: look right or left, rather than up, if you want to know what your syllabic status is.

Standard Government Phonology (Kaye *et al.* 1990) introduced the lateral project, but ran out of breath half-way: the result is a hybrid model where lateral relations cohabitate with arboreal structure that is left over from the traditional tree-based approach. On many occasions, lateral and arboreal structure do the same labour, which is an intolerable situation for a theory (this was pointed out by Takahashi 1993 early on, see Vol.1 §208): either syllable structure is lateral or it is arboreal – it cannot be both. Hence if the lateral project is on the right track, it must be applied all the way down. This is what Lowenstamm's (1996) idea is about: arboreal syllable structure is done away with altogether (constituents reduce to a strict sequence of non-branching onsets and non-branching nuclei), and lateral relations alone define syllabic positions. Vol.1 works out the conditions and consequences of these premises, thereby fleshing out CVCV (or strict CV) in sufficient detail so that it can sustain comparison with other theories. Finally, recall from note 1 that CVCV may be implemented in a number of different ways.

11 2.2. The lateral project leaves no place for arboreal prosodic constituency

The result at the end of Vol.1 is a (fully) lateral theory of phonology – or rather, of syllable-related phonology. For there are other areas in phonology where arboreal structure is traditionally assumed: below the skeleton for the representation of melody (Feature Geometry), above the skeleton for the representation of morpho-syntactic information (the Prosodic Hierarchy). While unary melodic representations (Anderson & Jones 1974 and ensuing applications in Dependency Phonology, Particle Phonology and Government Phonology) provide a non-arboreal alternative for the former, the Prosodic Hierarchy stands unchallenged in the latter area (or almost, see §§24, 122, BlueVol §580).

The question is thus whether a scenario is viable where arboreal structure is absent from all areas of phonology except for the representation of morpho-syntactic information. This ties in with Lowenstamm's (1999) idea that morpho-syntactic information can be represented by an empty CV unit, i.e. a *non-arboreal* object that is inserted *locally* into the linear string. Also, the initial CV is an important ingredient of the Coda Mirror (Ségéral & Scheer 2001a, 2005, 2007, 2008b, Vol.1 §§83, 110, see §§213,223 below).

12 2.3. The Prosodic Hierarchy is a diacritic

There is thus reason to question the arboreal standard of carrying morpho-syntactic information into phonology: if this information is represented in terms of objects that are inserted into the linear string, rather than by prosodic constituency, phonology as a whole has a non-arboreal perspective.

But there is also positive evidence that pleads against the Prosodic Hierarchy, which turns out to be a diacritic upon closer inspection. If diacritics do not qualify, this is reason enough for the Prosodic Hierarchy – and hence for the arboreal representation of morpho-syntactic information – to be counted out. The diacritic issue is discussed at length in §93 below (where the arguments from BlueVol §402 and Scheer 2008a are recalled).

On this backdrop, Direct Interface is an attempt to make the representation of morpho-syntactic information

1) non-arboreal
2) local and
3) non-diacritic.

It completes the deforestation of phonology by doing away with the last piece of traditional arboreal structure. The historical inquiry of Scheer (2011a) is a consequence of Direct Interface: by looking at the history of interface theories I originally wanted to make sure that I am not reinventing the wheel. In this sense, the overall causal chain runs from the inception of the lateral project in the late 80s (Standard Government Phonology) over Vol.1 (a lateral theory of phonology: CVCV), the history of interface theories (Scheer 2011a) to Direct Interface (this book), which completes the idea that that phonology is "flat", i.e. does not accommodate any tree-building device.

In this perspective, the following section shows that the deforestation of phonology is also independently motivated, especially in the broader context of the minimalist architecture of grammar: the phenomena that are expected to result from arboreal structure (such as recursion) are absent from the record. So is Merge (or equivalents), therefore, from phonology.

13 2.4. Recursion and other expected consequences of trees are absent in phonology

The so-called inverted T model is the baseline of the generative architecture of grammar, in place since Chomsky (1965:15ff) and unchallenged to date (§35). Part and parcel of the inverted T model is that only morpho-syntax has the privilege of concatenation: phonology and semantics merely interpret; they are not equipped for gluing pieces together. In the minimalist environment, concatenation is the result of Merge. This operation is thus available in morpho-syntax, but not in phonology and semantics.

Phonological theories, however, have always relied on tree-building devices, at least since the advent of autosegmental structure. While feature geometric trees are lexically specified, syllabic and prosodic arborescence is assumed to be the result of online tree-building activity, today as much as in the past. A classical example are syllabification algorithms, which build arboreal syllable structure on the basis of the segmental properties of a lexically unsyllabified linear string.

It is true that phonological trees do not involve any concatenation of pieces (they are built on a pre-existing linear string): this is what makes them different from morpho-syntactic trees. As a consequence, though, phonological and morpho-syntactic trees are not the same thing. Hence if any, the phonological tree-building device is different from morpho-syntactic Merge. Accommodating distinct $\text{Merge}_{\text{m-synt}}$ and $\text{Merge}_{\text{phon}}$ in grammatical theory of course ruins the minimalist ambition, which counts on only one universal piece-gluing (and hence tree-building) device.

But there is more reason to believe that a tree-building phonological Merge cannot be the correct scenario. Neeleman & van de Koot (2006) show that trees of whatever kind have certain formal properties that make predictions on the type of phenomena that should be found in a tree-bearing environment. These include projection, long-distance dependencies and recursion. Neeleman & van de Koot (2006) demonstrate that phonological phenomena do not display any of these properties. They therefore conclude that the presence of trees in phonology overgenerates: arboreal structure predicts things that are absent from the record.

This issue is picked up by van Oostendorp (2010), who argues that the mere presence of a tree-building device in a computational system does not mean that literally anything can dominate anything, i.e. that there are no restrictions on how trees are built. He illustrates this with a fact from syntax, where the tree-building system is restricted in such a way that X" cannot be the mother of Y". Hence there are restrictions built into tree-building devices, and these may be idiosyncratic for each computational system: X-bar in syntax prohibits mother-daughter relationships between two maximal projections; in phonology, two items of the same kind happen to be unable to dominate each other (i.e. recursion: two syllable nodes, two onsets etc.).

The analogy that van Oostendorp establishes between syntactic and phonological trees, however, is incomplete: it is not the case that the X-bar restrictions on trees are arbitrarily imposed, i.e. do not follow from anything. The prohibition for two maximal projections to enter in a mother-daughter relationship stems from projection: X" is a projection of x – X could never be the label attached to a node whose terminal is a y. Note that there is no equivalent in phonology that could motivate the phonology-specific restriction against recursion. This restriction thus continues to beg the question: there should be recursive structure in phonology, unless there is a good reason against its existence.

14 2.5. The lateral project predicts that phonology is non-recursive

15 2.5.1. An undisputed fact: there is no recursion in phonology

The same point can be made from the other end, i.e. the phonological perspective. There is no phonological phenomenon that would be equivalent to multiple phrasal embedding, where the only limit on the number of recursions is set by performance restrictions (see BlueVol §803). Relevant examples from syntax and morphology are shown under (1) below.

(1) recursion in syntax and morphology

a. Peter thinks [that John says [that Amy believes [that…]]]

b. Czech iterative *-áv*

dĕlat	"to do"
dĕl-áv-at	"to do repeatedly/often"
dĕl-áv-áv-at	"to do even more often"
dĕl-áv-áv-áv-…-at	"to do really really often"

French *re-* prefixation (about the same in English)

faire	"to do"
re-faire	"to do again"
re-re-faire	"to do with two repetitions"
re-re-re-faire	"to do with three repetitions"
re-re-re-re-…-faire	"to do with n repetitions"

Recursive structure in natural language has the property of producing grammatically unbounded embedding: grammar happily generates and tolerates an infinite number of embedded clauses (or phrases), and in the case of recursive morphology, an infinite number of embedded morphemes. The limits on recursive structure in actual production are imposed by performance (factors such as memory), not by competence. That is, speakers will get confused upon the third of fourth level of embedding.

Also, recursion is obviously a consequence of concatenation: there is no embedding without gluing pieces together. This is reflected in the operation Merge, which is the central (and only) recursion-creating device in current syntax. The simple fact that phonology does not concatenate anything but merely interprets fully concatenated strings shows that there could not be any recursion in phonology, at least not anything that satisfies morpho-syntactic standards.

Empirically speaking, nothing that resembles the phenomena under (1) and their pre-theoretical description has ever been reported in phonology. This empirical situation is the reason why the absence of recursion is firmly established as a major property that sets phonology (and semantics) apart from morpho-syntax (e.g. Pinker & Jackendoff 2005a,b). Note that this is entirely independent of eventual *analyses* that use recursive constructions: having some prosodic constituent such as the prosodic word ω and the "prosodic word prime" ω' where the latter dominates the former (e.g. Booij 1996, Peperkamp 1997, Truckenbrodt 1999) does not make the *phenomenon* at hand recursive.

The same goes for *analyses* of other phonological phenomena that use recursive constructions. Van der Hulst (2010) has gathered a number of this kind of analyses regarding for example the internal structure of segments (melodic organisation). He argues that they document the existence of recursion in phonology. They do not: the only thing that they document is the existence of analyses that use recursive structure in order to account for non-recursive phenomena. The existence of recursion (in phonology) is established by a pre-theoretical and pre-analytic checklist, and nobody has ever found a phonological phenomenon that qualifies.

16 2.5.2. Is the absence of recursion in phonology accidental?

It was mentioned that the absence of recursion has long been recognised as a major difference that sets phonology apart from morpho-syntax. Everybody knows about the fact, which however still begs the question: there must be a reason why phonology is not recursive, and van Oostendorp's (2010) hint that this could be an accidental restriction on phonological tree-building (§13) is not really illuminating.

Nespor & Vogel (1986) for example make the difference explicit, but leave it at that.

(2) "In relation to the difference between the morpho-syntactic and prosodic hierarchies, it should be noted, furthermore, that the two differ not only in the way they divide a given string into constituents. They also differ with respect to depth. That is, since the rules that construct the phonological hierarchy are not recursive in nature, while the rules that construct the syntactic hierarchy are, the depth of phonological structure is finite, while the depth of syntactic structure is, in principle, not finite." Nespor & Vogel (1986:2)

Nespor & Vogel say the same thing as van Oostendorp (2010): there is no particular reason why syntactic rules are recursive, but phonological tree-building is not. Therefore the absence of recursion in phonology is accidental: rules happen to be non-recursive, but could well be.

By contrast in a phonology where trees are absent altogether because interpretational devices have no access to the tree-building device Merge, the absence of recursion is *predicted*. This is because recursion is formally defined as a node that is dominated by another node of the same kind: if a computational system is unable to build trees, there can be no domination at all, and hence no recursive phenomena (this was also pointed out in the foreword to Vol.1; further discussion is provided in BlueVol §§802ff).

The absence of recursion in phonology is thus predicted by the lateral project and its concomitant elimination of trees.

Part One
Desiderata for a non-diacritic theory of the (representational side of) the interface

Chapter 1
17 What representational communication with phonology is about

18 1. Five defining issues

The issues mentioned under (3) below are the backbone of what representational communication with phonology is about. One could probably say that the representational side of the interface reduces to these five questions. Part I of the book is designed to discuss them, and to decide which options are correct. These are then the input to Part II where they are condensed into the theory of Direct Interface.

(3) major issues for representational communication with phonology

a. **modularity and its consequence, translation**
[is there any translation at all?]
are morpho-syntax and phonology distinct computational systems whose input are distinct sets of vocabulary items? If so, in order to be able to communicate at all, the output of morpho-syntactic computation needs to be translated into phonological vocabulary before phonological computation can proceed.

b. **chunk definition: procedural or representational?**
[is translation responsible for chunk definition?]
everybody agrees that the linear string is cut into a number of chunks that are phonologically relevant in the sense that they limit the application of phonological processes (which are blocked by chunk boundaries). The question is whether the definition of these chunks is done procedurally (by cyclic derivation, today called phase theory) or representationally (by prosodic constituents, i.e. the output of translation).

(3) major issues for representational communication with phonology

c. **(non-)privativity of translation**
[what exactly is translated?]
it is an observational fact that phonology is underdetermined by morpho-syntactic information: only some pieces thereof impact phonology. That is, most of morpho-syntactic information is entirely transparent to phonology. The question is thus whether only phonologically relevant information should be translated, or whether everything, including irrelevant noise, should be shipped to the phonology.

d. **the diacritic issue**
[what does the output of translation look like?]
what kind of objects are inserted into the phonological string? Could this be any kind of object, i.e. diacritics such as #, or are there restrictions? Given modularity and domain specificity, diacritics do not qualify: only genuine members of the specifically phonological vocabulary can be carriers of morpho-syntactic information.

e. **local vs. non-local insertion**
[how exactly is the output of translation inserted into the linear string?]
how exactly do carriers of (non-morphemic) morpho-syntactic information intervene in phonology? Locally (i.e. as a piece in the linear string that is located between two morphemes) or not (i.e. in form of autosegmental domains that cannot be localised in the linear string)?

The present chapter offers a hansel of what is at stake. The remainder of Part I then fleshes out the issues at hand, locates them in their historical context and relates to other relevant topics. Mostly on the basis of a digest from Scheer (2011a), the three remaining chapters of Part I thus describe the landscape of interface design on the representational side: modularity and its consequence, translation, are introduced from the broader perspective of Cognitive Science in chapter 2 (§19), the way the output of translation was and is conceived of in interface theories is examined in chapter 3 (§82), and the way this output is (or should be) inserted into phonological representations is discussed in chapter 4 (§131).

19 2. Modularity and its consequence, translation

In generative quarters, (3a) is settled, or rather, ought to be settled. Since its inception, the generative architecture of grammar (the inverted T model, §35) is modular: it is made of three independent and domain-specific computational systems, morpho-syntax, PF and LF. Modularity and its foundations in Cognitive Science are discussed at greater length in Scheer

(2011a:§586), as well as the fact that generative linguistics are an application of modularity to language (BlueVol §623, also §33 below). §30 below recalls the core properties of modularity that are defined in Cognitive Science and supposed to describe lower cognitive functions, among which language is but one case in point.

The major consequence of modularity, the need for translation, is discussed in §51 below where the history of translation in its various incarnations since Trubetzkoy is recalled. This brief survey also includes discussion of generative modularity offenders, which have always existed, but are especially harsh and concentrated in OT because of the roots that this theory also has in the competing model of how the mind / brain works, connectionism (§75).

20 3. *Direct* Interface ≠ Direct Syntax: please no misunderstanding!

21 3.1. Why Direct Interface is direct

Before moving on, the experience that I have from presenting Direct Interface commands a section to prevent a misunderstanding: *Direct Interface has got nothing to do – absolutely nothing – with Direct Syntax*. The occurrence of the word "Direct" in both is purely coincidental: it means very different things in the two contexts.

Direct Interface is called direct because it eliminates any mediating diacritic object (such as # or ω, i.e. prosodic words) between morpho-syntax and phonology: carriers of morpho-syntactic information can only be items that exist in the phonological vocabulary anyway (such as an onset-nucleus pair). Therefore Direct Interface is direct: it does away with the buffer, i.e. #, omegas and the like whose only raison d'être is to store and release morpho-syntactic load.

While Direct Interface respects modularity and hence practises translation, the heart of Direct Syntax is to violate modularity, and to abandon translation. Since we will come across Direct Syntax on a number of occasions in the book, it is introduced in some greater detail below.

22 3.2. Direct Syntax in the late 70s

Direct Syntax was a movement in the late 70s and early 80s. It grew out of the feeling that something was wrong with SPE-type boundary theory, which seemed to lead nowhere (BlueVol §131: Rotenberg 1978, Clements 1978, Pyle 1972, Hyman 1978:459, Kenstowicz & Kisseberth 1977). The alternative was to do away with translation altogether: instead of storing morpho-syntactic information in a sponge – hash marks at that time – and then having phonological processes make reference to that buffer, phonology could shortcut and *directly* mention morpho-syntactic information in its rules. Hence instead of saying that "the phonological event X happens in presence of #" and # representing the beginning of an adjunct, the phonological instruction would directly say that "the phonological event X happens at the beginning of an adjunct".

That is, there are no hash marks or any other carriers of morpho-syntactic information anymore: phonology makes direct reference to any morpho-syntactic information that is required, and the representational side of the interface is eliminated altogether.

23 3.3. Mid 80s: Direct Syntax vs. Prosodic Phonology

The founding battle of Prosodic Phonology was against Direct Syntax. The central claim of the former theory was *Indirect* Reference, i.e. the assertion that SPE (and all other interface theories since the 19th century) was right in providing for carriers of morpho-syntactic information in phonology (hash marks): translation exists, and this is the way that some morpho-syntactic information reaches phonology. Indirect Reference prohibits any direct mention of morpho-syntactic categories in phonological rules.

Representatives of Direct Syntax at that time were for example Kaisse (1983, 1985) and Odden (1987, 1990). The conflict was decided in favour of Indirect Reference within a couple of years, and Prosodic Phonology stands (almost) unchallenged since then.[4] This episode of the history of the interface is discussed at greater length in BlueVol §407.

An issue that for some reason did not play any role in the debate between Direct Syntax and Indirect Reference is modularity (§67, BlueVol §414). The former approach violates modularity, while the latter applies it to language: translation is a necessary consequence of modularity (see §51 below).

Modularity thus defines a major front line among interface theories: those that practise translation (e.g. Prosodic Phonology) are instantiations

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4 There is a modern offspring of Direct Syntax (see Seidl 2001 and §24 below), which is also revived in much modularity-violating work in OT (see §77).

of modularity, while those which believe that translation does not exist (e.g. Direct Syntax) are incompatible with the modular architecture of grammar that defines the generative enterprise (the inverted T, Chomsky 1965:15ff, see §35 below).

Direct Interface stands on the modular side: the inverted T is correct, the mind and grammar are organised in a number of distinct computational units each of which works with a domain-specific vocabulary. Hence there is no way in which phonological computation could understand, parse or process any morpho-syntactic vocabulary such as "adjunct" (see §43).

24 3.4. The baby (translation) and the bathwater (the Prosodic Hierarchy)

Direct Syntax and Direct Interface thus belong to strictly opposite camps. Within the realm of the modular camp where translation is practised, then, Direct Interface opposes Prosodic Phonology, as was explained in §9 and will be discussed below (§§82, 147). To further complicate the landscape, there are also other critics of the Prosodic Hierarchy, largely for the same reasons as Direct Interface, but who go down exactly the same road as the early representatives of Direct Syntax in the late 70s: Pak (2008:42ff, in a DM environment) and Samuels (2009a:284ff) are dissatisfied with prosodic constituency and make the obvious point that if Direct Syntax is correct, the Prosodic Hierarchy is redundant and needs to be done away with altogether. As a consequence, they throw out translation together with the Prosodic Hierarchy (also see §122 on the impact of this issue on chunk definition).

Direct Interface argues that this is throwing out the baby with the bathwater: there is no use abandoning modularity, the generative architecture of grammar and translation when one specific way in which translation is done, the Prosodic Hierarchy, is bankrupt. What is needed is a truly modular way of translation, i.e. one where the output is a piece of the domain-specific vocabulary of phonology, rather than a diacritic that cannot be parsed.

The take of Direct Interface is thus: yes, interactionism and hence phase theory are necessary; yes, prosodic constituency has to go; no, grammar is modular and Direct Syntax is wrong; yes, there is translation.

25
4. Chunk definition

Let us now turn to (3b). If everybody agrees that the linear string is divided into a number of phonologically relevant chunks, and if it is also consensual that the decision which pieces are grouped together in a given chunk is made outside of the phonology, there is no agreement whether chunk definition is done procedurally or representationally.

The former solution is based on cyclic derivation, which today incarnates as phase theory (Chomsky 2000 and following, see §120): phonologically relevant chunks are phases, and these have got nothing to do with translation. By contrast in the latter perspective, chunks are defined as the output of translation: the constituents of the Prosodic Hierarchy group together certain pieces of the linear string.

Since the advent of phase theory in the late 90s, these two positions compete. The question is examined in the light of its historical development in §99 below. It is then concluded that chunk definition can only be procedural (chunks are phases), because otherwise the labour would be done twice: phase theory is needed anyway for reasons that have got nothing to do with phonology. This then constitutes an additional argument against the Prosodic Hierarchy, independent from the diacritic issue.

Chunk definition is about the only time in this book (which recall focuses on the representational side of the interface) that a procedural aspect is considered.

26
5. The diacritic issue

Like modularity and translation, the diacritic issue (3d) is supposed to be settled, but in fact is not. Everybody agrees that diacritics ought to be banned from phonology: this was a founding statement of Prosodic Phonology (§94). But what happened in fact in the early 80s when Prosodic Phonology took over from SPE-type boundaries was the replacement of a linear by an autosegmental diacritic (hash marks by prosodic constituency).

This is discussed at length in BlueVol §§365, 399 and §§66, 93 (see also Scheer 2008a, 2009a,c). Since the issue is central, a summary of this piece of the history of (representational) interface thinking is exposed at greater length in §68. The goal is to establish that there is an issue at all: the (non-)respect of modularity, the existence of translation and the No Diacritics! requirement may appear to be an old hat – but they are not.

The goal and raison d'être of Direct Interface is to build a diacritic-free theory of the representational communication with phonology in a modular and hence translation-based environment: only truly phonological objects can be carriers of morpho-syntactic information in phonology. What exactly counts as a truly phonological object (and what is a diacritic) is therefore a central question that is discussed in §95.

27 6. (Non-)privative translation

Unlike the three other questions, (3c) (privativity) and (3e) (local insertion) have gone unnoticed in the design and historical development of interface theory in the sense that they are not discussed, or even identified as relevant issues.

Regarding the translation of irrelevant noise, there was a major cultural break in generative quarters between Chomsky *et al.* (1956) on the one hand and SPE followed by all subsequent interface theories on the other. While Chomsky, Halle & Lukoff practise privative translation and for obvious reasons of economy only ship the subset of morpho-syntactic information that will really impact phonology, from SPE on phonology is burdened with (almost) everything, including irrelevant noise. This issue is discussed in §78, where it is argued that in a minimalist environment translation must be privative.

28 7. Local vs. non-local insertion

Regarding the way the output of translation is inserted (3e), the transition from local SPE-type boundaries to non-local domain-based carriers was not identified as such as far as I can see (BlueVol §§365f, §376): nobody has ever evaluated whether morpho-syntactic intervention in phonology should be local or non-local, what the consequences and the predictions are, what kind of evidence pleads in favour or disfavour of either view and so on.

Therefore, what happened when SPE-type hash marks were replaced by prosodic domains in the early 80s is that the local insertion baby was thrown out with the diacritic bathwater: since diacritic hash marks are bad, they need to go. The fact that they had a second property – local insertion – went unnoticed.

Also, it is evident that a local *and* non-diacritic alternative is rather counter-intuitive. This is certainly a reason why it was not discussed: what kind of object could be inserted into the linear string that is not a hash mark-like diacritic? This is precisely the question that Direct Interface forces individual phonological theories to answer: different theories promote different vocabulary, and only items of this vocabulary can be carriers of morpho-syntactic information. Therefore different theories make different predictions *at the interface*, and these predictions can be run against what we know about interface phenomena (§§151, 154). In other words, Direct Interface discriminates phonological theories according to their more or less successful behaviour at the interface.

The issue of local vs. non-local insertion is introduced at greater length in chapter 4 (§131), where it is also shown that domain-based insertion is necessarily diacritic (§136). The only way to insert a non-diacritic object is as a local member of the linear string. Therefore on the standards of Direct Interface, the correct output of translation are non-diacritic hash marks. That this is not a contradiction in terms is shown as we go along: syllabic space for example *is* an object that is both non-diacritic and locally inserted.

Chapter 2
29 Modularity and its consequence, translation

30 1. Modularity in Cognitive Science and language

31 1.1. There is no representational side of the interface without modularity

Modularity is the idea that the human cognitive system is made of a set of independent, specialised, genetically endowed and interconnected computational systems, the modules.

Antiquity set aside, the idea that the mind is a set of functional subsystems each of which is devoted to a specific task amounts to 18^{th} century Austrian physiologist Franz Joseph Gall (1758-1828). In the 19^{th} and early 20^{th} century, his theory was known under the header of phrenology (see BlueVol §600).

Today these specialised individual computational systems are called modules (Fodor 1983), and the modular theory of the mind is opposed to another conception of how the cognitive system works, connectionism (e.g. Rumelhart *et al.* (eds.) 1986, Rumelhart 1989, Smolensky 2003, the overview literature includes Stillings *et al.* 1995:63ff, Braddon-Mitchell & Jackson 1996:219ff, Harnish 2002).

In the 50s, Noam Chomsky participated in the development of the general computational paradigm (Turing - von Neumann, see BlueVol §603) that underlies modularity as well as much modern science and grew into the standard paradigm of Cognitive Science. Generative linguistics may be said to be an application of this computational perspective to language. Therefore modularity is one of the deepest layers of generative thinking.

Isac & Reiss' (2008) and Boeckx's (2010) recent (text)books on language and cognition cover a number of issues that are discussed below. They provide a broad introduction to language and linguistics from the Chomskian (and, in the case of Boeckx, specifically biolinguistic) point of view, and argue on the backdrop of Cognitive Science (without however engaging into discussion with connectionism: modularity is taken for granted). Scheer (2011a:§586) provides an introduction to modularity for linguists in the context of Cognitive Science (with specific attention to historical aspects and the competition between modularity and connectionism).

The present chapter recalls a number of central notions because the very existence of representational communication between morpho-syntax and phonology relies on the premise of translation, which in turn exists only in a modular environment. If the competing view of the human cognitive system, connectionism, turns out to be correct, or if modularity comes to be known as incorrect in some other way, the grounds for translation, and hence for the entire book that the reader holds in hands, evaporate (as much as about all interface theories since the 19th century). If language is not made of distinct computational systems, there is nothing to translate among these systems, and hence no objects to be inserted into phonological representations in the first place.

32 1.2. Modularity, connectionism, mind and brain

Under the header of what today is called the cognitive revolution (e.g. Gardner 1985:10ff, Harnish 2002:37ff), the modular approach to cognition was put on the agenda in the 50s and 60s as an alternative to (psychological) behaviourism and parts of (linguistic) structuralism. Rather than describing the stimuli and the responses of an organism, focus was put on the actual cognitive processes that take place when speech is produced and processed (an area that was a black box in behaviourism). Rather than describing a linguistic system without location in space and time, the cognitive operations that it supposes became the centre of interest. This call for cognitive realism is essentially what Chomsky's (1959) critique of Skinner's book *Verbal Behaviour* is about. Generative linguistics were leading in the introduction of the new cognitive conception then, and today language remains a central issue in Cognitive Science.

Critical for modularity and generative linguistics is the difference between mind and brain, which is akin to the distinction between competence and performance. Although the mind of course has a neural implementation, it may be studied independently of the neuro-biological reality. In fact, trying to get hold of language by looking at its neuronal reality alone is quite unlikely to produce significant insight. On the other hand, models of the mind are constrained by the limitations of what is neurally possible and plausible. The best understanding of language may therefore be expected from a dialectic exchange between the study of mind and the study of brain, bottom-up as much as top-down.[5]

The debate between the classical cognitive model on the one hand and connectionism on the other is about 25 years old; the following discussion only ambitions to provide a brief summary of some basic aspects. More detail is available for example in Dinsmore (ed.) (1992). Laks (1996) and Pylyshyn & Lepore (eds.) (1999) offer informed overviews, more specialised literature includes Newell (1980), Fodor & Pylyshyn (1988), Smolensky (1988, 1991), Fodor & McLaughlin (1990), Harnad (1990), and other references that are mentioned as we go along. Finally, Fodor (1985) provides a helpful overview of the different schools of thought in Cognitive Science.

33 1.3. A spearhead of the cognitive revolution of the 50s in language

Language has always played a prominent role in the development of Cognitive Science: it was a prime candidate for the implementation of the Turing-von Neumann programme (see Gardner 1985:182ff, §67 below and BlueVol §§603, 623) that really started to penetrate modern science in the 50s (e.g. Gardner 1985:28ff).

Noam Chomsky and generative linguistics were the spearhead of the computational conception in the realm of language (e.g. Cosmides & Tooby 1992b:93ff, Chomsky 1993). In 1972, computer scientists Allen Newell and Herbert Simon recall the 50s and the inception of Cognitive Science.

(4) "Within the last dozen years a general change in scientific outlook has occurred, consonant with the point of view represented here. One can date the change roughly from 1956: in psychology, by the appearance of Bruner, Goodnow, and Austin's *Study of Thinking* and George Miller's 'The magical number seven'; in linguistics, by Noam Chomsky's 'Three models of language'; and in computer science, by our own paper on the Logic Theory Machine." (Newell & Simon 1972:4, emphasis in original)

Also, Chomsky has always considered that the study of language is undissociable from the study of mind: cognitive realism is a founding statement of the generative enterprise – since Chomsky (1959) it constitutes

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[5] Simon & Kaplan (1989:7f) and Pylyshyn (1989:60ff) elaborate on the standard notion of levels of representation in Cognitive Science.

the fraction line with (certain types of) structuralism (in linguistics) and behaviourism (in psychology and learning theory).

In this context, modularity is a necessary ingredient of the generative enterprise, both regarding language in the concert of other cognitive functions and its internal organisation. The former area may be illustrated by the following quote from Chomsky (1975) (among a host of others, e.g. Chomsky 1972, 1980, 1984, 1988, 1993 etc., Higginbotham 1987 and Hirschfeld & Gelman 1994:5ff provide historical discussion).

(5) "[T]he position we are now considering postulates that this faculty [the language faculty] does exist, with a physical realization yet to be discovered, and places it within the system of mental faculties in a fixed way. Some may regard this picture as overly complex, but the idea that the system of cognitive structures must be far more simple than the little finger does not have very much to recommend it.
The place of the language faculty within cognitive capacity is a matter for discovery, not stipulation. The same is true for the place of grammar within the system of acquired cognitive structures. My own, quite tentative, belief is that there is an autonomous system of formal grammar, determined in principle by the language faculty and its component UG. This formal grammar generates abstract structures that are associated with "logical forms" (in a sense of this term to which I will return) by further principles of grammar. But beyond this, it may well be impossible to distinguish sharply between linguistic and nonlinguistic components of knowledge and belief. Thus an actual language may result only from the interaction of several mental faculties, one being the faculty of language. There may be no concrete specimens of which we can say, these are solely the product of the language faculty; and no specific acts that result solely from the exercise of linguistic functions." Chomsky (1975:43)

Another point of interest is that language has always been considered a prime candidate for modularity – more than other cognitive systems – in the debate regarding which faculties exactly are modular, and which ones are not, i.e. result from the activity of Fodorian central systems (see §38). Smith & Tsimpli (1995:30) for example distinguish between perceptual and cognitive systems, where the former identify as "the sensorium plus language", while the latter are Fodor's central systems (fixation of belief, thought, storing knowledge). On this view, language is on a par with vision, audition, taste, smell and the sense of touch.

The intimate relationship of language and modular theory is also reflected by the fact that Fodor's (1983) seminal book has emerged from a class on cognitive theory that Fodor co-taught with Chomsky in fall 1980.

34 1.4. Modularity implies biology and innateness: the language organ

A consequence of the view that language is a module is its genetic determinacy: modules, among other things, have the property of being genetically endowed (see also §37 below, BlueVol §627).

This is where Chomsky's biological conception of language – known under the header of the language organ and more recently the biolinguistic programme (§41) – comes from. On this view, the neural existence of the language module and the genetic endowment for its inception in the growth of young humans gives rise to an organ just like the liver, the heart or other parts of the human body that are specialised in some particular task: cleaning or pumping of blood etc. The only peculiarity of the language organ, then, is to be localised in the brain, rather than elsewhere in the body.[6]

In this perspective, linguistics is "that part of psychology that focuses its attention on one specific cognitive domain and one faculty of mind, the language faculty" (Chomsky 1980:4). Therefore, "we may regard the language capacity virtually as we would a physical organ of the body and can investigate the principles of its organization, functioning, and development in the individual and in the species" (Chomsky 1980:185). Another quote along the same lines is from Chomsky (1975:11): "the idea of regarding the growth of language as analogous to the development of a bodily organ is thus quite natural and plausible. It is fair to ask why the empiricist belief to the contrary has had such appeal to the modern temper." The modern offspring of this genuinely generative tradition is Chomsky's biolinguistic program (e.g. Hauser *et al.* 2002, Chomsky 2005), on which more in §41 below (also BlueVol §637; see Jenkins 2000 for an overview).

Together with UG, the language organ is probably the best-known property of generative grammar outside of its own quarters. It has become a buzz-word in popular scientific texts and neighbouring disciplines, foremost philosophy and psychology where its validity is challenged. This debate goes far beyond the scope of the present book. Relevant literature from

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6 In psycholinguistic quarters that were a priori Chomsky-friendly, the biological conception of language was anything but popular in the 80s: people refused even to think about an eventual neural correlate of cognitive functions. Dehaene *et al.* (2001) report on this pre-brain imaging period with the following quote from Jacques Mehler, which sums up Mehler *et al.* (1984): "For all I know, language perception might be going on in the brain, but my research would not be affected if it was found to be occurring in the left pinky." Dehaene *et al.* (2001) and the section on Brain and Biology of Dupoux (ed.) (2001) that they introduce then show how things have changed today.

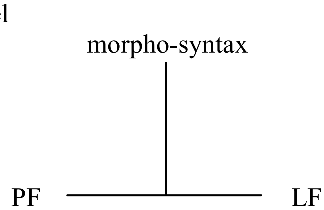
both sides includes Stich (1972), Katz (1984), Devitt & Sterelny (1989), Kasher (ed.) (1991), Fodor (1981), Chomsky (2002); Wauquier (2005:175ff) provides an informed overview.

35 1.5. The inverted T is the baseline since the 60s

If language is a piece of the modular architecture of mind, the question arises whether there is only one single computational unit that carries out all grammatical calculation, or whether there are several linguistic modules. In turn, if language is made of distinct computational systems, the question is how many linguistic modules there are, and how exactly they are delineated.

The baseline regarding language-internal modularity was condensed in Aspects. Chomsky (1965:15ff) grants modular status in terms of independent and domain-specific computational systems to three components of language: (morpho-)syntax is the central concatenative system, whose output is interpreted by phonology (PF) and semantics (LF); these produce form and meaning, respectively. The architecture is shown under (6) below; it is known as the inverted T model (or the Y model).

(6) the inverted T model



In SPE and further practice, morpho-syntax and the two interpretative modules are procedurally ordered so that words and sentences are pieced together before being shipped to interpretation at PF and LF. That is, all concatenation is done before all interpretation

The three computational systems of the inverted T feature the core of "internal" linguistic activity and are related to non-linguistic cognitive activity by at least a conceptual device (which matches real-world objects and concepts with linguistic items) and pragmatics. Or, in other words, the interplay of the three "internal" components is called grammar, while their exchange with grammar-external cognitive activity produces language (see Newmeyer 1986:172ff for a historical description and the state of the art in early GB). In more recent minimalist times, syntax is emptied of quite some of its original content, which was relocated in PF. Some issues that are raised by this shrinking of the concatenative module and the simultaneous pumping up of PF (clean syntax, dirty phonology?) are discussed at greater length in BlueVol §727.

36 2. Core properties of modularity

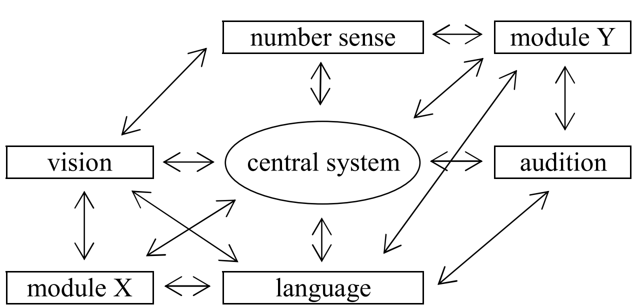
37 2.1. Higher and lower cognitive functions, modules and the central system

If the mind is made of a number of distinct computational systems, the question arises what exactly counts as a module: how many different faculties are there, how coarse-grained and of what type are they, what kind of evidence can be brought to bear in order to identify them and how can they be delineated?

Regarding the problem of functional taxonomy, Franz-Joseph Gall already argued against very broad abilities (whose operations may apply to different domains) such as intellect, acuity, volition, attention, judgement or memory (Fodor 1983 calls these horizontal faculties). Just like instinct (of birds to sing etc.), these abilities do not have a specific neurological localisation in Fodor's model. Rather, they emerge from the conjugation of more fine-grained abilities (which Fodor 1983 calls vertical faculties) such as vision, audition or number processing. A range of this kind of problem-solving entities (which are known as lower cognitive functions in psychology) are thus the construction workers of higher cognitive functions such as moral and social judgement, which Fodor (1983) calls the central system.

Table (7) below depicts the relationship between Fodor's central system and modules (how modules communicate with other modules, and with the central system, is discussed in §§51, 160 below).

(7) Fodor (1983): modules and the central system that they inform



The central system is (or rather: the central systems are) informed by the work that is done by modules, but it is (they are) not a module itself (themselves). Namely, higher cognitive abilities that are the result of the central system lack the two main characteristics that define modules: they are not domain specific, and they are not (informationally) encapsulated (more on these notions in §§43f). Also, they try "to make sense" of the information that is submitted to them and hence may be goal oriented.

Unlike central systems, modules are "dummy" and non-teleological: they have no decisional latitude, do not make or evaluate hypotheses and hence do not try to achieve any goal: they are simple computational systems that calculate a predictable output on the grounds of a given input ("input systems" which are stimulus-driven). They provide the evidence that the central system needs in order to manage hypotheses, but are entirely insensitive to whatever the central system may "ask" them to do. Modules do their job fast, well, they are very reliable, and they are mandatory: humans cannot decide to switch them off. For example, visual stimulus always ends up as a three dimensional picture, language is always processed as such and not as noise, and subjects cannot help identifying what kind of surface their fingers are running over.

Prime examples of lower cognitive functions that qualify as modules have already been mentioned: audition, vision, number sense. At least the two former are no doubt genetically endowed. Being innate is thus another property of modules. Fodor (1983:44) grants modular status to "the perceptual faculties plus language" – an interesting definition.

Following the Fodorian track, general introductions to the modular conception of the mind include Stillings *et al.* (1995:16ff), Segal (1996), Cattell (2006:43ff), Samuels *et al.*(1999:85ff) and Harnish (2002:105ff). Since Marr (1982), vision is certainly the best studied cognitive faculty which indeed provides pervasive evidence for a modular architecture of the mind/brain (see for instance the papers on vision in Garfield (ed.) 1987:325ff, as well as Stillings *et al.* 1995:461ff).

38 2.2. How much of the mind is modular?

39 2.2.1. Peripheral vs. massive modularity: is there a non-modular core?

Fodor (1983) is pessimistic about our ability to understand how central systems work: he assumes that they are resistant to scientific theorising and ultimately to human understanding because they cannot be appraised through the modular prism: "the more global […] a cognitive process is, the less anybody understands it" (Fodor 1983:107).

A different line of thought expands the modular architecture to central systems as well. Pinker (1997) and Plotkin (1998) are prominent figures of this direction: according to them, all mental processes are computations. Smith (2002, 2003) also questions the strict separation between modules and non-modular central systems, and Smith & Tsimpli (1995:164ff, 1999) are optimistic regarding our chances to understand how central systems work: they craft the notion of quasi-modules, which they believe higher cognitive functions are produced by. The volume edited by Hirschfeld & Gelman (eds.) (1994) also contains a number of papers that argue for the domain specificity of higher cognitive functions such as social categories, cultural representations and emotions (domain specificity is a central property of modules, see §43).

Following the same track, Higginbotham (1987:129f) argues that language is a central system *and* modular. Sperber (1994, 2001) also promotes the modular character of central systems: according to his *massive modularity*, the brain is modular through and through. The three-chapter debate on "how modular is the mind?" in Stainton (ed.) (2006:3ff) provides a good overview of the issue.

Considering massive modularity and related approaches, Fodor (1987:27) says that the "modularity thesis [has] gone mad". The article opens like this: "There are, it seems to me, two interesting ideas about modularity. The first is the idea that some of our cognitive faculties are modular. The second is the idea that some of our cognitive faculties are not."

More recently, Fodor (2000) is a book entirely devoted to the question whether all or only part of the cognitive system is based on a modular architecture. The book is an exegesis and a refutation of Pinker's and Plotkin's "New Synthesis Psychology" (which Fodor calls rationalist psychology, see also Fodor 1998). Gerrans (2002) provides an informed overview of the debate regarding the articulation of modules with central systems.

40 2.2.2. Is the central system impenetrable for human intelligence?

What really is behind this debate is (against a possible prima facie impression) a categorical, rather than a gradual distinction – one that has deep philosophical roots and far-reaching consequences. That is, the modular paradigm falls into two opposing camps, one holding up Descartes' position that the mind, or at least some of it (the central system in Fodor's terms), is beyond what can be understood by human intelligence and will always remain an impenetrable mystery (the soul is of course lurking behind the mind of Descarte's mind-body dichotomy); by contrast, the other camp makes no difference between lower and higher cognitive functions, which are both the result of modular activity, and whose workings may be discovered by human intelligence.

We have seen that the former view is defended by Fodor (1998, 2000), but also by Chomsky in linguistics (e.g. Chomsky 1984:6f, 23f, Chomsky 1995b:2f, chapter 4 of Chomsky 1975 is called "Problems and mysteries in the study of human language"). Fodor's and Chomsky's position blocks any inquiry into how the mind really works (all of the mind for Descartes, just a subset of it, the central system, for Fodor/Chomsky) before it has even started: don't try to find out how it works, you will fail anyway. This has direct consequences for the dialogue with the implementational level: only a subset of the mind may be mapped onto neuro-biology – the central system is not based on any neuro-biological activity, or at least will humans never be able to understand what the relationship is.

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2.2.3. Is the mind (are modules) the result of Darwinian adaptation?

It was mentioned that the position where all cognitive functions are in principle accessible to human intelligence and must ultimately be able to be mapped onto neurobiology is what Fodor calls rationalist psychology. In other quarters, it is called evolutionary psychology in recognition of the fact that it is intimately interwoven with the Darwinian perspective. Pinker (1997) and Plotkin (1998) hold that the mind, like the brain and all other properties of living beings, is the result of an adaptive evolution which was marshalled by selectional pressure over millions of years.

Obviously, if all is the result of environment-driven adaptation, no part of the mind can stand aside. Which means, viewed from the other camp, that Fodor and Chomsky must deny the idea that all of the mind is the result of Darwinian selection. This is precisely what they do in the biolinguistic programme: the controversy between Hauser *et al.* (2002) (also Fitch *et al.* 2005) and Pinker & Jackendoff (2005a,b) is about this issue.

Hauser *et al.* (2002) argue that the FLN (Faculty of Language in the Narrow sense), i.e. what really makes language distinct and unique (with respect to other cognitive functions), boils down to recursion (of morpho-syntax) and the ability to talk to other modules (namely phonology and semantics). In other words, only Merge and Phase are specifically linguistic instruments among the mechanisms that participate in language perception and production. Hauser *et al.* (2002) also hold that the FLN is the only property of language that could not possibly be the result of an (adaptive) evolution based on an animal ancestor: the FLN is given (BlueVol §609). This claim lies at the heart of the biolinguistic programme (where phonology and semantics for example are not specifically human, see BlueVol §637) and is further developed with specific attention for phonology by Samuels (2009a,b).

On the other hand, the general viewpoint of evolutionary psychology on the mind is exposed by Cosmides & Tooby (1992a, 1994) and Barkow *et al.* (1992). Samuels *et al.* (1999) offer a valuable digest of the debate between peripheral (Fodor/Chomsky) and massive (evolutionary psychology) modularity on the backdrop of the opposition between what they call Chomskian and Darwinian modules. Even though based on a non-evolutionary perspective, Sperber (1994, 2001), Smith (2002, 2003) and Smith & Tsimpli (1995:164ff, 1999) go along with the Darwinian party.

42 2.3. Core modular properties

43 2.3.1. Domain specificity

Modules are computational units that are devised for just one highly specific task. Therefore the symbolic vocabulary that they work with is as specific as their task. The input, written in a (domain) specific vocabulary, its transformed by (modular) computation into an output, the structure. The difference between (domain-specific) vocabulary (input) and structure (output) is a core property of modularity.

Modules thus speak different languages (of the mind), and they are unable to understand other languages (of the mind). Modules can only parse objects that belong to their own language, i.e. which are part of the domain-specific vocabulary that they are designed to process. This is what Jackendoff explains in the quote below.

(8) "'Mixed' representation[s] should be impossible. Rather, phonological, syntactic and conceptual representations should be strictly segregated, but coordinated through correspondence rules that constitute the interfaces." Jackendoff (1997:87ff)

Hence, whatever information is submitted that is not written in the specific symbol code of a module is uninterpretable: it is treated as noise and simply ignored. For example, the visual module can only take visual stimulus as an input. It will ignore any auditive or other alien information.

Arguments for domain specificity come from various fields, including neuropsychology, computational theory and cognitive evolution (Gerrans 2002:261 provides an overview, see in particular Cosmides & Tooby 1992a). Hirschfeld & Gelman (eds.) (1994) provide a synopsis of domain specificity and the kind of domains that can be isolated (which include higher cognitive functions such as social categories, culture-specific representations and emotions); Fodor (2000:58ff) discusses the various ways in which domain specificity has been used.

44 2.3.2. Informational encapsulation

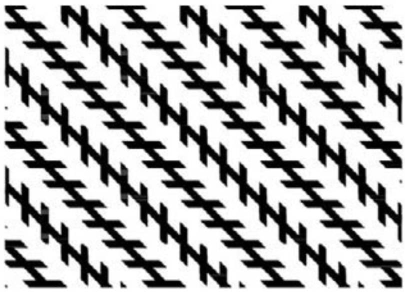
Modules are also (informationally) encapsulated, which means that during the computation performed, they do not need and cannot take into account anything that was not present in the input. That is, once the input is defined and computation has begun, nothing can alter the course of events, and the output is produced in complete disregard of any module-external information such as high-level expectations, beliefs (coming from the central system), memory, inference and attention, or results of other modules.[7] Conversely, modules are unable to communicate any intermediate result of their work: transmission to other modules or to the central system is only possible once the computation is completed. In sum, modules are autistic (Fodor 2000:62ff, Gerrans 2002 and Smith & Tsimpli 1995:30f provide a concise introduction to encapsulation).

The effect (and hence existence) of encapsulation is often shown on the grounds of optical illusions. Under (9) below appear a number of well-known cases, which all demonstrate that humans are "fooled" by their visual system even if they know beforehand that what they "see" is not true: there is no way to willingly marshal vision according to prior knowledge of the central system, to some desire or presupposition. Vision does whatever it does without asking any other cognitive system, and even against the will

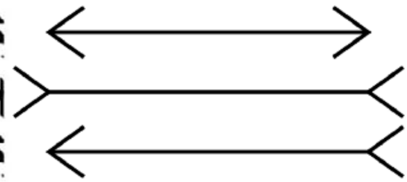
[7] This of course does not withstand the existence of networks of modules or of "loops" whereby the result that is achieved by a given module serves as the input of several other modules and eventually, enriched with additional information, is pulled several times through the same module.

of the subject: no other cognitive system, modular or central, can "break into" vision in order to change its course once computation has begun.

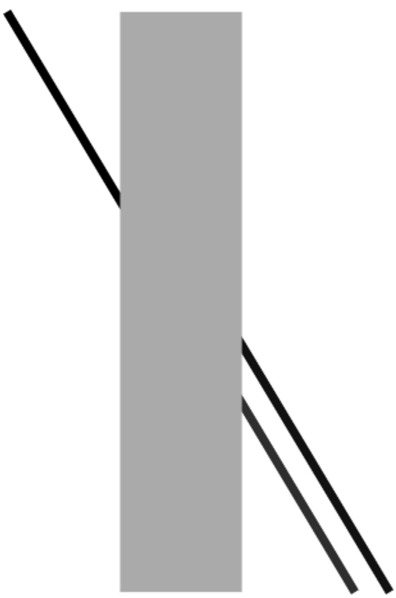
(9)



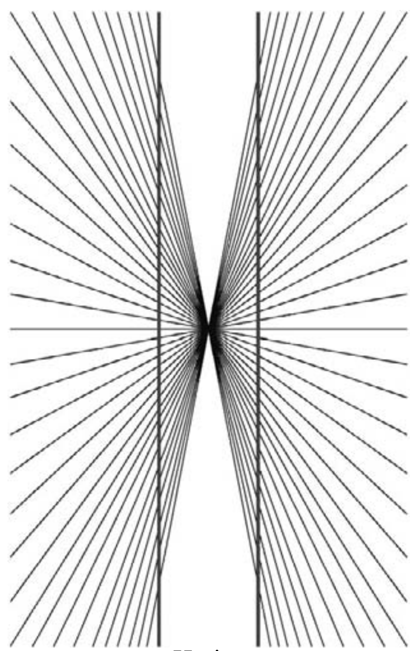
Zöllner:
all long lines are parallel



Müller-Lyer
lines are equal in length



Poggendorff
the lower line on the righthand side of the rectangle is the same (straight) line as the one on the lefthand side



Hering
vertical lines are parallel

Encapsulation has been challenged by evidence suggesting that there is also non-encapsulated communication between the central system and modules whereby the former affects ongoing modular computation.[8] Arguments to this end have been made on the connectionist side (e.g. Elman 1994), but also in developmental psychology (Karmiloff-Smith 1998). Ongoing debate is reviewed by Gerrans (2002), who argues in favour of encapsulation.

The syntactic application of encapsulation is Chomsky's (1995a:228) inclusiveness: syntactic structure must be exclusively based on information that is present in the input; no element may be added in the course of a syntactic derivation.

45 2.3.3. Summary: how to identify a module

A module is thus a hard-wired and genetically determined computational unit that builds on a fixed and localisable neural structure; it is domain specific (i.e. content-based), autonomous, automatic, mandatory, stimulus-driven and insensitive to central cognitive goals. Segal (1996:145) provides an informed and concise overview of the modular idea in its various incarnations. His list of core properties contains nine items, which are shown under (10) below.

(10) core properties of cognitive (Fodorian) modules according to Segal (1996:145)
- a. domain specificity
- b. informational encapsulation
- c. obligatory filtering
- d. fast speed
- e. shallow outputs
- f. limited inaccessibility
- g. characteristic ontogeny
- h. dedicated neural architecture
- i. characteristic patterns of breakdown

Crucially for linguistics (as we will see below), a module is designed for a special purpose and can only work with the specific vocabulary associated – all the rest is noise: modules "solve a very restricted class of prob-

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[8] The reason and genesis of the illusions are secondary for the argument. Also note that the effect is the same for all humans (who are subject to the illusion: some are not), i.e. perfectly independent of culture, language, age, social parameters and so forth.

lems, and the information it can use to solve them with is proprietary" (Fodor 1998).

Chomsky & Halle's (1968) description of the phonological rule system is quite close an anticipation of what Fodorian modules will look like 15 years later.

(11) "The rules of the grammar operate in a mechanical fashion; one may think of them as instructions that might be given to a mindless robot, incapable of exercising any judgment or imagination in their application. Any ambiguity or inexplicitness in the statement of rules must in principle be eliminated, since the receiver of the instructions is assumed to be incapable of using intelligence to fill in gaps or to correct errors." Chomsky & Halle (1968:60)

Given these core modular properties, a question is how modules are practically delineated within the host of cognitive functions. The typical answer is domain specificity: a computation that builds on heterogeneous primitive units cannot be done in one and the same module. There is serious debate in linguistics regarding the question which entities (subdisciplines) exactly are identical or distinct computational systems (BlueVol §622, ongoing controversy namely concerns morphology and syntax, see BlueVol §537). In this situation, the guiding light will be to look at which kind of vocabulary is processed on each side, and whether or not it is the same. In case it is not, the two entities cannot be incarnations of the same module.

Another way of detecting modules is so-called (double) dissociation, which may be viewed as an external means in comparison to the internal handle that is offered by domain specificity (BlueVol §618, e.g. Smith 2003). While the latter requires only the inspection of linguistic properties (the vocabulary used, see below), (double) dissociation requires the examination of speakers that experience significant cognitive and/or brain damage.

Overview literature regarding the general properties of modules includes Segal (1996), Pinker (1997), Plotkin (1998), Sperber (2001), Gerrans (2002), Jackendoff (2002:218ff), Smith (2002, 2003) and Fodor (2000). Cosmides & Tooby (1992b:93ff) provide a historical overview of the modular idea from the psychologist's perspective.

Below the refereeing of different language-internal candidates for modularity according to domain specificity and (double) dissociation is not undertaken (see BlueVol §640). Only the distinction that the book is about, i.e. the one between morpho-syntax and phonology, is discussed.

46 2.4. The major ontological gap in language: phonology is distinct

47 2.4.1. Domain specificity (Starke): morpho-syntax-semantics vs. phonology

In unpublished work,[9] Michal Starke argues that morphology, syntax and semantics are just one module because they use the same vocabulary: number, person, animacy, quantification, aspect and so forth are categories that are used, understood and processed by syntax as much as by morphology and semantics.[10] This is much unlike phonology, where number, person and the like are unknown: phonology does not use or process these categories. Conversely, morphology, syntax or semantics neither process or are sensitive to genuinely phonological concepts such as labiality, stopness and the like.

On Starke's count, then, phonology (as much as pragmatics and the conceptual device) works with specific vocabulary and is thus a module distinct from morpho-syntax-semantics. Discussing the detail of the evidence that Starke relies on would lead too far afield here (a published version will hopefully be available at some point). Let us merely note the structure of his argument, which is along the lines of domain specificity. The result is a broad distinction of two macro-modules, phonology and morpho-syntax-semantics, which are supplemented by (at least) two modules that mediate between grammar and other cognitive functions (pragmatics and the conceptual device).

48 2.4.2. Domain specificity (Jackendoff, Chomsky): phonology is distinct

Jackendoff's (1987, 1992, 1997) modular theory, Representational Modularity (which Jackendoff 2002:218ff prefers to call Structure-Constrained Modularity today), also points out the obvious ontological gap between phonology and other linguistic devices, which is greater than the distance between any other two linguistic candidate disciplines.

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9 Starke's work has been presented at various conferences and at the Central European Summer School in Generative Grammar (EGG) in 2002 (Novi Sad) and 2006 (Olomouc).

10 Of course semantics is to be understood as "grammatical" semantics, i.e. the system that assigns an interpretation to morpho-syntactic structure. The meaning of lexical items and the relation with the conceptual world are entirely different issues.

(12) "The overall idea is that the mind/brain encodes information in some finite number of distinct representational formats or 'languages of the mind.' Each of these 'languages' is a formal system with its own proprietary set of primitives and principles of combination, so that it defines an infinite set of expressions along familiar generative lines. For each of these formats, there is a module of mind/brain responsible for it. For example, phonological structure and syntactic structure are distinct representational formats, with distinct and only partly commensurate primitives and principles of combination. Representational Modularity therefore posits that the architecture of the mind/brain devotes separate modules to these two encodings. Each of these modules is domain specific.
[…] The generative grammar for each 'language of the mind,' then, is a formal description of the repertoire of structures available to the corresponding representational module." Jackendoff (1997:41)

Chomsky (2000) makes the same point.

(13) "The phonological component is generally assumed to be isolated in even stronger respects: there are *true* phonological features that are visible only to the phonological component and form a separate subsystem of FL [the Faculty of Language], with its own special properties." Chomsky (2000:118, emphasis in original)

Domain specificity within grammar thus identifies what appears to be the deepest fraction line, which separates phonology on the one hand and all other classical disciplines (syntax, morphology and semantics) on the other.

Jackendoff ends up with three modules that are involved in the management of grammar: phonology, syntax and the conceptual device. He calls modules processors and distinguishes between integrative and interface processors (see §175). The latter translate the output of the former into vocabulary items that can be understood by other modules. Intermodular communication is discussed at greater length in §160 below.

49 2.4.3. Late Insertion is the segregation of phonological and other vocabulary

The ontological separation between phonology and morpho-syntax is also central in Distributed Morphology: while up to GB morpho-syntactic computation was done on the basis of complete lexical information that included syntactic, morphological and semantic features as much as phonological material (sealed suitcases), Late Insertion is the idea that phonological material is absent from morpho-syntactic computation (see BlueVol §§536, 646). That is, only morpho-syntactic information is available at the beginning of a derivation; phonological material (vocabulary items) is only inserted after the completion of the morpho-syntactic derivation.

50 2.4.4. Phonology vs. phonetics

Although this book does not consider the relationship of phonology with phonetics, i.e. the (eventual) lower limit of phonology, it is worth pointing out that domain specificity is also used in the large body of literature that debates this issue in order to insulate both areas: this is what Hale & Reiss (2008:118) do. Kingston (2007) provides a good overview of the positions that are taken, and especially of the debate whether phonology and phonetics are distinct modules or instances of the same computational system.

51 3. How translation works (in phonology)

52 3.1. Application of domain specificity to phonology: Indirect Reference

Applied to the phonological module, domain specificity means that phonology could not react to any untranslated input from the morpho-syntactic module. This is precisely the principle of Indirect Reference that was introduced by Prosodic Phonology (see §§23, 85): phonology can only take into account morpho-syntactic information that was previously translated into phonological vocabulary. The whole architecture of Prosodic Phonology is shaped according to Indirect Reference: a Translator's Office mediates between morpho-syntax and phonology. That is, the morpho-syntactic output is mapped onto prosodic constituency, which is the input to phonology.

The basic idea of intermodular communication that materialises in the architecture of Prosodic Phonology is thus the following: in order for two modules to talk to each other, there must be a mediating instance which understands the vocabulary of both the input and the output module and translates information from one into the other. Untranslated information is noise and will be ignored by the receiving module. The kind of "dynamic" translation that is practised in Prosodic Phonology, i.e. by a computation in its own right that transforms vocabulary X into vocabulary Y, instantiates Jackendoff's (1997 and following) model of correspondence rules (or more recently interface processors). Jackendoff's system is presented in greater detail in §172, and an alternative, i.e. non-computational translation, is introduced in §§169, 181f.

The idea that morpho-syntactic information must be translated before phonology can use it has always been present in phonological theory since the 19th century. A summary of how translation was practised since structuralist times is provided in §66 below.

53 3.2. Is structure, but not vocabulary, translated?

In principle, translation could translate vocabulary items and structure alike. There is some indication, though, that modules may be sensitive to the former, but not to the latter. This empirical generalisation is discussed in BlueVol §398: there is at least a strong trend for phonology to be sensitive to morpho-syntactic structure, i.e. geometric properties of the tree, while node labels are by and large ignored.

The same is true in the opposite direction: it is shown in §127 that phonology-free syntax is in fact melody-free syntax: the basic vocabulary items of phonology are the objects that occur below the skeleton, i.e. melodic primes such as labiality, stopness and so on. On the other hand, syllable structure and other properties of supra-skeletal phonological representations are the result of phonological computation that is based on this basic vocabulary.

If it is true that structure may be translated, while vocabulary remains untranslated, melody is predicted to be unable to bear on morpho-syntax. By contrast, supra-skeletal phonological structure may be read by other modules. Both predictions indeed match the empirical record (see §127).

54 3.3. Translation is selective, and the choice of translated pieces is arbitrary

Another pervasive property of intermodular communication appears to be the fact that translation is never complete. That is, only a subset of the structure of the sending module is made available to the receiving module through translation. Also, it appears that the pieces which are chosen for transmission cannot be predicted.

Ray Jackendoff's work regularly draws attention to the underfeeding of the receiving module.

(14) "Correspondence rules perform complex negotiations between two partly incompatible spaces of distinctions, in which only certain parts of each are 'visible' to the other." Jackendoff (1997:221)

"The overall architecture of grammar consists of a collection of generative components $G_1, \ldots, G_n$ that create/ license structures $S_1, \ldots, S_n$, plus a set of interfaces I_{jk} that constrain the relation between structures of type S_j and structures of type S_k. […] Typically, an interface I_{jk} does not 'see' all of either S_j or S_k; it attends only to certain aspects of them." Jackendoff (2002:123)

The fractional character of translation in intermodular communication is further discussed in §§177, 180 below, where illustration from a number of cognitive functions is provided.

In language, the selective character of translation is echoed by the contrast between interface theories that translate everything (including irrelevant noise) and others that translate only information which is phonologically relevant (see §78). The unpredictability of the pieces that are translated is what is called the mapping puzzle in BlueVol §753: thus far linguists are by and large unable to characterise morpho-syntactic contexts that provoke a phonological reaction as a natural class, let alone to predict when and where they occur.

55 4. Linearisation

56 4.1. Introduction: no business of phonology, computational in kind

An important issue regarding the morpho-syntax - phonology interface in general and translation in particular is linearisation: the phonological string is linear, but syntactic structure is not. Everybody agrees that the input to phonological computation is a linear string.[11] Or, in other words, phonological computation does not create linearity. This is why phonologists never talk about linearity and linearisation: they work on linear strings and thus take linearity for granted.

Linearity is thus no business of phonologists or of phonology, and this book has got nothing to add to the question: like all other theories of

[11] But even this notion needs to be further defined: we will see in §60 below that Raimy's (2003) and Idsardi & Raimy's (forth) system allows for different degrees of linearisation of the string.

translation, Direct Interface supposes that there is a linear string into which the output of translation can be inserted. In other words, linearisation must either be completed by the time translation is done, or both operations are concomitant. That is, the linear string is made of morphemes and boundary information that are linearly ordered. This string may be pieced together by a single mechanism that successively drops phonological representatives of morphemic and non-morphemic (hash marks) information into the phonology.

Be that as it may, the reason why there is a section on linearity in this book is that its genesis is relevant for the bigger picture, i.e. the one that goes beyond the simple translation of non-morphemic information. In §172 below, Jackendoffian translation by computation is opposed to an alternative, translation through a lexical access (which is Michal Starke's take). Translation by computation is the standard everywhere: in SPE (§§102f) as much as in Prosodic Phonology (§83), and more generally in Cognitive Science (§172).

As will be seen below, one question that models of linearisation address is whether linearisation is concomitant with Vocabulary Insertion, i.e. with translation. Both operations occur somewhere between the end of (narrow) syntax and the beginning of phonological computation: the midfield today is more and more pumped up, and called PF (see BlueVol §726). Although concealed in this area, both operations are logically independent, as shown below. One thing that nobody doubts, however, is the computational character of linearisation. If linearisation is a computation, a legitimate question is how translation could be non-computational. It is argued in §160 below that translation indeed involves a lexical access, rather than computation (One-Channel Translation, see specifically §168 on linearisation). Whether a linearisation can be computational in an environment where translation is not, or whether there is also a non-computational alternative for linearisation, are interesting questions that need to be addressed in future study.

In order for the reader to appraise the general issue, a digest of current approaches to linearisation is provided below. Relevant questions are where exactly in the derivation linearisation occurs, how it works and eventually into how many sub-components it falls. Roughly speaking, Kayne's (1994) LCA (Linear Correspondence Axiom) places linearisation in narrow syntax, while all other proposals (which typically build on the LCA) locate it in PF (where "in PF" opens a rather large array of possibilities in modern minimalist times, see in BlueVol §726).

57 4.2. In minimalist times: no business of syntax either

In syntax, linearity was long taken to follow from syntactic constituent structure: word order is a function of constituent order. This was the case until (and including) GB: phrase structure rules were parameterised and responsible for language-specific variation in word order. In a language where prepositions precede nouns, the rule was PP → P, NP, while in a language where the opposite order is observed, the rule PP → NP, P was instrumental. The difference between right-branching languages such as English where heads precede their complements and left-branching languages like Japanese where the reverse order occurs is thus managed by a parameter setting, the *head parameter*.

In the minimalist perspective where trees are constructed by Merge and hence phrase structure rules eliminated, a different means for deriving linear order needs to be found. Estranging syntax from linear order ties in with the observation that syntactic generalisations are about hierarchical organisation (command and dominance relations), not about linear order. Therefore Chomsky (1995a:334) concludes that syntax has got nothing to do with linearity, not any more than LF: linearity is only relevant for phonology. That is, it is imposed upon the linguistic system by external conditions of language use: linearity is the result of the constraints that follow from the transmission of human language whereby speech unfolds in a temporal sequence.

58 4.3. Both syntax-internal and syntax-external linearisation is minimalism-compatible

Given that linear order is imposed upon language by a non-linguistic constraint, Chomsky (1995a:335) welcomes Kayne's (1994) antisymmetry in a minimalist perspective. Kayne's idea is to derive linear order *in the syntax* by leftward movement: at the end of all movement operations, the highest item is the leftmost in the linear order, and so on. On Kayne's take, this is true for all languages: SVO is the universal order underlyingly, and languages like Japanese with an overt SOV order are derived by leftward movement.

Incorporating the mechanism that creates linear order into the syntax may at first appear contradictory with the minimalist insight that syntax and linear order are independent. Chomsky (1995a:335), however, argues that syntax-internal linearisation is a prototypical implementation of minimalist thinking whose headstone is to reduce syntactic representations and computation to "bare output conditions". Hence linearity, imposed from the outside by language use, marshals syntax: movement needs to be carried out in order to satisfy its requirements.

Chomsky therefore writes that Kayne's perspective is "very much in the spirit of the Minimalist Program and consistent with the speculation that the essential character of C_{HL} [the computational system of human language] is independent of the sensorimotor interface" (Chomsky 1995a:335). A few pages later, however, he places the LCA outside of (narrow) syntax, in PF: "we take the LCA to be a principle of the phonological component that applies to the output of Morphology" (Chomsky 1995a:340, note that Chomsky operates with the traditional split between (narrow) syntax and morphology).

Another line of attack that follows Kayne's track is Fox & Pesetsky's (2004) whereby successive cyclic movement (in narrow syntax) is derived from linearity requirements. That is, just like in Kayne's system and in line with the minimalist philosophy, syntax-internal movement is motivated by a necessity of a syntax-external cognitive system. The key idea of Fox & Pesetsky is that there is a mechanism that controls the result of linearisation at every phase and compares it with the linear order achieved at previous phases. In case there is a mismatch between former and current linear order, the derivation crashes. This is what Fox & Pesetsky call order preservation: linear order must be the same at every spell-out of every phase. For the sake of illustration, consider the example under (15) below (from Fox & Pesetsky 2004:5).

(15) [To whom will he [__say [$_{CP}$ __ that Mary [$_{VP}$ __ gave the book __]]]]?

Did the movement skip Spec,VP and went directly to Spec,CP as indicated, and if VP is a phase head, Fox & Pesetsky argue, the derivation will crash at PF since the result of linearisation in the VP phase (where the displaced item remains in situ) is different from the linearised string after the CP phase (where nothing will be left in situ). By contrast, if movement goes through Spec,VP, the VP will be linearised with the displaced item in Spec,VP at the lower phase as well as at all other phases: order preservation is satisfied. Therefore, Fox & Pesetsky (2004:8) argue, "[a]n architecture of this sort will in general force successive cyclicity when movement crosses a Spell-out domain boundary."

In sum, then, minimalist principles seem to be able to be used in order to locate linearisation in either (narrow) syntax or PF. Or rather, the competition between both options cannot be refereed on minimalist grounds.

59 4.4. Everybody but Kayne does linearisation "at PF"

Work in Kayne's original perspective set aside, it appears that the field has by and large followed Chomsky's indication that linearisation occurs "at PF".[12]

However, the question is treated without much argument in the literature: people acknowledge the existence of Kayne's LCA, but then do linearisation "at PF" without saying why it should or could not be done by movement in (narrow) syntax.[13] One argument is provided by Richards (2004): Kayne's LCA is based on c-command, i.e. on an asymmetric relationship between the items that are to be linearised.

(16) "Linear Correspondence Axiom
If α asymmetrically c-commands β then (the terminals dominated by) α precede(s) (the terminals dominated by) β"
version of the LCA given by Richards (2004:11)

What, then, about cases of mutual c-command? Richards argues that the minimalist Bare Phrase Structure, which eliminates trivial, i.e. vacuous or unary-branching projections, regularly produces this kind of structure, for example in [John [ate it]] where *ate* and *it* are sisters and c-command

12 Shiobara (2009) does not follow the PF road completely, proposing to replace cyclic derivation by Left-to-Right Derivation: rather than not done bottom-up, syntactic structure-building is done in the sense of how items are pronounced over time, and under the (interface) pressure of this performance constraint. hence a good deal of linearisation is done in (narrow) syntax.

13 E.g. Bobaljik (2002) and Embick & Noyer (2001, 2007), discussed below, who do linearisation at PF "by hypothesis" or "assume" that it occurs at PF: "[a]ssuming that linear order is not included in the syntactic representation, PF operations, because they are responsible for creating the interface level that mediates between syntax and the articulatory/perceptual systems, must at the very minimum be responsible for linearizing hierarchical structures" (Embick & Noyer 2007:293). Hence Kayne's syntax-internal option is dismissed without argument or discussion.

each other. Kayne's LCA fails when trying to linearise this kind of structure. Richards therefore concludes that

(17) "the LCA cannot be a constraint on phrase-markers themselves, i.e. a property of Narrow Syntax, but must be a *linearization strategy* operative only after Spell-Out in the mapping of syntactic hierarchy onto phonotemporal order (cf. MP [Chomsky 1995a]: 340: 'We take the LCA to be a principle of the phonological component that applies to the output of Morphology'). This recasting of the LCA as a PF-mapping strategy (cf. the operation *Linearize* of Nunes 1999) conforms to the general principle that the 'horizontal' dimension of time and sequential ordering is relevant only in the phonological component, so that the syntactic component of C_{HL} [the computational system of human language] deals only in the 'vertical' dimension of hierarchical relations." Richards (2004:12, emphasis in original)

Richards (2004:23) then goes on to rehabilitate the old head parameter of GB in order to make it a parameter of the PF-located LCA. Based on Epstein *et al.*'s (1998:139ff) Precedence Resolution Principle, Richards (2004, chapters 2 and 4, 2007) proposes a sisterhood-based linearisation strategy. If a c-command relation translates to precedence at PF, heads and complements provide contradictory instructions to PF since sisters c-command each other: the head must precede the complement, but the complement must also precede the head. Which precedence will be chosen, Epstein *et al.* and Richards argue, is a matter of which head-complement directionality is deleted. This is what Richards (2004, 2007) calls desymmetrisation. While Esptein *et al.* (1998) apply this mechanism only to external Merge, Richards extends it to internal Merge, thereby promoting it to a parameter that governs the entire language. Parameterised desymmetrisation is then the old head parameter based on the LCA, but located in PF.

Other syntax-based linearisation strategies also typically implement the head parameter in one way or another. Bobaljik (2002:216) for example says that "it should be clear that I am espousing a more or less traditional view of headedness parameters, for instance, that the German V' is head-final while the English V' is head-initial; this is the information encoded in the precedence rules."

Bobaljik's precedence rules are "a procedure that maps each node to an ordered pair: [X → Y] or [Y → X] (where the arrow is to be read as 'precedes')" (Bobaljik 2002:213). He then shows how a German SOV and an English SVO order can be derived from the same syntactic structure when reverse precedence rules are applied to certain nodes (the head parameter): German will have $[_{I'}$ VP → Infl] and $[_{VP}$ DP_2 → V], while English accommodates $[_{I'}$ Infl → VP] and $[_{VP}$ V → $DP_2]$. On Bobaljik's count, thus, each language possesses a language-specific set of precedence rules (that look much like good old phrase structure rules, except that there is only one item to the right of the arrow).

In Bobaljik's system, this all happens upon spell-out from (narrow) syntax to PF, whereby the spell-out process falls into four distinct operations (which Bobaljik 2002:214, note 16 calls "components"): "a) assignment of precedence conditions to syntactic nodes [the precedence rules mentioned], b) chain reduction (= trace or copy deletion), c) conversion to linear string of X°s, d) Vocabulary Insertion" (Bobaljik 2002:214).

The same picture is found in DM quarters. Embick & Noyer (2001, 2007) and Embick (2007) hold that linearisation is concomitant with Vocabulary Insertion.

(18) "By hypothesis, linear ordering is not a property of syntactic representations but is imposed at PF in virtue of the requirement that speech be instantiated in time (see Sproat 1985). It is therefore natural to assume that linear ordering is imposed on a phrase marker at the point in the derivation when phonological information is inserted, that is, at Vocabulary Insertion.

(8) *The Late Linearization Hypothesis*
The elements of a phrase marker are linearized at Vocabulary Insertion."
Embick & Noyer (2001:562, emphasis in original)

Embick & Noyer work with a notational variant of Bobaljik's precedence rules which they call "Lin" (or the reverse: Bobaljik's precedence rules are a notational variant of Lin):

(19) "linear order is a binary operator – represented by '*' – imposed by an operation Lin:

Lin [X Y] → (X*Y) or (Y*X)

This relationship is one of immediate (left-)adjacency; subsequent steps concatenate terminal nodes. Other types of conditions might be imposed by distinct linearization operations." (Embick & Noyer 2007:294).

Embick & Noyer thus cut linearisation into (at least) two distinct operations, Lin and Concatenate (see Pak 2008:26ff for a summary).

The linearisation procedures reviewed share the idea that linearisation in fact falls into a number of different operations that are serially ordered: (at least) two with Embick & Noyer (2001, 2007), three with Idsardi

& Raimy (forth) (immobilisation, spell-out and serialisation, see BlueVol §740), four with Bobaljik (2002) (precedence conditions, chain reduction, linearisation of X°s, Vocabulary Insertion).

This is also the take of Arregi & Nevins (2012) who develop a DM-system where linearisation is a central anchor point in a list of successive events at PF, each of which is a module in its own right: morphological operations (some of which are morphotactic, a term coined in order to refer to the linearity of the string of morphemes) are either pre- or post-linearisation in kind according to whether or not they need to refer to linear order (Arregi & Nevins 2012:2). Operations such as fission and fusion do not and are therefore pre-linearisation, but morphological metathesis for example does and therefore occurs after linearisation. As was mentioned, linearisation itself is done in several steps, the first of which is viewed as an enrichment of the hierarchical structure: precedence relations are added, hence preserving hierarchy. The output of this kind of linearisation is thus a tree whose terminals correspond to the order in which they are pronounced (Arregi & Nevins 2012:313f). Arregi & Nevins (2012:230) call this stage, where Vocabulary Insertion has not yet taken place, the Linear Operations module.

60 4.5. Linearisation in phonology in order to derive phonetics (Raimy)?

Raimy (2000a,b, 2003) proposes a view on linearisation that is quite different from what we have seen thus far: he looks at the issue through a phonological, rather than through a syntactic lens. Raimy's basic idea is that precedence relationships must be explicitly noted in all phonological representations. Linear order is implicit in the standard graphic notation: "kæt" (representing *cat*, the word used for the sake of illustration by Raimy) for example reads "k before æ before t", and the same is true for x-slots in an autosegmental representation. Raimy proposes to make this explicit and to note "# → k → æ → t → %" instead (where # indicates the beginning of a linear string, and % its end). He calls the result a *directed graph*.

What is this good for if the graphic material added can be deduced from "kæt" and is therefore fully redundant? Raimy argues that there are cases where arrows actually represent *morphological* information: morphological computation is one that adds precedence relationships, i.e. arrows, to lexical material. The operation is trivial when prefixes and suffixes are concatenated, but involves the addition of "loops" within a root in case of reduplication and infixation. A process whereby "kæt" is entirely reduplicated, producing "kætkæt", thus boils down to the addition of an arrow that originates in the *t* and points to the *k*, as shown under (20) below.

(20) linearisation of loop-including representations

a. # → k → æ → t → %

b. # → k → æ → t → k → æ → t → %

The loop under (20a) thus represents the morphological operation of reduplication. The resulting structure (which Raimy calls non-asymmetrical) is then spelled out into a strictly linear string (an asymmetrical structure) as under (20b): "[l]inearization eliminates non-asymmetrical precedence structures through repetition of segments which preserves the overall organization of a precedence structure while not causing problems of interpretation for the phonetics module" (Raimy 2003:133). The "problems of interpretation" that Raimy talks about are the loops: he assumes that phonology can live with loop-containing representations, but phonetics cannot – here a fully linearised string is needed.

In sum, then, phonological representations are only partially linear (loops are non-linear elements). Analogous to the relationship between (narrow) syntax and PF, bare output conditions – the requirement of fully linearised strings at the phonetic level – provoke a spell-out.

(21) "Analogous to the syntactic LCA (Kayne 1994), phonology contains a *linearization* process which ensures that representations have *asymmetrical* precedence structures and are thus interpretable at the phonetics interface. Linearization in phonology repeats segments within a 'loop' in order to eliminate [non-]asymmetrical precedence relations." Raimy (2003:132, emphasis in original; obviously Raimy means to say *non*-asymmetrical in the last line, the absence of the *non-* is an error)

The operation that adds arrows to strings needs to "know" where to place the origin and the endpoint (anchor points). Adopting Raimy's directed graphs, Samuels (2009a:147ff) has studied the cross-linguistic variation of infixation in order to determine what kind of information the arrow-placing algorithm needs to be able to access and interpret. The list of anchor points that infixes look at in order to determine their landing site falls into two categories: edge-oriented and prominence-oriented. For the left edge for example, documented situations are "after the first consonant (or consonant cluster)", "after the first vowel", "after the first syllable" and "after the second consonant". Prominence-based attractors are stressed vowels, stressed syllables or stressed feet.

An example discussed by Samuels (2009a:179ff) is Tzeltal (Maya) intransitivisation whereby a verb is made intransitive by infixing an *-h-* after the first vowel: compare *puk* "to divide among" with *pu-h-k* "to spread the word", and *kuč* "to carry" with *ku-h-č* "to endure". The representation of this operation with directed graphs is as under (22) below.

(22)
$$\begin{tikzcd} & & & h \arrow[d] & \\ \# \arrow[r] & p \arrow[r] & u \arrow[r] \arrow[ur] & k \arrow[r] & \% \end{tikzcd}$$

It is to be noted that since its original implementation, Raimy's system has changed labels in Raimy (2003) and Idsardi & Raimy (forth): loop-containing representations are now called morphophonology (instead of phonology), and representations from which loops have been eliminated run under the label of phonology (instead of phonetics). This leaves the workings of the system unaffected, but does away with the idea that phonology can handle non-linear structure. In other words, like all other approaches, the relabelled version of directed graphs holds that the input to "true" phonological computation, i.e. the one that phonologists call phonology and from which concatenation is absent, is strictly linear.

61 5. Morpho-syntax has no bearing on the content of phonological computation

62 5.1. Morpho-syntax alters the application of phonological instructions, rather than the instructions themselves

An important generalisation regarding the interface is that whatever morpho-syntax does to phonology, it is unable to create, to suppress or to modify phonological processes. That is, phonological computation exists independently of morpho-syntactic computation and of any procedural or representational agent thereof. It is not phonological instructions themselves that are impacted by extra-phonological information: rather, it is their *application* that may be altered by morpho-syntax.

On the procedural side, of course, there is no influence on the content of phonological computation: procedural influence on phonology is achieved by the successive submission of growing chunks of the whole to an invariable phonological computation. This may produce opacity effects but leaves the phonological computation alone with the vocabulary items that are the result of the spell-out of morphemes.

In the case of representational communication, some carriers of morpho-syntactic information that are not part of the morphemic endowment (juncture phonemes, hash marks, prosodic constituency) have been added to the input to phonological computation. These carriers may then modify the application of the phonological computation (as compared with a situation where they are absent). The computational system itself, however, i.e. the set of instructions (the rule inventory and ordering, the constraint inventory and ranking etc.), remains unaltered.

63 5.2. Empirical reflects

Empirically speaking, the effect of this division of labour is that nobody has ever seen a phonological process that is active in a certain morpho-syntactic environment (or in mono-morphemic strings), but not in others. It does happen frequently, of course, that processes are blocked (or triggered) in a specific morpho-syntactic environment, and this may have procedural as much as representational reasons (e.g. affix class-based phenomena, see BlueVol §§163, 166). This does not mean, however, that the content of the phonological computation was modified: rather, pieces thereof are made inapplicable (or applicable).

Also, nothing withstands the existence of distinct computational systems, which may either be morpheme-specific (level 1 vs. level 2 in Lexical Phonology BlueVol §148, co-phonologies BlueVol §478, indexed constraints BlueVol §482) or chunk-specific (lexical vs. postlexical in Lexical Phonology, BlueVol §234). What was said in the previous paragraph is only true for phenomena that fall into the competence of a given computational system. Or, put differently, the properties of phonological computation themselves remain unmodified, whatever morpho-syntactic influence comes to bear. This holds true in all theories, including those that accommodate several mini-phonologies.

64 5.3. Complete if tacit agreement across all theories

As far as I can see, the inalterability of phonological instructions in the face of morpho-syntactic information is entirely consensual across all theories and protagonists over the 70 years of interface literature that are covered in

Scheer (2011a). That is, all theories have attempted to reduce morpho-syntactic influence to procedural and/or representational influence along the lines described. Although it is a logical possibility, nobody has thought of modifying the phonological computational system according to morpho-syntactic contexts.

One could imagine for example a rule k → t͡ʃ / __i,e (or the equivalent constraint set) to be changed into k → t͡s / __i,e at a certain suffix boundary. Another way to alter phonological computation would be to add a rule (or a constraint) when some morpho-syntactic division is run through the phonology. Nobody has ever attempted to do that: morpho-syntax influences the application of pre-existing phonological computation (by blocking or triggering processes), but it does not create or modify it.

65 5.4. The inalterability of phonological instructions follows from modularity

The fact that the definition of the properties of phonological computation is an exclusively phonological matter on which morpho-syntax has no bearing follows from modularity: morpho-syntax (or morphology and syntax) and phonology are distinct computational systems that work on distinct vocabulary (domain specificity). The only way for modules to talk to each other is through the exchange of their respective outputs. The output of modules, however, is structure, not computation. Therefore the respective computational systems that modules are made of live in complete autarky and could not possibly bear on one another.

The generalisation at hand is probably too obvious to arouse specific concern in the literature: I have not come across any text that makes an explicit statement regarding the issue. The fact that it follows from modularity is certainly a good point for this theory of cognitive organisation.

66 **6. Translation in structuralist and generative interface theory**

67 6.1. Interface design was done in absence of a modular/cognitive background – but translation has always been practised

We have seen that translation is obligatory on modular assumptions: whatever information morpho-syntax wants to be carried by an item that phonology can make reference to, this item must be the output of a translational process.

This Cognitive Science context was entirely absent from interface theory until very recently, and today still is in some quarters. Structuralists for sure were not working with a cognitive background. By contrast, generative linguistics and its interface architecture are an application of cognitive/modular ideas to language: Noam Chomsky actively participated in the computational movement that, following the Turing - von Neumann programme, founded Cognitive Science in the 50s (§33, BlueVol §§603, 623). This notwithstanding, as far as I can see there is no identifiable and explicit footprint of modular ideas when it comes to translation, perhaps beyond a general sympathy for modularity.

Generative phonology has violated modularity/translation on a number of occasions (including SPE, see §75 below, BlueVol §§95, 702), and with the exception of the work by Charles Reiss, Eric Raimy and colleagues (see BlueVol §587, note 148), I am not aware of any explicit mention of modularity in the older (or even more recent) literature that would have been used in order to impose translation. What is more, there are two cases where modularity would have been a decisive referee in ongoing debate, but was not used in the literature of the time: Indirect Reference (§§23, 85, BlueVol §414) and interactionism (BlueVol §680).

What I want to say is that in spite of what appears to be a complete absence of modular background in the operational design of interface theories, translation has always been present. Modularity, then, appears to be some kind of cognitive post-hoc confirmation of what linguists have always done anyway – to which degree and with what kind of exceptions is discussed below and in §§75, 78 below (§75 is specifically on generative modularity offenders).

68 6.2. The birth and variable incarnation of diacritics

69 6.2.1. Juncture phonemes and SPE-type boundaries: diacritic translation and various degrees of camouflage

Structuralism has tried to make the carrier of morpho-syntactic information a truly phonological object that has got nothing to do with morphology (BlueVol §§59, 61). Juncture phonemes were the result of the descriptivism-rooted requirement of Level Independence: the bottom-up discovery procedure did not allow phonology to contain any morpho-syntactic information.

Much effort was put into the camouflage of the extra-phonological identity of morpho-syntactic information: as indicated by their name, juncture phonemes were supposed to be phonemes, that is truly phonological objects.

SPE basically does the same thing, only that the phonological currency has changed: phonology is now made of segments (rather than of phonemes), which means that boundaries are [-segment] segments (BlueVol §87). The generative camouflage is not really less outlandish than its structuralist predecessor: # is not any more a segment than it is a phoneme. The unwarranted consequences of its alleged segmental status were made explicit early on, namely by Pyle (1972) (see BlueVol §136).

The real difference with the structuralist strategy is the admitted hybridity of the carrier of morpho-syntactic information. Instead of denying the morpho-syntactic origin of boundaries, the generative perspective organises its identity as a morpho-syntactic agent in phonology (see BlueVol §§90f). Boundaries are thus supposed to be truly phonological units (i.e. segments) and carriers of morpho-syntactic information at the same time.

The masquerade, however, was entirely transparent right from the start: unlike in structuralist theory where the phonemic status was given real credit (see BlueVol §701), hardly anybody took the [-segment] camouflage seriously. The naked # was taken for what it really is in all phonological quarters: a unit whose only purpose is to store and release morpho-syntactic information.

70 6.2.2. The abandonment of Level Independence makes boundaries diacritics

A direct consequence of this evolution is the emergence of the diacritic issue: if nobody believes that boundaries are segments, they must be non-phonological objects – diacritics (see §95 below for a definition of this notion).

The legalisation of morpho-syntactic information in phonology has thus prompted the diacritic issue – which is here to stay. The question what arbitrarily chosen symbols have got to do with phonology, or why phonology, but not other linguistic modules, should have them, is a major concern in interface theory since SPE and until the introduction of prosodic constituency in the early 80s, which is (wrongly) believed to have solved the problem (see §93).

71 6.2.3. Since structuralism, the output of translation has always been a diacritic

At least since the late 70s, enough discomfort with diacritic boundaries was accumulated (see BlueVol §131) to make the disqualification of diacritics broadly consensual. This, however, does not mean that a better solution was in sight. A radical alternative was to do away with boundaries and to replace them with nothing, i.e. to give up on translation altogether: the result was Direct Syntax (see §§22f, BlueVol §702).

The mainstream, though, replaced linear diacritics (boundaries) by autosegmental diacritics (the Prosodic Hierarchy). Paradoxically enough, the argument which was used in order to promote this move was precisely the idea that diacritics do not qualify (BlueVol §373). The demonstration that the Prosodic Hierarchy is a diacritic just as hash marks are, if an autosegmental one, is undertaken in §93 below.

Since structuralist times and up to the present day, then, the output of translation has always been a diacritic, and the degree of awareness of this fact among the protagonists of the respective theories is variable: high for SPE-type boundaries, choked but sensible for juncture phonemes, completely absent for prosodic constituency.

72 6.3. Modularity and translation were invented by structuralism

73 6.3.1. Non-cognitive modularity: Level Independence enforces translation

The dismissal of Level Independence and hence the recognition that morpho-syntactic information plays a role in phonology is typically quoted when it comes to explain the difference between structuralist and generative theory (e.g. St. Anderson 1985:313ff, Durand 2006:2266, Aronoff 2003).

This is certainly correct – but it spots light only on one side of the coin. Disqualifying Level Independence as a description-based relic of naive structuralist times is nearsighted. For Level Independence also expresses the idea that morpho-syntax and phonology are incommunicado, i.e. that they are two distinct ontological entities – exactly the insight of modularity.

Structuralist practice was then to circumvent the prohibition to use morphological information in phonology by its translation into a truly phonological object – a (juncture) phoneme. This gross camouflage may be sniggered at from hindsight. But this would fall short of structuralist thinking (BlueVol §§72, 415). Willingly or unwillingly, consciously or not, structuralists were the first linguists to translate morpho-syntactic into phonological vocabulary. And it was Level Independence that forced them to do so.

Level Independence and ensuing translation may therefore be considered the birth of modular thinking in linguistics, albeit on grounds that have got nothing to do with a cognitive perspective.

74 6.3.2. Translation affords the assessment of phonological theories according to their behaviour at the interface

Interestingly enough, structuralist translation was far more serious than subsequent translational attempts. For the output identity – a phoneme – was taken seriously: as all other phonemes, juncture phonemes had to enjoy free distribution (and hence independence from morpho-syntactic divisions, see BlueVol §§66f), and they had to have a phonetic correlate (BlueVol §70). That this led to absurd results (juncture abuse, see §143) is all to the good: it falsifies a phonological theory that is based on this particular kind of translation.

This opens the possibility for phonological theories to be assessed (or falsified) by their behaviour at the interface – if only the arbitral award of the interface is taken seriously. That is, when the specific vocabulary of a given phonological theory makes outlandish predictions, if translation is not given up on and if diacritics are not a possible output of translation, it may be concluded that the vocabulary (phonemes, segments, autosegmental trees) is not appropriate: the *phonological* theory in which this vocabulary originates needs to be modified. This line of reasoning is central for Direct Interface: it is pursued in §§151, 154 below (see also BlueVol §138).

An example are hash marks in SPE. Pyle (1972) and Rotenberg (1978) pointed out their absurd consequences (BlueVol §131). Had this critique been taken seriously, phonologists would have been forced to change the then current phonological theory. That is, the outlandish behaviour of # at the interface would have enforced the conclusion that segments, of which # was supposed to be a sub-species, are not the adequate interface currency. In other words: there must be something else than just segments in phonology: autosegmental representations.

75 6.4. Generative modularity offenders: reference to untranslated morpho-syntactic information

76 6.4.1. Translation was not a standard in generative theory until the mid 80s

When talking about translation in SPE, the diacritic character of boundaries is only a minor problem when compared to the systematic offense that is made to modularity. SPE freely allows for the presence of untranslated morpho-syntactic information in phonology: both morpho-syntactic structure (i.e. brackets) and its labels (NP, VP etc.) are constantly available in untranslated guise (see §101 below, BlueVol §95). The former, however, are only there to run inside-out (i.e. cyclic) interpretation: phonological rules cannot refer to brackets (§105 below, BlueVol §97).

SPE thus provides for both translated (boundaries) and untranslated (morpho-syntactic labels) reference to morpho-syntactic information. Also note that there was no clear rationale for a division of labour: should a given phonological rule make reference to morpho-syntactic information rather in translated or in untranslated form?

In the late 70s, the post-SPE practice led to a general frustration regarding the diacritic issue (BlueVol §131). In recognition of the problems that piled up, some voices called for the complete elimination of translated information (boundaries) in favour of direct reference to morpho-syntactic categories. This strand condensed in the 80s under the header of Direct Syntax approaches and became the major rival of Prosodic Phonology, whose founding statement is Indirect Reference (§§23, 85). Since the late 80s, this principle – the ban on any untranslated reference to morpho-syntactic information – has become the baseline of generative interface theory on the representational side.

77 6.4.2. Turning back the wheel: weak and strong modularity offenders in (more or less) recent development

Hence it is only since the advent of Prosodic Phonology in the 80s that generative theory meets the standards that were set by structuralist Level Independence, and later on by modularity. In this sense, structuralism was far more generative than SPE, and it took generative phonology twenty years to catch up with the modernity of Level Independence.

More recently, however, the clear modular waters of Indirect Reference are muddied again by a number of approaches that allow phonology to make reference to untranslated morpho-syntactic information. These fall into two kinds: on the one hand those that work on a modular basis where morpho-syntax and phonology are clearly distinct ontological spaces and computational systems, but allow for direct reference to morpho-syntactic information (weak offenders). On the other hand, there are approaches where the existence of distinct computational systems is either unclear or overtly denied (strong offenders).

Weak modularity offenders include SPE, the Direct Syntax approaches of the 70s and 80s and more recently van Oostendorp's Coloured Containment (BlueVol §503). Strong modularity offenders are OT as a whole (BlueVol §§469, 523) and Distributed Morphology (DM). In DM, PF movement is incompatible with modularity because it supposes that a computation simultaneously accesses morpho-syntactic and phonological vocabulary (BlueVol §§574, 580), and current analyses also interleave PF operations such as linearisation with phonological rules (BlueVol §739). In OT and DM the existence and/or the contours of distinct modules is unclear. They are denied altogether in Sign-Based Morphology, an outgrowth of HPSG (BlueVol §512).

The OT-trope to scramble all linguistic facts into one single constraint ranking is probably not unrelated to its connectionist roots (BlueVol §529): connectionism is an all-purpose computational theory that makes content-unspecificity a programmatic claim (see §32, BlueVol §§597f). The heart of modularity, however, is domain specificity, i.e. the claim that each computational system works on a specific vocabulary.

Also, PF as conceived of in certain versions of minimalist syntax is a strong modularity offender (independently of the issue regarding PF Movement that was mentioned above). In PF, syntactic-looking operations are carried out because they displease in narrow syntax (clean syntax, dirty PF). On the consensual assumption that Vocabulary Insertion occurs upon spell-out of narrow syntax, PF (or the subset of PF that excludes what phonologists call phonology) is an ill-defined intermundia where computation needs to simultaneously access morpho-syntactic and phonological vocabulary – a violation of domain specificity (BlueVol §§738, 747).

Finally, the diacritic issue also violates modularity, if in a much weaker sense: we have seen that all generative (and non-generative) theories to date propose diacritics as an output of translation, and that this is incompatible with domain specificity (§43: diacritics do not belong to the domain-specific vocabulary of phonology and hence cannot be parsed).

78 7. What is translated: only information that is used or everything, including irrelevant noise?

79 7.1. Phonology only uses a small subset of morpho-syntactic information

It is an undisputed fact that only a small subset of the available morpho-syntactic information is actually relevant for phonology: most of it has no phonological effect at all. As far as I can see, this basic observation was first formulated by Chomsky *et al.* (1956), who conclude that phonology is underfed by translational activity (BlueVol §79).

(23) "Since junctures are introduced for the purpose of reducing the number of physical features that must be recognized as phonemic, we do not require that every morpheme boundary be marked by a juncture. […] Only those morpheme boundaries are marked by a juncture where actual simplifications in the transcription are achieved. In other words, junctures are postulated only where phonetic effects can be correlated with a morpheme boundary." Chomsky *et al.* (1956:68)

Chomsky *et al.* (1956) thus argue for the *privative* representation of morpho-syntactic information in phonology: if only a small subset of morpho-syntactic information is used, the translational device has fed phonology only with this subset – phonologically irrelevant information has never been translated and is thus absent from phonology.

It is shown in the following section that in spite of this basic observation, SPE reverts back to non-privative translation. Like most other architectural properties of SPE, this stance then abides in all subsequent interface theories. That is, full morpho-syntactic information is shipped to phonology regardless of whether it will be used or not. Phonology then appeals to whatever is relevant for its computation; finally, irrelevant information, which is present in form of SPE-type boundaries or prosodic constituency, is either erased by phonological action (as in SPE), or just sits in phonology and remains inert (as in Prosodic Phonology) (more on this kind of "sleeper" in §155).

80 7.2. Unanimous non-privative translation since SPE

The position of individual theories in regard of privative translation is as follows. Structuralists such as Moulton (1947) use "+" in order to anchor the beginning and the end of each word in the phonemic transcription, irrespectively of whether it will have an effect or not (BlueVol §64). The rigid mapping mechanism of SPE also sends all edges of major categories and higher projections thereof to the phonology without discriminating between those that will and those that will not be used (§§102f). That is, the "syntactic" # boundary restores full morpho-syntactic information in phonology: the syntactic distance of two neighbours in the linear string is a direct function of the number of intervening #s. The input to phonological computation is thus a string made of lexical items and clusters of hash marks. After the application of phonology, remaining hash marks are erased by rule at the end of the derivation.

In the 70s, the non-privative heritage of SPE has prompted the need to distinguish between those boundaries that are phonologically relevant and those that have no phonological function. The former have sometimes been called "phonological", the latter "morpho-syntactic" (Devine & Stephens 1976:286f, 1980:75, see BlueVol §132) – a misleading distinction since a "phonological boundary" is a contradiction in terms.

Lexical Phonology is also on the non-privative side, at least those versions that use Mohanan-type brackets, which mark the beginning and the end of every morpheme in phonology, and to which phonological rules may make reference (Mohanan 1986, BlueVol §§168f).

Prosodic Phonology promotes non-privative translation as well, even if it is true that not all morpho-syntactic information is projected onto phonology (the Translator's Office makes readjustment decisions, see §§85, 103 and the discussion of non-isomorphism in §134, BlueVol §§380, 416). Non-privativity in fact is a by-product of the Strict Layer Hypothesis (BlueVol §383): all strings are exhaustively parsed at all prosodic levels independently of whether or not there is an associated phonological effect. That is, the full six-layered prosodic constituency is always constructed no matter whether there is evidence for particular divisions or not (see §87, BlueVol §§383, 400).

Finally, models that implement Direct Syntax also stand on the non-privative side: van Oostendorp's (2006) Coloured Containment and Orgun's (1996 and following) declarative sign-based morphology allow phonology to directly see and refer to all elements of morphological (and syntactic) structure (see BlueVol §501). Bermúdez-Otero (forth :21ff) discusses this approach in greater detail; he calls Orgun's view on the matter isomorphism (of morphological and phonological structure).

81 7.3. Four arguments in favour of privative translation

Privativity is not a notion that ranks high among the issues that interface theories manipulate consciously. I have not come across any case in the literature where it is named and argued for or against. This is much unlike the situation in melodic representations where privativity is the major front-line that sets apart those theories which use binary primes from those that rely on monovalent/unary primes.[14]

Nonetheless, (non-)privativity of translation is a fundamental design property that contrasts competing approaches, especially in a minimalist environment where representational and computational economy matter. For this architectural reason, but also for four others that are discussed below, there is good reason to believe that translation is privative.

Argument 1
Non-diacritic outputs are necessarily privative: the Direct Effect
If the output of translation is non-diacritic, translation must be privative. This point is made in greater detail in §155 below: diacritic morpho-syntactic information is always accessed by a specific proviso in the formulation of phonological instructions (constraints or rules) of the kind "only within the prosodic word", or "if a hash mark precedes". A hash mark or a prosodic word alone are perfectly inert: they are "sleepers" that have no effect unless they are called on by a specific mention in a computational statement. By contrast, if non-diacritic, i.e. phonologically meaningful objects are the output of translation, they have an immediate effect on phonological computation without needing to be referred to by computational statements. This is what I call the Direct Effect (see §154, Scheer 2009a,c). In turn, this means that every single object that is inserted into a phonological representation as the output of translation will have an effect: inserting a "sleeper" is impossible. Therefore, if carriers of morpho-syntactic information are to be non-diacritic, their distribution is necessarily privative.

[14] Binary approaches are standard since Jakobson and SPE; the privative alternative was introduced by Anderson & Jones (1974) and then implemented in Dependency Phonology (Anderson & Ewen 1987), Government Phonology (Kaye *et al.* 1985) and Particle Phonology (Schane 1984).

Argument 2
Why carry around useless things?
The second argument concerns the bare observation that only a small subset of morpho-syntactic information is phonologically relevant. This fact at least puts the burden of proof on those who wish to argue for non-privative translation. Why should the grammatical system bother putting the translational mechanism to work in order to translate things that will never be used? And why should useless structure (boundaries, prosodic constituency) be built and carried around on the phonological side?

The minimalist philosophy is certainly privative. GB syntax in the 80s was full of useless structure: functional categories were built regardless of whether they would be relevant or not. The minimalist perspective is privative: phrase structure is only built when it serves a purpose in the derivation. Minimalist privativity is the result of a concern for extra-linguistic resources such as active memory, which non-privative structure wastes (BlueVol §304).

Also, phonological representations were present in the syntactic derivation in GB: they were carried around in so-called "sealed suitcases", which were opened only once the derivation had reached phonology. Sealed suitcases are also done away with in minimalism and namely in Distributed Morphology (§49): Late Insertion assures that only morpho-syntactic vocabulary is present during morpho-syntactic computation – phonological representations (Vocabulary Items) are only inserted when the morpho-syntactic derivation is completed and terminals (or bigger pieces of the tree) are transformed into phonological material (through Vocabulary Insertion).

Argument 3
Procedural communication: selective spell-out is also privative
Along the same lines but on the procedural side, Bermúdez-Otero (forth:21ff) discusses the unwarranted empirical consequences of untempered proliferation of cycles. He concludes that selective spell-out is required for that reason. Selective spell-out is the procedural cousin of privative translation (see BlueVol §756): while SPE and Lexical Phonology spell out all morphemically relevant nodes of the morpho-syntactic tree (all morpheme boundaries delineate cycles), Halle & Vergnaud (1987) introduce the idea that spell-out is selective. That is, only a subset of morpho-syntactic nodes is transferred to the phonology: some define spell-out domains, others do not. In modern phase theory, nodes that trigger spell-out are called

phase heads (what exactly is a phase head is a debated question, see BlueVol §773 and §294 below).

Argument 4
Translation is known to be selective in Cognitive Science
The general properties of communication among modules that are known from other cognitive functions are discussed in §§54,179f: two important generalisations are that the information which is made available to the receiving module through translation is only a small and arbitrarily chosen subset of what the sending module offers. Transposed to the representational communication between morpho-syntax and phonology, this means that translation is privative.

Chapter 2
160 Just one channel: translation goes through a lexical access

161 1. Introduction

162 1.1. We know what is translated and how it is inserted, but we do not know how translation works

Chapter one has introduced Direct Interface, which is a theory that takes translation and hence modularity seriously. It also holds that phonologically relevant chunks are defined by cyclic derivation (derivation by phase), rather than by some representational means. Given these premises, Direct Interface defines

– what is translated (only phonologically relevant information)
– what is the output of translation (only pieces of the domain-specific vocabulary of phonology, i.e. non-diacritic objects, which however do not include melody)
– how carriers of morpho-syntactic information are inserted into phonological representations (locally into the linear string at morpheme breaks).

A question that Direct Interface does not comment on is *how* translation works: we know the input, the output and the way the output is inserted, but thus far nothing has been said about how exactly the input and the output are related. This is what the present chapter is about.

It is argued that the classical position which stands unchallenged up to the present day is on the wrong track: translation is not computational in kind; that is, there is no computational system that takes morpho-syntactic structure as an input and produces some phonological object as an output. Rather, translation is done through a lexical access, i.e. with no participation of any computation and just like morpho-syntactic terminals are translated into phonological material (lexical or Vocabulary Insertion).

While reading through the pages below, it needs to be borne in mind what was said in §56 about linearisation: the transition from morpho-syntactic structure to the input to phonological computation involves two major operations, linearisation and translation of non-morphemic (as well as of morphemic) information. The book in general and Direct Interface in particular are only about the latter – they have got nothing to say about the former. If below it is argued for translation via a lexical access, rather than through a specific computation, this leaves the question of how linearisation is done untouched. As was reported in §55, all theories of linearisation that are available on the market are based on a specific computation that creates linear structure. Whether translation may be non-computational while linearisation is computational, or whether there is a workable global scenario whereby the whole of the transition between morpho-syntactic structure and the input to phonology (i.e. including linearisation) is done in a non-computational way, are questions that are left pending.

163 1.2. Only one channel: all phonological material originates in the lexicon

The difference between one- and two-channel translation is this: either phonological material of morphemic (lexical/Vocabulary Insertion) and non-morphemic (boundary) origin is the result of two distinct translational mechanisms, one lexical, the other computational, or all pieces of phonological material are born through the same mechanism, a lexical access. This is what I call One-Channel Translation: all pieces that constitute the input to phonological computation, morphemic and non-morphemic alike, originate in the lexicon as a result of lexical (or vocabulary) insertion.

The elimination of the Translator's Office is thus a perspective that has never been thought of as far as I can see, and hence for sure was never discussed as an alternative to translation by computation.

Besides the unifying perspective that One-Channel Translation offers (all translation is done through the lexicon), it is shown that computational translation is hardly compatible with modular assumptions (§§169, 172). Domain specificity indeed requires that a module can process and understand only one specific kind of vocabulary. Computational engines such as the Translator's Office, however, must be able to read the morpho-syntactic language, and to produce objects that are made of phonological vocabulary. Therefore it is a modular monster, or rather, some kind of Big Brother that can see and read everything in different modules. If the engine that does computational translation is not a module, however, what is it? The modular environment does not provide for computational engines beyond modules.

The present chapter is based on unpublished work by Michal Starke. The modular arguments against the Translator's Office and the request for an interface architecture where all translational work is done by a lexical access are his. More detailed argumentation is to be found in Starke's forthcoming work.

164 1.3. Translation has always been computational, also in theories of other interfaces (e.g. phonology-phonetics)

Recall that in all interface theories, classical or modern, the computational nature of translation is (tacitly) taken for granted and in any case undisputed: SPE's mapping algorithm (§102) and readjustment component (§103, BlueVol §91), Prosodic Phonology's Translator's Office where mapping takes place (§85) and Jackendoff's (1997 and following) correspondence rules (or interface processors more recently, on which more below) all share a computational conception of translation.

Note that this is also the case for theories of other interfaces, such as the one between phonology and phonetics. The model developed by Paul Boersma and Silke Hamann for instance, Bidirectional Parallel Phonology and Phonetics (Boersma 2009, Boersma & Hamann 2008), relates phonology and phonetics by a set of specialised constraints (so-called cue constraints), which thus represent a computational system in their own right.

There is a tradition in Government Phonology, though, where a more list-like mapping between phonological primes and phonetic values is practised: labour that is traditionally done by phonological computation is outsourced to the phonology-phonetics mapping. For example, on Gussmann's (2007) analysis there are three phonologically distinct font mid vowels in Polish, which happen to be all pronounced in the same way, i.e. [ɛ]. This neutralisation is done in the phonology-phonetics mapping through a list of correspondences (the phonological entity X has the phonetic value Y), rather than by phonological computation (see also Scheer 2010b). More detail would lead too far afield. Cyran (forth a,b) provides a good introduction to and valuable illustration of this approach.

165 1.4. Lexical translation imposes restrictions on the output

One-Channel Translation impacts current (phonological) theories of the interface (including Direct Interface) since the kind of phonological object that qualifies as the output of translation is different according to whether translation is computational or lexical. It is shown below that the latter is more restrictive: the phonological objects that it allows for are only a subset of those which can be handled by the former. That is, all objects that transit through a lexical access must be able to be recorded in the lexicon. By contrast, the output of the Translator's Office is not restricted in this way: it may also include objects such as domains that cannot be lexically recorded.

The particular phonological theory that I am committed to, CVCV, is adapted to the requirements of One-Channel Translation and Direct Interface in Part III. This notwithstanding, restrictions on phonological carriers of extra-phonological information that are due to the difference between computational and lexical translation are already made explicit in the present chapter.

166 2. The classical two-channel architecture

167 2.1. Distinct translation of morphemic and non-morphemic information

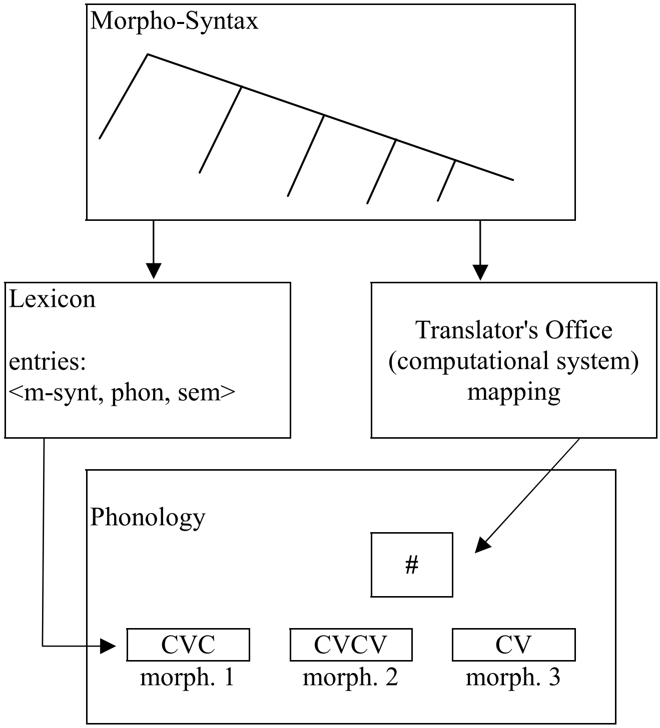
The interface literature systematically reduces the question of translation to the question of how boundary information (i.e. morpho-syntactic information that is not included in morphemes) reaches phonology. The answer has always been: through a Translator's Office (readjustment component, general mapping algorithm, mapping rules etc.).

The presence of "regular" phonological material, i.e. that represents morphemic information and is ready for the insertion of carriers of morpho-syntactic information, is taken for granted. This regular phonological material, however, is also the result of a translational process, i.e. of one that transforms morpho-syntactic terminals into phonological vocabulary. This process is called lexical insertion (or Vocabulary Insertion), and phonologists talk about lexical material, which is at the origin of the phonological derivation. By contrast, due to the computational tradition of translation of boundary information, phonologists do not consider hash marks or prosodic constituents as lexical information, and do not talk about them in these terms.

The existence of lexical (vocabulary) insertion is undisputed, and nobody doubts that the phonological exponent of morphemes comes into being through a lexical access. The translation that the (phonological) interface literature is about, however, only concerns the kind of morpho-syntactic information that does not ride on morphemes, i.e. which is "added". That is, boundary information materialises as phonological objects that represent morpho-syntactic information, but do not belong to any morpheme.

In presence of the translation that is done by lexical insertion, the terminology that was used thus far is inappropriate: morphemes are as much carriers of morpho-syntactic information as are boundaries. Only do the former carry morphemic information, against the latter which transport non-morphemic information.

(49) translation in generative interface thinking



The classical picture that is represented by SPE, Prosodic Phonology and Jackendoff's work thus needs to be completed: phonological objects have two different origins and two different derivational histories. Looked at from the vantage point of phonology, morphemic material originates in the lexicon: its is the result of a lexical access that has translated morpho-syntactic into phonological vocabulary. By contrast, boundary information originates in the Translator's Office, where translation is done through computation. The Translator's Office does not access any lexicon in order to insert an object into the phonological string; rather, it makes sovereign decisions that determine the correspondence between morpho-syntactic information and phonological objects (the readjustment component in SPE, the Black Box and non-isomorphism in Prosodic Phonology, see §§85, 103).

Table (49) above provides the complete picture of how translation is thought of in the generative tradition: morpho-syntactic information is translated into phonological material through a lexical access for morphemic information, but through a computational system for boundary information.

Note that "#" is shorthand for any kind of boundary information (juncture phonemes, hash marks, prosodic constituency or some other kind of item), which is "added" to the morphemic material.

168 2.2. Spell-out and linearisation

The existence of a spell-out mechanism is undisputed. Spell-out is responsible for the translation of morphemic information: its job is to produce a linearised sequence of phonological material on the grounds of the morpho-syntactic tree.

This is done by the arrangement of certain chunks of the arboreal structure (terminals and eventually non-terminals) into packs that phonologists (and others) call morphemes. These morpho-syntactic packs, or pieces of the morpho-syntactic tree, are then transformed into phonological material through a lexical access: the lexicon contains arbitrary correspondences of morpho-syntactic, semantic and phonological information. Hence for each morpho-syntactic pack, or portion of the tree, the lexicon provides the associated semantic and phonological material. This is how translation of morphemic information works, and the output of the lexical access is sent to PF/LF for interpretation.

There are several ways of either packaging the morpho-syntactic tree into morphemic shape or spelling out entire portions of the tree. The former is the way that Distributed Morphology goes about spell-out (fission, fusion, impoverishment: e.g. Halle 1997, Embick & Noyer 2007, Arregi & Nevins (2012), BlueVol §§536, 538, 733), while the latter option is argued for in nanosyntax (Starke 2009, Caha 2009).

How spell-out exactly works is irrelevant for the present discussion as long as it is agreed that there is such a device, and that it operates via a lexical access whereby pieces of morpho-syntactic structure are matched with pieces of phonological material in arbitrary fashion.

A related issue, linearisation, is discussed in §55 and §162.

169 3. Lexical vs. computational translation

170 3.1. The Translator's Office cannot be a module: it is a Big Brother

The two boxes that output phonological objects under (49) are very unlike each other. The lexicon does not perform any computation, does not make any decisions, and knows nothing about either morpho-syntax or phonology – in fact the lexicon does not even know that these modules exist. By contrast, the Translator's Office carries out its own computation, makes decisions and has direct access to the content of both morpho-syntax and phonology: it can read and understand the vocabulary that is used in both modules, and it translates one into the other.

Given these properties, neither the lexicon[29] nor the Translator's Office could be a module. Modules are computational systems (see §30), but there is no computation in the former. The latter does not have any (domain-)specific vocabulary of its own, but is able to look into two distinct modules, whose vocabulary it can understand and parse. This is incompatible with domain specificity, a necessary modular property: modules operate on homogeneous and specific vocabulary (§43), and they cannot understand the language (vocabulary) of other modules – this is why translation is necessary in the first place (§31).

Although they do the same job, i.e. the translation of morpho-syntactic information into phonological material, the lexicon and the Translator's Office thus are very different: the latter has Big Brother qualities (it sees and understands everything), while the former is autistic (it sees and understands nothing).

[29] Distributed Morphology distinguishes three kinds of lists (e.g. Embick & Noyer 2007:300f): the so-called encyclopaedia, a morpho-syntactic lexicon that accommodates morpho-syntactic features and feeds morpho-syntactic computation, and a "phonological" lexicon that associates phonological material (vocabulary items) to morpho-syntactic units. The latter is accessed upon Vocabulary Insertion (lexical insertion), and "lexicon" here is shorthand for this list.

171 3.2. What is computational translation good for?

The question is whether grammar really needs two non-modules that do the same job. Nobody doubts the existence of a lexicon. On the other hand, there is only one argument for the computational character of the translation of boundary information that I have come across: readjustment or, in the terminology of Prosodic Phonology, so-called non-isomorphism. Since SPE, it is admitted in generative theories of the representational management of the interface that at least in some cases, the output of morpho-syntax may not be ready for use in phonology: some information may be missing, or may not be derivable from morpho-syntactic structure. The example that runs through the literature since SPE is about cats, rats and cheese (see §§103, 134).

In this perspective indeed, doing translation involves decision-making – something that the lexicon for sure is unable to do. Non-isomorphism is thus a good argument for computation-based translation. It was shown in §134, however, that non-isomorphism is a fact about the domain-based bias of SPE and Prosodic Phonology, rather than about language: it evaporates as soon as representational intervention in phonology is local.

This obstacle being out of the way, there is no reason left why the lexicon could not do the translational job also for non-morphemic information. It certainly has a better prospect than the Translator's Office, which does not qualify as a module. While it is not clear what kind of status a Big Brother could have in a modular environment, the status of a lexicon is obvious and unproblematic.

There is good reason, then, to admit the lexicon as a serious competitor for the translation of boundary information: translation in grammar would be unified, and a strange Big Brother eliminated. On the backdrop of Jackendoff's model, the following pages therefore inquire on the properties of non-morphemic translation. The goal is to see whether they line up with what we know from regular lexical storage, and the answer will be yes: the translation of boundary information bears the signs of lexical activity.

172 4. Jackendoff's model of translation (in language and elsewhere)

173 4.1. Jackendoff's computational translation makes generative practice explicit

In order to find out about the properties of translation, it is useful to look at Ray Jackendoff's (1992, 1994, 1997, 2002) work on modularity, which used to be called Representational Modularity, but now runs under the header of Structure-Constrained Modularity.[30]

For one thing, Jackendoff is a linguist and looks at modularity from this perspective. But in his work he also takes a closer look precisely at what we are after: how intermodular communication works.

Finally, Jackendoff's computational view of translation has the merit of making generative practice explicit. Computational translation was timidly implemented in SPE where hash marks were translated by a non-computational means (a fixed algorithm that always produces the same result for a given input, §102), but a readjustment component (§103) allowed for computational transformations at the interface that became the backbone of the architecture of Prosodic Phonology in the 80s. In this theory, then, translation is exclusively computational, and this is overtly advertised under the header of non-isomorphism (§85): the Translator's Office becomes the central translational device.

174 4.2. Does encapsulation make intermodular communication impossible?

Jackendoff (2002:218ff) introduces his model on the backdrop of the critique that the classical Fodorian framework leaves intermodular communication unexamined. Jackendoff therefore calls for a more detailed inspection of the Fodorian frame, which he believes is correct but too coarse-grained. He argues that not only Fodor (and typically the modular literature) says nothing about how modules talk to each other, but the Fodorian notion of informational encapsulation (see §44) also leads to a dysfunctional system if interface modules dot not de-insulate regular modules. That is, modules could neither receive any input nor communicate their output to other modules or to the central system, were there no interface: "the pres-

[30] Jackendoff (2002:20) explains that "representation" (and also "symbol"), should not be used for the description of cognitive structure since these terms suggest intention.

ence of an interface between two levels of structure is what makes them *not* informationally encapsulated from each other" (Jackendoff 2002:229, emphasis in original).

Jackendoff thus worries about the fact that the Fodorian notion of informational encapsulation is too strong and makes intermodular communication impossible. It is useful to point out that this is a peculiar understanding of encapsulation: Jackendoff (2002:219) himself explains what Fodorian encapsulation means: once an input is submitted to a module, its computation starts and produces a result on nothing but the grounds of this input. That is, no alien information that is absent from the input can interfere or "break into" the computation, and no intermediate result can leave the module. In syntax, encapsulation is called inclusiveness (see §44).

Encapsulation is thus about what happens (or rather: what cannot happen) *during* modular computation. What Jackendoff is after, on the other hand, is what happens *before* and *after* modular computation: he seems to hold encapsulation responsible for the inability of modules to communicate with other parts of the mind. This is not the case, though: the reason why modules cannot directly communicate with other modules or central systems is domain specificity, i.e. the fact that computation is symbolic and hence based on a proprietary vocabulary (§43).

175 4.3. Translation is done by computational systems with modular status

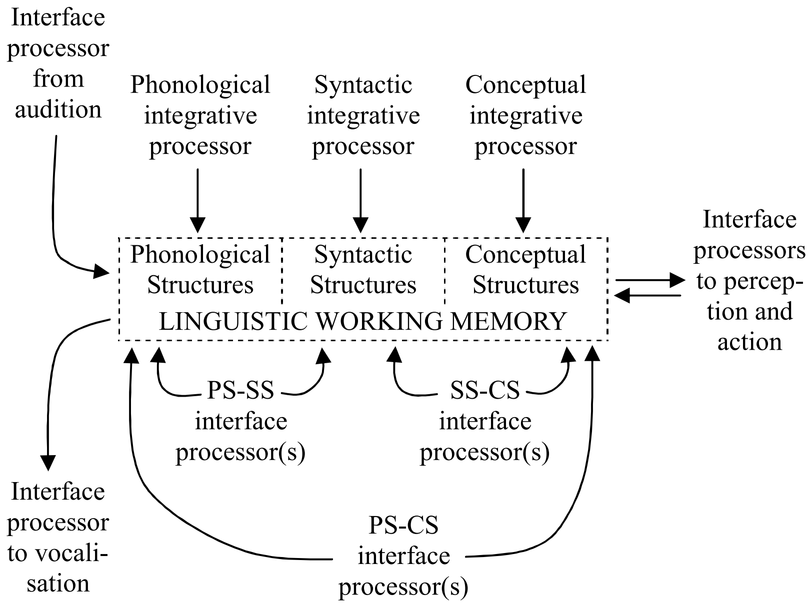
Jackendoff's purpose is thus to introduce the possibility for a module to communicate with the rest of the mind. On the face of it (but see below), he accepts domain specificity and hence needs to set up a translational mechanism between two distinct languages (of the mind). He is explicit on the computational nature of the translational process: "it is not like sending a signal down a wire or a liquid down a pipe. It is, rather, a computation in its own right, just the kind of computation that an interface processor performs" (Jackendoff 2002:223).

The interface module relates two regular modules by accessing their content simultaneously and transferring information from one to the other – much along the lines of the Translator's Office of Prosodic Phonology. Jackendoff (2002:223, note 19) is explicit on the modular status of the computational system that carries out translation. The problem that its Big Brother qualities conflict with domain specificity is not discussed.

Jackendoff thus promotes a general modular architecture of the mind where three types of modules (which he calls processors) are active: inferential processors (Fodor's central system, i.e. which construct inferences and judgments, §38), integrative processors (Fodor's domain-specific modules, e.g. colour recognition, paucal counting, phonology, syntax etc.) and interface processors. Integrative processors are related by interface processors, which also assure the communication with central systems (inferential processors).

The modular structure that Jackendoff (2002:199) proposes for language in this general environment is shown under (50) below.

(50) modular structure of language according to Jackendoff
(reproduction of Jackendoff's 2002:199 diagram)



The following section examines how Jackendoff's interface processors work.

176 4.4. Jackendoff's computational translation is all-powerful and unconstrained

In Jackendoff's modular architecture (which is designed for language as much as for other cognitive functions), the description of how intermodular communication works is not very detailed. This is simply because Jackendoff considers that it is entirely unconstrained: translation among different languages of the mind can do everything that needs to be done for the information flow to work, and must not be limited in any way. His position in this respect has not varied for twenty years: interface processors appear as translation rules in Jackendoff (1987), and as correspondence rules in Jackendoff (1997).

Jackendoff explicitly defends all-powerful translation against the critique of overgeneration, i.e. the fact that unconstrained transmission of information allows for the description of existing as much as of non-existing interface activity.

(51) "[C]orrespondence rules are conceptually necessary in order to mediate between phonology, syntax, and meaning. It is an unwarranted assumption that they are to be minimised and that all expressive power lies in the generative components. […] In other words, correspondence rules, like syntactic and phonological rules, must be constrained so as to be learnable. Thus their presence in the architecture does not change the basic nature of the theoretical enterprise." Jackendoff (1997:40)

The quote also shows that Jackendoff conceives of correspondence rules in the same way as of phonological or syntactic processes: translation is modular computation. Given the modular status of translation, the only restriction that Jackendoff admits is learnability.

177 4.5. Bi-domain specificity and partial homology

A direct consequence of the computational and hence modular status of translation is what Jackendoff calls bi-domain specificity in his 2002 book (Jackendoff 2002:220ff).

In his 1997 book, he provides the following description of correspondence rules: "correspondence rules perform complex negotiations between two partly incompatible spaces of distinctions, in which only certain parts of each are 'visible' to the other" (Jackendoff 1997:221). Hence interface processors have only access to a subset of the structure that is present in either of the two modules that are related.

The amount of structure that is visible for interface processors in a given module may be small or big, and this is unpredictable (see §54): the translational channel between two modules may have a more or less narrow "information bottleneck" (Jackendoff's 2002:229 term). In his idiosyncratic use of the notion of encapsulation (which merely refers to the ability of modules to communicate with each other, see §173), this means that the informational encapsulation of (integrative and inferential) modules (i.e. their autism) is relative: they may be more or less encapsulated, and this depends on the permeability of the relevant interface processor.

In this sense, thus, interface processors define their own domain of competence, which is composed of a subset of the structure of each module that they relate. Jackendoff (2002) is consistent in his use of the word "module" in order to refer to interface processors: as all other (integrative) modules, they operate over a specific domain – only is this domain not proprietary, but composed of pieces from other modules. Hence Jackendoff's term of bi-domain specificity, from which he also infers that one should talk about "partial homology", rather than about translation.

178 4.6. Bi-domain specificity seals the fate of domain specificity

Bi-domain specificity is the exact opposite of domain specificity: it declares that modules – but only a specific kind thereof, i.e. those that do translation – may be specific for two domains, rather than for just one. What domain specificity requires, however, is that modules be specific to just one domain (§43). Bi-domain specificity is thus a contradiction in terms or, in other words, an attempt at selling non-modules in a modular guise.

Saying that modules can only parse their own vocabulary and that this is how we recognize them, except that some of them may as well be able to parse several distinct vocabularies, is meaningless and seals the bankruptcy of the entire modular idea.

Jackendoff is aware of this contradiction, but tries to discuss away the facts by saying that mentioning them is cynical: after having introduced his idea of "degrees of modularity" (an object is more or less modular according to the width of the channel that relates it to other modules), he writes that "a cynic might say therefore that the issue of modularity is dissolved. I would disagree" (Jackendoff 2002:229). There is no further argument, though, and Jackendoff does not explain what the definition of a module looks like when objects that violate domain specificity may be declared modules on the basis of a terminological amendment that adds "bi-" to a concept whose purpose is precisely to exclude this "bi-".

179 4.7. Translation is arbitrary: Jackendoff's claim is well supported by language

Jackendoff's self-contradicting understanding of domain specificity set aside, he identifies two interesting properties of the translational process: selectiveness (or arbitrariness), i.e. the fact that any structure of the input module can be translated into any structure of the output module, and the fractional character of translation, i.e. the fact that only a subset of the structure of each of the two modules that are related is visible for the translator (§54).

This is precisely what practitioners of the interface of morpho-syntax with phonology have observed. The so-called mapping puzzle is a pervasive property of the interface that escorts the reader through all interface theories (see Scheer 2011a): all efforts at finding cross-linguistic patterns of translation have been by and large vain. That is, phonologists could not come up with natural classes of boundaries (see BlueVol §753 for a summary).

Facing this seemingly unlawful behaviour of the interface, the field has tried to produce detailed descriptions of individual languages in the 80s and early 90s (with the tools of Prosodic Phonology), but when cross-linguistic generalisations failed to emerge has lost interest. From the mid 90s on, the literature on mapping has moved from the study of untameable morpho-syntactic to other factors such as information structure and eurhythmy (see BlueVol §463).

In sum, then, it may certainly be said that Jackendoff's point regarding the arbitrariness of translation is well supported by the empirical record from intermodular communication among modules that are concerned with language.

180 4.8. Translation is partial: Jackendoff's claim is again well supported

The same is true for the fractional character of translation: melody and morpho-syntax are fully incommunicado (§124), and morpheme-internal phonological properties are not accessible (§141).

The latter restriction follows from lexical translation, while there is no reason for the morpheme-internal area to be excluded from interface activity if translation is computational. In case the translational device is the lexicon, indeed, the output of translation must be a lexical entry. In this perspective, the linear string that is pieced together in view of phonological computation is simply the concatenation of a number of lexical entries, among which representatives of morphemes and of boundary information. Therefore there is no way for the latter to be inserted in the middle of morphemes. By contrast, nothing prevents an all-powerful and unrestricted Translator's Office from intervening on any object in the target module: computational translation could well insert an object in the middle of a morpheme.

181 5. Interim summary: translation bears the signs of lexical activity

Let us now compare the two options for the translation of boundary information. Having translation done by a computational system that has modular status but Big-Brother qualities at the same time seals the fate of domain specificity. If modules can parse more than one proprietary vocabulary, the whole concept of modularity dissolves.

On the other hand, the properties of the translational process suggest lexical activity: arbitrary relations of an input and an output and the refusal to obey cross-linguistic lawful behaviour are typical signs thereof. Also, economy militates for the lexical alternative: while translation through a computational Translator's Office requires the creation of a Big Brother unit that is unheard of in the modular landscape (where only modules, lexica and eventually central systems are known), translation through a lexical access uses a resource that exists anyway. It offers a system where all translation is done by the same device and following the same laws.

By hypothesis, then, the lexical access of morphemic and non-morphemic information is done through the same lexicon. The two categories of morpho-syntactic information may have a distinct status on the input side of the translation (the spell-out mechanism may not treat them in the same way), but they are transformed into items of the same vocabulary by the lexical access, whose output pieces together the linear string that is subjected to phonological computation.

There is thus certainly reason to pursue the alternative of One-Channel Translation. The following section discusses how a modular network could look like where modules are related by lexica.

182 6. Intermodular communication through a lexical access

183 6.1. Modules receive variable inputs, but produce a uniform output

We now turn to the properties of modular networks. Modules may draw on information that comes from a range of other modules (many-to-one); conversely, the output of a given module may be used as the input to a range of other modules (one-to-many). Jackendoff (2002:223f) reviews a number of relevant cases.

Let us first look at the latter pattern, i.e. the multiple usage of (different parts of the) structure that is created in a given module. Audition for example is an information-provider for a number of very different modules: sound is processed by all-purpose audition (e.g. the perception of sound that is produced by animals), voice recognition (the identification of humans according to their voice), auditory affect perception (emotion detector) and of course the perception of linguistically relevant phonetic material. Nobody precisely knows how the uniform auditory signal is chopped into the pieces that are relevant for these four (and other) clients (and there may of course be overlap). But the fact is that the linguistic system receives all relevant information that is needed for linguistic computation.

The reverse pattern is encountered when the same module receives input from different sources. In perception for example, phonology is fed at least by acoustic-phonetic and visual information. The latter is documented by the so-called McGurk effect (McGurk & MacDonald 1976, Ingleby & Azra 2003): when exposed to auditory and visual information that simultaneously provide conflicting information, subjects consistently perceive something different from what reaches their ears: either the visual input overrides the auditory stimulus ([ba] is perceived when the subject is exposed to auditory [da] and visual "[ba]"), or the perceived sound is a compromise (so-called McGurk fusion: [da] is perceived from auditory [ba] and visual "[ga]"). This kind of "lip reading" enhances perception in noise-impaired environments.

Also, the circuitry of visual stimuli that reach grammatical processing appears to be different from auditory stimuli, but processed by the auditory cortex (Calvert & Cambell 2003).

Interestingly, the McGurk input into the phonological module appears to be the complementary set of what morpho-syntax can provide: melodic primes. Recall from §124 that morpho-syntax and melody are incommunicado. By contrast, McGurk (i.e. visual) input seems to exclusively impact melody (McGurk fusion: [da] is perceived from auditory [ba] and visual "[ga]"), but does not bear on phonological properties above the skeleton.

184 6.2. Variable input to the lexicon must be reduced to a uniform output

Given the preceding, there can be no doubt that modules must be able to take multiple inputs, and to allow for multiple usage of the structure that they build. In a perspective where translation is done by a computational Big Brother, nothing more needs to be said because Big Brothers can see and do everything. Jackendoff (2002:223ff) argues along these lines.

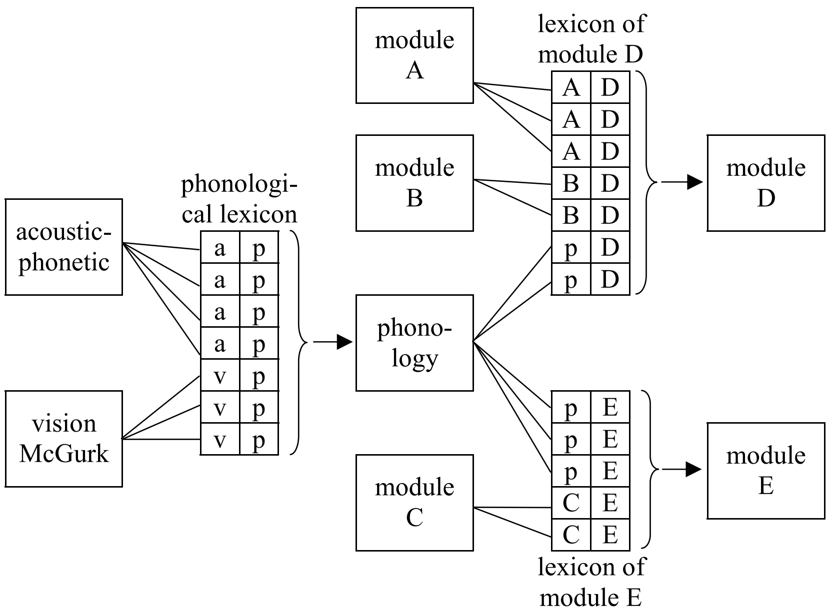
By contrast, if translation is done through a lexical access, further discussion is needed. Namely, the input and the output of modules must be carefully distinguished from the input and the output of the translating lexicon. We know that modules may receive variable input, i.e. which is formulated in different vocabularies. We also know that modules are domain-specific and hence can only parse their own vocabulary. The only solution to this logical problem is that the lexicon which feeds a given module allows for an input in a number of different languages (say, French, Italian, Swedish), but systematically pairs these input items with output items that are formulated only in one single language, the language of the target module (say, Polish).

In other words, each module has, on its input side, a proprietary lexicon that produces an output in the domain-specific vocabulary of this module. This output, however, may be the result of input-stimuli from all kinds of modules in all kinds of languages: an acoustic-phonetic stimulus may trigger a phonological output of the lexical access as much as a visual stimulus. The arbitrary association of the two items of a lexical entry is precisely what makes a lexicon. Looked at from the perspective of a module, however, the origin and language of the stimulus that has provoked an output are neutralised: modules only see the output side of their lexicon.

Table (52) below shows how a modular network communicates through lexical access along the lines discussed; note that the example is taken from language perception.

In this perspective, lexical entries are pairs of arbitrarily associated items which belong to two different domains. Under (52), "a" are pieces of the acoustic-phonetic vocabulary, "v" of the visual vocabulary, "p" of the phonological vocabulary etc.

(52) intermodular communication through lexical access



From the point of view of language production, phonology will be fed by just one module, morpho-syntax. Note that neither the lexicon nor morpho-syntax or phonology need to make any difference between morphemic and non-morphemic morpho-syntactic information. On this account, what has made linguists write a lot about the interface and the lexicon as commonly understood is not any different: a morpho-syntactic structure cohabitates with some phonological object in a lexical entry, which is activated when spell-out produces the relevant morpho-syntactic stimulus on the input side of the lexicon. Whether the origin of this stimulus is morphemic or boundary information is irrelevant.

185 7. Consequences for carriers of boundary information

186 7.1. Phonological computation cannot be the output of translation

Let us now look at the consequences of One-Channel Translation for the carriers of boundary information in phonology. Unlike in the classical architecture, boundary as much as morphemic information must transit through a lexical access. This implies two things: 1) whatever the carriers of non-morphemic morpho-syntactic information, they must be able to be stored in the lexicon, and 2) boundary information must always be identifiable as an independent piece in the linear string.

We already knew that diacritics and melody (§124) do not qualify for carrying boundary information. The fact that boundary information must be recorded in the lexicon now eliminates one more candidate: computation. Since computation and the lexicon are necessarily distinct,[31] the former cannot be stored in the latter. This may appear to be trivial, but I have been arguing for a system where the government that final empty nuclei are subject to is the output of translation (e.g. Vol.1 §406, Scheer 2008a, more on this in §234 below). Government, however, is part of the phonological computation in CVCV and therefore cannot be the output of a translation that is stored in the lexicon.

187 7.2. Representational intervention must be local: boundary information is inserted between morphemes

The other consequence of the lexical storage of boundary information is its necessary identity as an independently identifiable object in the linear string. The string over which phonological computation operates is pieced together from lexical entries. These are linearised and appear in the phonological module in a linear sequence.

Classically, the lexical pieces at hand are only morphemes. The one-channel perspective now treats boundary information in the same way, to the effect that the linear input string to phonology is made of pieces that represent morphemic as well as non-morphemic information. Hence whatever the mechanism that is responsible for the construction of the linearised string, it will treat pieces that represent morphemic and non-morphemic information in the same way. Since we know that the former end up in a linear order, and that they are indistinguishable from the latter, carriers of boundary information must also end up as identifiable pieces in the linear string.

Note that there is no such linear requirement when translation is done by computation: prosodic constituency is not anything that can be identified as a piece in the linear string (see §132). In other words, the lexical origin

[31] Except in usage-based approaches which deny the distinction between the lexicon and computation: according to Langacker (1987) and Bybee (2001:20f), rules are an "emergent" property of the lexicon, the "rule/list fallacy" needs to be done away with.

of boundary information enforces local insertion. That local insertion is the only workable way to manage boundary information in phonology was also the conclusion reached in §136: only locally inserted carriers of morpho-syntactic information can be non-diacritic.

Finally, as was mentioned in §180, the observation that morpho-syntax has no bearing on morpheme-internal phonology also follows from lexical translation and the ensuing linear order of morphemes and carriers of boundary information.

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- this index refers to paragraphs §, that is the running number in the page margins.
- reference to a § that identifies the beginning of a chapter or a section refers to this chapter or section *and to all of its sub-sections*.
- cross-reference to other entries of the subject or the language index are introduced by "→": look up here.
- cross-reference to a sub-entry of the subject index uses the structure of computer files: the sub-entry "architecture" of the entry "Prosodic Phonology" identifies as "→ Prosodic Phonology/architecture".
- boldfaced § numbers indicate that the subject is most prominently studied there.
- reference to footnotes is made by indicating their number, but also by mentioning the number of the § in which they occur: "note 63 (198)" refers to footnote 63 which occurs in §198.

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Language index

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