The Nature and Limits of Variation across Languages and Pathologies

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Abstract

The aim of this dissertation is to explore the nature and limits of variation across different (i) linguistic phenotypes and (ii) cognitive phenotypes, showing that a strong parallel exists between the two. It is proposed that the same loci of variation can be identified across the two research programs: *comparative linguistics*, which deals with variation across languages and *comparative biolinguistics*, which has variation across pathologies among its research questions. In both cases, variation is shown to be confined to the externalization component of the language faculty. The picture on variation across pathologies is established on the basis of describing and comparing the grammars of aphasia, Specific Language Impairment, Down Syndrome, autism and schizophrenia. Variation is approached from a generative perspective. Arguments against presenting variation as syntactic or parametric are put forth on the basis of results obtained from a semi-automatic program analysis. The proposed analysis measures parametric relations in two pools of data that target the nominal domain and span over 32 contemporary and 5 ancient languages. In the absence of parameters, a novel acquisition algorithm is sketched out. This algorithm approaches the task of language acquisition from the very beginning and identifies the cognitive cues that guide the learner in each step of the acquisition process.

Resum

L'objectiu d'aquesta tesi és explorar la naturalesa i els límits de la variació entre els diferents (i) fenotips lingüístics i (ii) fenotips cognitius, mostrant que existeix un fort paral·lelisme entre aquests dos dominis. Es proposa que el mateix 'loci' de variació pot ser identificat mitjançant dos programes d'investigació: la lingüística comparativa que s'ocupa de la variació a través de les llengües i la biolingüística comparativa, la qual té entre les seves preguntes d'investigació l'estudi de la variació a través de les patologies. En tots dos casos, es mostra que la variació es limita als components d'externalització de la facultat del llenguatge. La imatge de la variació entre patologies s'estableix a partir de la descripció i comparació de les gramàtiques de l'afàsia, el Trastorn Específic del Llenguatge, el Síndrome de Down, l'autisme i l'esquizofrènia. La variació és abordada des d'una perspectiva generativa. Els arguments en contra de la presentació de la variació com sintàctica o paramètrica són exposats a partir dels resultats obtinguts amb un programa d'anàlisi semiautomàtic. L'anàlisi que es proposa mesura relacions paramètriques en dos conjunts de dades que tenen com a objectiu el domini nominal, comprenent més de 32 llengües contemporànies i 5 d'antigues. En absència de paràmetres, s'ha esbossat un nou algorisme d'adquisició. Aquest algorisme enfoca la tasca de l'adquisició del llenguatge des dels seus inicis, identificant els senyals cognitius que guien el principiant en cada pas del procés d'adquisició.

You ask me why I spend my life writing?
Do I find entertainment?
Is it worthwhile?
Above all, does it pay?
If not, then, is there a reason?

I write only because
There is a voice within me
That will not be still

– Sylvia Plath

Letters Home: Correspondence, 1950-1963

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Writing a dissertation is part of a challenging and eye-opening journey, or so it has been in my case. A wise Chinese proverb (roughly) says “when you drink water, don’t forget those who dug the well”. This section is dedicated to the people whose presence in my life made the journey pleasurable.

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Variation in Bilbao, *3rd Annual Meeting of the European Society for the Study of Human Evolution* in Vienna, *Language Sciences in the 21st Century* in Cambridge, *Comparative Biolinguistics: An Exploratory Workshop* in Barcelona, *33rd workshop on 'What Made Us Human? Biological and Cultural Evolution of Homo sapiens'* in Sicily and *Biolinguistic Investigations on the Language Faculty* in Pavia. I thank the audiences of these events for helpful comments and feedback. I also thank Anna Maria di Sciullo for her instrumental role in organizing conferences and events related to biolinguistics. All these trips and the writing of this dissertation were possible thanks to funds from the Spanish Ministry of Science and Innovation (FPI grant related to project FFI2010-20634, PI: Cedric Boeckx), the Universitat de Barcelona and the Generalitat de Catalunya to the Group of Biolinguistics and Cognitive Disorders. In my trips, I met people who helped me understand aspects of the field better. I thank Theodore Marinis, Giuseppe Longobardi, Itziar Laka, Theresa Biberauer, Cristina Guardiano, Napoleon Katsos, Maia Duguine, Bridget Samuels, Valantis Fyndanis, Carolina Silva, Lluís Barceló-Coblijn, Andrea Ceolin, Adriana Fasanella and Marianna Martzoukou. I'm sure I'm forgetting some names here.

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Στη Μάγδα, τον Σπύρο και τον Γιώργο

List of Abbreviations

ABSL	Al-Sayyid Bedouin Sign Language
Ar	Arabic
ASD	Autism Spectrum Disorders
Asp	Aspect
Aux	Auxiliary
AuxP	Auxiliary Phrase
Bas	Basque
BCC	Borer-Chomsky Conjecture
Blg	Bulgarian
BoG	Bovese Greek of Southern Calabria
BP	Biolinguistic Program
Cal	Northern Calabrese
CG	Cypriot Greek
ClG	Classical Greek
C	Complementizer
CP	Complementizer Phrase
D	German
Da	Danish
D-link	Discourse-link
DM	Distributed Morphology
DM	Distributed Morphology Account
DP	Determiner Phrase
DoP	Duality of Patterning
DS	Down Syndrome

DSM	Diagnostic & Statistical Manual of Mental Disorders
DST	Developmental Systems Theory
E	Modern English
E-language	External language
Evo-Devo	Evolutionary Developmental Biology
Fin	Finnish
fMRI	Functional Magnetic Resonance Imaging
FL	Faculty of language
FOFC	Final-over-Final Constraint
Far	Farsi
Fr	French
GB	Government & Binding
Gri	Grico
Grk	Modern Greek
Got	Gothic
Heb	Hebrew
Hi	Hindi
Hu	Hungarian
Ice	Icelandic
I-language	Internal language
IMA	Isolating-Monocategorial-Associational
INFL	Inflection
Ir	Irish
It	Italian
Lat	Latin
LCA	Linear Correspondence Axiom
Ma	Marathi
MP	Minimalist Program
MPF	Morphophonological
MS	Morphological structure

N	Noun
NA	Not analyzable
Nor	Norwegian
NP	Noun Phrase
NS	Narrow Syntax
NTG	New Testament Greek
NUM	Number
O or Obj	Object
OE	Old English
P&P	Principles & Parameters
PP	Prepositional Phrase
PF	Phonetic Form
PLD	Primary Linguistic Data
Po	Polish
PoS	Poverty of the Stimulus
Ptg	Portuguese
Rum	Rumanian
Rus	Russian
S	Subject
Sal	Salentino
SC	Serbo-Croatian
SES	Socio-economic status
SG	Singular
Sic	Sicilian
SLI	Specific Language Impairment
Slo	Slovenian
SMG	Standard Modern Greek
Sp	Spanish
SUT	Strong Uniformity Thesis
T	Tense
TD	Typically developing

TP	Tense Phrase
TPH	Tree-Pruning Hypothesis
UG	Universal Grammar
UPLH	Universally Preserved Linguistic Loci Hypothesis
V	Verb
VP	Verb Phrase
Wel	Welsh
Wo	Wolof
WS	Williams Syndrome

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1. Introduction

One of the key points in the linguistic agenda relates to understanding the nature of crosslinguistic variation as well as its limits and constraints. The relevant literature identifies different flavors of variation on the basis of describing a broad range of grammatical phenomena across a variety of languages. In a similar vein, studies that investigate the nature of linguistic competence and/or performance in instances of atypical cognitive phenotypes often identify various loci of variation as an answer to the question of which aspects of language show up impaired.

The present work approaches the notion of variation by discussing two types of entities: linguistic phenotypes and cognitive phenotypes. These two terms are meant to be read as designations of two different parts of the literature that deal with languages and pathologies respectively. In terms of their essence, the two terms intersect: the linguistic phenotype called English refers to a knowledge that is part of a cognitive phenotype of a specific population that understands English but not Japanese. Similarly, when I describe the grammar of a cognitive phenotype such as autism, I essentially talk about a linguistic phenotype too.

The simultaneous use of both terms is available in the literature that deals with clinical aspects of language performance. Describing one of the pathologies that will be discussed in the context of the present dissertation, Fidler (2005) talks about the "cognitive phenotype" and the "linguistic phenotype" of Down Syndrome, referring to the former not only in reference to language, but also in reference to verbal working memory, visuospatial processing and spatial memory (p. 88). The understanding of the linguistic phenotype is somewhat narrower in the sense that it arises in relation to deficits as these are manifested in a given language (p. 96). Within the literature from theoretical linguistics, the designation 'linguistic phenotype' has been used as a cover term to denote different particular languages (e.g., in Lightfoot 2006: 10, Longobardi 2008: 207, Haider 2013: 32, Huang 2015: 1). Committed to an interdisciplinary perspective, the present dissertation integrates findings from both theoretical and clinical linguistics. To this end, figure 1 schematically represents a treatment of the terms 'linguistic phenotype' and 'cognitive phenotype' that is (i) faithfully representing the above descriptions of the terms and (ii) integrating the various assumptions that are behind these terms across different parts of the literature.

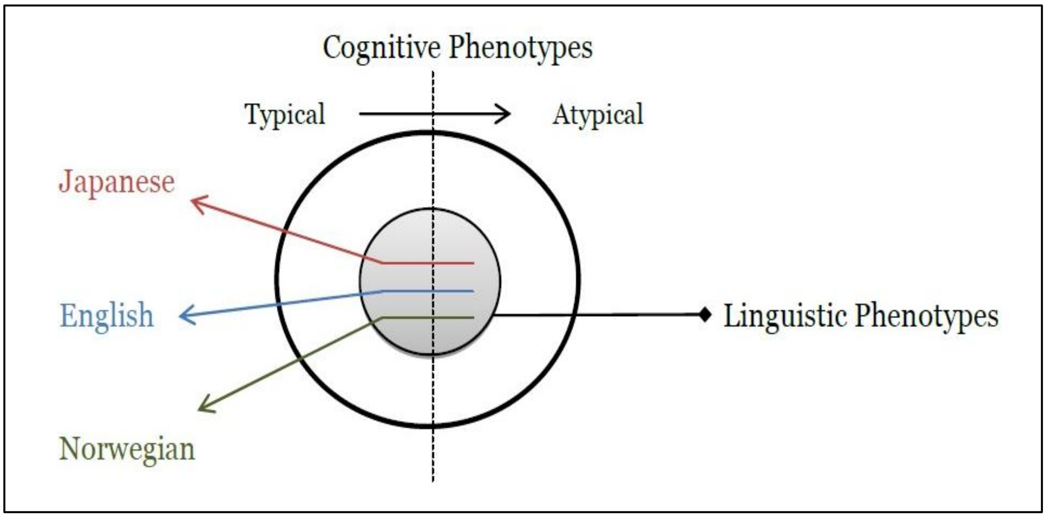

Figure 1: Linguistic and cognitive phenotypes

Figure 1 represents typical and atypical cognitive phenotypes on a continuum, in agreement with a long line of literature on this topic. To give one example that also touches upon a disorder that will be discussed in chapter 4, the existence of subsyndromal schizotypal traits in the general population is higher in the first-degree relatives of patients with schizophrenia (Calkins et al. 2004). This led to the realization that "schizophrenia is not, despite its clinically important and reliable categorical diagnosis [...], a binary phenotype (present, absent) with sudden disease onset" (Ettinger et al. 2014: 1). In line with this view, the dotted vertical line in figure 1 refers to a cut-off point where the diagnosis of a specific pathology is being possible. The continuum of (a)typicality applies to linguistic phenotypes too: talking about mild vs. severe language impairment in English-speaking patients with aphasia makes sense only in comparison to a certain knowledge about a linguistic phenotype called English; a knowledge that is experimentally defined by testing a neurotypical English-speaking population.

The starting point of the discussion of variation boils down to the contents of the initial state of the human language faculty, often referred to as Universal Grammar (UG). This term comes from a specific linguistic framework called Principles & Parameters (P&P; Chomsky 1981). The overall analysis aims to approach the issue of variation from an interdisciplinary perspective that focuses on a biologically plausible language faculty. In this context, the specific languages featured in this work as well as all the linguistic data are accidental choices. Another set of data or languages could have been equally good for sketching out the nature and limits of linguistic variation from the two perspectives identified above. As such, the conclusions drawn at the end of this work should not be read only in relation to the languages featured in this dissertation; they are not conclusions with respect to specific languages but with respect to the language faculty.

An important characteristic of this work is that the *comparative linguistics* agenda goes hand in hand with the *comparative* *biolinguistics* agenda. At all points, my intention is to pursue an approach to the language faculty that is informed from a biolinguistic point of view. Biolinguistics can be described as a research enterprise that is dedicated to uncovering the biological basis of the language faculty. In the course of doing so, it inescapably establishes interdisciplinary bridges between linguistics, cognitive science and biology. Importantly, in and of itself, biolinguistics is framework-free. It is neither necessarily grounded within the generative enterprise (although it may be, as it may be grounded within another framework of theoretical linguistics), nor is an alternative to or a successor of the Minimalist Program (MP; Chomsky 2005). It is a research program within which choice of framework (or frameworks) is appropriate or, at least, available (Boeckx 2013).

Bearing these assumptions in mind, I review the notions of syntactic, semantic, morphological, phonological and lexical variation. Syntactic variation has been described in terms of parameters in the generative literature (Chomsky 1981). Most of the related works assume an architecture of UG that consists of principles and parameters, with the latter awaiting setting on the basis of the linguistic data that a child encounters during the first years of her life. Since the present work aims to shed light to the nature of language variation in part through discussing the feasibility of parametric approaches to language, this discussion has direct implications for the topic of language acquisition. It also has implications for the contents of UG or whatever name one employs to denote the initial state of the faculty of language.

The overarching goal of this dissertation is to show that a parallel exists between comparative linguistics and comparative biolinguistics in terms of the observed loci of variation. More specifically, the argument put forth is that certain aspects of language never seem to vary, whereas others do so consistently. When mapping the loci of variation that are identifiable across the two research programs, one notices that variation is confined to the same components of grammar. The exploration of variation begins in chapter 2, where syntactic parameters are reconstructed as realizational variants of a morphophonological flavor. I argue in favor of approaching points of variation (i.e. 'parameters') as environmentally-driven, emergent properties. Having established the theoretical motivation for this argument, I suggest that it gains empirical support from instances of recent language emergence as these are witnessed in specific sign languages (e.g., Al-Sayyid Bedouin Sign Language).

In the second part of chapter 2, I offer empirical evidence for the implausibility of assuming that our species is innately endowed with a UG that consists of parameters and parametric hierarchies. Assuming that any parametric approach to UG and variation is at the same time a theory that makes use of parametric paths and hierarchies, this dissertation provides insights into the nature of such concepts by analyzing in depth two pools of data that consist of hierarchically organized parameters. The notion of parametric hierarchy is examined through implementing a novel program-based analysis that measures relations of setability between the different parameters in the two pools of data presented in Longobardi & Guardiano (2009) and Longobardi et al. (2013). These are binary parameters coming from the nominal domain, presented alongside setting states and setability relations, across 32 contemporary and 5 ancient languages. Setting occurs on the basis of language data, whereas setability depends on the status [+, -, 0] of the parameters that the parametric dependency specifies. Several issues pertaining to intertwined considerations of setability, (species-)uniformity, fixity, overproduction, and optimality are discussed. The discussion of these issues eventually leads to the claim that a parameter-free version of UG and an approach of points of variation as surfacy, morphophonological realizations is the most plausible and economical way to go about acquisition and variation respectively.

In chapter 3 the focus is on language acquisition. The organization of variation in terms of hierarchies entails that the child has to go through certain parametric paths, while other paths will not be explored. Depending on the setting a top parameter receives, children acquiring different languages need to navigate different parametric paths. If the notion of parameter is eliminated from our list of linguistic primitives, something more needs to be said for the acquisition process. Therefore, in chapter 3, I sketch out a novel acquisition algorithm that draws its components from statistical approaches to language learning, cognitive biases that mediate acquisition and rules that determine how much of noise/exceptions the learner can tolerate before revisiting the rules she hypothesizes.

Chapter 4 discusses variation across different pathologies. It has been argued that certain domains of language seem to be particularly vulnerable to impairment, while others appear to be consistently preserved (Benítez-Burraco & Boeckx 2014). Building on this claim, in chapter 4 I present the grammars of aphasia, Specific Language Impairment, Down Syndrome, autism and schizophrenia. Through comparatively discussing the nature of linguistic impairment in these disorders, I show that variation is either confined to the externalization components of language or is related to extragrammatical factors. These disorders have a quite different etiology, however they appear to converge with respect to the patterns of deviation from the target linguistic performance they show. This distribution of patterns seems to best fit the distribution of operations assumed in the framework of Distributed Morphology (DM; Halle & Marantz 1993). The overall picture that emerges from the literature on the nature of linguistic impairment across cognitive phenotypes leads to the observation that the same loci of variation stand out across the two domains of inquiry: languages and pathologies.

Chapter 5 concludes and sketches out the issues that the present discussion leaves unaddressed. This chapter offers some insights about the context in which unaddressed issues should be better explored and why this context would be of benefit when one discusses the nature of the language faculty.

2. Variation across Languages

It is an incontestable fact that languages vary. This variation has received a number of designations in the literature: syntactic, lexical, semantic, morphological, and phonological variation. The aim of this chapter is to explore variation across languages by discussing these different loci of variation from various theoretical and empirical perspectives, including and extending on the material presented in Boeckx & Leivada (2013, 2014) and Leivada (2014).

The topic of crosslinguistic variation has often been related to two central research questions in the field of linguistics: innateness and acquisition. Starting off from innateness, inquiries about the initial state of the faculty of human language usually involve some discussion on what Chomsky (1965 et seq.) identified as UG. This initial state of the human language faculty was explicitly related to language variation when a few years later, Chomsky (1981) introduced the notions 'principle' and 'parameter'.

Innateness, in the form of UG, got described in terms of principles, which are UG properties with fixed values and as such invariant across languages, and parameters, which are unvalued —hence parameterizable— principles that come together with a finite set of values and await setting on the basis of the primary linguistic data (PLD) that a child is exposed to. In more recent work, Chomsky proposed that "[UG] might be defined as the study of the conditions that must be met by the grammars of all human languages" (2006: 112).

Principles, by being the invariant and unparameterizable part of UG, adhere to this description so they can be viewed as these conditions.

Organizing variation in terms of parameters had important implications for the acquisition task. Within the P&P approach, the variation space got organized in terms of parametric hierarchies: depending on the values that top parameters receive, certain parametric paths are (not) explored. According to standard descriptions of this approach, UG encapsulates an *ordered* representation of parameters, ordered either by means of a hierarchical representation (see Baker 1996, 2001 et seq., Ayoun 2003) or by a timing factor that allows for certain options to be late-set, only after other parameters are fixed (e.g., in Wexler's 1994, 1998 Very Early Parameter Setting model). More specifically, in Wexler's model, it is argued that "*basic* parameters are set correctly at the earliest observable stages" (1998: 25; emphasis added) "with representational possibilities added over time" (p. 63) in the course of development. To use the description of Thornton & Tesan (2007: 54), in the Very Early Parameter Setting model "certain linguistic principles are biologically timed to become operative later than others in the course of development". In general, the topmost/early-set parameters have been described as *high-level macroparameters* that deal with the most central differences that can be found across languages (Culicover 2013).

An ordered representation of parameters makes available certain hierarchies that start off with an independent parameter at the top of the hierarchy. One example is the Polysynthesis Parameter in figure 2 below. According to figure 2, variation is organized in such a way that the child acquiring Mohawk will enter a specific path upon setting polysynthesis to 'yes' and the child acquiring Malagasy will not have to decide between possible values for the parameter Adjective Neutralize. In this sense, such a hierarchical organization of parameters has direct implications for the acquisition task.

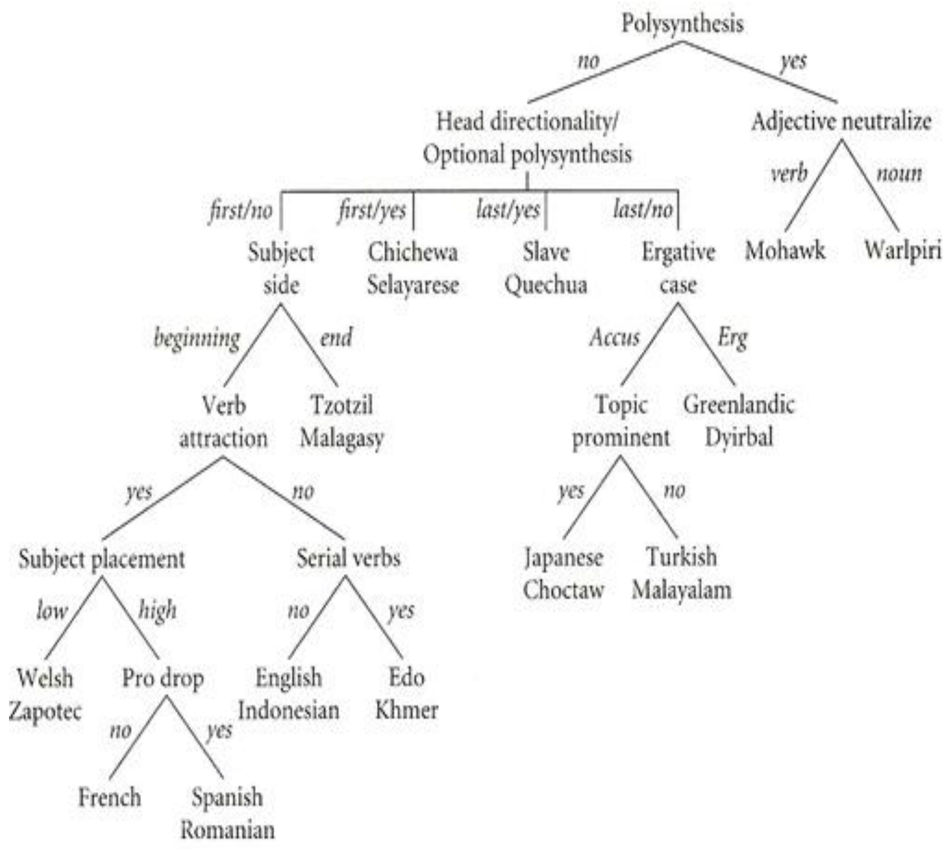

Figure 2: Hierarchical organization of parametric variation (Baker 2003)

One of the reasons for supporting the existence of a UG that consists of principles and parameters is the need to constrain crosslinguistic variation through defining the possible space for it. This need to ensure that languages do not vary in an unconstrained way is in part rooted in a position of American structuralism, frequently —and sometimes misleadingly— attributed to Joos (1957),[1] where it is ar-

[1] Misleadingly in the sense that Joos is presenting an argument of a school of thought and not of his own when arguing that

> "Trubetzkoy phonology tried to explain everything from articulatory acoustics and a minimum set of phonological laws taken as essentially valid for all languages alike, flatly contradicting the American (Boas)

gued that “languages could differ from each other without limit and in unpredictable ways” (p. 96). Perhaps the latter is a claim that biolinguistics would take issue with, since viewing language as a biological organ entails that the language-related makeup of healthy organisms is to some degree uniform and this shared biological basis means that variation in what these organisms produce cannot be without limits if there are certain things that the makeup of organisms can(not) do. At the same time, though, it is a thesis easily dismissed by assuming the existence of even a single linguistic principle: Any amount of invariance suffices to kill the ghost of infinite variation (Boeckx 2014a), therefore the notion of parameter is not necessary for the task of constraining variation.

Since UG has been described as our genetic endowment for language (i.e. the first factor in language design according to Chomsky 2005), it is fit that the biolinguistics enterprise —precisely dedicated to uncovering the biocognitive basis of language— revisits long held linguistic assumptions about UG primitives. In doing so, Di Sciullo et al. (2010) argue that

> “[a] major aim of the Biolinguistic Program has been to explain why [UG], extracted from commonalities across languages, is what it is and not something else. This basic ques-

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tradition that languages could differ from each other without limit and in unpredictable ways, and offering too much of a phonological explanation where a sober taxonomy would serve as well” (p. 96).

Biberauer (2008) notes that it is even doubtful whether the American descriptivist Franz Boas, to whom the view “languages could differ from each other without limit and in unpredictable ways” is ascribed, really held this conviction. She further argues that there is no evidence that other descriptivists like Bloomfield and Sapir held this view. However, Sapir (1921) argues that “language is a human activity that varies without assignable limit”. Despite noting that such statements were not intended literally, Chomsky (1986: 21) claims that statements like the one of Sapir “reflect a fairly broad consensus of the time”.

> tion leads to an investigation of what the genome specifies that is particular to language, and raises the possibility that this genetic endowment specifies only a few, basic computational features". (Di Sciullo et al. 2010: 6)

Di Sciullo et al. (2010: 7) notice two advantages in this approach: (i) by identifying a set of computational principles (i.e. commonalities), a more direct link to animal behavior can be established and (ii) it is possible to integrate hypotheses on how our cognition constrains language universals with a theory that spans biology and formal linguistics.

Perhaps more advantages exist. In identifying these computational principles, we preclude the possibility of infinite variation, since an invariable, common basis would be established. In other words, we do not need parameters for constraining variation. Moreover, by narrowing down our expectations and focus to a few computational principles, we obtain a picture of our biological endowment for language that is easier to work with. If any, it is this picture —rather the one presented in figure 2— that is more promising to overcome the "granularity mismatch problem" and perhaps give a positive answer to the "ontological incommensurability problem" (Poeppel & Embick 2005). Poeppel & Embick (2005) define these two problems in the following way:

> "Granularity Mismatch Problem: Linguistic and neuroscientific studies of language operate with objects of different granularity. In particular, linguistic computation involves a number of fine-grained distinctions and explicit computational operations. Neuroscientific approaches to language operate in terms of broader conceptual distinctions." (p. 105)

> "Ontological Incommensurability Problem: The units of linguistic computation and the units of neurological computation are incommensurable." (p. 105)

In more recent work, Poeppel (2012) talks about the *mappin*g problem and, in its phrasing, he stresses the need to formulate linking hypotheses that create interdisciplinary bridges. In his words,

> "the mapping problem corresponds to a more troublesome challenge, namely how to formulate the formal links between neurobiology and cognition. This principled problem thus addresses the relation between the primitives of cognition (here speech, language) and neurobiology. Dealing with this mapping problem invites the development of linking hypotheses between the domains". (Poeppel 2012: 34)

Abandoning the idea of an innate component for language that is rich in terms of linguistic structure is likely to bring linguistics at a more appropriate level of granularity for the purposes of formulating the linking hypotheses that Poeppel refers to in his definition of the mapping problem.

Despite these advantages, the idea that dominates the literature on variation within the generativist framework is the one of figure 2, according to which variation is syntactic and comes in the form of parametric hierarchies. To illustrate this with an example, in a recently edited volume that approaches the topic of linguistic variation from a variety of different perspectives, the attention shifts to syntax as early as the title of the introductory chapter, where variation is called 'syntactic' and the chapters that deal with aspects of the parametric approach significantly outnumber the contributions under the title 'variation without parameters' (Picallo 2014).

The picture from another edited volume that deals with the topic of variation is similar. In Biberauer (2008), the title *The Limits of Syntactic Variation* draws attention to variation of a particular kind as early as possible. Also, the volume for the most part evokes a parametric approach to variation and acquisition. It seems that work on these topics consistently lays on emphasis on describing variation as syntactic and/or parametric. Therefore, the distribution of chapters that comprise Picallo (2014) and Biberauer (2008) is not an accident; they rather reflect quite accurately the current state of mind in the field, at least the one that is found within the generativist framework.

It is important to highlight the fact that parametric variation *must* come in the form of hierarchies that organize variation in certain ways for the proposed benefits of P&P to be retained. In other words, when we associate a parametric vision of language with a reduced workload in the acquisition task, we necessarily make reference to *interlocked* parameters that are organized in an 'X proceeds Y' and 'if X(yes) then Y, if X(no) then Z' fashion (which is the picture depicted in figure 2). It is pointless to talk of parameters as unrelated dots on the variation map. Such a view neither reduces the acquisition work, nor seems plausible from an evolutionary perspective. The best illustration of why the latter is so comes in the words of Newmeyer (2005):

> "If the number of parameters needed to handle the different grammars of the world's languages, dialects, and (possibly) idiolects is in the thousands (or, worse, millions), then ascribing them to an innate UG to my mind loses all semblance of plausibility. True, we are not yet at a point of being able to 'prove' that the child is not innately equipped with 7846 (or 7,846,938) parameters, each of whose settings is fixed by some relevant triggering experience. I would put my money, however, on the fact that evolution has not endowed human beings in such an exuberant fashion". (Newmeyer 2005: 83)[2]

[2] This view expresses quite transparently why variation should not be ascribed to an overspecified, parametric UG. The only caveat to it is that the burden of 'proof' lies on the one making the claim for a parametric UG and not to the one pointing out the implausibility of this idea from an evolutionary perspective. In logic, this translates along the following lines: "[O]ne who makes an assertion must assume the responsibility of defending it. If this responsibility or burden of proof is shifted to a critic, the fallacy of appealing to ignorance is committed"

Since it is highly unlikely that the course of evolution would have endowed the human species in the exuberant fashion of having thousands of unrelated parameters (i.e. unconnected points of variation), postulating the existence of interlocked (i.e. hierarchically organized and connected) parameters is the only way to go if one wishes to describe variation by means of a theory that consists of parameters. This is the topic of this chapter. More specifically, I will first review the theoretical premises of parametric approaches to language alongside some criticism that has been raised towards them in the literature. Then I will focus on the notion of parametric hierarchy from two different perspectives: UG-specified hierarchies and emergent hierarchies.

After presenting the theoretical basis of these concepts, I will empirically determine the properties of parametric hierarchies by running a semi-automatic analysis on parametric hierarchies as these are established in two pools of data (taken from Longobardi & Guardiano 2009 and Longobardi et al. 2013). Both pools of data consist of interlocked parameters that define the space of variation in one domain of grammar: the nominal domain.

Interpreting the obtained results, I will propose that they point out to problems in the organization of parametric hierarchies, and on this basis I will argue that variation does not come in the form of (syntactic) parameters. Instead, it is confined to one component of grammar: the externalization component. In this context, I will be eventually talking about 'morphophonological variants' (MPF variants), instead of '(syntactic) parameters'.

(Michalos 1969: 370). Therefore, it is not the task of those who are sceptical of the possibility that the child is innately equipped with 7,846,938 parameters to 'prove' that this is not the case, but the task of those who make a claim in favor of a parametric UG to show that this is the case.

2.1. *Variation and the Principles & Parameters Architecture*

Parameters in the early stages of P&P were conceived as clusters of grammatical properties manifested across syntactic environments (i.e. macroparameters). The notion of parameter is a well-motivated and theoretically plausible concept. Particularly in relation to language acquisition, the notion of parameter is very attractive because it offers concepts designed to address not only the topic of variation across linguistic varieties but also across possible interim grammars as these are contemplated by the child in the course of language development (Meisel 1995).

However, despite its theoretical soundness, when put under empirical, crosslinguistic scrutiny, this notion of macroparameter seems hard to maintain for it fails to retain its 'macro' status. It quickly decomposes in order to account for subtler points of variation. Classical macroparameters such as the null subject parameter (referred to as '*pro*-drop' in figure 2) have been shown to break under the weight of empirical evidence. In Baker's words, "[h]istory has not been kind to the *pro*-drop parameter as originally stated" and in retrospect one can claim that this is a 'medioparameter' (2008: 352). It seems that the clusters of properties that were assumed behind the concept of 'macroparameter' have decomposed into a number of medio- and microparameters. Recall that it has been argued that the idea of having a big number of (macro)parameters seems implausible from an evolutionary point of view (Newmeyer 2005). One can imagine how difficult it will be to maintain the idea that we are biologically endowed with a UG that consists of principles and parameters, if by parameters we mean minimal points of variation. To provide an overview of how parameters 'leak', I will now turn my attention to attested patters of variation across different languages.

Since Rizzi's (1986) work on the null subject parameter, languages are classified either as allowing null subjects (*pro*-drop languages, e.g., Italian) or not (non-*pro*-drop languages, e.g., English), or as not allowing drop of referential subjects, but allowing drop of expletive/non-referential third person subjects in some environments (e.g., German, classified as a partial *pro*-drop language in Safir 1985 or as non-*pro*-drop of the 'Group B2' type by Vainikka & Levy 1999). In German, the variation is subject to restrictions (i.e. expletive constructions in embedded clauses), so this could be viewed as variation across syntactic environments.

In Finnish and Hebrew, however, the situation is more complicated: "Finnish and Hebrew (in the relevant tenses) behave like Italian in the first and second person. However, in the third person the German-like pattern is attested, where subject NPs are preserved except in the case of certain expletives and other special constructions" (Vainikka & Levy 1999: 616). In other words, Vainikka & Levy (1999) report that Hebrew and Finnish exhibit mixed null subject behavior. Grammar-independent, pragmatic factors of language in use might also play a role in deriving variation: Haegeman (1990) discusses the existence of non-overt, pronominal subjects in 'diary contexts' in English, German, and Dutch, outside embedded clauses and without a third person restriction applying.

One naturally wonders what exactly would the place of Finnish and Hebrew be in figure 2: aligned with languages that set *pro*-drop to 'yes' or with those that set it to 'no'? The answer is that figure 2 does not provide the full picture. Probably this parameter would need to be further decomposed in a way that would allow different environments to receive a different setting for *pro*-drop. This of course entails that the hierarchy in figure 2 will become considerably more articulated in a way that would affect the representation of the parameters that are dependent on *pro*-drop (i.e. parameters whose setability depends on saying 'yes' or 'no' to *pro*-drop).

Since *pro*-drop is a parameter that has a low position on the hierarchy, this question does not arise in the context of figure 2. However, an equivalent question can arise as early as the topmost parameter: polysynthesis. Greek, for example, is a language that has some polysynthetic traits, including noun and adverb incorporation into the verb (Charitonidis 2008) —so the top parameter must be set to 'yes'—, but since the incorporated arguments can be also expressed analytically, the parametric path below 'no' is also set all the way down until setting *pro*-drop to 'yes'.

A parameter that refers to the (in)existence of null subjects or polysynthesis in a language is decomposable into many microparameters which in turn result to an overspecified UG. The observation that macroparameters 'leak' has led to a number of proposals that question the feasibility of the classical notion of (macro)parameters, suggesting that this concept should be abandoned (e.g., Pica 2001, Newmeyer 2004, 2005, Evers & van Kampen 2008, Haspelmath 2008, Boeckx 2011a, 2012, 2014a). This in turn paves the way for viewing ('parametric') variation as an externalization product in the context of the Biolinguistic Program (BP): "[T]here is only one language with minor dialectal variations, primarily —perhaps entirely— in mode of externalization" (Berwick & Chomsky 2011: 41).

Although this is an idea that gains attention in the literature, it is still not clear whether variation arises mainly or entirely in the externalization component. The phrasing in Berwick & Chomsky (2011) explicitly acknowledges both possibilities. A similar conclusion is reached in Sigurðsson (2011: 210): "language variation is largely or entirely restricted to externalization". Richards (2008a) eliminates one of the two possibilities: that variation is entirely confined to the externalization component. In his view, there are two flavors of variations: one that is syntactic and one that arises at the mapping to PF. Roberts (2011a) shares this view. Evidently, although many scholars contemplate the idea that variation arises at the externalization component, some of them —but not all (see Boeckx 2014a)— do not commit to the claim that variation arises *only* at the externalization component. Yet, this is the claim I will pursue in the remaining of this chapter. The aim is to see whether the flavor of variation that receives the label 'syntactic' in the literature can be reconstructed in morphophonological terms. If the latter happens, variation would be indeed confined to one component of grammar.

Behind the picture of UG that consists of principles and parameters one finds the need to balance different factors. First, as Yang (2006: 131) argues, "the theory of parameters is charged with two ambitious missions —to provide a theory of the languages of the world and the language of the child— in a single stroke". Second, there is the need to accommodate two different tendencies: to not put too much burden to the genetic component and the need to not put too much burden to the acquisition task (Chomsky 2004: 166). The latter has been referred to as the Minimax Problem.

2.1.1 The Minimax Problem

Assuming that innateness exists in the form of a P&P-shaped UG reduces the cost of acquisition because it makes certain parametric paths available.[3] The child then has to make use of PLD to navigate through a constrained domain of possible grammars and set parameters to their target values. In simple words, the idea is that a more

[3] Crucially, the reference here is to the classical notion of parameter, meaning connected macroparameters and not unconnected, minimal points of variation.

specified UG entails a less burdensome acquisition task, or as Kandybowicz (2009) puts it:

> "Another speculation, first discussed years ago in class lectures by Noam Chomsky and then later independently proposed by Massimo Piattelli-Palmarini (Noam Chomsky, p.c.), is that variation/parameterization involves a 'mini-max' problem: Leaving principles open/unspecified reduces genetic information, but increases the cost of acquisition. One conceivable solution is that the existing parameters are an optimal trade-off". (Kandybowicz 2009: 94-95)

However, it is not clear that an underspecified UG will actually increase the acquisition cost; not if one takes into account that there are principles of general cognitive architecture that might aid acquisition. Chomsky (2005) has identified three sets of factors as relevant for language design. For Chomsky, the first factor amounts to genetic endowment (i.e. UG), the second factor is the environment, and the third factor involves general cognitive factors, not specific to the language faculty. The minimax problem is phrased above in such a way that only the first factor is presented as a possible candidate for reducing the burden of the acquisition task. However, there is no theoretical or empirical reason for not bringing the third factor into the equation. Once the third factor is taken into consideration, macroparametric effects could be viewed as the result of learning principles that may or may not be specific to language. In this context, there would no longer be a need to relocate all points of variation in UG in order to reduce the acquisition workload. Consequently, parameters should be viewed as "an attempt to navigate between the path of least genetic specification (minimal UG) and the path of least instruction (superset bias)" (Boeckx 2011a: 221),[4] a navigation that

[4] Superset bias refers to a third factor principle by which children "strive for parametric-value consistency" (Boeckx 2011a: 217). In Roberts (2011), generalization effects are related to the "computational conservatism of the learning

would probably be aided by certain learnability conditions and cognitive biases that reflect the interaction of the three sets of factors in language design. I will return to these cognitive biases and their role in acquisition in chapter 3.

Minimax considerations that seek to reduce the acquisition task possibly derive from the need to understand how language is acquired, given the slender, often noisy, nature of the input (i.e. a question known as 'Plato's Problem' or the 'logical problem of language acquisition'). It has been suggested that the PLD that a child receives during her first years of life are not adequate enough to account for the richness of the linguistic attainment that she will have as a competent speaker of any language (Chomsky 1965). Therefore, PLD alone are insufficient to explain the ultimate linguistic competence of any (typically developed) speaker (or signer) in any natural language and this observation is usually referred to as the Poverty of (the) Stimulus (PoS) argument.

Parameters in P&P were precisely intended to be a solution to this logical problem of language: PLD *alone* are not sufficient, but if coupled with an innate predisposition for acquiring language that comes in a form that makes available a range of possible grammars, then the acquisition task looks less complex. Moreover, the ultimate linguistic attainment of a mature speaker is much easier to justify in the presence of this innate predisposition. In this context, one can straightforwardly understand that it is no accident that parameters have been long entertained as the key to variation (i.e. languages vary because they correspond to different combinations of parametric values).

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device", formally captured under the 'Input Generalization': "There is a preference for a given feature of a functional head F to generalise to other functional heads G, H…".

Despite the fact that in the present work the view of seeing language variation as an externalization by-product will be endorsed, the discussion that follows in the next two sections of this chapter will refer to parameters in two different variants of the original sense[5] in an effort to first clarify some terminological issues and second identify with precision the different possible loci of variation that have been proposed in the literature. Then the implications that interlocked (macro)parameters have for the nature of UG will be discussed, laying out the basis on which empirical issues will be explored in section 2.4.

2.1.2 No-Choice Principles and No-Choice Parameters

Principles and parameters have been presented in the previous sections in what could be called the "standard" way: principles were defined as fixed properties whereas parameters come with a finite range of values and have to be fixed on the basis of PLD. In simpler words, parameters come with a menu of choices (e.g., 'yes' or 'no' to polysynthesis in figure 2), but principles do not have such choices (e.g., the ability to perform recursive operations in Narrow Syntax is not parameterizable). Although this state of affairs is generally accepted as standard, there is a proposal that puts forth the existence of *no-choice parameters* (Biberauer et al. 2013a, Biberauer & Roberts 2013), at times also referred to as mafioso parameters (Biberauer et al. 2013b).

[5] It is perhaps useful to repeat that this is the only sense that has some theoretical substance. Terminological confusion aside, it is fine if one wishes to call minimal, unrelated points of variation 'parameters' as long as one understands that these 'parameters' neither offer fertile ground for broad typological predictions nor constrain the space of grammars that a child has to navigate through in the course of acquisition.

No-choice parameters are the result of a UG devoid of the rich structure assumed in the Government & Binding (GB) era and of functional pressures that influence parameter-setting in a way that creates offers that cannot be declined (Biberauer et al. 2013a), hence the no-choice effect. The parametric hierarchies are emergent and not encoded in UG. They are based on UG in that they derive from the interaction of "UG-given components" with PLD and third factor principles (Biberauer et al. 2013a).

Assessing the proposal of no-choice parameters, the effort of Biberauer et al. (2013a, b) to derive parametric variation without resorting to an overspecified, rich in terms of linguistic primitives, UG is certainly a move in the right direction. It is also theoretically sound to assume that the interaction of the three factors is responsible for deriving variation. However, the concept of no-choice parameters leaves certain issues unclear. The first issue relates to the very nature of *no-choice* parameters. In the original GB sense, it is typical to talk of principles, which by definition are no-choice. Having a theory with both no-choice principles and no-choice parameters, makes available two concepts with the same essence and description but with different names. Since the relevant proposals do not justify on what basis the distinction between these two notions is warranted and pursued, such a duplication of entities should be avoided by virtue of one of the most widely accepted minimalist principles: Occam's razor.

The second issue boils down to the interaction of the three factors in the emergence of no-choice parameters. The hierarchies in Biberauer et al. (2013a), apart from no-choice parameters, also involve parameters that come with two choices, similar to what is illustrated in figure 2. However, it is not explained why the interaction of the very same three factors gives rise to two quite different results: no-choice parameters and parameters in the classical sense (i.e. with a range of finite choices). In other words, it is not clear why the interaction of the same components results to different primitives (no-choice parameters and parameters with choices) as well as what factors are responsible for deriving the difference.

The third issue is related to the degree of discrepancy in the presentation of the notion of no-choice parameter, which makes it difficult to tell apart the theoretical substance behind the notions of principles, parameters, (emergent) no-choice principles and (emergent) no-choice parameters. The following formulations in Biberauer et al. (2013a) are relevant to illustrate the issue: "Our conclusion in relation to the ordering asymmetries discussed in this section is therefore that rethinking a version of Kayne's LCA as a *no-choice parameter* serves to explain structured variation in word orders without either the need to posit a richly specified UG or the need to discount the role uncontroversially played by parsing, a desirable outcome"[6] (p. 6; emphasis added) and "[i]n the context of this type of approach, it becomes possible to see how properties that might previously have been thought of as hard-wired UG principles could actually reduce to emergent *no-choice principles*" (p. 9; emphasis added).

Returning to Chomsky's (2005) three factors in language design, if *principles* are also emergent and not UG-encoded, what is left in UG in the context of the proposal that puts forth emergent parameters/principles? Earlier I have argued that by abandoning a parametric view of UG and by narrowing down our expectations to a few computational principles, we obtain a picture of our biological endowment for language that is easier to work with if the goal is to establish interdisciplinary bridges between linguistics and biology. However, in Biberauer et al. (2013a), UG principles are not UG-encoded and in Biberauer & Roberts (2013) UG specifies "only formal features not intersecting with the set of semantic features", with for-

[6] The Linear Correspondence Axiom (LCA) posits that c-command maps onto precedence relations (Kayne 1994).

mal features being defined as "syntactically visible/grammaticalized features". In the context of establishing interdisciplinary linking hypotheses, it would perhaps be more fruitful if one talks about computational principles and not about grammaticalized features. Of course the latter are assumed to drive syntactic operations —and, in this sense, by talking about the UG-encoded feature Merge or diacritic Move, Biberauer & Roberts (2013) do talk about applications of the core computational principles I refer to here—, however they also open up the can of (terminological) worms. The postulation of features in order to explain grammatical phenomena has been pervasive in linguistics. Although features are traditionally brought up in an attempt to describe certain grammatical phenomena, their substance is debatable, especially if one shifts the focus of inquiry from specific grammars/languages to language from a biolinguistic point view. In this context, for all the reasons outlined in Boeckx (2011b), it seems more useful to talk about principles of computation and not about features.

The last issue to be kept in mind is that, in the context of proposals that put forth the existence of no-choice parameters, the resulting emergent hierarchies may not be UG-encoded but are UG-derived, because they are based on "UG-given components" (Biberauer et al. 2013a). It is possible that some of the empirical issues that I identify in section 2.4 for UG-encoded hierarchies are relevant also in the context of emergent hierarchies. Some of these issues boil down to the architecture of a hierarchically organized system of binary parameters and not to whether the relevant values are encoded in UG or not. Of course, arguing that the issues identified in section 2.4 extend to those emergent hierarchies that deal with variation outside the nominal domain is something that needs demonstration and can only be definitively asserted once the proponents of emergent no-choice parameters articulate the variation space they work with in sufficient detail. Once this is done, it will be possible to work out relations of setting and setability among the relevant points in the hierarchy in a way similar to the analysis pursued in the present work.

In the next section, I will focus on the classical notion of parameter, although the notion of no-choice parameters has perhaps the potential to be developed into an interesting factor in explaining variation once the above issues have been clarified. I will return to the proposal of emergent hierarchies in chapter 3, when I discuss the implications that a theory of variation carries for the task of language acquisition.

2.2. *Different Loci of Variation: The Lay of the Land*

Two of the most perennial questions in linguistics concern (i) the locus and (ii) the nature of variation: Why do languages vary the way (we observe) they do and where does this variation come from? Before turning our attention to interdisciplinary endeavors, it is vital to ensure that our understanding of variation across languages is well-established and minimally defined.

As mentioned already, the traditional claim within the generativist framework is that languages differ in limited ways and variation is encoded in the form of parameters in UG. Yet if language is indeed "an optimal solution to legibility conditions", as Chomsky's (2000) Strong Minimalist Thesis suggests, and if one wishes to put forth the existence of parameters, this existence should make available certain paths that channel variation in limited ways (i.e. interlocked parameters), rather than come in the form of thousands of unrelated parameters. In other words, unrelated parameters as well as the consequent vast amount of combinations of them, apart from being theoretically superfluous in having stripped the notion of parameter off its original theoretical substance, offer no insights in viewing language as an optimally designed system.

Apart from the organization of the parametric space, one has to define the locus of variation. The relevant literature makes reference to four possible loci:

i. parameters that are part of the mental lexicon by being localized on functional heads (lexical parameters),
ii. parameters of a semantic nature (semantic parameters),
iii. parameters that are syntactic in that they pertain to narrow syntax variation (NS parameters), and
iv. parameters that arise at the externalization component; viewed as the product of the externalization process (PF 'parameters' or MPF variants)

Starting off from the first option, taking the lexicon as the locus of variation has been a long-held assumption within P&P, traditionally associated with the so-called Borer-Chomsky Conjecture (BCC), which reflects two views expressed by Borer (1984) and Chomsky (2001):

(1) Variation is restricted to possibilities that the inflectional component makes available (Borer 1984: 3).

(2) Variation is restricted to the lexicon; to a narrow category of (primarily inflectional) morphological properties (Chomsky 2001: 2).

The BCC has been long entertained because it has the advantage of relating parameters to a component of language that already contains (lexical) variation and already reflects a part of language that has to be acquired:

> "An advantage of the BCC is that associating parameter values with lexical entries reduces them to the one part of a language which clearly must be learned anyway. Ultimately, on this view, parametric variation reduces to the fact that different languages have different lexica, in that sound-meaning pairs vary arbitrarily: the most fundamental and inescapable dimension of cross-linguistic variation. The child acquires the values of the parameters valid for its native language as it acquires the vocabulary (more precisely, as it acquires the formal features associated with the functional categories of its native language)". (Roberts & Holmberg 2009: 56-57)

This view by Roberts & Holmberg echoes Roberts & Roussou's (2003) pre-existing claim that "[u]ltimately, this [i.e. the fact that a functional head F might have an overt exponent in one language, while not having one in another language] relates to the fact that different languages have different lexica, in that sound-meaning pairs vary arbitrarily: the most fundamental and inescapable dimension of crosslinguistic variation" (p. 6).

Attributing parametric variation to differences in features of functional heads in the lexicon raises some concerns when one decomposes the concept of the lexicon along the assumptions of an antilexicalist framework like DM (Halle & Marantz 1993). Leaving variation in terms of lexical inventories aside, if in figure 3, List 1 does not consist of internally complex words but only of "roots and features drawn from a universal set" (Pfau 2009: 89), and if the components of syntactic operations allow no variation by virtue of being prewired mechanisms for structure-building operations,[7] the earliest

[7] See Boeckx's (2011a, 2014b) *Strong Uniformity Thesis* (SUT) according to which principles of narrow syntax are not parametrizable.

that variation can enter the model is at MS; the level that morphological operations take place.

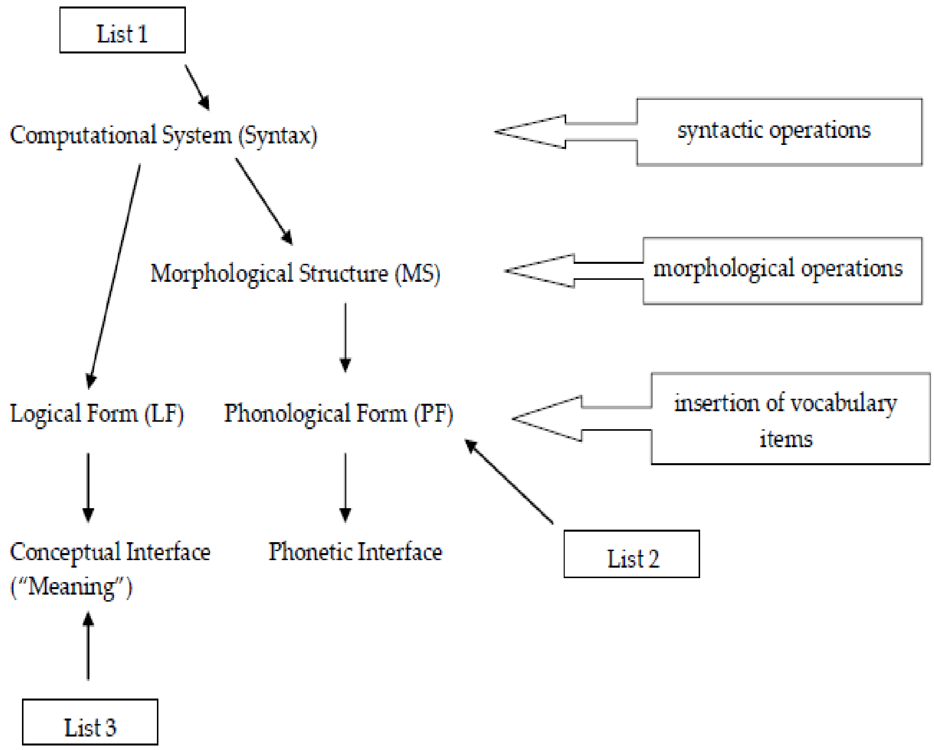


Figure 3: The model of grammar in DM (adapted from Pfau 2009)

Even outside the DM framework, the BCC is in itself a hypothesis to be taken with a pinch of salt. Even if lexical entries have to be learned and so do points of variation in the grammar (one might call these points of variation 'parameters'), there is no independent reason for assuming that these two fall under the same component, nor does this assumption reduce the acquisition workload that the child has to carry out in the course of acquisition. In other words, both grammar and lexical entries will still have to be learned regardless of whether one's theory packages them together. Since this packaging does not reduce the acquisition workload, the former should not be made solely in the name of the latter. Moreover, the alleged advantage of the BCC (recall

Roberts & Holmberg's above quoted position: "[a]n advantage of the BCC is that associating parameter values with lexical entries reduces them to the one part of a language which clearly must be learned anyway") offers no explanatory insights with respect to the nature of variation; on the contrary, it obscures it by relocating it to a poorly investigated component of the language faculty (Newmeyer 2004: 226).

Returning to the null subject parameter discussed earlier, Duguine (2013a) explored data from different languages and suggested that there is no set of formal features that forms a class which would effectively identify and group the relevant items together. In her words, lexical parameters are defined by the formal features of functional categories, subject to crosslinguistic variation, but when one asks what is the property (i.e. formal feature) that sets apart Italian, Catalan, Japanese, etc., from French, English, German, etc., the answer that surfaces is that there is no such property. The reasonable conclusion to draw would be that likewise there is no lexical parameter such as *pro*-drop.

One might wonder whether the point Duguine makes can be valid for other parameters as well. Put differently, *pro*-drop being one of the standard examples of a (lexical) parameter, one wonders whether there really exists in the literature a single example of a lexical parameter that can be accurately classified as such. The unified approach that is offered in Duguine (2013b) according to which the non-*pro*-drop/*pro*-drop difference is a property that arises in the post-syntactic morphological component is a more plausible way to describe the phenomenon at hand. It is also possible that an analysis along these lines can be extended to other parameters that are identified as 'lexical' or 'syntactic' in the literature.

The second locus of variation identified above is that of semantic parameters. Lexical semantics vary and form-sound associations differ across languages but such differences are arbitrary. Ramchand & Svenonius (2008) argue that we can talk about semantic variation, but not about semantic parameters. According to their proposal, languages vary in their inventories of lexical entries, but such differences do not give rise to a parametric system. In line with the assumption that variation is a PF-related matter, Picallo (2014: 3) agrees with Chomsky (2008) in noticing an asymmetry between the two interfaces: Variation is ubiquitous at PF, but no variation is likely to be found at LF.

Chierchia (1998a) presents a different view when he describes semantic parameters. In his words, "[i]f crosslinguistic variation is to be accounted for in terms of parametric differences, then the mass/count noun distinction seems to provide evidence for a semantic parameter" (p. 53). For the purposes of the present work, I will assume that semantic variation exists, as morphophonological variation does, without semantic variation reducing to a discrete parametric system, following the proposal of Ramchand & Svenonius (2008). The fact that form-sound/-sign associations vary across different languages is consistent with the idea that variation arises primarily or even entirely in mode of externalization (Berwick & Chomsky 2011: 41).

Even if Chierchia (1998a) is right in arguing in favor of the existence of semantic parameters, by organizing the variation space in form of parametric hierarchies, the arguments raised against this form of encoding for syntactic parameters in Boeckx & Leivada (2013) should apply in the case of semantic parameters too. As will be explained in further detail in section 2.4, the results obtained on the basis of the two program analyses should be viewed independently of the grammatical status of the parameters under investigation. The program does not see the grammatical status of the parameters in question; it simply traces issues related to the architecture of the system. Perhaps Chierchia does not adopt a proposal that organizes the parameters he describes in the form of a hierarchy, however semantic parameters have been shown to 'leak' too. For example, Chierchia's (1998b) Nominal Mapping Parameter makes typological predictions about three language types. The Nominal Mapping Parameter determines whether NPs in a language denote names of kinds or predicates or both; a distinction stated in terms of the features ±arg (nouns may or may not denote kinds) and ±pred (nouns may or may not denote predicates).

It has been argued though that a number of languages show combinations of patterns that cannot be captured by the predictions of this parameter (e.g., Indonesian discussed in Chung 2000, Brazilian Portuguese in Schmitt & Munn 2002, Afro-Bolivian Spanish in Gutiérrez-Rexach & Sessarego 2011, Greek in Lazaridou-Chatzigoga & Alexandropoulou 2013). This means that exactly as happened in the case of syntactic macroparameters, more fine-grained distinctions have to be introduced in order to do justice to the attested variation. Once these distinctions are translated into more parameters, the variation space will progressively get organized in a hierarchical fashion in a way similar to what is shown in figure 2. In this sense, it is likely that the findings reported in section 2.4 which are based on the parameters identified in Longobardi & Guardiano (2009) and Longobardi et al. (2013) may also be readable in the context of the Nominal Mapping Parameter.

As a matter of fact, Longobardi (2008) represents Chierchia's Nominal Mapping Parameter by means of a two-level hierarchy that consists of two parameters: ± Grammaticalized Person and ± Strong Person. These two parameters are part of the pools of data presented in Longobardi & Guardiano (2009) and Longobardi et al. (2013) and, as such, they are part of the parametric space analyzed in the present work. It thus seems reasonable to think that the concerns raised in section 2.4 about the organizational properties of parametric hierarchies may be relevant also for semantic parameters, once the latter are put into a context that offers a finer articulation of the variation space.

Having discussed the lay of the land for lexical and semantic parameters, the focus now is on the third possible locus of variation which is the most widely discussed one and pertains to syntactic parameters. It has been earlier argued that, following SUT, principles of narrow syntax are not parameterizable (Boeckx 2011a, 2014b). However, a number of studies put forth the existence of what they refer to as 'syntactic parameters/variation'. The argument I would like to put forth here is that even when variation is explicitly dubbed syntactic, a closer look of the respective proposals suggests otherwise. For example, Gallego (2007) aims to offer a syntactic, phasehood-informed account of variation, however his summary of two of the three main points of his account makes explicit reference mainly to *morphology* and not to syntax:

> (i) "there is a correlation between *C* and *v* (the phase heads) in terms of *morphological* richness that boosts their Left Periphery (the richer the *morphology* of *C/v*, the more left-peripheral fronting they can display"
> (ii) "some varieties of verb movement [...] manifest 'domain extension' effects that strongly indicate a syntactic status, triggering the application of a *morphologically* motivated Transfer, referred to as Phase Sliding".
> (Gallego 2007: 380, emphasis added)

Similarly, some of the 63 parameters in Longobardi & Guardiano (2009) are given in (3).

(3) parameter 5 ± feature spread to N
parameter 6 ± number on N
parameter 19 ± plural spread from cardinals

parameter 33 ± feature spread to structured APs
parameter 57 ± feature spread on possessives

These parameters seem to boil down to instances of morphological exponence that involve spreading of morphological markings across elements of different categories. Perhaps such cases can be better described as MPF variants instead of syntactic parameters. It is possible that the entire group of parameters in Longobardi & Guardiano (2009) —given in Appendix A (table 6)— can be reconstructed in morphophonological terms.

This reconstruction has already taken place for a variety of syntactic phenomena. For example, Acedo-Matellán (2010) approaches the Talmyan distinction between satellite-framed and verb-framed languages in terms of the differing morphological realization of Path in the satellite of the verb (i.e. as an affix or as a different word). Similarly, information-seeking questions and echo questions have been traditionally associated with a wh-movement parameter (wh-ex situ and wh-in situ respectively), but recent proposals want the two types of questions to be indistinguishable within NS: "[the] distinction takes place at PF, via intonation" (Vlachos 2008: 13).

Another parameter that figures prominently in the literature on syntactic variation is the head-directionality parameter (also depicted in figure 2) which refers to whether a phrase is head-initial or head-final. This parameter too has been explained in PF terms in Richards (2008b) by means of the Symmetrical Syntax Hypothesis.

(4) *Symmetrical Syntax Hypothesis*
"Syntactic operations/relations make no reference to notions of linear ordering and directionality. (Chomsky 1995: 334, Uriagereka 1998: 217-218, Nunes 1999: 222-223)"
(Richards 2008b: 276)

Richards (2008b) argues that consonant with the Symmetrical Syntax Hypothesis, the head parameter is enforced only at PF. In his words, "this avoids the problems associated with lookahead: a PF-problem — the relative ordering of a head and its complement— receives a PF-solution." (Richards 2008b: 278).

Having seen that a number of proposals aim to reconstruct syntactic parameters in a way that makes reference to the externalization component, it has to be noted that one can find in the literature the opposite scenario too. Approaching points of variation as MPF-decisions pertaining to morphophonology and not to syntax is far from a universal desideratum, as there are recent attempts to illustrate the feasibility of a lexicocentric, feature-based approach to syntactic parameterization. Biberauer (2011 et seq.), for example, brings up the case of constraints on word-order variation —captured via the Final-over-Final Constraint (FOFC; given in (5) and predicting the absence of (6))— in defense of lexicocentric parametric variation.

(5) *FOFC*

A head-final phrase cannot (immediately) dominate a head-initial phrase in the same extended projection.

(Biberauer et al. 2013a)

(6) *[$_{X'}$ [$_{YP}$ Y ZP] X] (adapted from Biberauer 2011: 5, (12d))

Roberts (2010a: 7) endorses this view and calls FOFC "[t]he *signature asymmetry*, showing this parameter [i.e. word-order/linearization] to be non-PF" (emphasis in the original).

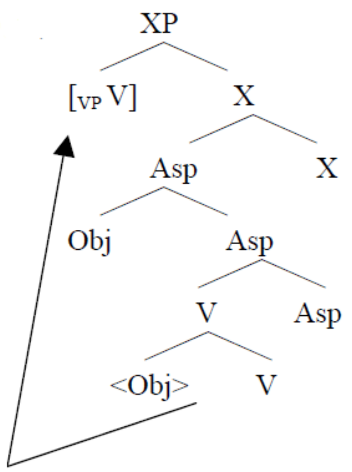
Exploring, however, the predictions of FOFC across different languages, one observes that, contra (5), head-final VPs may immediately dominate head-initial PPs in verb-second languages such as

German, as Biberauer et al. (2008) also acknowledge. The discovery of patterns that induce FOFC-violations rendered necessary a modification of FOFC that sets aside the challenging data from German and other languages by introducing the factor of categorial agreement. FOFC then gets the following revised form:

(7) *[$_{Aux'}$ [$_{VP}$ V O] Aux] (Biberauer et al. 2008)

However, the new formulation of FOFC is not immune to counterexamples either. Hindi, for instance, involves V-O-Aux instances where a head-initial VP is dominated by a head-final VP (see Mahajan 1990 for data). These data are discussed by Sheehan (2013) who argued that FOFC-violating V-O-Aux orders in Hindi are derived via remnant VP movement (A' movement) which is *not* subject to FOFC. She illustrates the underlying structure by the syntactic configuration in (8).

(8)



(Sheehan 2013: 12)

Biberauer et al. (2014a) do not discuss V-O-Aux in Hindi, but they do discuss Latin V-O-Aux structures such as the ones in (9)-(10).

(9) ...adducta quaestio est. [Latin]

adduced.NOM.F.SG *question.NOM.F.SG* *is*
'...the question has been adduced.'
(Biberauer et al. 2014a: 180 from Kühner & Stegmann 1955: 603)

(10) ...damnetur is
condemn.PRES.SUBJ.PASS.3SG *that.3SG.NOM*
qui fabricatus
who.3SG.NOM *manufactured.NOM.M.SG*
gladium est. [Latin]
sword.ACC *be.3SG.PRES*
'...he should be condemned, who manufactured the sword.'
(Biberauer et al. 2014a: 180 from Danckaert 2012a)

Biberauer et al. (2014a: 181) argue that these examples

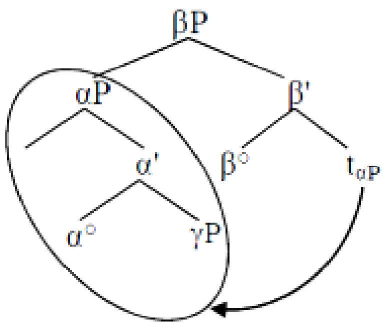
> "would both be FOFC violations if they involved a head-initial VP dominated by a head-final AuxP, but, again, there is evidence that this is not the structure underlying these examples. This emerges most clearly if we consider the transitive deponent case [(10)], where V and O do not bear the same case; more specifically, V is nominative-marked, whereas O is accusative-marked. Taking into account standard Minimalist assumptions about locality and Case assignment, this pattern is not possible if V and O both remain in situ".

In sum, the argument of Biberauer et al. (2014a) is that the observed case-markings in (10) shouldn't be possible if V and O were in situ (in what would indeed count as a FOFC-violating configuration). Since we do get them, some movement must be in place, thus the underlying structure in (10) is not FOFC-violating. However, it is worth to notice that Danckaert (2011) presents S-O-V-Aux (i.e. consistent head-final hence not FOFC-violating) patterns that show exactly the same case assignment as the one observed in (10): V is nominative-marked, whereas O is accusative-marked, as shown in (11). Crucially, this is *not* a marked order, derivable via movement. In fact, Danckaert (2011) argues that these S_{NOM}-O_{ACC}-V_{NOM}-Aux patterns correspond to the neutral order and are “those most frequently attested” (p. 53) in Archaic and Classical Latin. In this context, the argument of Biberauer et al. (2014a) about the non-FOFC violating underlying order of (10) on the basis of the observed case-markings does not look very strong, because it is the same case-markings that surface in the neutral, unmarked order in (11).

(11) ...utilitas amicitiam secuta
utility.NOM friendship.ACC followed.NOM
est. [Latin]
is.3SG.PRES
‘Advantage has followed friendship.’ (= Cic. Lael. 51)
(Danckaert 2011: 53)

Moreover, Danckaert (2012b) claims that the surface Latin V-S-Aux patterns violate FOFC, on the premises of the syntactic analysis pursued in Biberauer et al. (2014a), as such patterns are derived from a head-initial structure, as illustrated in (12).

(12)



(Danckaert 2012b: 29)

Latin is not the only language that seems to have FOFC-violating patterns. Commenting on the alleged absence of V-O-Aux patterns, Walkden (2014) argues that, strictly speaking, it is not true that the V-O-Aux order is never found in Germanic and Old English. He further hypothesizes that the few counterexamples that are available could be the result of scribal error. This is a valid hypothesis, but equally valid is the hypothesis that these examples might be rare but available. It is even more important for the purposes of the present discussion that Walkden (2014: 333) claims that he "simply stipulate[s] a PF filter barring VOAux (which this system is otherwise capable of deriving)". Illuminating in this respect is the following point raised in Haeberli (2008), where the stipulative character of a ban on V-O-Aux is shown:

> "Biberauer and Roberts (2005) propose an analysis of [Old English] for which they claim that "[t]he surface order SVOAux is [...] underivable, as we know it must be" (2005: 36). In a footnote on the same page, the authors admit, however, that there would be a way to derive V-O-Aux. They then discard this option by saying that it is ruled out by a ban on finite TP movement that seems to hold across the Germanic languages. However, the relevance of this point is somewhat mysterious as the crucial derivation does not involve finite TP movement but non-finite TP movement [...]. It is therefore not clear how V-O-Aux could be ruled out in this approach".
>
> (Haeberli 2008: fn. 2)

Naturally, one can evoke once more an argument similar to the one pursued in Biberauer et al. (2014a) for Latin, according to which V-O-Aux structures in Old English and Germanic have been generated via a type of movement that is not sensitive to FOFC. If evoked, this would be a weak argument because it seeks to avoid counterexamples by stipulating further constraints and, in doing so, it begins where it wants to end: structure α is not sensitive to FOFC on the basis of an added part to the definition of FOFC α that posits that structure α is not sensitive to FOFC.

In sum, this discussion of FOFC aimed to show two things: first, it is not clear that V-O-Aux patterns are inexistent across languages. Second, even if one accepts for the sake of discussion that indeed they are, it is not clear that their inexistence is due to a syntactic universal and the arguments given in favor of presenting it as such are purely stipulative. An alternative analysis already exists. Etxepare & Haddican (2013) suggest that Basque verb clusters favor a PF-based analysis of FOFC as opposed to a syntactic one. Walkden (2014) stipulates a PF filter for ruling out V-O-Aux. These options are theoretically more minimal and are compatible with the view entertained here: the locus of variation lies in the externalization component of language.

This discussion of FOFC can serve as an illustration of how proposals that discuss syntactic parameters eventually break under the weight of crosslinguistic evidence. Demonstrating so in the case of FOFC is important because FOFC has been portrayed as the *signature asymmetry* (Roberts 2010a) that (i) weakens a view of the word-order/linearization parameter as an MPF-decision and (ii) provides evidence for assuming a lexicocentric, feature-based approach to variation.

Two other arguments by Roberts (2010b, 2011b) against assuming that all[8] points of variation can be reduced to MPF concern (i) the absence of a non-stipulative way to rule out the existence of NS parameters and (ii) the inability of MPF variants to give rise to hierarchies. These two points are summarized in Boeckx (2014a) in the following way:

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[8] It is important to stress here the fact that Roberts does accept the existence of some PF 'parameters' (what I call 'MPF variants') but also of some NS parameters. Crucially, once one assumes two (or more) flavors of variation, one has to provide some explanation as to why such variation exists and what prevents syntactic operations from specifying some options (resulting to MPF variants) the moment they specify others.

> "While recognizing the existence of realizational 'parameters,' Roberts thinks that it would be wrong to limit variation to the PF-component of the grammar, as he sees no non-stipulative way to exclude syntactic parameters in current minimalist models, hence, he claims, such syntactic options for variation should be exploited as well. [...] Roberts takes realizational parameters to be "dumb" and to be unable to give rise to parametric hierarchies". (Boeckx 2014a: 171)

Starting off from the second point and the proposed inability of PF 'parameters' to give rise to hierarchies, this is a claim pursued in Roberts (2011b), but Roberts (2011a) makes reference to macroparameters and markedness which both entail (parameter-internal) hierarchy. Crucially, Roberts (2011a) claims that markedness principles are "*not* grammatical principles but acquisition strategies (deriving from F[actor]3: computational conservatism of the learning device)" (emphasis in the original). Assuming that markedness principles are the result of acquisition strategies, one cannot restrict markedness to what one may call 'NS parameters', because PF 'parameters' are also part of the acquisition task and are certainly subject to (indeed, third factor) learning generalizations that give rise to 'macroparametric' effects.

Relating Roberts (2011a) to Roberts (2011b), the following paradox arises: On the one hand, PF 'parameters' are "dumb"/unable to give rise to parametric hierarchies but on the other hand, markedness and hierarchy should be there also in the case of PF 'parameters' by virtue of being products of acquisition strategies and not of grammar/NS. A theory cannot have it both ways though; hierarchy is either present or absent. Assuming that it is present, Roberts's argument in favor of the existence of NS parameters on the basis of the absence of hierarchies in the case of PF 'parameters' should be revisited.

In relation to the first point and the absence of a non-stipulative way of ruling out NS parameters, perhaps Roberts (2010a, b) provides a way when he argues that PF 'parameters' are symmetrical and a parameter P is a non-PF one iff the realized variation defined by P contains a gap. FOFC is claimed by him to be a case in point for this view; however, as argued above, it seems that FOFC violations are realized in some languages and that the entire domain of variation for the word-order/linearization parameter is manifested (i.e. consistent head-initial/-final, inverse FOFC, and FOFC). Under these assumptions, first, FOFC shows that word-order is a PF 'parameter', since there is no gap in the realization of the domain of this parameter's predictions. Second, Roberts's view of parametric variation makes available a criterion that defines PF 'parameters', hence it also makes available a way to (empirically) exclude NS parameters.[9]

The last point that is worth commenting on with respect to the above state of affairs pertains to the dubious nature of what counts as an NS parameter vs. a lexical parameter. In Roberts (2010a), FOFC is a case in point of word-order variation, an NS parameter. In Biberauer (2011), FOFC is brought up again in relation to limits in word-order variation, however she uses it as a case study "illustrating the value of a *feature*-based, *lexico*-centric approach to at least certain types of systematic (parametric) variation" (emphasis added). The question that arises is whether FOFC, provided it had no violations, is to be taken as making a point for parametrizable principles of

[9] This discussion remains silent with respect to the credibility of the criterion itself; the goal is to address the argument about the absence of non-stipulative ways to exclude NS parameters. In itself, the criterion is rather weak: Even if one is able to show that PF-decisions ought to be symmetrical —something that awaits demonstration—, there still is a difference between what is realized and what is realizable. It is theoretically possible that a PF 'parameter' shows a gap in the realization of its predictions but this gap is due to independent reasons; a possibility indeed acknowledged in Roberts (2010a).

NS —contra SUT—, for feature-based variation that exists in the lexicon, or both.

In this context, viewing parameters as MPF variants seems a more economical alternative. This view entails that variation is related to the externalization component of language, neatly allowing for a non-overspecified UG and for viewing parameters as emergent properties (in line with Roberts & Holmberg 2009 and Roberts 2011a). Showing that parameters are indeed emergent properties would be a further step towards the direction of having a non-overspecified, biologically plausible theory of UG. I will return to this issue in the next section, and argue that instances of recent sign language emergence suggest that certain core properties of language —even properties traditionally treated as design characteristics— emerge as a response to environmental, externalization-related factors.

This message is well-received by some phonologists too. For example, Samuels (2011: 180) writes that investigating phonological variation is important in the context of discussing linguistic variation, if the latter is indeed confined to (morpho)phonology. Samuels (2011) is right in noticing the connection that exists between the idea of confining variation to the MPF component of grammar and the BCC. Both Borer and Chomsky in their respective formulations of variation —given in (1)-(2) and repeated in (13)-(14)— explicitly refer to the very same part of grammar when they identify the locus of variation: inflectional markers.

(13) Variation is restricted to possibilities that the *inflectional* component makes available (Borer 1984: 3, emphasis added).

(14) Variation is restricted to the lexicon; to a narrow category of (primarily *inflectional*) morphological properties (Chomsky 2001: 2, emphasis added).

In this context, the choice of Samuels (2011) to summarize the state of affairs that emerges when one deals with the topic of language variation with the following quote is well-placed:

> "We don't expect genuine internal variation, for it would be virtually impossible for infants to acquire it. What crucial information would set it? But by the very same reasoning, variation in the external domain is expected, indeed even natural if the system, like much else in basic biology, doesn't specify its full structural details". (Uriagereka 2007: 110)

All in all, the idea entertained so far is that linguistic variation is confined to the externalization component. At the same time, much of recent work supports the opposite idea; namely, that variation is syntactic and comes in the form of parameters, either UG-encoded or UG-derived. The point to which I will turn my attention in the remaining sections of this chapter is whether there is empirical evidence that casts doubt on the feasibility of the notion of (syntactic) parameters. I will pursue this topic through (i) the investigation of cases of recent language emergence and (ii) the examination of parametric hierarchies.

2.3 Towards a Uniform Theory of Variation

On the contrary to what one observes in the linguistic literature, in biology, the robustness of the link between the biological makeup of an organism and the environmental influences that affect its development is made explicit when one examines the phenotypical properties of an organism. This point has been made even in the case of language. Genes contribute in determining the capacities of organisms, yet the limits of these capacities may never be explored, depending on how adequate the environmental factor eventually proves to be;[10] in other words, “human beings can speak because they have the right genes and the right environment” (Lewontin 2000: 28).

Linguists, on the other hand, have often argued that a distinction should be made between I(nternal)-language and E(xternal)-language, viewing language from a cognitive and a socio-cultural perspective respectively. Different accounts in the literature lay emphasis on different aspects of the I- vs. E-language distinction, most of them however, agree that such a distinction is viable. Yet linguistic data coming from cases of language emergence in its earliest stages show an area of intersection between what lies behind the terms ‘I-/E-language’; an intersection that reflects the point where the development of innate traits (i-properties) gets affected by environmental, externalization-related triggers (e-factors).

The idea explored in this section is that certain properties of language emerge gradually due to the need to meet communicative, externalization-related needs. The underlying assumption is that if language emergence is in its earliest stages, the time that has elapsed is not enough for language to have already undergone significant environmentally driven adaptations. The prediction that follows is that some i-properties would be still under development into these recently emerged languages. If this claim can be supported by empirical facts, a uniform theory of variation can be defended.

Data that come from fieldwork on specific sign languages such as Al-Sayyid Bedouin Sign Language and Providence Island Sign Language seem to be in agreement with respect to the gradual emergence of certain aspects of variation. Such observations point to the ‘surfacy’ nature of points of variation that are traditionally called ‘parametric’ and treated as UG-wired. If certain grammatical properties are shown

[10] However, cf. Lewontin (2000: 28) on caveats related to the formulation of the empty bucket metaphor.

to be absent in the early stages of life of a recently emerged language, their absence is an argument in favor of viewing points of variation across grammars (i.e. 'parameters') as emergent properties that develop over time and in order to meet externalization-related needs. Chomsky has acknowledged this possibility over three decades ago, when he wrote that "it is entirely conceivable that some complex structures just aren't developed by a large number of people, perhaps because the degree of stimulation in their external environment isn't sufficient for them to develop" (Chomsky 1980: 176). In this context, it seems more reasonable to develop a theory of variation that treats grammatical markers as realizational, MPF variants rather than as the outcome of parametrized syntactic operations or as UG-specified principles with unfixed values.

2.3.1 The Emergence of Variation

Al-Sayyid Bedouin Sign Language (ABSL) is a language that first appeared about 75-80 years ago within a Bedouin community in Israel. The presence of a gene for nonsyndromic, profound pre-lingual neurosensory deafness (Scott et al. 1995) within the endogamous community resulted in the birth of a proportionately large population of deaf individuals (≈100 in a population of ≈3500) in a relatively short period of time (Aronoff et al. 2008).

ABSL can be treated as a case of truly spontaneous language emergence —perhaps the most recently documented one— and as such a very crucial source of insights into the early stages of language genesis.[11] A language that bears similarities to ABSL in terms of

[11] A point that merits clarification here is whether ABSL is indeed a case of language emergence de novo or a case of creolization. Both views are found in the literature: On the one hand, Hurford (2012) refers to it as "arguably a creole"

emergence is Providence Island Sign Language, once known by the majority of the people on Providence Island at the Caribbean sea (Washabaugh 1986), but now “nearly extinct” (Lewis et al. 2014).

Fieldwork on ABSL suggests that the development of certain markers, but also of design properties of language, such as signifier/signified-consistency (else known as ‘semanticity’ in Hockett’s 1960 terminology), are absent from the production of the first-generation signers and develop gradually. Their development is subject to environmental factors (e.g., time, input from previous cohorts, etc.) and reflects environmental needs (e.g., size of the community, distribution of speakers, degree of interaction, etc.). If grammaticalization is shown to develop gradually and in response to environmental factors, then the markers themselves —which are points of variation across grammars, traditionally referred to as ‘parameters’— develop gradually. They develop in response to environmental factors as well, and under these assumptions, the link between points of variation and the externalization process is hard to miss.

Grammaticalization is a linguistic process whereby lexical items lose some of their phonological substance and/or semantic

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(p. 456) and notices that it shows properties observed for other creole languages. On the other hand, Sandler et al. (2011) talk about language development de novo. Knowing whether ABSL is a creole or not is important when it comes to interpreting issues pertaining to the development of grammatical markers. In a discussion of why particular properties of grammar are manifested the way they are in ABSL as well as what are the implications of this manifestation for language development and the role of the environment, one needs to know whether the properties under examination are the properties of a language evolved from scratch or whether they are the impoverished residues of a pidgin and/or the languages behind it. Given the absence of a clear account for the existence of certain creole characteristics —for example, there is no reference to the development of a pidgin or to the existence of a superstrate language behind ABSL—, it seems that this language should be viewed as a case of language emergence de novo (as argued in Sandler et al. 2011) and not as a creole.

specificity and develop morphological or syntactic functions. In a nutshell, the process of grammaticalization entails a gradual progression from something being a semantically contentful item (i.e. a lexical element) to a grammatical marker (i.e. a functional element).

With respect to grammaticalization, Meir et al. (2010) argue that ABSL first-generation signers often break an event that requires two arguments into two clauses (i.e. two verb signs that each predicates of a different argument). For example, a description of a girl feeding a woman would be realized with two SV clauses rather than a single SOV:[12] WOMAN SIT, GIRL FEED instead of GIRL WOMAN FEED. The conclusion that Meir et al. (2010) draw based on their data from ABSL is a very important one: language takes time to develop grammatical markers such as the ones that facilitate distinguishing between the subject and the object phrases in a clause. This claim suggests that grammaticalization is an environmentally driven process and it is not an accident that its occurrence coincides with the period of language development during which syntactic and morphophonological properties of language need to develop as means to meet environmental needs.

Grammaticalization is one of the ways to enhance (grammatical) complexity in language since, in itself, complexity is linked with the emergence of finer grammatical markers, most of which are more often than not subsumed under the designation ‘parameters’. If certain markers of complexity are shown to be absent in the early stages

[12] SOV is the prevalent word-order among ABSL signers, however it is worth stressing that SOV is the *prevalent* order from the second generation of signers onwards but variation still exists given that Sandler et al. (2005: 2663) report the existence of some (S)VO patterns. The fact that SOV patterns became robust in the second generation of speakers illustrates the existence of variation when certain grammatical properties are still emerging. This variation is an indication that word-order should indeed be better viewed a surfacy decision that allows for varying realizations, rather than a fixed, deeply rooted syntactic parameter.

of the life of a recently emerged language, this absence is an argument in favor of viewing points of variation across grammars (i.e. 'parameters') as emergent properties that develop over time and in order to meet environmental, externalization-related needs. In this context, it seems more reasonable to make an effort to approach and describe these markers as MPF variants rather than as the outcome of parametrized syntactic operations or as UG-specified principles with unfixed values. In relation to the development of grammatical markers, Washabaugh (1986) has argued for the case of Providence Island Sign Language that the absence of consistent, direct *interaction* among deaf signers on Providence Island affected the development of complexity and this can account for the simplicity of the structure of this language. Studies on ABSL corroborate this claim by reporting a gradual emergence of certain language characteristics in both prosodic and syntactic structure (Sandler et al. 2005, 2011, Meir et al. 2010).

Having observed the absence of certain grammatical markers in the early stages of language emergence de novo, as this is witnessed in the case of ABSL, the bottom-line for a theory of variation is that linguistic complexity accrues over time and that 'parameters' should better be viewed as emergent properties. If they are indeed, then arguments in favor of linking points of variation with e-factors (i.e. environment, externalization) are claims that do not need much further justification.

The emergent nature of certain language properties is shown to be true also in the cases of core, invariant principles. In other words, the question that arises now is whether the absence of certain properties could be robust enough to also touch upon one of Hockett's (1960) design characteristics of human language: the fact that there are stable associations between speech sounds, signs, or components of communication in the tactile modality and specific meanings; a fact known as semanticity. The roots of semanticity lie in the signifier/signified association which dates back to 1916, when de Saussure introduced his 'theory of the sign' and defined the sign as being made up of a matched pair that consists of a signifier (i.e. a word, a string of sounds, etc.) and a signified (i.e. a denoted concept). The pairings of sound/sign and meaning are synchronically stable within a language, meaning that the fact that the word 'salt' denotes the concept SALT for speakers of English reflects a synchronically consistent association that disallows inter- or intraspeaker variation in general.

Systematicity and signifier/signified-consistency both refer precisely to the non-fluid nature of this association, in the sense that in English, 'salt' stands for a specific white, crystalline mineral. Speakers of this language will form the same signifier/signified association in a consistent fashion, that is, without changing 'salt' into another string of sounds for denoting SALT, but also without attaching to this string of sounds a different concept.[13] It seems that signifier/signified-consistency (signing-consistency for the purposes of the present discussion since the emphasis is on sign language) is a cardinal property of language design. At the same time, judging from its absence from newly emerged languages, it is perhaps the most credible indication that i-properties develop by adaptation to e-factors.

Studies on different sign languages are in agreement with respect to the absence of signing-consistency in the early stages of development of a language. Washabaugh (1986) for Providence Island Sign Language, Senghas et al. (1997) for Nicaraguan Sign Language[14],

[13] Instances of synonymy and polysemy are of no interest here since they just add a layer of complexity to the sign-/sound-meaning association, but do not entail that signers/speakers inconsistently use different signifiers to refer to a signified or vice versa.

[14] Since the late 1970s in Nicaragua, a number of deaf children and adolescents were brought together in special education programs and a sign language emerged. As Senghas (2005) describes, students spontaneously began using signs and these signs have been taken up by the new students every year since then.

and Sandler et al. (2011) for ABSL, all give similar reports on how consistency improves over new generations of speakers. To illustrate the absence of signing-consistency with an example, figure 4 (taken from Meir et al. 2010) shows three different variants of the sign CAT in ABSL:

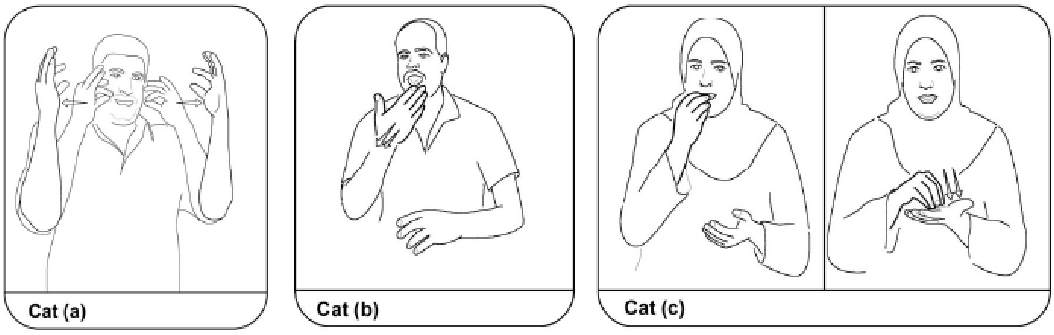

Figure 4: Three variants of CAT in ABSL (Meir et al. 2010)

Washabaugh (1986) notices the absence of signing-correction and signing-consistency in the case of Providence Island Sign Language; he suggests that signers do not correct their peers for incorrect signing and there is a great deal of variation in the descriptive signs people use to refer to other people. Correction is present in the case of ABSL (Meir et al. 2010); this difference between the two languages once more reflects the environment factor. More specifically, ABSL is in use among the members of a tight-knit community and this degree of interaction allows room for a rapid growth of consistency and correction, whereas the number of signers on Providence Island is small and their distribution wide.

For Nicaraguan Sign Language, Senghas et al. (1997) note the existence of verbs that include some use of spatial direction in first generation signers "but not consistently or contrastively; [use of spatial direction] is therefore not yet a morphological device indicating argument structure" (p. 553). On the contrary, the second generation makes use of "spatial direction on verbs quite consistently, and for contrastive purposes, within and across subjects" (p. 553), whereas a consistent verb agreement system is argued to take two to three generations to develop in Israeli Sign Language[15] (Padden et al. 2010).

Duality of patterning (DoP) is another characteristic that is part of what Hockett (1960) called "design features of human language". It refers to the property of the human language to have discrete, meaningful units (i.e. morphemes) that are made from discrete, non-meaningful units (i.e. phonemes or their sign language equivalents). For Hockett, the existence of DoP is related to the level of complexity that a system like language acquires:[16] "There is excellent reason to believe that duality of patterning was the last property to be developed, because one can find little if any reason why a communicative system should have this property unless it is highly complicated" (p. 95). Being a combinatorial property at the root of language (Rosselló 2006), DoP is a property of sign languages as well. The signs are made up of features such as hand configuration, location, movement, etc.; features that correspond to the phonemes one finds in spoken languages (Stokoe 1960). However, the status of DoP as a design property has been challenged since Aronoff et al. (2008) propose that ABSL does not show it: "The evidence we have amassed in our research on ABSL, however, points away from the systematic meaningless level of structure, although the language clearly has a robust basic syntax and a rich communicative repertoire" (p. 134). These authors base their claim on the absence of minimal pairs arising

[15] Israeli Sign language evolved in "a pidgin-like situation" among members of the Israeli deaf community beginning about 75 years ago (Meir et al. 2010: 271).

[16] It has been argued that the link between complexity and DoP is not that of mere relation, but of causation: It is the need to control structural complexity and reduce the size of the morphological storage that probably facilitated the emergence of DoP (Fortuny 2010).

from the substitution of meaningless parts (i.e. the equivalents of phonemes) and they attribute the similarity observed across some signs to iconicity rather than to substitution of meaningless contrastive formational elements.

To put findings from sign languages in perspective, one of the roles of the biolinguistic enterprise is to approach linguistic results from a biological point of view. Thus the following question arises: What are the implications of the above reported findings from sign languages for a biologically plausible theory of UG? Agreeing that the goal is to minimize the content of UG by approaching it from below (Chomsky 2007), the analogies have to be drawn with the right flavor of biological theory for this question to be answered in the most optimal way. One such flavor, explicitly acknowledged in Chomsky's recent work (e.g., Chomsky 2007, 2010), is Evolutionary Developmental Biology (evo-devo).

Evo-devo is a branch of theoretical biology that "offers both an account of developmental processes and also new integrative frameworks for analyzing interactions between development and evolution" (Robert 2002: 591). Building on his claim for the existence of three sets of factors that come into play in language design, Chomsky (2007: 3) has argued that "[s]ome of the third factor principles have the flavor of the constraints that enter into all facets of growth and evolution, and that are now being explored intensively in the 'evo-devo revolution'". Since evo-devo is a heterogeneous theory with a diverse range of perspectives (Robert 2002: 597), it would be useful to be more specific with respect to what exactly Chomsky refers to when he talks about evo-devo. Benítez-Burraco & Longa (2010: 310) are right to notice that Chomsky talks about a gene-centered theory (evo-devo$_{GEN}$). The following parts in Chomsky (2007) are telling:

> "Within the 'biolinguistic perspective' that began to take shape fifty years ago, the concern is transmuted into the effort to de-

> termine *the genetic endowment of the faculty of language FL*, understood to be a 'cognitive organ', in this case virtually shared among humans and in crucial respects unique to them, hence a kind of species property." (p. 1, emphasis added)

> "The conclusion that Merge falls within UG holds whether such recursive generation is unique to FL or is appropriated from other systems. If the latter, *there still must be a genetic instruction to use Merge* to form structured linguistic expressions satisfying the interface conditions."
> (p. 7, emphasis added)

Benítez-Burraco & Longa (2010) argue that if one of the goals of the biolinguistic enterprise is to reduce the role of genetic endowment in relation to language (in line with Chomsky's idea to approach UG from below), evo-devo$_{GEN}$ does not seem an accurate analogy to pursue. On the basis of the linguistic properties observed across newly emerged sign languages, a genocentric perspective does not seem to do justice neither to the role of environmental factors nor to the developmental properties of the system itself.

Following Benítez-Burraco & Longa (2010), I take Developmental Systems Theory (DST, Oyama 1985 et seq.) to be a better suited evo-devo theory than evo-devo$_{GEN}$ for accommodating the aforementioned different types of developmental resources in the case of language. DST replaces the genocentric perspective with the vision that genes and other developmental resources are on a par (Griffiths & Knight 1998).

In this sense,

> "DST is a general theoretical perspective on development, heredity, and evolution, according to which the need exists to reduce the importance that genes were traditionally given. According to DST, development does not entail any kind of preexisting genetic program; genes are not the source of the form. Quite the opposite: Genes are just one of many developmental resources. Therefore, DST rejects the idea that genes are endowed with any special directive power. The main notion of

> DST is that of ‘developmental system’, which is to be understood as the overall collection of heterogeneous influences on development”. (Benítez-Burraco & Longa 2010: 318)

In the literature coming from biology, an interaction, rather than a distinction, between genes and environment is put forth when one examines the i-properties of organisms. The lesson linguistics can learn from biology is highly relevant as to how internalist inquiries are formulated and revolves around the idea that genes determine the capacities of organisms, yet the course of developing these capacities depends also on other factors. A genocentric perspective to UG cannot accommodate the data from newly emerged sign languages, neither can it provide informative answers to the questions that biolinguistics deals with. Lehrman’s following dictum seems to hold in the case of language: “[...] although the idea that behavior patterns are ‘blueprinted’ or ‘encoded’ in the genome is a perfectly appropriate and instructive way of talking about certain problems of genetics and evolution, it does not in any way deal with the kinds of questions about behavioural development to which it is so often applied” (Lehrman 1970: 35).

It is important to note at this point that in the case of design properties of language, the role of the environment is crucial in developing them, however it should be clear that the seeds from which capacities evolve lie with biological endowment. Moreover, although it is true that what gets externalized reflects in part what is internal, this does not entail that if a design property is not manifested in what is externalized (i.e. in case a language does not exhibit a design property), the status of this property as a design property is disproved.

The main conclusion to be drawn by the above data from ABSL and other sign languages is suggestive of the role of the environment in deriving certain properties of language. [17] Properties like grammaticalization have more often than not been treated as pertinent to the most deeply rooted constituents of the language faculty, be it the lexicon or NS, however, by illustrating their gradual emergence, one establishes a critical relation between the surfacy character of points of variation and the externalization process which is what facilitates their emergence. Put differently, if points of variation arise in the course of the externalization process, their nature as emergent properties alludes to their character as realizational variants rather than the result of UG-/NS-rooted variation. In this theory of variation, a more minimal and biologically plausible version of UG arises; a non-parametric version of UG.

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[17] Despite the fact that I refer to data from sign languages, all the drawn conclusions would be equally supported by data from spoken languages too. In spoken languages the role of the environment in deriving certain properties is crucial too. Gil (2009) suggests that the level of grammatical complexity that is needed for some contemporary cultures is no greater than that of an Isolating-Monocategorial-Associational (IMA) language. The second characteristic of such a language, which according to Gil characterizes an early stage in the phylogenetic development of human language, refers to the absence of distinct syntactic categories. According to the description of the IMA prototype in terms of complexity given in Gil (2009), no contemporary language absolutely satisfies this prototype, but there are some examples of Relative IMA languages. One such language is Riau Indonesian described in Gil (1994 et seq.).

Basic sentence structure in Riau Indonesian might consist entirely of items that reflect the underspecified, monocategorial character of the language. Gil (2009) describes (i) as underspecified in terms of thematic roles.

(i) Ayam makan. [Riau Indonesian]
chicken *eat*
(An association of CHICKEN and EAT) (Gil 2009: 23)

(i) can mean, depending on the context, that 'the chicken is/was/will be eating' or 'the chickens that were eaten' or 'the reason chickens eat'. It seems that lexical categories such as V and N or functional categories such as T are underspecified in Riau Indonesian and the classification of *ayam* or *makan* in terms of their categorial status is not intrinsic to syntax but arises post-syntactically.

In the next section, I will defend a non-parametric version of UG from yet another perspective, by investigating the properties of parametric hierarchies. I will first present the properties of parametric hierarchies by discussing in further detail the features of the network presented in figure 2 and then I will analyze parametric hierarchies in a novel way, showing that this way of organizing variation runs into certain empirical problems.

2.4 Interlocked Parameters and Parametric Hierarchies

The aim of this section is to examine whether the notion of interlocked parameters is an empirically sound concept in relation to understanding what the primitives of the initial state of FL are. As mentioned already, interlocked parameters seem to be a concept that is theoretically sound and well-motivated, however crosslinguistic evidence suggests that the minimal, well-organized picture shown in figure 2 has to be further articulated in various points in order to accommodate the variation that really exists.

It is worth highlighting again that the GB notion of parameter did not intend to assume thousands or millions of minimal points of variation as primitives of UG but instead made certain predictions with respect to the existence of specific parametric paths. This state of affairs is theoretically appealing in the sense that it reduces acquisition to a limited range of 'set-menu' options. According to the schema in figure 2, languages differ in certain ways and certain combinations of parameters are shown to be unavailable: For example, a language cannot have both 'verb attraction' and 'serial verbs' set to 'yes', presumably because there is no known language manifesting both. Similarly, according to the same hierarchy, English says 'no' to serial verbs. However, data given in Tallerman (1998: 81) suggest that some serial verb constructions still exist in English. To complicate things further, where would Hebrew and Finnish be placed on the schema in figure 2 in terms of the *pro*-drop parameter? Of course, one would probably reply that, since Hebrew and Finnish exhibit mixed behavior, *pro*-drop as a macroparameter should be articulated in more detail to capture the different manifestations of the parameter's value across syntactic environments.

If we do articulate the parametric space in further detail, the first concern that arises is that of an overspecified UG; of a version of linguistic primitives that makes the establishment of interdisciplinary bridges more difficult to pursue. Yet this is not the only issue to be addressed. The parametric hierarchy in figure 2 proceeds in a binary fashion from top to bottom. In other words, the overall hierarchy consists of theoretically appealing, neat and binary 'set-menu' parametric paths. But if one does articulate the parametric space in more detail, as one should do in order to obtain a picture that does justice to the attested variation, the outcome does not look as neat as figure 2 suggests. Once more fine-grained relationships among parameters are integrated in the hierarchy, figure 1 would progressively convert into figure 5. Despite the fact that these two figures have the same hierarchical architecture, the difference between figure 2 and figure 5 is sharp.

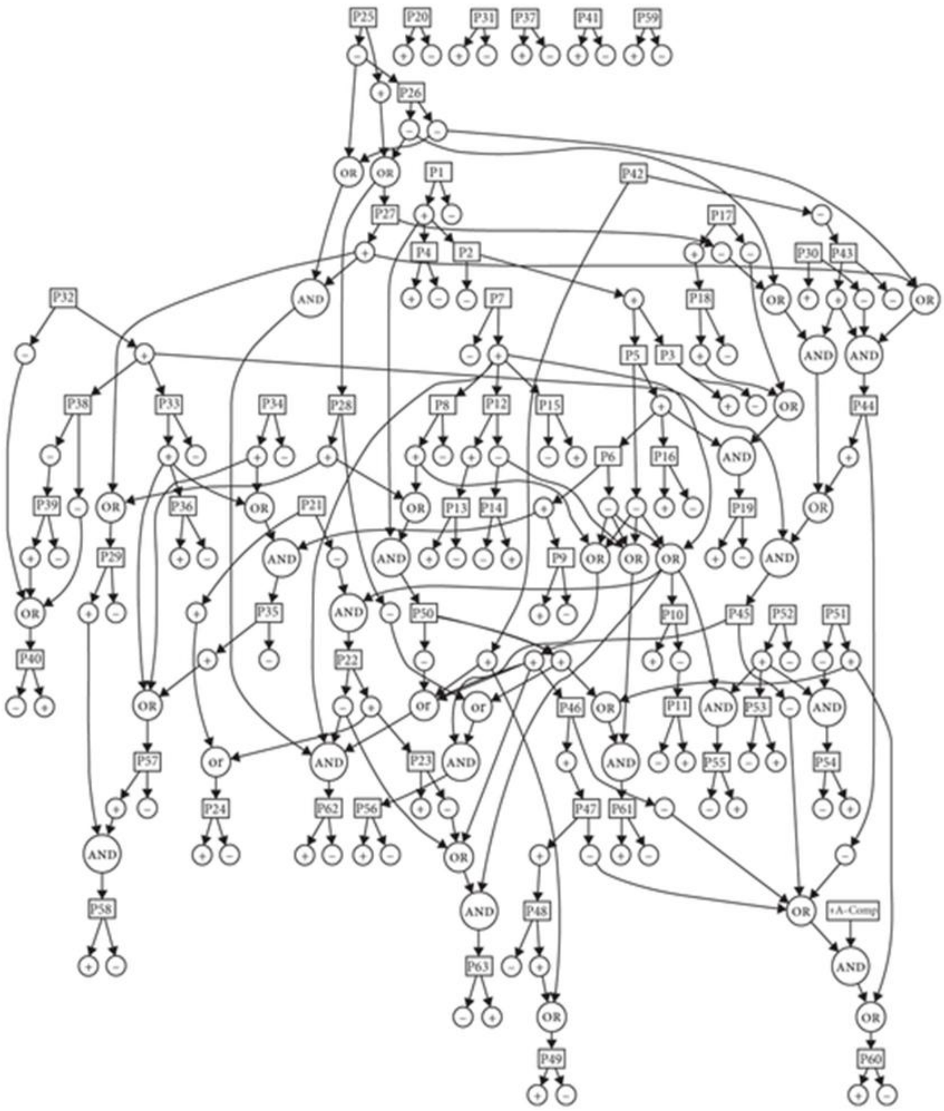

Figure 5: Parametric hierarchies in the nominal domain (Longobardi 2012 from Rigon 2009)

Another concern pertains to crosslinguistic dissimilarity of depicted 'set-menu' options. Assuming schematic representations that start off with a top parameter such as polysynthesis in figure 2, a child acquiring Warlpiri would have to set two parameters before reaching the end of the 'set-menu' option (i.e. polysynthesis to 'yes' and adjective neutralize to 'noun'), whereas a child acquiring Spanish would have to set five parameters before setting *pro*-drop to 'yes' and reach the end of her option. In figure 2, the differences appear rather robust: there exists a 3:1 ratio —which turns into 5:1 if one focuses only on the dependent parameters of the schema[18]— between the parameters that await setting in Spanish vs. Warlpiri.

One could say here that this non-trivial difference is the result of figure 2 covering a quite large amount of parametric space while not being articulated enough. If the equivalent calculations are done for Longobardi & Guardiano's (2009; henceforth, L&G) pool of data, a schematic depiction of which is given in figure 5 and a table with all the parameters in Appendix A, one observes that the discrepancies that arise from the setability of 63 DP parameters in 28 languages are again quite wide-ranged. The maximum difference is found between Grico and Latin: 21:10 for the dependent parameters of the pool of data (29:18 in the overall) with the raw numbers for settable dependent parameters being 42 and 20 (58 and 36 in the overall) for Grico and Latin respectively.

Before I proceed to the analysis of the hierarchy in figure 5, it is important to stress that if this type of hierarchical organization of parameters is shown to run into empirical problems (e.g., if it is shown

[18] This is a not so arbitrary restriction. The one non-dependent parameter in figure 2 is common in all languages in the network. In other words, it *must* be set in all languages that appear on this parameter schema. The question of comparative crosslinguistic dissimilarity aims to shed light on how different the acquisition paths turn out to be once the 'set-menu' options enter the equation, that is, when different languages follow different ways. Therefore, the 5:1 ratio of the dependent parameters in figure 2 is a rather important indication. If Spanish and Warlpiri are understood here for expository purposes as whatever languages correspond to the 'set-menu' options they follow in figure 2, the fact that the child that acquires Spanish has to do five times the acquisition work of the child acquiring Warlpiri is a rather surprising finding, given that the acquisition period is crosslinguistically uniform.

to be not deterministic enough or if it has subnetworks that run into loops or that involve redundant branches), variation should not be described as a part of UG that specifies 'set-menu' parametric options anymore. This, in effect, will lead to the exploration of the externalization components, and the lack of certain constraints therein, as the locus of variation, especially since this is the simpler theory: in Hornstein's (2009: 166) words, "methodologically speaking, the burden of proof is on those that postulate UG specified parameters, as this is the richer theory".

2.4.1 Analyzing Parametric Hierarchies

Outside the generativist persuasion, it has been argued that claims of theories of UG are empirically false, unfalsifiable or misleading because they refer to tendencies and not to universals (Evans & Levinson 2009). The third possibility does not need an extensive response. We can consider linguistic recursion, defined as the ability to generate an infinite set of hierarchically structured expressions by using recursive operations in syntax, as a property shared by all languages, as a universal or as "the foundational linguistic universal" as Watumull et al. (2014: 6) call it. With respect to UG being empirically false, if we have successfully identified a linguistic universal, then at least some parts of UG theories are correct. The findings of this section are more important in relation to the second point of Evans & Levinson (2009): unfalsifiability. This criticism against UG seems ill-grounded, for the purpose of this section is precisely to shed light to the deeper properties of a UG primitive: the notion of parametric hierarchy. This exploration is a 'calculatory' exploration that measures relations between nodes in a network and not a linguist's personal view on the interpretation of some linguistic data.

This exploration will be conducted by looking at the relations of setability that are formed in two pools of data from the nominal domain. These two pools of data have a partial overlap both in terms of parameters but also in terms of languages, but they show a sufficient degree of difference to be addressed independently. Another important point to highlight here is that despite the fact that the present discussion revolves around two specific sets of parameters that come from the nominal domain, it is the notion of interlocked parameters and the resulting hierarchies as such that are addressed. The identified properties are expected to exhibit very close parallels to all pools of data —of sufficient detail— that assume interlocked parameters (for example, the dozens of functional heads in the left periphery), regardless of what functional domain one chooses to focus on. Put differently, dependencies and states aside, the developed tool does not see the linguistic status of the parameters under examination; it simply traces issues related to their existence. More accurately, it reads logical expressions which are formed by the conjunction of Boolean literals (to construct a very simple hypothetical case: for parameter 27 to reach a setability state [27set], conditions [7+] AND [21-] have to be satisfied). Of course, the tool is oblivious as to whether the mutually exclusive values of a parameter that it may trace in a logical expression —a fact that obviously makes this parametric path non-realizable and shows the system not to be deterministic enough since it predicts as theoretically possible a setability path that is practically impossible to realize— target a grammatical phenomenon that pertains to this functional domain instead of another.

Since logical expressions like the one given above are what all models of interlocked parameters have in common, any observed problems related to this model are highly likely to be found in all such models, once a sufficient amount of languages and parameters is built in their respective pools of data. These problems are the result of capturing the linguistic patterns observed across a fair amount of languages by means of hierarchies; they are problems *inherent* to the concept of interlocked parameters and, by extension, inherent to any theory that postulates a UG that involves interlocked parameters.

L&G describe the dependencies that correspond to specific DP parameters across a variety of languages in meticulous detail and further tabularize their results in a transparent way that shows setting but also setability. This makes their pool of data a unique candidate for demonstrating the properties of parametric hierarchies by means of a specific tool: program modelling. The first program was developed on the basis of the properties of the L&G pool of data and customized to address specific questions about issues that arise from the hierarchical organization of interlocked parameters; issues that underlie the networks in figures 2 and 5.

These questions involve:

i. the concept of setability (is there always one way to reach setability of a given parameter *within* a given language as figure 2 neatly suggests?),
ii. crosslinguistic uniformity (do all languages set roughly the same number of parameters or are the big differences observed in figure 2 preserved regardless of how articulated the parametric domain is?),
iii. the notion of parametric dependencies from an empirical point of view (once a sufficient number of languages and parameters is built in, do parametric dependencies produce networks that end up running into loops or involving mutually exclusive values within the very same path?),
iv. the tendency of languages to go for the easier rather than the most complex setability path, if a dependency predicts that

there are more than one ways to reach setability of a parameter,

v. the system itself; whether it is deterministic enough or whether it predicts an inordinate number of setability ways that are *not* manifested in any language, and
vi. the structural properties of the networks that correspond to every dependent parameter in the pool of data at hand.

Finding the answers to these questions can be informative in relation to the feasibility of acquisition models that work with interlocked parameters. In addition to this, the obtained answers will be revealing as to the contents of UG. The grammatical phenomena that L&G describe are meant to be understood as parameters of UG. In their words,

> "grammar acquisition should reduce, for a substantial part, to parameter setting, and the core grammar of every natural language can in principle be represented by a string of binary symbols (e.g., a succession of 0,1 or +, -; cf. Clark and Roberts, 1993), each coding the value of a parameter of UG". (p. 1684)

2.4.2 Pool of Data I

L&G identify 63 binary parameters in the DP domain, listed in table 6, appendix A. Before describing the pool of data —on which the first program and the first analysis are based—, two discrepancies between table 6 and the data set that the program received as input (henceforth, program input) must be noted. First, what is referred to as parameter 62 in table 6 was excluded from the program input due to an inconsistency that exists between the states that the dependency shows as necessary for 62 to be able to be set and the states that some languages have when setting 62 in reality.[19] This reduces the total number of the discussed parameters to 62, and what appears as parameter 62 in the following analyses corresponds to parameter 63 (± Grammaticalized Geographical Article) in table 6.

The second discrepancy refers to the dependency that gives rise to the setability of parameter 60: None of the five possible ways to reach [60set] is satisfied for Modern English and Norwegian and yet both languages set parameter 60. This parameter was not excluded from the program input; instead the dependency that gives rise to its setability was modified into {51+ OR 43- OR 44- OR 45- OR 46- OR 47-}.[20]

Returning to the pool of data, this consists of values for parameters spanning across 23 contemporary and 5 ancient languages:

> "The 28 languages were chosen from the Indo-European ones with six exceptions. They are the following: Italian (It), Salentino (Sal), Spanish (Sp), French (Fr), Portuguese (Ptg), Rumanian (Rum), Latin (Lat), Classical Greek (ClG), New Testament Greek (NTG), Grico (Gri), Modern Greek (Grk), Gothic (Got), Old English (OE), Modern English (E), German (D), Norwegian (Nor), Bulgarian (Blg), Serbo-Croatian (SC), Russian (Rus), Irish (Ir), Welsh (Wel), Hebrew (Heb), Arabic (Ar), Wolof (Wo), Hungarian (Hu), Finnish (Fin), Hindi (Hi), and

[19] More specifically, from the six languages that set parameter 62 according to table 6, only two (i.e. Irish and Welsh) show up with combinations of parameter states that fall within the range of combinations that the dependency shows as necessary for 62 to be settable; the remaining four (i.e. Old English, Hebrew, Arabic, and Wolof) do not. Since the table shows that parameter 62 is eventually set in these four languages, this means that the dependency has to be amended, hence its exclusion from all analyses below. As Giuseppe Longobardi (personal communication) also points out, it was precisely this parameter that was eliminated in their updated database and it was again this parameter that was left out in subsequent work (e.g., Colonna et al. 2010).

[20] Thanks are due to Giuseppe Longobardi for providing the modification that allowed this parameter to be included in the program input. The [A-compl] part of the dependency was not taken into account since it is not part of the pool of data.

> Basque (Bas). The basic alternative states of each parameter are encoded as '+' and '-' in Table [6]. [...]
>
> Within the chosen DP module, further subdomains can be distinguished: the status of various features, such as Person, Number, Gender (param. 1-6), Definiteness (roughly 7–16), Countability and related concepts (17-24), and their impact on the syntax/semantic mapping; the grammar of genitive Case (25-31); the properties of adjectival and relative modification (32-41); the position of the head noun with respect to various elements of the DP and the different kinds of movements it undergoes (42-50); the behavior of demonstratives and other determiners, and its consequences (51-55 and, in a sense, 60-6[2]); the syntax of possessive pronouns (56-59)". (L&G: 1688)[21]

If a dependency is not satisfied in a language, the corresponding parameter is marked with 0 (e.g., assuming that [5set] depends on [4-], if the latter is in any other state, the former is marked with 0 which indicates that the parameter is not settable). '?' in L&G refers to "a few empirically uncertain states" (p. 1689), most probably uncertain in the sense that their value as [NUM+] or [NUM-] is dubious and not their status as settable vs. non-settable. Since, however, these uncertain stages had to be coded somehow for the program to be able to read the logical expressions that make use of the parameter states into which these '?' occur and since these states do not unambiguously show the target value as either [NUM+] or [NUM-], for the purposes of the program input, '?' was treated uniformly with 0 and values opposite from the target ones (e.g., assuming that [5set] depends on [4-], if the latter reads [4+] or [0] or [?], the program returns the same outcome for [5set]: False, which corresponds to non-settable).

[21] As L&G note in a footnote to this quote, Salentino refers to the Italo-Romance variety spoken in the areas of Brindisi and Lecce and is represented here by the variety of Cellino San Marco, whereas Grico refers to a Greek variety spoken in the south of Lecce, represented here by the variety of Calimera.

For the purposes of the program input, all +/- values were assumed as presented in L&G and whatever discrepancies are noted in the following sections as found between the results of the program and the settable parameters as these are depicted in appendix A are only due to (re-)calculation issues and not due to altering judgments with respect to real-language data. The dependencies were also received as presented, after being checked for consistency with the states on which they operate, which is what led to the aforementioned exclusion of what in L&G appears as parameter 62. The setting of a given parameter does not affect the setting of another, only the setability; setting is always based on language data that L&G have collected. The overall number of the dependent and the independent parameters are 46 and 16 respectively. Obviously, as more parameters/dependencies are added to the system, the dependent parameters become increasingly complex as their analysis involves other parameters that are also dependent and therefore further analyzable.

In this context, showing the setability paths of a dependent parameter without showing the setability paths of the parameters that make up this setability does not provide the complete picture in terms of the properties of the hierarchies under examination. Figure 5 offers an overall representation of the hierarchies under examination; however, this representation is not entirely informative when the discussion comes to certain characteristics such as (non-)binarity, length of the simplest vs. the most complex setability path that exists for each complex parameter, etc. For these properties to be shown all parameters need to be separately represented in the form of individual networks. This individual representation will then enable a discussion of how complex and how optimal these (UG-encoded) hierarchical schemata are.

The two networks given in figures 2 and 5 look quite dissimilar in terms of complexity. Drawing a comparison between the two, in the former it is easy to trace the available parametric paths, to identify the setability relations across the different 'set-options', and to eventually calculate the number of parameters set in each parametric path. On the contrary, the way figure 5 is built makes the task of pinpointing parametric paths rather complicated. Since keeping a clear track of the paths is crucial for addressing issues of network complexity, all parameters in the L&G pool of data were re-drawn for the purposes of the present discussion in the form of individual networks for each parameter. The networks that were created still look more complex than the one in figure 2, however they do allow for a more transparent representation of paths compared to figure 5.

Each of the developed networks is read top-to-bottom and each parameter is analyzed to the ones that give rise to its setability. If this analysis makes use of other dependent parameters, these are analyzed as well all the way down until reaching an independent parameter. Put differently, the depicted ways of setability refer to overall setability, once all nodes in the network are exhaustively analyzed, and not only to immediate setability of the topmost parameter. To give a hypothetical example, if the setability of parameter 5 (i.e. [5set]) depends on [4+] and in turn [4set] depends on [1+] with 1 being an independent parameter, the network will represent [5set] all the way until reaching [1+].

Slightly modifying this example to include optionality,[22] if [5set] depends on [4+] which depends on either [3-] or [1+], the network will represent parameter 5 by showing two possible paths for reaching [5set], although 5 itself is immediately set only in one way, [4+]. Sketching out the full development of a network, instead of just the portion that is immediately responsible for the setability of a pa-

[22] All instances of optionality should be read as entailing *inclusive* disjunction: One of the two states, [3-] or [1+], is necessary to make parameter 5 settable in this example but nothing precludes the manifestation of both.

rameter, is necessary if one wants to see how complex the parametric paths turn out to be in their totality. The network in figure 2 is also fully developed in the sense that all relevant parameters that exist between ‘polysynthesis’ and ‘*pro*-drop’ are placed in the hierarchy even though ‘*pro*-drop’ itself is immediately related only to ‘subject placement’ set to ‘high’.

Once figure 5 is decomposed into individual networks, multiple sizes of representations and multiple ways to reach setability are revealed. Both are captured in figure 6 below which is a representation of one parameter in the pool of data at hand. The simpler and one of the most complex ways of reaching setability are represented. The rightmost tree incorporates all ways. This parameter is a representative example of the dissimilarity in the alternative paths to reach setability. Multiple branches stemming out from nodes that have numbers indicate conjunction. Branches stemming out from the ‘OR’ node indicate optionality. ‘NA’ means that the analysis reached an independent parameter in the preceding node and past that node the branch is not further analyzable. A hierarchy is complete at the level that all branches reach independent parameters.

According to figure 6, the simplest way to reach [57set] is based on a single node and has just one level of embedding. The complex way given in the middle is based on seven nodes, involves conjunction and has five levels of embedding. Thus figure 6 suggests that the setability paths available *within* a parameter are far from uniform and, given that different languages choose different ways to reach setability, the respective acquisition paths will end up being quite dissimilar too; something that was earlier observed and discussed in relation to the nodes that await setting in each language in figure 2. What was not shown in the case of figure 2 but is shown through the program analysis for all parameters in this pool of data is that languages differ yet across another dimension: the number of available setability paths for a parameter that each language makes available. A schematic representation of the different paths for parameter 57 is given in figure 6. As the presentation of the program results in the section 2.4.2.2 will show, not all languages have only one way to reach setability of a given parameter and, once more, crosslinguistic differences can be quite robust.

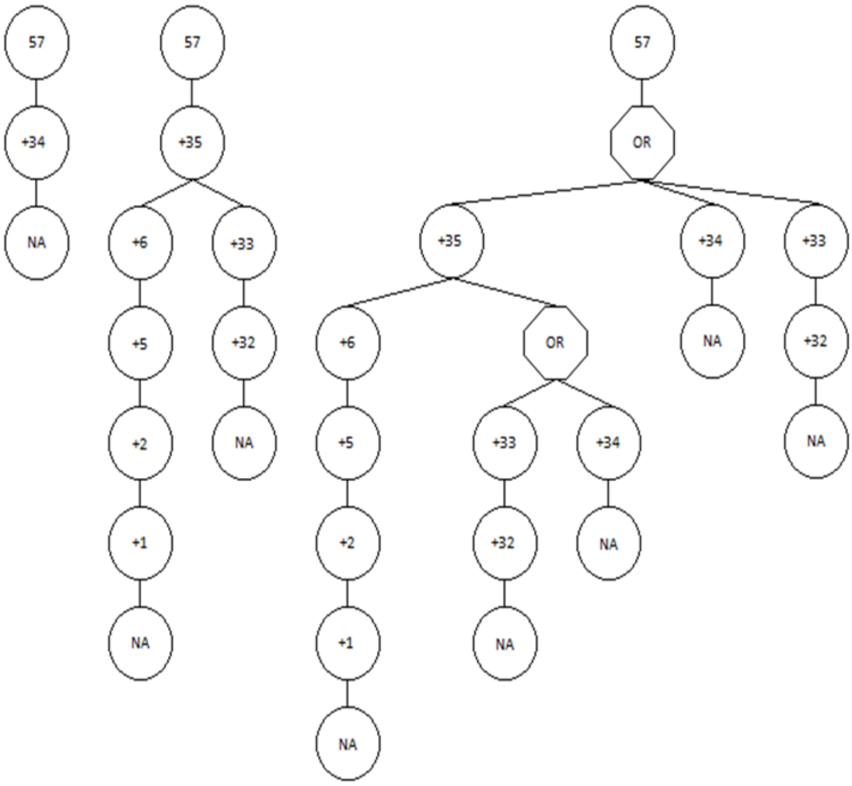

Figure 6: Four ways to reach setability for parameter 57

So far the discussion mainly targeted properties of networks; the focus was on what happens within parameters in terms of their setability paths. However, any comparison between Baker's example of parametric hierarchies in figure 2 and the networks that show a hierarchical representation of interlocked parameters in the DP domain, such as the ones in figures 5 and 6, needs to be established also on the basis of discussing crosslinguistic differences across parameters/'set-menu' parametric options. With respect to the latter, the differences were shown to be robust in figure 2: they were translated into a 5:1 ratio for the dependent parameters that await setting in Spanish vs. Warlpiri. It has been also argued that the differences in the L&G pool of data are also wide-ranged, with the maximum difference being found between Grico and Latin: 21:10 for the dependent parameters of the network and 29:18 in the overall.

For the purposes of this chapter, any mentioned language that exists in the pools of data is meant to be understood for expository reasons as whatever values the parameters under discussion correspond to. Starting off from measuring nodes that await setting, the earlier mentioned calculation that showed Grico and Latin as the languages that involve the most and the least settable nodes respectively was originally done on the basis of 63 parameters. This picture does not change because the eliminated parameter is not settable to either Grico or Latin. Excluding what appears as parameter 62 in appendix A for reasons discussed above, the picture that emerges for the nodes that await setting in each language is presented in table 1 below:

Languages	*Overall (62)*	*Dependent (46)*	*Independent (16)*
It	53	37	16
Sal	54	38	16
Sp	53	37	16
Fr	51	35	16
Ptg	53	37	16
Rum	54	38	16
Lat	***36***	***20***	16
ClG	48	32	16
NTG	52	36	16
Gri	***58***	***42***	16
Grk	53	37	16

Got	47	31	16
OE	53	37	16
E	46	30	16
D	50	34	16
Nor	49	33	16
Blg	52	36	16
SC	41	25	16
Rus	42	26	16
Ir	50	34	16
Wel	49	33	16
Heb	49	33	16
Ar	49	33	16
Wo	42	26	16
Hu	50	34	16
Fin	40	24	16
Hi	41	25	16
Ba	41	25	16

Table 1: Settable parameters across languages

Emphasis should be on the column that shows the results for dependent parameters, since this is where languages proceed in non-uniform ways. Grico and Latin lie on the edges of the continuum but they do not form the only combination showing that a significant amount of variation/non-uniformity exists in the parameter-setting task that each language requires.

A schematic representation of the third column in the form of a line chart is given in figure 7 in order to show that neither Grico nor Latin can be treated as outliers. The difference that Grico has from Salentino and Rumanian, which have 38 settable nodes, is not that robust so as to justify elimination of Grico, neither does the difference between Latin and Finnish, which has 24 settable nodes.

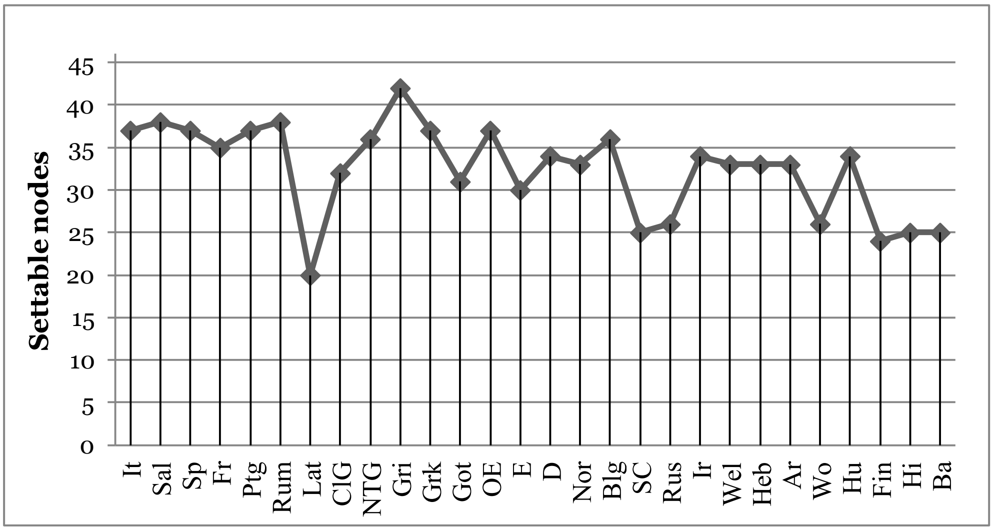

Figure 7: Settable dependent parameters across languages

Even if Grico and Latin were to be excluded from the picture given in figure 7, the difference between Salentino and Rumanian on the one hand and Finnish on the other involves a parametric space of 14 nodes which basically amounts to more than half of the settable parametric space (in terms of dependent parameters) that Finnish has. Apparently, not only do the 'set-menu' options show up as far from uniform, but the degree of difference is quite large and demands an explanation since it is in sharp contrast to the species-uniform character of language acquisition. Put differently, if language design is viewed as the composition of three factors and upon agreeing on the fact that the primitives of UG are species-uniform, environmental stimuli is quantitatively uniform in typical acquisition scenarios, computational mechanisms and principles of general cognitive architecture are uniform as well, one wonders: Where does all this variation with respect to the parametric space behind figures 2 and 7 come from?

If the answer is the environment —in the sense that grammatical properties change through acquisition in way that eventually affects the quantity of (un)explored options that a child receives as input from the environment and produces as a mature speaker—, there is nothing in this state of affairs that suggests a need for encoding this non-uniformity/variation in UG in the shape of 'set-menu' parametric paths. On the contrary, since everything hints at the role of the *environment* in deriving non-uniformity and the role of *externalization* in deriving change (or even emergence; recall the case of ABSL), it seems more plausible to tie points of variation to the factors that facilitate their very existence; in other words, to suggest that points of variation are emergent, externalization-related properties.

Figure 7 shows a significant portion of the available parametric space as an 'unexplored area', for the child that acquires Serbo-Croatian will never have to set 21/46 dependent parameters available in that parametric space. If, in parametric approaches to UG, UG is like a cognitive map that pictures all the possible roads and turns that acquisition and variation can take, at point zero the child has all the roads open and active, so there needs to be some process that renders a portion of the parametric space an 'unexplored area'. This is the job of interlocked parameters: to organize all the roads in certain zones, in a way that if a child enters a specific zone, other zones become territories that will never be explored (in monolingual situations). This architecture, by coming in the form of (interlocked) parameters, is meant to be part of UG. In this context, figure 2 indeed looks appealing in that, leaving crosslinguistic quantitative dissimilarity of the explored nodes aside, it provides a very neat, at all levels binary,[23] or-

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[23] Head directionality can be easily reconstructed into two nodes ('first' and 'last') each of which will have two branches ('yes' and 'no').

ganization of zones and roads. A key characteristic that makes figure 2 appealing is that all zones come with a single entrance. This means that there is only one way of reaching setability in each and every case. Under these assumptions, the navigation space is indeed constrained, the child will never have to consider alternative paths to setability so no extra work will be required, and the architecture of the depicted hierarchy is optimally structured.

The aim is to see whether all these theoretically appealing properties of figure 2 are retained once the variation space in question is more articulated. If they are, one may make a point in favor of the existence of interlocked parameters in UG. If they are not, the idea of the child having to consider alternative paths for setability contradicts the nature of interlocked parameters: they are supposed to constrain the space a child has to navigate by making available certain zones, not to turn the cognitive map into a convoluted labyrinth. If it turns out that they do the latter, and given that encoding unrelated (i.e. non-interlocked) points of variation in UG is an uneconomical alternative, a parameter-free version of UG emerges. Aiming to uncover whether figure 2 has parallels in the hierarchies of the pool of data at hand, the latter obviously lacks the neat organization of the former (see figure 5), but as suggested already, this could be the result of the style of representation. For this reason, figure 6 was drawn. Figure 6 gives an idea of the architecture of the hierarchies under discussion, but it still does not give the full picture. More specifically, it is not informative in relation to crosslinguistic uniformity and/or complexity because it does not map the internal architecture of the hierarchy to the landscape that every language realizes.

For these reasons, the setability paths of those complex parameters that allow for optionality in the L&G pool of data needed to be calculated. Table 6 in appendix A lists the states of the input parameters as well as the parametric dependencies on which the setability of the dependent parameters relies, so the calculation of which and how many setability paths each language realizes is doable on the basis of the data that L&G provide. However, the manual computation of all possible combinations for every language would likely give rise to miscalculations due to the number of the states that one has to keep track of in the most complex dependencies.[24]

For these reasons, a program was developed and the computation was done in a semi-automatic way. Having checked manually that the dependencies are indeed respected in every case that a language is argued to set a parameter —on this basis, original parameter 62 was excluded—, the relevant (i.e. optionality showing) portion of the dependent parameters in table 6 was converted to program input.

2.4.2.1 The Program

The developed tool is a program implemented in Java language. The full code is given in appendix E. The part 'editable code section' in appendix E includes instructions on how to adapt the code to similar pools of data.

The program parses a file that contains the setability paths for each parameter/language pairing in a specific format. In this sense, it is a semi-automatic program because it takes as a prerequisite the construction of the paths by the user.[25] The output is produced as fol-

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[24] This is probably what justifies the existence of some discrepancies between the program output and what is originally listed as (non-)settable in table 6. These discrepancies are listed and explained in appendix C that presents results in the form of individual tables.

[25] Paths here do not refer to the dependencies as these are given by L&G in the first column of table 6, because the dependencies that involved analyzable parameters had to be amended into a list of all the relevant nodes until reaching an independent parameter. The idea is that the analysis has to proceed all the way down for the complete picture to emerge, exactly as happens in Baker's

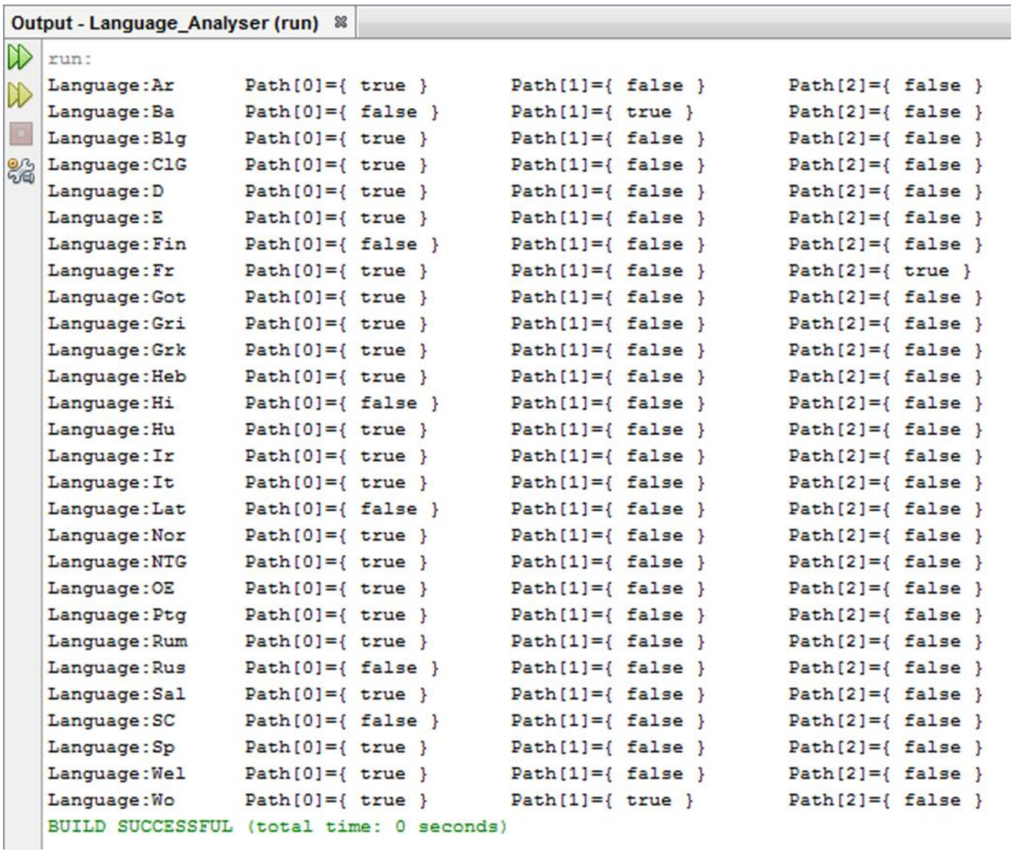
lows: Every path is converted to a logical expression which is formed by the conjunction of Boolean literals. In this case, a Boolean literal is every valued parameter (e.g., [1+], [12-]) that a path makes use of in order to specify setability of another parameter. The levels of embedding were flattened and complexity was measured in terms of the number of nodes that appeared in the setability path.

Upon receiving a logical expression (i.e. the states of a dependency) by the user, a program run automatically tests its realization in every parameter/language pairing, returning a T(rue)/F(alse) output for setability and non-setability respectively. This T/F output is coded in the tabularized version of the results in appendix C as 1 and 0 respectively. 1 means that the setability path is available in the language (i.e. all input states are satisfied) whereas 0 means that the path is not realized.

Following the instructions in appendix E, this semi-automatic tool can be adapted to other pools of data of similar architecture to perform the same process for really large sets of parameter/language pairings and/or for more complex dependencies. The code for pool of data II is different because the input values of pool of data II have a feature that is absent from pool of data I. The differences between the two pools of data and how these are reflected in the code will be presented in section 2.4.3.

Figure 8 provides an image of the program output.

hierarchy in figure 2.



```
Output - Language_Analyser (run)
run:
Language:Ar     Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Ba     Path[0]={ false }    Path[1]={ true }      Path[2]={ false }
Language:Blg    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:ClG    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:D      Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:E      Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Fin    Path[0]={ false }    Path[1]={ false }     Path[2]={ false }
Language:Fr     Path[0]={ true }     Path[1]={ false }     Path[2]={ true }
Language:Got    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Gri    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Grk    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Heb    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Hi     Path[0]={ false }    Path[1]={ false }     Path[2]={ false }
Language:Hu     Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Ir     Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:It     Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Lat    Path[0]={ false }    Path[1]={ false }     Path[2]={ false }
Language:Nor    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:NTG    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:OE     Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Ptg    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Rum    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Rus    Path[0]={ false }    Path[1]={ false }     Path[2]={ false }
Language:Sal    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:SC     Path[0]={ false }    Path[1]={ false }     Path[2]={ false }
Language:Sp     Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Wel    Path[0]={ true }     Path[1]={ false }     Path[2]={ false }
Language:Wo     Path[0]={ true }     Path[1]={ true }      Path[2]={ false }
BUILD SUCCESSFUL (total time: 0 seconds)
```

Figure 8: Program output

Figure 8 shows an image of the output, but its way of representing the results is not fully transparent. More specifically, figure 8 does not show the picture that emerges once all outputs for all parameters are compared. One of the most unexpected and interesting results that the program output yielded is the following: if there are multiple ways to reach setability for a parameter, languages mostly realize the 'less complex' ways available, leaving the complex ways unattested. The details of this phenomenon are presented in full detail in appendix C which offers a tabular presentation of the program output. The results of the analysis and its implications for one's theory of variation are presented in the next section.

2.4.2.2 Results

The fact that languages typically go for the simpler setability paths that a dependency predicts may be taken to suggest that the notion of interlocked parameters gives rise to a system that is not deterministic enough. Put differently, the concept of interlocked parameters itself may not be deterministic in the sense that once enough languages and enough dependent parameters are put into the equation, the system, by operating on *combinations* of increasingly complex dependencies across levels,[26] overproduces and predicts setability paths that are not realized by any language;[27] it might even predict as theoretically possible some setability paths that are practically impossible to realize due to conflicts in the dependency: the analysis of the setability paths for parameter 62 in appendix C shows precisely this state of affairs, while the same analysis for parameter 56 is a good example to show

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[26] To illustrate this with a hypothetical example, imagine that all languages in a given pool of data are able to reach setability of parameter 70 on the basis of [1+]. Assume then that an outlier is added which reaches [70set] on the basis of [23+]. Up to this point and for all the languages in this pool of data, 23 might be settable on a simple path (e.g., [22-]), but then once a second outlier is built in, 23 might be settable in a more complex way (e.g., [20+] & [21+]), whereas this outlier might not set 70 at all. The system, however, by combining possible realizations of paths across levels, would predict a setability path for 70 which would be [23+(20+, 21+)] and which is not realized by any language from the ones that exist in the pool of data.

[27] Recall that this non-realized space is meant to be encoded in UG. Also, it would be far from a safe assumption if one argued that this space might not be realized in *these* specific languages but it will be realized if more languages are added in the system. On the contrary, it appears to be the case that when languages keep being added, the dependencies have to exponentially grow in order to capture the states that set/neutralize a complex parameter in the newly added languages. In the long run, this growth will add to the number of the complex paths, whereas languages will still not make use of the (newly-emerged) most complex paths that the system makes available.

the amount of unrealized setability paths; despite the fact that the majority of the languages at hand do set parameter 56 (i.e. realize at least one setability path and actually many of them realize more than one), more than 1/3 of the overall predicted paths for reaching setability of this parameter remains unrealized.

The extent to which the dependencies at hand make available an amount of setability paths not realized by any of the languages in pool of data I has been already sketched out. This abundance of paths has been the basis for claiming that the concept of interlocked parameters is not deterministic enough: when a fair amount of languages and dependent parameters are combined, the system predicts setability paths that are not realized by any language, and some of them are even impossible to realize. The existence of both unrealized and unrealizable paths is a manifestation of the exact opposite effect from the one interlocked parameters and the resulting hierarchies were intended to have. To pursue the analogy with the 'map' metaphor, a cognitive map that encodes interlocked parameters is put forth as an aid to acquisition, at least according to the minimax considerations discussed in previous sections (i.e. increase UG-encoded information in exchange for reducing the workload of the acquisition task). It goes without saying that this aid is dubious if the map shows roads that are not realized in any language landscape and this is an empirical finding that needs to be taken into serious consideration when one argues in favor of the existence of interlocked parameters.

Another empirical problem is that of observing a gradual progression of the map from an optimally designed network such the one in figure 2 to a mind-boggling puzzle of *optional* branches. This optionality derives from the fact that the system makes available alternative ways to reach setability and this is why the theoretically appealing neatness of figure 2 gives its place to a far less optimal/more complex pattern in figures 5 and 6. The most serious problem of all though, brought to the surface by the tabularization of setability paths in appendix C, is the one that pertains to the existence of qualitatively and quantitatively crosslinguistic dissimilarity in terms of the setability paths that each language has available for a given parameter.

Qualitative dissimilarity boils down to varying complexity: language A might achieve setability of a parameter on the basis of a path that consists of a single node, whereas language B might achieve setability of the exact same parameter on the basis of another path that has nine nodes (this is a scenario that actually occurs for parameter 49: Arabic sets it on a single node, whereas Salentino sets it on the basis of a path that involves nine nodes). Quantitative dissimilarity boils down to optionality: language A might be able to achieve setability of a parameter on the basis of one path, whereas language B might have four paths (again, this is a scenario that actually occurs for parameter 56: French has four ways to reach setability but Basque has one).

The problem of crosslinguistic dissimilarity also arose when discussing setting of parameters in relation to figure 7. The crucial difference between these two cases is that in figure 7, the problem of dissimilarity in terms of the number of parameters await *setting* in each language could be remedied if one argues that the fact that the child acquiring Grico has to set more nodes than the child acquiring Finnish is the result of these two children entering different zones on the map. The problem is not remedied in the case of *setability* because varying numbers of setability paths correspond to varying numbers of entrance points in zones on the map. Having earlier agreed on viewing the first factor in language design (i.e. UG) as species-uniform, the uniformity of a UG architecture that has interlocked parameters is retained in the case of parameters that await setting — because the cognitive map will make available the same amount of zones across speakers of different languages—, but it is lost in the case of alternative/multiple paths of setability, because a key component of the map is shown to vary quantitatively: the number of the entrances to each zone. Put another way, the architecture of interlocked parameters is uniform in the first case since the exact same number of zones/parameters is available to all children *regardless* of which zone/'set-menu' parametric path is eventually explored on the basis of environmental stimuli. In the second case, uniformity is lost: varying numbers of entrances into a zone exist, *depending on the target language*. These entrances, which correspond to varying ways/paths of achieving setability of a parameter, eventually embroider variation on the cognitive map, and of course this variation makes the species-uniform character of UG disappear.

This 'setability' problem is the most serious problem of all, because its existence contradicts a core property of UG: one must either abandon the idea that the primitives of UG are species-uniform or give up the notion of interlocked parameters that postulates variation in terms of the available setability paths.

Table 2 sheds light to the 'setability' problem in relation to parameter 57. A cell marked with 1 in the language columns, indicates that the setability conditions specified in the first column are satisfied in the respective language. This means that the setability path is available in that language. When a node has an attached parenthesis to its right (e.g., 33+(32+)), the node inside the parenthesis is the analysis of the node outside the parenthesis:[28]

[28] See also the reading key in appendix C for more details on how to read the tables.

4 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
34+	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	1	1	1	1	1
33+(32+)	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	1	1	0
35+(6+(5+ (2+(1+))), 34+)	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	0	1	1	1	0
35+(6+(5+ (2+(1+))), 33+(32+))	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	1	1	0

Table 2: Setability paths for 57 (± Feature Spread on Possessives)

Table 2 illustrates that most languages that set this parameter can have it settable in four different ways. French and Hungarian have 2/4 ways, while Basque has only one. The problem of quantitative dissimilarity is not remediable in this case, even if one argues that varying (numbers of) setability paths exist because the children that acquire Italian, French, and Basque select different options (i.e. as when they select different zones/'set-menu' parametric paths); the issue at stake is that, according to table 2, they do *not* have the same pool of options to select from: the map of the one has four ways to enter the zone [57set], whereas the maps of the others have two or one.

An advocate of interlocked parameters may try to save uniformity at this point by submitting that all children do underlyingly have the same number of setability ways and it is just that some of the ways are blocked at point zero, depending on the zone that each child selects. This claim is ill-founded in an empirical sense because it fails to notice that the (un)availability of a setability path materializes not at the beginning but in the course of navigating the parametric space and *after* setting the input parameters to a target value. In other words, in table 2 above, the unavailability of the second setability path for reaching [57set] in Basque crystallizes not when [33set] is achieved but when 33 is not set to +. [33set] is achieved in Basque as well, so the child acquiring this language does enter a zone that has the potential to give rise to [57set] through the second setability path, yet this path is not available in Basque because parameter 33 is eventually set to -.

This empirical problem boils down to the very essence of UG as —what Chomsky calls— an "innate *fixed* nucleus" (Piattelli-Palmarini 1980, emphasis added). In October 1974, a debate took place between Jean Piaget and Noam Chomsky. During this debate, the nature of this "innate fixed nucleus" (i.e. UG) was subject to much discussion and the positions of Piaget and Chomsky echo their different persuasions (empiricism vs. nativism) in the following way:

> "In this sense, the final position of Piaget at Royaumont represents a manifestation of the "empiricist" position. Once the existence of a fixed nucleus is acknowledged, the contrast between the paradigms is even more remarkable. For Piaget, accounting for the stability of the fixed nucleus in terms of self-regulating mechanisms becomes the first goal of epistemology, whereas for Chomsky, the fundamental issue is precisely the specificity of the fixed nucleus and not the manner in which is fixity is attained". (Piattelli-Palmarini 1980: 353)

Despite the fact that the two views diverge in certain ways, they converge in accepting the fixed character of UG: the issue at stake is specificity, fixity is indisputable. If one endorses this view, one cannot argue that the existence of varying numbers of setability paths (for the same parameter, across different languages) is due to the fact that certain entrances are rendered (un)available as the child navigates through the parametric space. Put differently, the *fixed* architecture of the system cannot be both fixed and moving at the same time, and yet it is moving if parts of it are continuously adjusted in the course of navigation.

The observed variability of setability paths derives from parametric dependencies and parametric dependencies derive from grammatical correlations, that is, from what is observed in (always subject to change) real-language data. If dependencies are modified on the basis of the languages that one adds in the pool of data, any new addition has the potential to add an 'OR' portion to a dependency, which in turn has the potential to make available new setability paths also for the languages that were already in the pool of data. The result is once more a continuously moving number of entrances/ combinations and, if one pursues this line of thinking, it is hard to avoid the paradoxicality of getting a moving "fixed nucleus"; especially so in instances of recent language emergence, as in the case of ABSL, where setability paths would have to change back and forth all along the time children fluctuate between different settings of a parameter, the setting of which might function as input for the setability of another parameter.

In this context, the 'setability' problem and the 'overproduction' problem will be the starting points for unweaving the implications that interlocked parameters and parametric hierarchies carry for the acquisition process and for the feasibility of parametric approaches to UG. Upon accepting that any parametric approach to UG which postulates thousands of unrelated minimal points of variation is implausible, interlocked parameters is the only way to go about a parametric UG. If, however, the hierarchies that arise from interlocked parameters are shown to run into certain empirical problems, this state of affairs would be suggestive both in terms of the nature of variation (i.e. it is not UG-derived) and of UG (i.e. it does not specify parameters, parameter values, and setability relations, etc.).

Using the pool of data proposed in L&G, it was shown that the neat organization of figure 2 can progressively change into much more complicated patterns that may involve (i) a significant portion of theoretically predicted but empirically not realized setability paths and (ii) setability paths that are predicted as possible but are practically impossible to realize due to mutually exclusive requirements in the dependency. Moreover, languages were shown to proceed in largely non-uniform ways with respect to the varying number of nodes (from the parametric space defined by L&G) that each of them sets. Assuming that the source of this variation is the environment, the idea of viewing 'parameters' (i.e. points of variation) as emergent, externalization-related properties seems more plausible than any other competing scenario.

If internal properties of parametric hierarchies hinted at the fact that the idea of postulating interlocked parameters in UG might not be a problem-free idea, the exploration of setability-relations was critical in illustrating so, in that the calculations given in appendix C brought to the surface an irremediable problem —referred to above as the 'setability' problem: the crosslinguistic dissimilarity in terms of the number of the setability paths that each language has available for a given parameter. This problem was earlier related to fixity and uniformity considerations but it is problematic in yet another dimension: optimality.

From all the implications that interlocked parameters carry for UG, the implications that the 'setability' problem puts forth in relation to optimality are probably among the most worrying ones. One cannot reasonably suggest that the "innate fixed nucleus" of "an optimal solution to legibility conditions" makes available all these alternative setability paths *for the same language*. If the setability paths multiply as new languages are taken into account and if there are

7.106 languages on the planet (Lewis et al. 2014),[29] UG would end up encoding an inordinate number of setability paths for a single parameter within a single language. Observing that in a sample of 62 parameters and only 28 languages, a language can show up as having five different ways to reach setability of a parameter, one can imagine first, to what an extent this number can raise if the dependency incorporates setability implications in a larger variety of languages and second, the astronomical number of all linguistic primitives that UG has to encapsulate, if one allocates parametric variation to it.

Aiming to confirm the findings obtained on the basis of the pool of data given in L&G, the analysis sketched out in this section has been rerun on the basis of input obtained from another pool of data. The results of the second analysis are presented in the next section.

2.4.3 Pool of Data II

Pool of data II consists of 56 nominal parameters and the settings that these parameters receive in 26 contemporary languages (Longobardi et al. 2013). The dependencies and the values are given in table 7 (appendix B).

There is a partial overlap between the parameters that are found in pool of data I and pool of data II. The degree of difference is sufficient with respect to what the program receives as input. As mentioned in section 2.4.2, only those parameters that show optionality are eventually converted into program input. This optionality is determined on the basis of a dependency which changes as new lan-

[29] Which should probably read more since the calculation of this number is unclear in the absence of any non-arbitrary way of deciding whether a variety counts as a language or a dialect.

guages are built in the pool of data at hand. Hence, the program input is different across the two program analyses.

With respect to languages, there is again a partial overlap between the two pools of data. Pool of data II consists only of contemporary languages,[30] whereas pool of data I involved 5 ancient languages. Figure 9 shows the percentage of languages that are shared vs. unique to each pool of data.

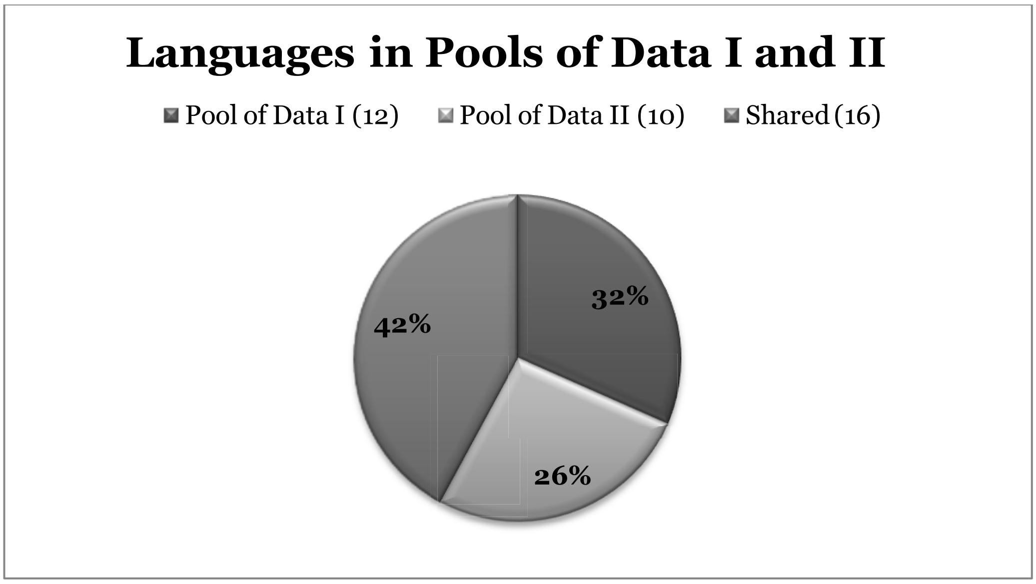

Figure 9: Distribution of shared vs. unique languages across pools of data

Another difference between the pools of data is that the dependencies involve negated states in pool of data II. For example,

[30] The languages of pool of data II are: Sicilian (Sic), Northern Calabrese (Cal), Italian (It), Salentino (Sal), Spanish (Sp), French (Fr), Portuguese (Ptg), Rumanian (Rum), Bovese Greek of Southern Calabria (BoG), Grico, i.e. Greek of Salento (Gri), standard Greek (Grk), English (E), German (D), Danish (Da), Icelandic (Ice), Norwegian (Nor), Bulgarian (Blg), Serbo-Croatian (SC), Slovenian (Slo), Polish (Po), Russian (Rus), Irish (Ir), Welsh (Wel), Farsi (Far), Marathi (Ma) and Hindi (Hi) (Longobardi et al. 2013).

[5set] might be reached on [3¬-], which means that the setability of parameter 5 depends on parameter 3 being in any other state apart from [-]. The code developed on the basis of pool of data I could not handle negated states. Hence, a new code was developed for the analysis of pool of data II. The code for the program analysis of pool of data II together with instructions for its adaptation (i.e. the editable code section) is given in appendix F.[31]

The results obtained confirm the empirical issues identified on the basis of pool of data I. Appendix D presents all the results of the analysis of pool of data II in a tabularized form. Overall, the obtained program output is smaller compared to the one obtained on the basis of pool of data I. This is due to the fact that both the overall number of parameters as well as the number of parameters that involved optionality, which are the ones eventually converted into program input, are smaller in pool of data II.

The discrepancies between what the program output shows as settable and what is shown is settable in Longobardi et al. (2013) and in appendix B, are on a par to those observed in pool of data I. As happened in the analysis that is based on pool of data I, in pool of data II too, whatever setability discrepancies exist between the program output and Longobardi et al. (2013) are noted below the tables in which they appear in appendix D. Recall that these discrepancies boil down to (re-)calculation issues and are not due to altering judgments with respect to real-language data. Probably, some of these discrep-

[31] The editable code section in appendix F presents a dependency that involves a negated state. Not all parameters in pool of data II reach setability on the basis of dependencies that involve negated states. However, one such parameter was chosen for demonstration in the editable code section because the possibility of dealing with negated states is a key difference between the code in appendix E (developed for pool of data I) and the one given in appendix F (developed for pool of data II).

ancies entail that the dependencies behind them have to be amended along the lines given in footnotes 19 and 20.

In general, the results obtained from the two analyses are similar. The same five empirical issues discussed in section 2.4.2.2 for pool of data I can be identified based on the results of the second analysis for pool of data II. The extent to which languages do not realize some of the most complex paths that the system predicts as possible varies across the two pools of data, but is a phenomenon observed in both analyses.

2.5 Conclusions

The picture that emerges from the state of affairs presented in this chapter suggests that one should put forth a parameter-free conception of UG. The notion of parametric hierarchy has been shown to run into empirical issues that make a theory of variation that involves parameters untenable. Moreover, it has been argued that claims about the existence of syntactic variation are in reality boiling down to MPF variants. On the basis of the attested patterns, it has been argued that variation arises in the externalization component of language. This conclusion has been recently voiced in the literature both from a generative (P&P) perspective (Chomsky 2001) and from a biolinguistic perspective (Boeckx 2011a, 2014a, Berwick & Chomsky 2011). In this context, parameters should not be conceived of as innate primitives, but rather as points of variation acquired through experience (Lasnik & Lohndal 2010: 43).

An issue that is not fully addressed in this chapter relates to determining the implications that an organization of UG in terms of principles and parameters carries for acquisition. Claims about the primitives of UG are in essence claims related to the theory of language acquisition one holds. Ever since Chomsky's (1965: 36) description of an "idealized 'instantaneous' model", generative linguists have often contemplated the possibility of an idealized picture of language acquisition that described the latter as 'instantaneous' (e.g., Smith 2005). A related yet distinct claim portrays language acquisition as gradual, but parameter-setting as instantaneous (Ayoun 2003). Addressing the relation between an idealized picture of language acquisition and P&P, the following passage is revealing:

> "...in the very very early 1980s, maybe 1980 or '81, when Noam in his class was laying out the theory in relation to the question of language acquisition and there was a lot of discussion in the class about how the big problem was why language acquisition is so rapid, given that language is such a complicated thing — but as the theory was laid out it occurred to me: Jeez, we've almost reached the point where the question should be turned around. So I raised my hand and said: 'Don't we have a new question, now — Why is language acquisition so slow?' ... 'Why doesn't it take six minutes?'"
>
> (Lasnik 2002 in Boeckx 2014a: 160)

Given the amount of innate, structurally rich knowledge that P&P relegated to UG, it is a reasonable question why the process of language acquisition is not considerably faster. The present chapter has argued against the notion of parameter on empirical grounds. It would be interesting to try to voice Lasnik's question in the absence of parameters. It seems that once the notion of parameter is abandoned, the acquisition process is neither instantaneous nor slow. It is not instantaneous because it involves an ordered representation of successive steps. It is not slow because the context that prompted Lasnik's question is not part of the picture anymore. In other words, if the theory that encoded much of the *end* result (i.e. the language of any adult speaker/signer in any scenario of typical development) in the *initial* state of the language faculty is abandoned, the question will not surface.

If parameters do not exist, the acquisition process does not correspond to a process of navigating the relevant hierarchies and fixing parametric values. In the next chapter, it will be argued that the process corresponds to an ordered application of different steps that make use of different cognitive principles. More specifically, the next chapter approaches the process of language acquisition first in the presence and then in the absence of parameters and parametric hierarchies. After comparing the two pictures, a set of cognitive cues and biases that aid the learner in the acquisition process is presented, first by listing the cues and biases individually and then by schematically integrating them in the form of an acquisition algorithm that relies on successive steps.

3. Life with(out) Parameters: Implications for Acquisition

One of the aims of the present work is to approach linguistic findings from an interdisciplinary perspective. This chapter deals with the topic of language acquisition through such a perspective. In recent years, many linguists claim that their work is driven by an interest to understand and describe the biological underpinnings of FL. However, a more careful look at this literature shows that this interest is not always reflected in the bulk of their work.

In *Me and Chomsky: Remarks from Someone Who Quit*, Sascha Felix wrote about the orientation of current work in the field of (comparative) linguistics:

> In some sense I feel that much (but obviously not all) of current linguistic work displays a relapse to the spirit prevailing in pre-Chomskyan times. *Linguistics is about describing language data. Period. Beyond this there is no deeper epistemological goal. Of course, those who became linguists because they like to play around with language data could not care less, because they can pursue their interests under any development of the field, nowadays possibly with less pressure and stress.* Personally I felt that much of what I was offered to read in recent years was intolerably boring and that the field of linguistics was becoming increasingly uninteresting and trivialized". (Felix 2010: 71; emphasis added)

Despite the fact that linguists are often quick to acknowledge an interest in core properties of FL, it seems that this interest fades away and the focus shifts from FL to particularities of grammar — described in highly technical detail— that would not mean much if the real focus was on FL, in the sense that the specific realizations of a grammatical phenomenon across languages might have a place in the grammar books dedicated to these languages, but not in a book about FL and human cognition, unless a specific claim about the nature of FL is explicitly put forth. In other words, it seems that there is a divide between *linguistics* (or biolinguistics, with focus on FL) and *languistics* (with focus on what Felix calls 'language data')— a state of affairs reminiscent of the distinction between biolinguistics in the strong and biolinguistics in the weak sense (Boeckx & Grohmann 2007).

The biolinguistic enterprise aims to deal with five key issues, each of which can be formulated as question or, alternatively, as a 'problem'. Boeckx & Grohmann (2007: 1), following Chomsky (1986), have laid out the questions as follows:

(15) i. What is knowledge of language?
ii. How is that knowledge acquired?
iii. How is that knowledge put to use?
iv. How is that knowledge implemented in the brain?
v. How did that knowledge emerge in the species?

Each of the questions in (15) have been referred to as 'Humboldt's Problem', 'Plato's Problem', 'Descartes' Problem', 'Broca's Problem' and 'Darwin's Problem' respectively (Chomsky 1986, 1988, Boeckx 2009).

Despite the frequently acknowledged interest in biolinguistics, it seems to be true that this conception of the discipline is not really depicted in discussions that deal exclusively with particular grammatical phenomena, and this comes at a cost for the discipline itself. The existence of this linguistics/languistics divide is at times problematic when one seeks to establish truly interdisciplinary bridges between linguistics and neurobiology, due to the granularity mismatch between the primitives on which each discipline operates (Poeppel & Embick 2005). In Hornstein's (2013) words, it seems that "[t]here really is a linguistics/languistics divide that is quite deep, with a very large part of the field focused on the proper description of language data in all of its vast complexity as the central object of study. Though, there is no *a priori* reason why this endeavor should clash with the biolinguistic one, in practice it does".

The observed clash could be the result of linguists employing a folk biology of language when discussing FL as a component of the human mind/brain. For example, linguists (at least those within the generative enterprise) have often followed Chomsky (2005) in assuming the three factors identified there as crucial components of language design. They also followed Chomsky (2005) in calling the first factor in language design 'UG' and further describing it as the *genetic endowment* for language.[32] It is highly likely that this narrow, genocentric vision of UG will prove problematic, particularly so when it comes to the integration and assimilation of results from linguistics into biology, which has progressively moved away from its genocentrism (Pigliucci & Müller 2010).

Another reason for the clash Hornstein talks about could be the diversity of interdisciplinary insights that the two fields (comparative linguistics and comparative biolinguistics) encompass: There are considerations about FL that are dealt with in a narrower way within the former than within the latter. For example, comparative linguistics tends to favor a more narrow and restricted view of variation; what Benítez-Burraco & Boeckx (2014: 123) refer to as "deal[ing] with lin-

[32] See Lorenzo & Longa (2009) for a list of studies that make reference to UG as 'blueprint', 'genetic endowment', or 'genetic equipment'.

guistic variation ‘at the surface’ (languages, dialects, sociolects, and the like)”. However, as Benítez-Burraco & Boeckx (2014) point out, a novel, comparative approach within the realm of biolinguistics should ask questions that aim to uncover the locus of variation (and its constraints) across genotypes, pathologies or species. This comparative biolinguistic approach entails the integration of various insights from the literature on evolutionary biology, genetics, paleoanthropology, clinical linguistics, and studies on externalization and variation across species.

Variation comes in many forms and the realizing the non-homogeneity of language is important when one discusses language acquisition and its terminal state. The reasons for this are well-captured in Yang (2004):

> “One of the most compelling demonstrations of such intrinsic linguistic variability comes from the study of language change by Tony Kioch and his colleagues. For instance, Santorini (1992) demonstrates that in early Yiddish subordinate clauses, an *individual* speaker allowed both INFL[ection]-medial and INFL-final word orders. Pintzuk (1997, 2002) found evidence that throughout the period from Old English to Middle English, both VO and OV base orders in the VP were present. *Thus adult speakers, at the terminal state of language acquisition, may retain multiple grammars, or more precisely, alternate parameter values; these facts are fundamentally incompatible with the triggering model of acquisition*, symptomatic of the typological thinking in linguistics. [...] It is often suggested that the individual variation is incompatible with the Chomskyan generative program. Suzanne Romaine says, “[i]f one take the data Labov typically deals with as the basis for a theory, we certainly arrive at a different theory of language than Chomsky” (Romaine 1981, p. 96)”.
>
> (Yang 2004: 50-51; emphasis added)

In other words, Chomsky’s idealized picture of a “completely homogeneous speech community” (1965: 3) which is coupled with an “ideal speaker-listener [...] who knows its language perfectly” (1965:

3) does not do justice to the existing patterns of variation. Similarly, when Chomsky (1981: 137) describes how "a core grammar is determined" "when the parameters of UG are fixed", this picture seems idealized too. In line with Yang (2004), section 3.1 of the present work will argue that the terminal state of language acquisition is not fixed. Speakers (and signers) may fluctuate among different values for any 'parameter' even at whatever counts as the terminal state.[33] This realization is incompatible with a theory of fixing parametric values and navigating parametric hierarchies, because such a theory requires a parameter to be fixed and depending on what value is selected a different parametric path will be explored.

Building on the material published in Boeckx & Leivada (2014) and Leivada (2014), the present chapter discusses the process of language acquisition without believing in the homogeneity of the end-product or the instantaneous nature of the process. This discussion aims to serve three goals. The first goal is to provide an overview of the acquisition theory from the P&P perspective, both in the traditional sense as well as from the viewpoint of emergent hierarchies (such as those discussed in chapter 2). The strengths and the weaknesses of the different proposals are highlighted. The second aim is to present a novel acquisition algorithm that does not assume innate linguistic knowledge in the form of UG-based or UG-derived hierarchies. The cognitive cues that aid the learner in every step of the ac-

[33] Due to the lack of criteria to demonstrate that a language state is 'terminal', I take the latter to be another idealization. The problem here is the absence of criteria to demonstrate that the adult language performance is at some point 'terminal', meaning that it involves a termination point after which it is no longer changing. Several studies agree that there is no such point. While the progression of change is particularly visible before or during early adulthood, there are indications that speakers do not cease to show ongoing developments throughout the life cycle (Tagliamonte & D'Arcy 2009 and references therein). The possibility of seeing alterations of the 'terminal' state is one of the contentions of present-day evo-devo thinking (Balari & Lorenzo 2009: 8).

quisition process are also presented. The last goal is to formulate the questions that should be addressed in the context of the current (comparative) biolinguistics agenda in relation to the topics of language variation and acquisition.

3.1 Acquisition in the Principles & Parameters Framework

In the P&P framework, language acquisition involves parameter-setting. In chapter 2, several parametric hierarchies have been discussed. For example, it has been argued in relation to figure 7 that the maximum difference is found between Grico and Latin: 21:10 for the dependent parameters of the network (29:18 in the overall) with the raw numbers for settable dependent parameters being 42 and 20 for Grico and Latin respectively. Putting these differences in perspective, in models that introduce statistical notions into their approach to acquisition (e.g., Yang 2002, 2010), the value-fixing process involves a learning algorithm, according to which the child upon receiving datum *s* selects a grammar G_i with the probability p_i and depending on being successful in analyzing *s* with G_i, punishes or rewards G_i by decreasing and increasing p_i respectively. The algorithm kept constant, what can account for the fact that the acquisition task varies considerably from one language to another and yet children acquire their respective languages in around the same time?

A theory of acquisition that assumes parameters would have difficulties to explain variation *within* languages/linguistic communities. Yang (2004) cites examples of adult speakers that alternate parameter values. A similar case is presented in Smith & Cormack (2002) who provide evidence for parametric poverty by looking at sequences of tense possibilities in English. With some speakers of English accepting 'Did you know that Emily is ill?' and with others considering it unacceptable (i.e. accepting only 'Did you know that Emily was ill?'), these authors suggest that this is "a situation in which intuitions are completely clear-cut, so the relevant parameter has been fixed, but it has been fixed apparently at random, presumably because of the paucity of distinguishing data" (p. 286).

Although Smith & Cormack are right in showing the existence of variation within languages/linguistic communities, their proposed distinction between 'parametric' and 'non-parametric' choices within this variation is not equally clear. Returning to the issue of the nature of variation, Smith & Cormack take the 'randomness' in the value-fixing process of tense sequences as suggesting that this variation is non-parametric: Depending on whether choices are deterministic or not (i.e. allowing for randomness and variation or not), they view *pro*-drop as an instantiation of parametric variation (it does not allow for randomness) and tense sequences as an instantiation of non-parametric variation (it allows for randomness). However, the criterion they adopt is not so clear. Are data that involve overt subjects in English invariant enough after one takes into account what Haegeman (1990) refers to as 'diary contexts'? Similarly, are instantiations of polysynthesis in Greek deterministic enough when the very same verb-noun/-adverb complex can be realized both analytically and by means of noun-/adverb-incorporation into the verb?

In a similar vein to Smith & Cormack (2002), Smith & Law (2009) classify word-order and head-directionality as parametric variation but signers of ABSL and Providence Island Sign Language are not entirely consistent in their relevant productions (especially in case of the latter, much variation exists; see Washabaugh 1986: 60). Given that word-order data are not deterministic and allow for randomness across Providence Island signers, in pretty much the same way that tense sequences are not deterministic and allow for randomness across English speakers, word-order should not count as parametric variation.

In a nutshell, uniformity appears to be absent both within and across linguistic communities and variation is observed in what is traditionally assumed to allow only for a single value (by means of setting a binary parameter). However, fixing a *unique* value for a parameter is a necessary presupposition of the parametric theory. With respect to the latter, it is interesting to see how the process of language acquisition has been linked to our genetic endowment within the P&P approach.

For example, Lightfoot (2006: 45) argues that "children have triggering experiences that stimulate their genetic properties to develop into their phenotypic properties". According to Thornton & Wexler (1999: 1), "a basic tenet of this theory is that much linguistic knowledge is part of the child's genetic makeup. This knowledge is encoded in the form of universal principles". In Chomsky's (2009: 385) words, "the intuition is that if you take a parameter and you genetically fix the value, it becomes a principle, it moves from the domain of parameters to principles". Crucially, working this idea out is not a simple task. Chomsky himself acknowledges so: "To spell this out is not so simple, but from a certain point of view, when you add the value, you're adding genetic information. Try to work that out, it's not so trivial" (Chomsky 2009: 385).

If it is difficult to spell out the idea per se, one can imagine how difficult it would be to approach it from a biolinguistic, truly interdisciplinary perspective, by taking seriously the intention to link fixed values of parameters to the human genome. Yet these two *are* linked according to the aforementioned views. Not only are principles, parameters, values of the latter and setability paths encoded in UG, but so are the properties of the topmost, independent parameters and the hierarchies that connect the dependent parameters. More specifically, it has been argued that the child knows that she has to start from the independent parameters; this is one of the properties of the "efficient learner" according to the P&P approach.

3.1.1 The Properties of the Efficient Learner

The efficient learner in the P&P approach has certain properties. The goal of the present section is not to present an exhaustive list of these properties, but rather to show that under the P&P assumptions UG is overloaded to an extent that goes far beyond encoding principles, parameters and their possible set of values.

Baker (2005: 95) remarks that "an efficient learner should learn in a structured way in which some parameters are entertained first and others later". This knowledge of the efficient learner should be innate, given that these hierarchies are specified in UG; so not only does UG encode an array of parameters and their possible values but it is further specified by flagging certain parameters as top as well as by ordering them in certain ways. The various models of language acquisition exhibit a number of differences in their particular approaches to the process, however they largely agree in one respect: They adopt a distinction between independent or early-set parameters and dependent or late-set parameters.

Thornton & Tesan (2007) offer a fine analysis of the differences observed across three models of language acquisition: Baker's (2005) Hierarchical Acquisition model, Wexler's (1994) Very Early Parameter Setting model and Yang's (2002) Variational model. These three models make different assumptions in order to reach the claim that some parameters are set before others, but crucially they all arrive to the same claim: some parameters are set before others and the knowledge that makes the learner start from parameter A instead of parameter B is part of innate endowment. Baker's model introduces parameter ordering; some parameters are being placed at the top position of the hierarchies. Wexler's model, on the other hand, assumes independent, non-ordered parameters. However, in this model a distinction between early and late parameter-setting is pursued. According to Thornton & Tesan (2007: 54), in the Very Early Parameter Setting model "certain linguistic principles are biologically timed to become operative later than others in the course of development. Before these linguistic operations mature, child grammars may lack certain linguistic properties that characterize adult grammars although they may be latent in UG". This differential biological timing of parameters is an innate property of the learner, similar to the predetermined hierarchical sequences of parameters in Baker's Hierarchical Acquisition model.

The Variational model differs from the Hierarchical Acquisition model and the Very Early Parameter Setting model mainly in introducing statistical notions in the acquisition process. It converges with the other models in assuming a scattering of parameters that is "favorable to the learner" (Yang 2011: 6). This scattering entails that some parameters obtain their signatures only after some other parameters have been set. All in all, the three models presented here involve some way to reach an ordered tackling of different subsets of parameters.

Another property of the efficient learner in a parametric approach to acquisition is the innate ability to tell apart ambiguous chunks of input from unambiguous chunks of input and selectively pay attention to the latter for value-fixing purposes. This ability entails that only some input would eventually act as a trigger in the parameter-setting process. The P&P theory started with the optimistic assumption that for every parameter there would be an unambiguous trigger, which would be innately specified and effortlessly recognized by the efficient learner, once encountered in the input (Fodor 2009). As Fodor notes, Clark's work has shown that for some parameters there are no unambiguous triggers. At the same time, the learner might not be able to recognize the trigger, even if it exists (Clark 1989). Crucially, this property of the efficient learner combines with the ability to commence the acquisition task from the topmost (or early set, depending on the model) parameters. Fodor calls this the "interaction problem". According to her definition of the interaction problem, "the learner might not be able to recognize a trigger for one parameter until she has set some other parameter" (Fodor 2009: 272). A temporal order is stipulated again, but as Luigi Rizzi acknowledges in response to Fodor's arguments "it seems, though we are far from having a precise temporal chart of what happens. That is a big gap in our knowledge" (Fodor 2009: 274).

The picture that emerges from the combination of the two aforementioned innate properties of the efficient learner is one that is theoretically sound, but empirically not borne out. The following passage illustrates how this is so.

> "As I mentioned in my paper here, a learner would have to parse all the analyses of a sentence in order to detect the ambiguities in it; but one can detect that it is ambiguous just by noting the presence of a choice of analysis at some point in the parse. Then the learner could say, "I see there are two potential ways of analyzing this sentence. It is ambiguous with respect to which parameter to reset, so I will throw it away. I will learn only from fully unambiguous, trustworthy triggers." We have modelled that strategy, and we have found – disappointingly– that it doesn't always work. It is very fast, as you imply, when it does work, but it often fails (Sakas and Fodor 2003)."[34] (Fodor 2009: 273)

[34] Regarding the last part, Fodor's claim that the process is fast is an answer to a question by Cedric Boeckx that concerned the ambiguity of triggers. As Boeckx correctly noted, if triggers were indeed completely unambiguous, and given that parameters, values, and triggers will be altogether encoded in UG,

The properties of both the acquisition process and the efficient learner have been approached in this section from the perspective of UG-encoded parameters. However, as discussed in chapter 2, there are proposals that put forth the existence of no-choice parameters and emergent parametric hierarchies. These hierarchies are not UG-encoded, but are UG-derived. Under these assumptions, a different picture of language acquisition has been proposed.

3.2 Acquisition in the Context of Emergent Parametric Hierarchies

In chapter 2, it has been argued that no-choice parameters are the result of minimizing the amount of UG-encoded information coupled with the idea that functional pressures can influence parameter-setting in a way that creates offers that cannot be declined (Biberauer et al. 2013a). This entails the no-choice effect and the emergent character of the hierarchy.

In section 2.1.2, when presenting the proposal of no-choice parameters, I have argued that the effort to derive parametric variation without resorting to an overspecified, rich in terms of linguistic primitives, UG is both theoretically motivated and certainly a move in the right direction. In the context of the present chapter, the emphasis is on the acquisition process. More specifically, if the relevant parameters and/or the respective hierarchies are no longer part of UG, the acquisition picture is different from what was presented in section 3.1. In the most elaborate work on the topic to this date, it has been

the acquisition of a given grammar should be very fast, lasting some minutes and not some years. As discussed in section 2.5, a similar question is raised in Lasnik (2002).

argued that parameters arise from "underspecification of formal features in UG" (Biberauer et al. 2014b: 107). More specifically, in the context of emergent hierarchies, UG determines the following properties:

(16) a. certain formal features
b. recursive, binary Merge
c. a labelling algorithm
d. Agree (feature-valuation, relating elements of syntactic structures) (Biberauer et al. 2014b: 106)

According to Biberauer et al. (2014b), (16a) involves categorial features, φ-features, structural Case features, features such as [± wh], [± neg], [± tense] as well as diacritic features that trigger different types of Merge.

It is easy to enlarge the list in (16) by adding more features, once more fine-grained linguistic particularities are examined. As Biberauer et al. (2014b) correctly note in their evaluation of P&P, the parametric descriptions that have emerged since 1981 achieved an increasingly high level of descriptive adequacy, sacrificing though explanatory adequacy due to the postulation of more and more entities in UG. (16) is, in its current form of presentation, a description of UG that aims to target the most basic macroparameters (e.g., head-directionality). However, it is possible that once microparameters are being targeted, (16a) will have to be more specific and, as a result, it will exponentially grow to include more and more features, exactly as happened with parameters in P&P.

Another important point is that the absence of UG-parametric hierarchies does not guarantee a non-overspecified UG. On the contrary, if a variety of unrelated, independent, non-ordered features are described as primitives of UG, Newmeyer's view on exuberant nativism becomes relevant once more just by substituting the word 'parameters' in the original text with the word 'features':

> "If the number of [features] needed to handle the different grammars of the world's languages, dialects, and (possibly) idiolects is in the thousands (or, worse, millions), then ascribing them to an innate UG to my mind loses all semblance of plausibility. True, we are not yet at a point of being able to 'prove' that the child is not innately equipped with 7846 (or 7,846,938) [features], each of whose settings is fixed by some relevant triggering experience. I would put my money, however, on the fact that evolution has not endowed human beings in such an exuberant fashion". (Newmeyer 2005: 83)

Figures 10 and 11 show the degree of innate (i.e. UG-encoded) knowledge that is attributed to UG in the context of emergent hierarchies. Figure 10 offers a learning algorithm that does not operate on the basis of parameters and figure 11 is an illustration of a UG-derived, emergent hierarchy.

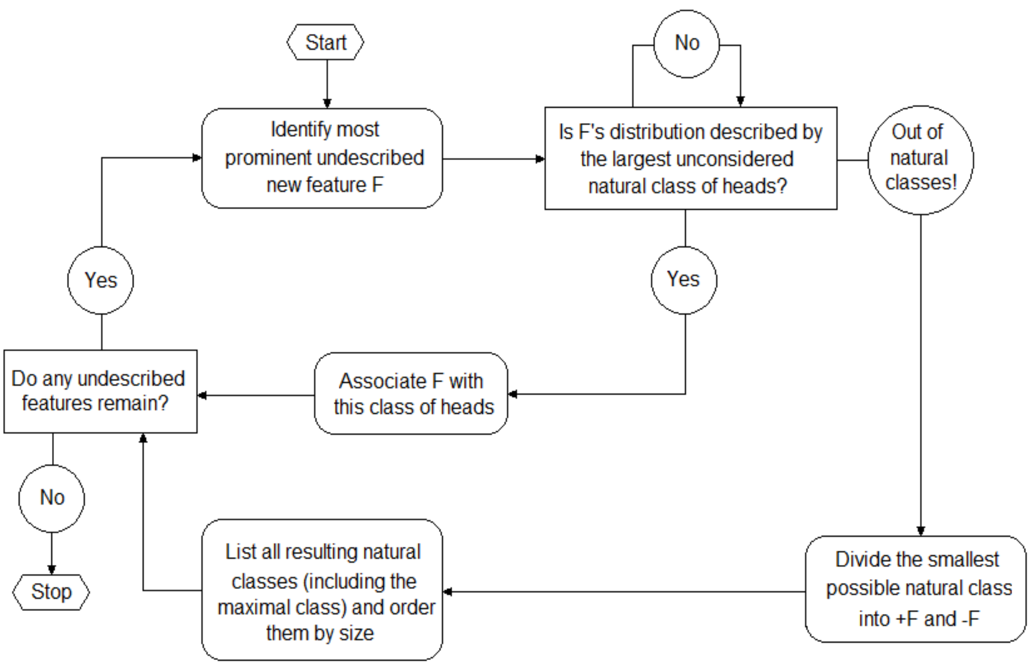

Figure 10: A learning algorithm (Bazalgette 2013)

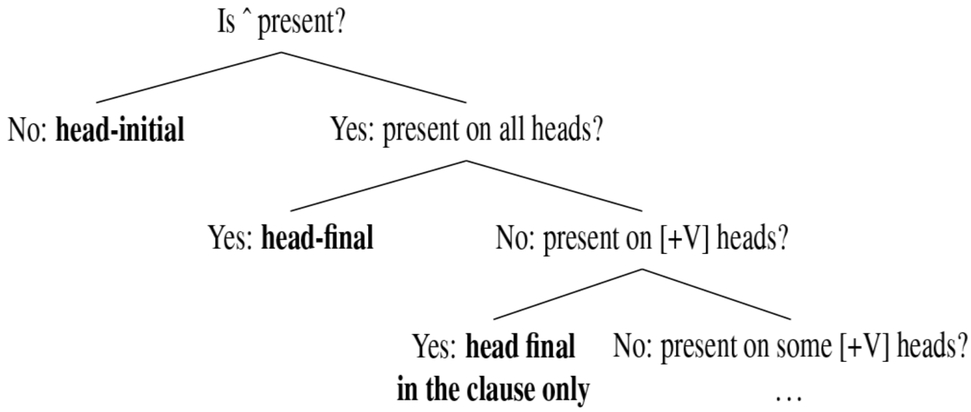

Figure 11: A non-UG-specified, emergent parameter hierarchy (Biberauer et al. 2013b)

The diacritic ^ in figure 11 signifies 'comp-to-spec' movement. Both figure 10 and figure 11 represent a theoretically well-motivated attempt to minimize UG and disentangle the acquisition process from the task of triggering innately specified values of parameters. Although these two proposals are on the right track in the sense of approaching acquisition without assuming a parameter-fixing process, they suffer from not being explicit on other counts. More specifically, a systematic attempt to maintain a non-overspecified UG that has no parameters cannot assume other pieces of innate knowledge without explaining why exactly this knowledge remains as a property of UG or how it surfaces in the acquisition task as a different type of (possibly third factor) property of the efficient learner.

The acquisition algorithm offered in figure 10, for example, presupposes that the learner somehow knows how to distinguish the largest unconsidered natural class of heads. However, it is not clear where this knowledge comes from or what exactly it corresponds to. Also, it is not clear how the division into +F and -F takes place in terms of how much noise/exceptions to a hypothesized rule the learner tolerates. Similarly, the hierarchy in figure 11 presupposes that the learner knows how to distinguish heads from non-heads, V heads from other types of heads, and how to apply the new feature selectively. In other words, the contents of UG have been minimized in the absence of UG-specified hierarchies, but much of these contents have been replaced by UG-derived hierarchies. In this sense, there still is a fair amount of linguistically-specific knowledge taken for granted: The hierarchy given in figure 11 presupposes that UG encodes the primitives listed in (16). Similarly, the learning schema in figure 10 presupposes that the learner has some linguistic knowledge, however the origins of this knowledge are not explicit and the cues that the efficient learner uses in order to perform the listed tasks remain to be defined.

Figure 11 presents a parametric hierarchy that is not encoded in UG. In this context, Biberauer et al. (2014b) argue that parameters emerge as a consequence of the learning process in the course of language acquisition, whereas parametric variation is the result of the interaction of Chomsky's (2005) three factors in language design. The important issue here is not the realization that the three factors together affect language development, as this is a claim well-established in biology (Lewontin 2000). The important step is to provide an explanation as to how a hierarchical ordering of parameters emerges from the interaction of these three factors and why the very same three factors give rise to different types of hierarchies. For example, the hierarchy given in figure 11 is an emergent hierarchy, but the 'mafioso' effect (as Biberauer et al. 2013b call it) is absent. The hierarchy in figure 12 is different in that it involves the 'mafioso' effect, since it starts with a so-called 'no-choice parameter'.

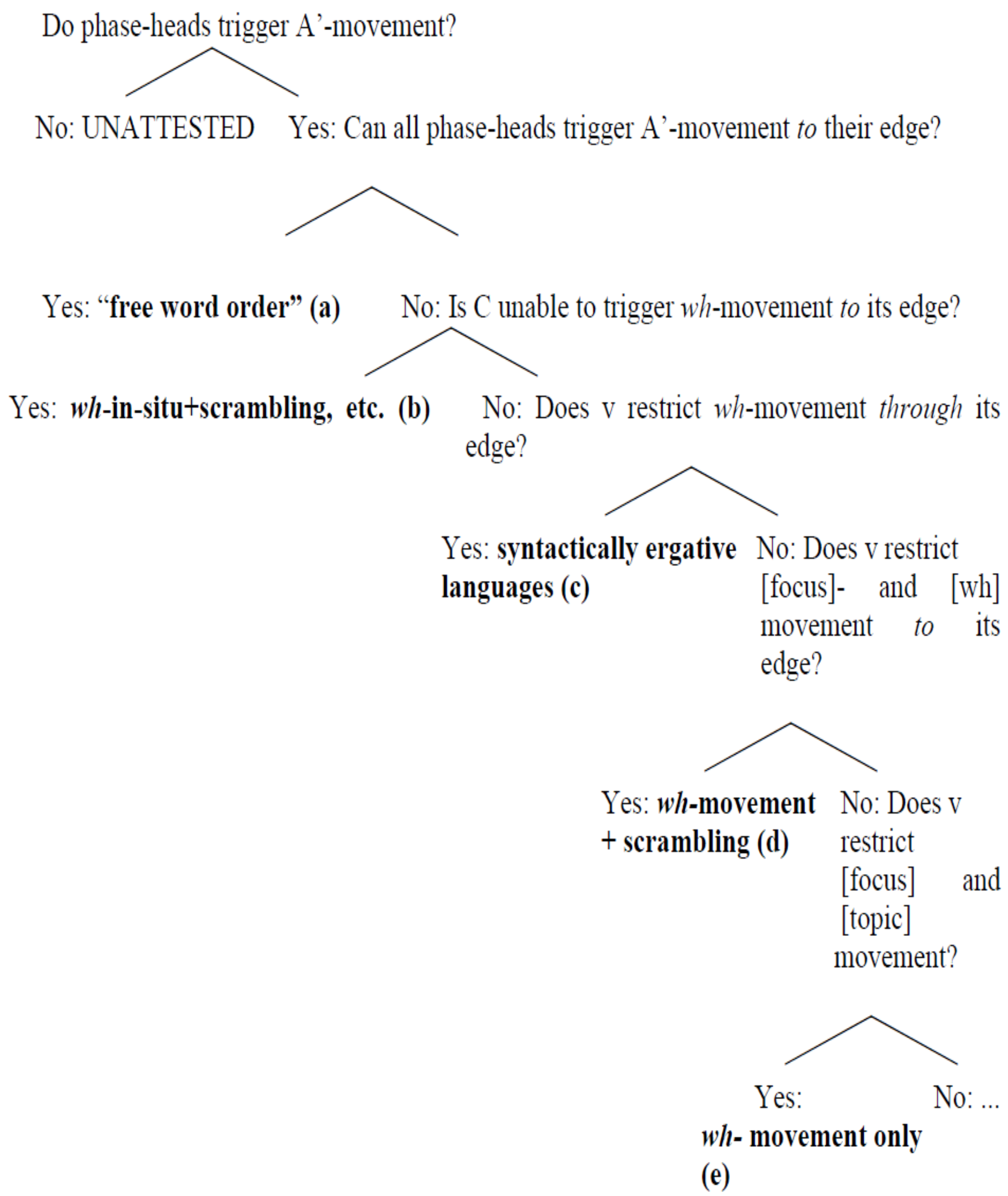

Figure 12: No-choice parameters (Biberauer et al. 2014b)

Since the hierarchy in figure 12 is an emergent hierarchy, the relevant ordering is not encoded in UG. More interestingly, the 'mafioso' effect is not induced by UG: As Biberauer et al. (2014b) argue the formal options exist and UG is indifferent to matters of expressivity and communication that lead to the (non-)instantiation of certain options. One such option would be the pattern marked as 'unattested' by Biberauer et al. (2014b) in figure 12.

Two important parts of the proposal behind figure 12 have to be highlighted for the purposes of the present discussion: First, Biberauer et al. (2014b) recognize a typological gap in patterns of A'-movement crosslinguistically (as demonstrated in figure 12). Second, when describing the unattested pattern of variation, they explicitly argue that "UG in principle allows such an option" (p. 122) but the latter is ruled out because of "communication" and "expressivity needs" (p. 122). In other words, they link the unattested option with externalization, pointing to the MPF nature of variation. However, recall that Roberts (2010a, b) has argued that it is the NS parameters that are asymmetrical/gap-containing. As mentioned in section 2.2, according to Roberts' definition, a parameter P is a non-PF one iff the realized variation defined by P contains a gap; and it is on this basis that FOFC was argued to be a non-PF issue. Figure 12 is argued by Roberts and colleagues to contain a gap, and yet this gap is neither UG-derived/-encoded nor syntactic; on the contrary, they say that the gap emerges only at the level of externalization due to the need to meet expressivity requirements.

The conclusion that can be drawn from this state of affairs is that although the effort to derive hierarchies instead of representing them in UG is a useful move, some parts of the theory behind emergent hierarchies are contradictory. Moreover, the learning algorithm that aims to approach the task of language acquisition in the absence of UG-specified parameters in figure 10 does assume some innate linguistic knowledge without explaining why exactly this knowledge remains as a property of UG or, if it is not a property of UG, how it emerges in the course of the interaction of the three factors in language design.

The next section will approach the acquisition task in the absence of parametric hierarchies of any of the two types discussed insofar (i.e. emergent or UG-encoded). This approach to acquisition is in line with Chomsky's (2007) urge to approach UG from below, by seeing how little we can ascribe to it. Also, this approach is more feasible from a biolinguistic point of view, because it minimizes the degree of linguistic specificity that needs to be explained from an evolutionary perspective. In Chomsky's (2007) words,

> "The task of accounting for the evolution of language would also be correspondingly eased, for the same reasons that hold for inquiry into evolution generally: the less attributed to genetic information (in our case, the topic of UG) for determining the development of an organism, the more feasible the study of its evolution. [...] Throughout the modern history of generative grammar, the problem of determining the character of FL has been approached "from top down": How much must be attributed to UG to account for language acquisition? The MP seeks to approach the problem "from bottom up": How little can be attributed to UG while still accounting for the variety of I-languages attained, relying on third factor principles? The two approaches should, of course, converge, and should interact in the course of pursuing a common goal."
> (Chomsky 2007: 4)

Setting apart the link established in Chomsky's above view between properties that are specific to the language faculty and the information that is coded in the genes for reasons discussed in chapter 2, the idea conveyed in the above excerpt is indicative of the task one has to perform when approaching the topics of language variation and acquisition. In the same work, Chomsky highlights the need to approach UG by talking about "mechanisms" (2007: 5). This is the idea behind the acquisition algorithm presented in the next section. More concretely, the intention is to provide a detailed description of the acquisition process, while assuming as few UG primitives as possible. The tasks that the efficient learner has to perform are listed and the cognitive principles that aid the learner to perform each of these tasks are identified as well. The outcome is a novel acquisition algorithm that is explicit in terms of the cognitive biases that the learner makes use of in order to perform the listed tasks.

3.3 Sketching Out a Novel Acquisition Algorithm

The aim of this chapter is to approach the task of language acquisition from the very beginning, without assuming a theory of parameters. The proposed algorithm agrees with the spirit of proposals such as those given in figures 10 and 11, by Bazalgette (2013) and Biberauer et al. (2013b) in keeping UG primitives at a minimum.

The proposal is that an acquisition algorithm should, in the absence of UG-provided acquisition cues, be able to account for the following needs:

- to account for the productivity of the hypothesized rules
- to integrate a parsing component that deals with how the learner uses the available input in order to formulate hypothesized rules
- to determine how much exceptions and/or noise to a hypothesized rule will be tolerated by the learner before modifying a rule, taking into account computing time of rule-application vs. 'exceptions list'-parsing (in the spirit of Legate & Yang 2013)
- to determine which biases can be of aid in the learning process without assuming that the learner is already able to understand heads from non-heads or other syntactic notions

In this context, I suggest that the acquisition process relies on a variety of factors, most of which are informed by processes also relevant in other modules of human cognition, hence processes that fall within the third factor domain. The first factor is the ability for 'reasoning under uncertainty'. Bayesian Networks are considered one of the most prominent frameworks for 'reasoning under uncertainty' and the majority of tasks requiring intelligent behavior have some degree of uncertainty implicated (see e.g., Gyftodimos & Flach 2004), which is also the case observed in language learning. A key characteristic of this reasoning is the ability to entertain overhypotheses and constraints on hypotheses at the same time.

Establishing the parallelism with acquisition, the efficient learner should be able to integrate in the process of learning some conflicting tendencies, such as the need to formulate generalizations over input, without however making the acquisition task more burdensome via forming assumptions that may be later hard to retract from. More specifically, the efficient learner internalizes linguistic knowledge by making use of biases that simultaneously allow for both overgeneralizing hypotheses (Boeckx's 2011a Superset Bias), but also for adequately constraining overgeneralizations, in line with Briscoe & Feldman's (2011) Bias/Variance Trade-off, according to which learners adopt an intermediate point on the bias/variance continuum in order to refrain from overfitting, backtracking and reanalyzing input.

Another property of the efficient learner is the ability to perform statistical computations. Many studies point out that humans are powerful statistical learners (e.g., Saffran et al. 1996). Yang (2005) suggests that productivity of hypothesized rules is subject to the Tolerance Principle, which seeks to define how many exceptions to a hypothesized rule can be tolerated without the learner deciding to abandon the rule as unproductive. One of the more recent formal representations of the Tolerance Principle holds that Rule R is productive if T(ime)(N,M) < T(N,N), with (N-M) being the rule-following items and M the exceptions (Yang 2005, Legate & Yang 2013). If T(N,N) < T(N,M), then R is not productive and all items are listed as exceptions (M=N, all items are stored as exceptions). This principle accounts for rule productivity in the course of acquisition in terms of the rules formulated by the learner.

Paying attention to morphophonological cues is the third characteristic of the acquisition algorithm proposed here. This view is in line with what was argued in chapter 2 about the relation between externalization and linguistic variation. Prosody, for example, defines constituents and helps in identifying position/edges of syntactic representation (Endress & Hauser 2010). This property is best phrased in Laka's (2009: 335) words: "Another example of an innate mechanism that appears very significant for language is found in the study of the perceptual salience of rhythmic/prosodic properties of speech". It can be thus claimed that points of variation are determined on the basis of explicit, saliently accessible morphophonological cues.[35] This is another component of the acquisition algorithm proposed here.

There are at least two more types of third factor principles that aid acquisition: first, the Elsewhere Condition (Anderson 1969) according to which the learner applies the most specific rule when multiple candidates are possible. A principle like this has to be operative in the course of acquisition in order to account for how the learner decides between different hypothesized rules. Second, perception and memory constraints of the sort described in Endress et al. (2009) and

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[35] This property is reminiscent of the Accessibility Condition, defined by Fasanella & Fortuny (2011) as a condition according to which "parameters must be set by directly inspecting phonological and morphological properties of utterances" (see also Fasanella 2014 for a more elaborate approach to the Accessibility Condition). It is also reminiscent of Chomsky's (2001: 2) Uniformity Principle: "In the absence of compelling evidence to the contrary, assume languages to be uniform, with variety restricted to easily detectable properties of utterances".

Gervain & Mehler (2010) also carry an important role. Endress et al. (2009) juxtapose the prevalence of prefixing and suffixing across languages with the rarity of infixing. They explain this state of affairs by means of a memory constraint according to which sequence edges are particularly salient positions, facilitating learning and giving rise to either word-initial or word-final processes much more often than otherwise.

If this finding is coupled with Boeckx's (2011a) Superset Bias, according to which learners strive for value consistency, one can understand why *consistent* head-initial or head-final patterns constitute the majority of the attested word-order patterns crosslinguistically. On the basis of 434 languages, Dryer (1992) observes that OV language are largely postpositional and VO languages tend to be prepositional. Hawkins (2010) calculates on the basis of the data reported in Dryer (1992) that 93% of these languages are consistently OV-Postpositional or VO-Prepositional. Hawkins (2010) approaches harmonic word-orders in terms of a processing preference that favors shorter processing domains. From this point of view, the rarity of disharmonic orders such as FOFC and inverse-FOFC can be convincingly described as the result of processing demands (Hawkins 2010 and references cited therein).

Following Yang (2002: 26-27, 2010: 1162) in assuming that the child upon receiving datum *s* selects a grammar G_i with the probability p_i and depending on being successful in analyzing *s* with G_i, punishes or rewards G_i by decreasing and increasing p_i respectively, the acquisition process corresponds to a learning algorithm that integrates the following principles:[36]

[36] Yang's model in its original formulation relied on the existence of parameters, whereas the algorithm proposed here entertains a non-parametric approach to the topics of language variation and acquisition. It seems right that the central features of Yang's model used here do not really require parameters to exist. Rules could equally be used to compute the relevant probabilities over.

Name	Description
(A) Reasoning under uncertainty (based on Bayesian models of learning)	Integrate conflicting tendencies in the process of learning through simultaneous entertaining of both overhypotheses as well as constraints on hypotheses
(B) Superset Bias (Boeckx 2011a)	Strive for value consistency
(C) Bias/Variance Trade-off (Briscoe & Feldman 2011)	Adopt an intermediate point on the bias/variance continuum. Do so by keeping (B) a bias, not a principle, in order to avoid backtracking
(D) Statistical Computation (e.g., Yang 2002, 2010)	Analyze datum *s* through a hypothesized grammar G_i with the probability p_i. Depending on being successful, punish or reward G_i by decreasing and increasing p_i
(E) Tolerance Principle (Yang 2005, Legate & Yang 2013)	Based on (D), turn G_i into a rule. Assume a Rule R is productive if T(N,M) < T(N,N)
(F) Elsewhere Condition (Anderson 1969)	Following (E), once multiple candidates are available, apply the most specific rule
(G) PF-Cues Sensitivity (cf. Fasanella & Fortuny's 2011 Accessibility Condition)	Fix points of variation on the basis of explicit, saliently accessible morphophonological cues. Make use of prosodic cues to define constituents
(H) Perception and Memory Constraints (Endress et al. 2009,	Keep track of sequence edges which are particularly salient positions in facilitating learning/giving rise to ei-

Gervain & Mehler 2010)	ther word-initial or word-final patterns much more often than otherwise

Table 3: List of biases and factors that aid acquisition

Table 3 presents the list of relevant biases and cues in an unordered fashion. Put differently, the relevant factors are identified but they are not related to each other and eventually integrated in the form of a learning schema. Connecting the different cues gives rise to an algorithm that approaches the acquisition process from the very beginning.

It is important to note that the ingredients of the proposed algorithm have been experimentally shown to help the acquisition process; for instance, the experiments reported in Endress et al. (2009) on the role of perception and memory functions in language processing in the course of language acquisition or Yang's (2005) assessment on a mathematical basis (through the Tolerance Principle) of the productivity of rules related to plural formation in German.

The factors that are in play in the course of language acquisition that are given in table 3 are ordered and interconnected in figure 13. The list of the offered cues is not exhaustive; the intention is to provide an indication of how each of the relevant tasks is performed, however it is likely that more than one factors and cues are in place in each step of the process.

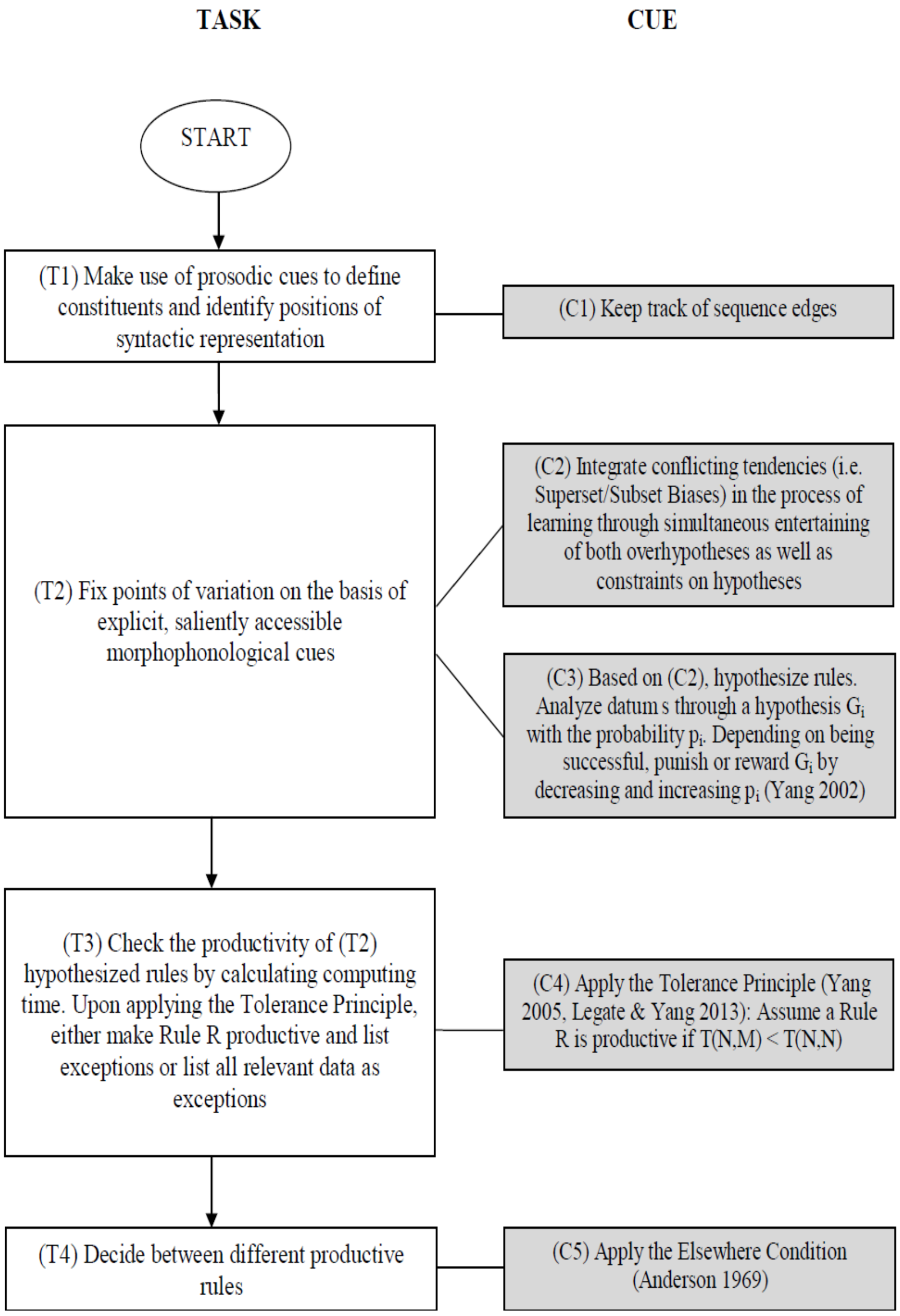

Figure 13: An algorithm for language acquisition

In this chapter, the focus has so far been on the process of language acquisition, approached across different proposals and through various angles. It has been argued that thinking of UG in strictly genetic terms is misguided. Genes do not code for parameters (i.e. points of crosslinguistic variation) and a direct link between the genotype and the phenotype is not only simplistic, but biologically untenable, given the way in which genes contribute to developmental processes and how development actually takes place (Benítez-Burraco & Boeckx 2014).

Likewise, putting forth a rich UG as an attempt to reduce the acquisition task is equally pointless if the UG primitives (i.e. parameters and the hierarchies they give rise to) eventually run into empirical problems of the sort identified in chapter 2. As argued already, the picture that emerges from current parametric models is that of a complex, subway-map-like network (see Rigon 2009) that cannot be used to guide the learner in any straightforward way.

If points of variation across languages reduce to realizational variants, the process of acquisition cannot correspond to triggering innately specified values of UG-encoded parameters. It is more plausible to argue that the learner integrates a variety of different factors in the process of learning. Reflecting this spirit, an algorithm that keeps the assumptions about the initial state of the language faculty at a minimum was sketched out in figure 13.

In the remaining sections of this chapter, the emphasis will be shifted to the role of acquisition and variation in the comparative biolinguistics agenda. One of the main purposes of the present work is to approach linguistic issues from an interdisciplinary, biolinguistic perspective. Defining the place that the topic of language acquisition holds in the biolinguistics agenda is fit in this context. As Benítez-Burraco & Boeckx (2014) note, the ways in which the child acquires language as well as the constraints to the learning mechanisms that mediate the acquisition process have been a key source of evidence since the early investigations of the biological foundations of language (e.g., Lenneberg 1967).

Addressing the kinds of the possible comparisons that can be established in this context is equally important. Comparative linguistics has been a very fruitful research program; the goal now is to discuss how the comparative method can be used to shed light to the biological underpinnings of FL.

3.4 Acquisition and Variation in the Comparative Biolinguistics Agenda

Comparative linguistics has been mostly dealing with variation that arises at the surface level. The basis of the present discussion of acquisition in the comparative biolinguistics agenda lies in the following realization offered in Benítez-Burraco & Boeckx (2014):

> "Our main contention in this article is that although the comparative method has figured prominently in linguistics, the objects routinely compared (languages, dialects, sociolects) may not be the only, or indeed the most appropriate ones to shed light on the biological foundations of our species-specific linguistic capacity. There are, we claim, deeper layers of variation to explore and to understand. Indeed, as we intend to show here, these deeper layers of variation beg questions regarding the proper biological interpretation of standard concepts in the field of (bio)linguistics [...]."
>
> (Benítez-Burraco & Boeckx 2014: 122)

The present chapter makes the passage from comparative linguistics to comparative biolinguistics by identifying the possible sources of variation through establishing comparisons across species but also across genotypes and impairments. Language is a complex and polylithic trait. In the introduction of this chapter, it has been argued that variation comes in many forms and the non-homogeneity of language is important when one discusses the 'terminal' state of language acquisition. A comparative approach can take many forms in addressing important questions about the nature of variation and its constraints across languages, pathologies, species and developmental stages.

To illustrate this with a concrete example, comparative work in biolinguistics can revisit standard linguistic assumptions by tackling the uniformity of language acquisition in cases of typical development. Variation is perhaps expected in the case of pathologies, but within the realm of comparative biolinguistics, the issue of variation should arise also in the absence of any impairment. Put another way, (bio)linguists have to abstain away from idealizations such as (i) the instantaneous, crosslinguistically uniform nature of acquisition, (ii) the idea that the attained adult performance is "essentially homogeneous with that of the surrounding community" (Anderson & Lightfoot 1999: 697), and (iii) the assumption that the so-called "linguistic genotype" is "uniform across the species (in the absence of fairly severe and specific pathology)" (Anderson & Lightfoot 1999: 702). These are descriptions that often arise when linguists talk about the nature of linguistic development.

Starting off from the hypothesis that the acquisition process is crosslinguistically uniform, there is no doubt that children that acquire different languages typically go through the same developmental stages. At the same time, it is also true that people that acquire language within the same language community will ultimately end up speaking or signing a different variant than the one given in their environment. Moreover, children that would be classified as belonging to the 'typical' population do differ from each other in terms of various psycholinguistic measures (Benítez-Burraco & Boeckx 2014).

Variation can have many faces here. For example, the pace of acquisition might differ across individuals even in the absence of any pathology. Second, the cognitive resources available in cases of *typical* monolingual vs. bilingual development can lead to different trajectories. It is a well-established fact that bilingualism enhances perceptual attentiveness (Bialystok et al. 2012, Sebastián-Gallés et al. 2012) and the derived cognitive benefits have an impact on the processing mechanisms that are active during the acquisition process.[37]

Third, the non-linguistic part of the environment may contribute to deriving variation in the course of development. The socio-economic status (SES) of families —especially the level of maternal education— has been shown to affect language development. Differences are evident as early as 18 months of age between infants from higher- and lower-SES families (Fernald et al. 2012), while higher than expected numbers of language delay were discovered for children whose mothers had minimum years of education (Letts et al. 2013).

Fourth, modality of externalization is another source of variation in the performance observed across the various stages of development in different individuals. It has been suggested that children that acquire sign languages show their first signs before the first words appear in the performance of their speaking peers (Lillo-Martin 2008). This is probably due to a "sign advantage", according to which speaking children take more time to develop articulatory control compared to signing children (Meier & Newport 2010).

[37] It goes beyond the scope of the present discussion to provide a list of the cognitive benefits that result from having two (or more) languages represented in the brain. Such reviews exist in the literature. For the purposes of illustrating the point made here, the most comprehensive such review is offered in Laka (2012).

Evidently, a cluster of factors as well as their possible interactions can be held responsible for deriving variation in the course of language development, even without any diagnosis of a linguistic and/or cognitive impairment.

Apart from environmental factors, genetic endowment can account for variation in typical language acquisition. As Benítez-Burraco & Boeckx (2014: 126) observe, "language can be preserved in individuals who are endowed with a pathogenic copy of one of these 'language genes' (null penetrance)". Similarly, individuals with a pathogenic variant of a gene can be impaired in a non-uniform fashion (variable penetrance). In this context, it becomes clear why, within comparative biolinguistics, the idea that the attained adult performance is "essentially homogeneous with that of the surrounding community" (Anderson & Lightfoot 1999: 697) should be revisited.

Within the comparative linguistics research program, it has been argued that language acquisition "constitutes the fundamental empirical problem of modern linguistic research" (Chomsky et al. 2003: 9). Plato's Problem' (Chomsky 1986), elsewhere called 'the logical problem of language acquisition, is also at the heart of biolinguistic inquiries. This is one of the five issues that figure prominently in the *Biolinguistics manifesto* (Boeckx & Grohmann 2007) as shown in (15), repeated in (17) below:

(17) i. What is knowledge of language?
ii. How is that knowledge acquired?
iii. How is that knowledge put to use?
iv. How is that knowledge implemented in the brain?
v. How did that knowledge emerge in the species?

The next section will deal with the logical problem of language acquisition, which will be approached as a component of 'the biological problem of language acquisition'. With the exception of (v), the biological problem of language acquisition encompasses all the research questions or 'problems' that are given in (17).

3.4.1 The (Bio)Logical Problem of Language Acquisition

The biological problem of language acquisition brings together a variety of research questions that constitute a large part of the agenda of comparative (bio)linguistics. Mapping it to the problems listed in (17), one cannot answer the question of how knowledge of language is acquired (ii), if one has not first defined what this knowledge consists of (i), which is impossible to do if one does not approach the faculty of language as a part of human cognition and biology (hence the characterization 'biological'). Similarly, the way to see how language is put to use (iii) goes through language acquisition; language is first put to use in the course of acquisition and, cases of extreme deprivation aside, the course of acquisition entails language use and one cannot have the latter without having the former. (iv) is an undetachable part of an in-depth understanding of (i) and (ii); it is hopeless to believe that one has a complete theory about what (knowledge of) language is and where the acquisition task aims at going, if the brain is not part of this theory.

The key question of the biological problem of language acquisition (point (ii) above) remains unaddressed though. The fact that one might approach points of variation as MPF decisions —rather than UG-derived parameters and/or parametrized NS operations— is a step towards understanding the character of variation and the nature of UG but its relation to acquisition is not entirely clear until a link between variation, acquisition, and the concept of interlocked parameters is offered. This link is the following: If

(a) the concept of interlocked parameters —which is a theory about acquisition since it aims to constrain the parametric space a child has to navigate in the course of acquisition by making available certain 'set-menu' options— runs into empirical problems of the sort identified in chapter 2, and
(b) in light of accepting that interlocked parameters and not thousands of unrelated parameters is the only reasonable way to go about a UG that specifies parameters alongside their possible values/triggers/setability paths, then
(c) uncovering empirical problems in the hierarchies that interlocked parameters correspond to is informative with respect to both the nature of variation (i.e. it is not UG-encoded) and our innate endowment to acquire language (i.e. it does not specify parameters and parameter-values/-triggers).

Identifying the relevant empirical problems entails progress with respect to the status of acquisition within the comparative biolinguistics agenda. Obtaining findings that suggest that generative linguists should refrain from describing acquisition as a process of triggering prewired values of unfixed linguistic principles minimizes the degree of the hypothesized linguistic specificity. In turn, this makes comparisons with other cognitive abilities as well as other with the communication systems of other species easier to establish.

All in all, the topics of variation and acquisition are interrelated in more than one ways. Precisely because of all the different factors that are in play (such as those identified in section 3.4), the biological problem of language acquisition entails approaching Plato's problem by taking the input of social and environmental influences seriously.

In doing so, the comparative method is likely to be of service once more.

While discussing the development of patterns of variation in human language, Wray & Grace (2007) argue that the nature of the communicative context affects the (surface) structure of language: esotericity allows for grammatical and semantic complexity, whereas exoteric, inter-group communication leads language towards rule-based regularity and semantic transparency. In Bolender (2007), the link between exoteric communication and enhanced linguistic complexity is related to syntax. Within comparative biolinguistics, one can approach the topic of the emergence of variation through development by establishing comparisons across species. To this end, Boeckx et al. (2013) write that

> "Complexity does not exhaust its existence in human language: Song quality in Bengalese finches "*partially* reflects early ontogenetic conditions", whereas "considering that song syntactic complexity is subject to female preference in the Bengalese finch, it is likely that maternal resource allocation strategies play a role in song evolution" (Soma et al. 2009: 363, emphasis added); such strategies obviously being a component of the environment factor. Moreover, it has been argued that long-domesticated Bengalese finches display a phonologically and syntactically more complex courtship song compared to their cousins that leave in the wild (Okanoya 2012). Evidently, the path to deriving complexity goes through the environment and this happens not only in the case of human language. It seems that the existence of properties like varying complexity in what gets externalized is not restricted to humans and also the factors that affect these properties are quite alike across species in that they are environmentally-driven adaptations." (Boeckx et al. 2013: 22)

In other words, it seems that a parallel pattern of emergence of variation can be observed when different communication systems are compared. It is the task of comparative biolinguistics to foster and investigate such comparisons between species, cognitive phenotypes, and developmental stages across different populations. Last, it is also the task of comparative biolinguistics to provide answers in questions such as those encompassed by the biological problem of language acquisition.

3.5 Conclusions

The present chapter had three goals. The first one was to give an overview of the treatment that the topic of language acquisition has received within parametric approaches to language acquisition. Second, aiming to see how little can be attributed to UG, the next goal was to propose a novel acquisition algorithm. In light of the findings reported in chapter 2, this algorithm operates on the basis of a truly underspecified UG and does not assume innate linguistic knowledge that encodes parametric hierarchies or features that derive parametric hierarchies. The cognitive cues that aid the learner in every step of the acquisition process were also presented and schematically integrated in a step-wise fashion. Last, this chapter presented possible ways to approach the topics of language acquisition and variation in the context of the current (comparative) biolinguistics agenda by establishing comparisons at various levels. Abandoning sharp divisions and establishing comparisons is in line with the change de Waal & Ferrari (2010: 201) notice: "A dramatic change in focus now seems to be under way, however, with increased appreciation that the basic building blocks of cognition might be shared across a wide range of species".

In Paris of 1866, all discussion on the origins of human language was famously banned by the Linguistic Society of Paris. Almost one and a half centuries later, it seems to be the case that adequate progress has been made and that we have accumulated enough knowledge from various disciplines such as evolutionary biology, genetics, paleoanthropology, (clinical) linguistics to make an attempt to provide linking hypotheses across these different disciplines through a novel, comparative biolinguistic perspective.

Crucially, this novel perspective does not intend to dismiss or neglect the progress made over the last decades within the comparative linguistics approach (i.e. variation across languages); instead it can benefit from this progress and make use of the relevant findings. However, it does require that the findings, tools, and primitives that survive the passage from one discipline to the other are informative within the somewhat larger frame of the new enterprise. More importantly, it seems that this novel perspective also requires that linguistic findings are linked more robustly with the five key questions of the biolinguistic enterprise given in (17). Put differently, linguistic representations, when used within a biolinguistic context, have to go hand in hand with interdisciplinary linking hypotheses that say something novel about FL.

Additionally, (bio)linguists who argue that their interest is in language as an organ of human biology should seek to establish comparisons across the different disciplines rather than simply offer highly technical discussions that provide no explanatory adequacy at all when they exhaust themselves on describing how construction A is realized in language B. In Felix's (2010: 68) words, once more, "[i]f you, like Chomsky, are primarily interested in cognitive psychology, your specific perspective on the entire generative enterprise might be somewhat different from the one of someone who is just interested in language and language data".

Reflecting this spirit, the next chapter aims to offer a concrete illustration of how comparisons between the two research programs, comparative linguistics and comparative biolinguistics, can be established. The vehicle for establishing the comparison will be the picture that emerges from variation across cognitive phenotypes. On the basis of experimental findings reported for five pathologies, it will be shown that a parallel exists with respect to the loci of variation that can be identified across the two research programs when one compares linguistic phenotypes to cognitive phenotypes.

4. Variation across Pathologies

The ultimate aim of the present work is to provide a bridge that connects two of the key research topics of the two programs: comparative linguistics and comparative biolinguistics. More specifically, the goal of this chapter is to explore the nature and limits of variation across different cognitive phenotypes and then match it to the picture of variation that was sketched out in chapter 2 with respect to linguistic phenotypes. The outcome of this comparison is that, in both cases, variation is confined to the same components of FL. The picture on variation across pathologies is established on the basis of describing and comparing the grammars of five –four developmental and one acquired– pathologies: aphasia, Specific Language Impairment (SLI), Down Syndrome, autism and schizophrenia. All these pathologies have been argued to usually involve some degree of language impairment.

The starting point of the exploration of the five aforementioned pathologies is the following observation made in Benítez-Burraco & Boeckx (2014):

> At the same time, our reading of the literature suggests to us that breakdowns and compensations, whenever they occur, do not proceed randomly. In reality, *some aspects of language processing seem to be particularly vulnerable in all pathological conditions, while others seem to be preserved in all of them*. For instance, inflectional morphology is problematic not just for people with specific language impairment (Marchman et al. 1999), but also for those suffering from speech-sound disorder (Mortimer and Rvachew 2010), Down's syndrome

> (Eadie et al. 2002), or (a subtype of) autism (Roberts et al. 2004). Ultimately, only some pathological phenotypes have been described, while others have not been observed [...].
> (Benítez-Burraco & Boeckx 2014: 122; emphasis added)

Aiming to establish the bigger picture for the attested patterns of variation across cognitive phenotypes, the first step is to describe the vulnerable domains that have been reported for each one of the five pathologies under discussion. The intention is to demonstrate in each case that the vulnerable domains are those related to the externalization component of language. This mirrors the picture reported in chapter 2 for variation across languages: It has been suggested that variation is neither syntactic nor UG-encoded, but instead related to the externalization component of language (morphophonology and lexical semantics). Similarly, the claim that will be defended in this chapter is that certain aspects of grammar such as morphophonology and lexical retrieval are consistently impaired in aphasia, SLI, Down Syndrome, autism and schizophrenia. Conversely, syntax is invariant and appears to be preserved across these pathologies.

Syntax is understood here as referring to applications of syntactic operations such as Merge and Agree, following the definitions of Chomsky (2001). The reason for choosing this conception of syntax over a conception of agreement being a postsyntactic operation (as sketched out in Bobaljik 2008) is purely practical. Since some of the studies that will be reviewed in the forthcoming sections of this chapter refer to omissions of agreement markers when they talk about 'syntactic deficits', it is necessary for the purposes of the present approach to variation to address them. In other words, it is necessary to revisit the findings behind these claims and show that they are not really making a case for a 'deficient syntax', instead of merely dismissing them on theoretical grounds. However, at a theoretical level, Bobaljik's (2008) proposal that agreement (i.e. copying/sharing φ-features) is not an NS process, but a morphological one, is sound.

Aiming to obtain a uniform picture, the main source of information with respect to the above pathologies will be experimental findings elicited from populations speaking an inflectionally rich language: Modern Greek. Two varieties of Modern Greek will be examined: one official language, Standard Modern Greek (SMG), and one heritage language that lacks the status of an official language, Cypriot Greek (CG).[38] For some of the reported findings, crosslinguistic comparisons with findings from languages other than SMG and CG will be established. Claims in favor of syntactic variation in the above pathologies will be discussed and it will be suggested that what is dubbed 'syntactic' is in reality something else.

For example, Penke (2015) writes that syntactic deficits are common in language disorders. When she begins enumerating the typical symptoms of syntactic deficits in spontaneous speech production, the first core symptom of a syntactic deficit that is given boils down to problems with bound inflectional morphology, followed by omissions of function words and reduced sentence length. In other words, the first deficit amounts to problems (mainly omissions) of bound inflectional markers, the second deficit to issues with lexical retrieval (mainly omissions) of free function words, and the last problem could be re-described as the natural outcome of the first two deficits. As a matter of fact, Penke herself acknowledges that subordinate clauses, wh-questions or passives are "rarely produced in spontane-

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[38] The grammars of the two languages will not be presented in detail here, apart from the parts identified as loci of impairment. Descriptions of the two grammars exist in the literature, and the present discussion would not have something new to offer from a descriptive point of view (e.g., see Holton et al. 1997 for a detailed description of the grammar of SMG, Terkourafi 2005 for a description of present-day CG, and Grohmann & Leivada 2012 for a comparison between SMG and CG). In the remaining sections, 'Greek' will be used as a cover term to refer collectively to both varieties.

ous speech" in Broca's aphasia, Wernicke's aphasia, SLI and Down Syndrome. If such structures are (rarely) produced, essentially the operation that assembles them is operative, while extragrammatical, non-linguistic factors can be held responsible for affecting their frequency. Some of these factors could be fatigue, normal vs. disturbed sleep patterns, and presence vs. absence of sleep disordered breathing, etc. (see Adams 2011 for a review).

One of the classic examples of a so-called syntactic deficit has to do with comprehension of (non-)canonical word-order. As Penke (2015) argues, most language-impaired individuals that speak English would understand better a canonical SVO (e.g., "John kissed Mary") compared to object clefts (e.g., "It is Mary who John kissed") or passives (e.g., "Mary was kissed by John"). It is typical that language-impaired individuals misinterpret such structures by interpreting the first NP encountered as AGENT (as would indeed be the case in the canonical SVO) instead of THEME. However, this is not a very concrete indication of a syntactic deficit in language-impaired individuals for the following reason: Healthy individuals without any diagnosis of a linguistic or cognitive impairment whatsoever might exhibit exactly the same mistake. As Penke (2015) notices, the strategy to interpet the first NP of a clause as AGENT is "*regularly* observed in control subjects who do not suffer from any language impairment" (emphasis added).

This state of affairs is reminiscent of the Moses illusion (Reder & Kusbit 1991), according to which healthy individuals are unable to detect distortions in the experimental stimuli such as "How many animals of each kind did Moses take in the Ark?". They might be unable to detect the distortion even if they know that it was Noah and not Moses the person who built the Ark. This phenomenon has been explained by means of suggesting that a partial-match strategy is operative when processing the relevant stimuli.

> "[...] the illusion results from an incomplete or partial-match strategy. As a question is read, the terms or concepts are matched to memory so that the answer may be retrieved. Not every word or concept in the question will be matched exactly to a corresponding memory structure, however. A criterion level will be set for a given situation, and the concepts in the question will be checked for overlap with the remainder of the sentence, with the criterion level determining how much overlap must be present. For example, since Moses is a biblical character and is thus loosely related to Noah, he will sometimes be accepted in the question about the ark, while Nixon, a modern politician, will never be accepted in this sentence."
> (Kamas et al. 1996: 688)

In other words, it seems that processing operates in a way that may give rise deviations from what is deemed expected knowledge or target performance even in the absence of any cognitive and/or linguistic impairment. This deviation might be the inability to detect distortions such as the one in Moses illusion or the inability to detect that the word-order given in the stimuli has reversed thematic roles than what is expected/canonical. Crucially, in both types of deviations, cues related to pragmatic knowledge are of great aid. As mentioned above, if Moses is substituted by Nixon, the distortion would be reported because Nixon does not arise in a biblical context, as do Moses and Noah. Similarly, reversible passives (e.g., "The dog is being chased by the cat" vs. "The cat is being chased by the dog") are more difficult to understand than non-reversible —pragmatically odd when reversed— passives (e.g., "The operation was performed by Dr. Brown" vs. #"Dr. Brown was performed by the operation"), even in instances of typical language development (Rondal 2007: 80). Therefore, it is no surprise that some brain-damaged patients show *selective* impairment of passives: Reversible passives are impaired, while non-reversible passives are preserved in the aphasic patient reported in Caramazza & Miceli (1991). Interestingly, the same pattern was observed for active voice. Overall, the difference between actives and passives was robust: 20 role reversal errors occurred on reversible sentences and only one on non-reversible structures.

If syntax was broken down to the point of not producing passive structures, the dissociation of reversible passives vs. non-reversible passives should not arise. It does arise precisely because the impaired structures do not boil down to a syntactic deficit per se. Put in a different way, if pragmatic and lexical cues are shown to be of some aid in eliciting the target/correct interpretation, this is because the underlying structure *can* be syntactically construed in the first place.

Aiming to discuss types of linguistic deficits in further detail, the next five sections will present and compare the grammars of aphasia, SLI, Down Syndrome, autism and schizophrenia respectively with the intention to show that certain aspects of FL are impaired across these disorders. This comparative analysis of different cognitive phenotypes fits well the purposes of the biolinguistic enterprise (cf. (17)) and especially the need to uncover how language is implemented in the brain. In Terzi's (2005: 111) words, research in language disorders is vital because of "the need to identify detailed physical mechanisms of the brain that correspond to the various domains of grammar and its structure [...]".

4.1 The Grammar of Aphasia

Aphasia is a neurological disorder that arises due to brain damage usually after stroke, infection or head injury. It affects language to varying extents, depending among other factors on the locus of the sustained damage. Different types of aphasia can typically be associated with different symptomatology: For instance, patients with agrammatism usually have lesions in Broca's area (i.e. the pars opercularis and pars triangularis of the inferior frontal gyrus) and show an impaired ability to produce words, an effortful, 'telegraphic' speech production, and a relatively spared comprehension. On the contrary, Wernicke's aphasia usually occurs due to a lesion located in the posterior section of the superior temporal gyrus and involves fluent speech that is devoid of communicative meaning.

The very first experiments in SMG-speaking aphasics showed the existence of retrieval deficits that resulted to the omission of morphological markers. The main claim of Kehayia (1988) and Kehayia et al. (1990) is that what is lost in agrammatism is *access* to morphological markers. The interesting fact is that "in most cases the subjects indicated their awareness of the [morphological] error or the missing item, which suggests that 'morphology' is not lost and that at least basic syntactical structures are available" (Kehayia et al. 1990: 149). As the present section will make clear, findings that support a problem in accessing/retrieving the target morphophonological form are recurrently appearing in studies of Greek aphasia. Defining the meaning of access, models of language processing have often proposed that word retrieval is a process that can be divided into two discrete stages: (a) lemma selection and (b) lexeme retrieval (Levelt 1989, Goodglass 1993). The lemma is an abstract conceptual form without morphophonological specification. Following lemma selection, in the second stage, lexeme retrieval takes place: the lexeme that corresponds to the selected lemma is morphophonologically specified. Levelt's (1989) model has been highly influential in clinical linguistics (not only in aphasia) precisely because the elicited findings suggest that a lemma/lexeme distinction is necessary. For example, when an aphasic subject does not retrieve the target verb but a morphophonologically-distinct yet conceptually similar or identical predicate, one can understand that the impairment does not amount to lemma selection but to lexeme retrieval. Similarly, in the study of Kehayia et al. (1990) it is argued that aphasic patients are able to provide judgments about the markers that are missing; this performance suggests intact conceptual awareness, but impaired access to the target lexeme.

In one of the earliest experiments with a variety of off-line tasks run in SMG-speaking aphasics, Tsapkini et al. (2001) presented the case of a 59-year-old man with agrammatism. His speech at the time of testing was moderately fluent albeit dysarthric. Upon being evaluated on the Greek adaptation of the Bilingual Aphasia Test (Paradis & Kehayia 1987), the patient showed word-finding difficulties, semantic categorization difficulties, and at ceiling performance in the syntactic comprehension task for passive constructions, pronoun use and genitive-possessive marker use. The cued elicitation task revealed problems with perfective past-tense morphology, whereas the repetition task indicated intact phonological representations. Overall, the study of Tsapkini et al. (2001) offers evidence for word-retrieval difficulties, occasional omissions of articles, problems with morphological markers and with semantic categorization. Syntax seems to be preserved, although of reduced complexity due to frequent interruptions when a word could not be retrieved.

Aiming to specifically address the issue of syntactic deficits in Greek agrammatism, Nanousi et al. (2006) examined the performance of six SMG-speaking agrammatic patients. The aim of the study was to examine the validity of the Tree-Pruning Hypothesis (TPH; Friedmann & Grodzinsky 1997). TPH assumes a truncation model according to which an element is more susceptible to impairment depending on its position in the syntactic structure. Nodes lower than the pruning site remain intact, whereas patients cannot construct syntactic trees higher than the pruning site. Interpreting their findings, Nanousi et al. (2006) argued that in both the production and the acceptability judgment tasks, aspect and tense were more impaired than agreement. Since agreement is located higher than aspect and tense in the syntactic clause in SMG, Nanousi et al. (2006) took their findings to not support the predictions of the TPH. Instead of assuming an impaired ability to build the syntactic tree past an impaired node, they suggested that agrammatic patients have access to syntactic operations such as Agree, but show problems with the morphophonological realization of interpretable features such tense and aspect.

The conclusion of Nanousi et al. (2006) that findings coming from SMG-speaking aphasics do not support structural/syntactic accounts of the deficit, such as the TPH, is in agreement with what has been pointed out in Plakouda (2001) and Stavrakaki & Kouvava (2003). Plakouda (2001) administered a sentence completion task designed to assess subject-verb agreement, tense and aspect to one SMG-speaking patient with agrammatism. She found that aspect was the most problematic category, whereas tense and agreement were relatively intact. The percentage of correct responses was 60% for aspect, 95% for tense and 87% for agreement (Varlokosta et al. 2006). Similarly, Stavrakaki & Kouvava (2003) argued that a high degree of grammatical sensitivity was found even for those structures associated with the highest projections of the syntactic tree, such as CP, and that are hardly found in spontaneous speech. The attested difficulties "were attributed to impaired *access* to grammatical representations, rather than to impaired grammatical representations" (Stavrakaki & Kouvava 2003: 140; emphasis added).

Varlokosta et al. (2006) examined patients with different types of aphasia (including Broca's and Wernicke's aphasia) and agreed with the previous studies in finding a dissociation between preserved agreement, on the one hand, and less preserved tense and aspect, on the other hand. Once more, these findings did not support a structural account of the deficit along the lines of TPH. The findings reported in Fyndanis (2009) and Fyndanis et al. (2012) largely agree with this pattern. In both studies, it was found that aspect is the most problematic category, followed by tense and then by agreement which is the least impaired of the three categories. It has been argued that the increased processing demands of tense and aspect render them more vulnerable than agreement, which bears an uninterpretable feature and relies on a grammatical operation (Fyndanis et al. 2012 in line with Nanousi et al. 2006). In this context, one cannot argue in favor of a syntactic deficit in Greek aphasia for the following reason. The difficulty with some types of markers but not with others that is presented in Fyndanis et al. (2012) —and in previous studies in Greek aphasia that showed similar results— is a difficulty related to "*encoding* T (and perhaps Asp) related diacritical features and/or *retrieving* the corresponding verb forms or constituents (stem and affix(es)) (p. 1144; emphasis added). For encoding the compromised markers, one "has to rely on extralinguistic/conceptual information" (p. 1144). Nowhere do the findings of Fyndanis et al. (2012) suggest a problem in assembling a bundle of features or in assembling a structure past a compromised marker. In agreement with what Fyndanis et al. (2012) argue, the correct conclusion to be drawn from this study should indeed talk about a problem in retrieving and externalizing the target marker, mainly in those cases that entail increased processing load when encoding extralinguistic/conceptual information is necessary.

A very interesting case-study is presented in Alexiadou & Stavrakaki (2006) and concerns a SMG-English bilingual patient with Broca's aphasia. Alexiadou & Stavrakaki administered a constituent ordering task and an acceptability judgment task to test both production and comprehension. Their findings showed that the CP layer causes difficulties in both languages "but it is not missing from aphasic grammar" (p. 207), whereas the lower VP layer is intact in both languages. The tasks targeted adverbial placement, and the adverbs that were tested give rise to following hierarchy: $CP_{fortunately}$-$MoodP_{propably}$-$NegP_{anymore}$-$AspP_{usually}$-$VP_{carefully}$ (Alexiadou & Stavrakaki 2006: 216 following Alexiadou 1997). The results of the acceptability judgment task indicated lower —but still well above chance— performance for the adverbs that occupy the high positions in the hierarchy, however not an in incremental fashion. Focusing on the results of the task in SMG and grouping together the 'correct' and 'correct but marked' responses in order to categorically draw the line between correct and incorrect responses the following pattern arises for correct responses: 83.32% for $CP_{fortunately}$, 100% for $MoodP_{propably}$-100% for $NegP_{anymore}$, 100% for $AspP_{usually}$ and 100% for $VP_{carefully}$. These percentages suggest that the aphasic subject examined in Alexiadou & Stavrakaki (2006) "did have access to grammatical knowledge required for correct grammatical judgments" (p. 215), even the one required for providing correct judgments associated with the CP domain.

In another study, Kambanaros (2007) examined five SMG-speaking aphasics with word-finding difficulties (i.e. anomic aphasics). The findings revealed that the anomic subjects made few phonological errors. Such errors were outnumbered by semantic paraphasias (e.g., produce 'tool' instead of 'hammer') or circumlocutions (e.g., produce 'make a house' instead of 'build'). The findings led to the conclusion that "*access* to the (morpho-)phonological representation of the target form is instead compromised, leaving the actual morphophonological representations themselves preserved" (Kambanaros 2007: 14-15). In this case too, the manifested impairment has been argued to boil down to access to representations at the lexeme level.

More recently, Fyndanis et al. (2010) and Nerantzini et al. (2014) aimed to shed light to another domain of the grammar of aphasia in SMG: wh-questions. On the basis of the results of a picture-pointing task and an elicitation task administered to three SMG-speaking agrammatic patients, Fyndanis et al. (2010) argued that production was found to be more impaired than comprehension and that all three participants largely preserved their ability to comprehend CP in the picture-pointing task. The picture that emerged from comprehension was quite different, as all participants showed severe difficulties constructing wh-questions. The explanation offered for these difficulties is not syntactic though; it is extragrammatical and relates to 'costly' processing.

> "The hypothesis we put forward here is similar to those that Kok, van Doorn, and Kolk (2007), Nanousi et al. (2006) and Varlokosta et al. (2006) formulated in order to account for the better performance of their agrammatic subjects on Tense or/and Aspect rather than on Agreement, as well as with Avrutin's account (2000) regarding the preponderance of wh-questions over wh-NP-questions in agrammatism. Building, thus, on the original proposal of Avrutin, we argue that a) both wh-questions and wh-NP-questions are demanding in terms of processing resources, given that they both bear an LF-interpretable feature and require integration of information/ knowledge from two levels of representation, the linguistic/grammatical one and the extra-linguistic/conceptual one, and b) these two question types possibly differ in that processing and integration of D[iscourse]-linked knowledge is more "costly" than processing and integration of non D-linked knowledge." (Fyndanis et al. 2010: 658)

Nerantzini et al. (2014) reach similar conclusions. They argue that the predictions of the Discourse-Linking Hypothesis (Avrutin 2000) are fully confirmed for their obtained results in terms of comprehension and partly in terms of production. Importantly, there is agreement between Nerantzini et al. (2014) and Fyndanis et al. (2010) in terms of relatively high performance for comprehension of wh-questions, indicating preserved comprehension of CP.

A proposal of a syntactic deficit in SMG agrammatism appears in Koukoulioti (2010). In her study, a sentence elicitation task was administered to three SMG-speaking aphasics in order to investigate the production of negation. SMG has two markers for verbal negation, 'ðen' and 'min'. The former is used with indicative verb forms and the latter with subjunctives, gerunds, etc. Koukoulioti's results showed that patients were significantly better in producing indicative forms than subjunctive forms, whereas production of the correct negation marker was not a problem either in indicative or in subjunctive verb forms. The patients performed better in indicative negative sentences (using *ðen*), than in subjunctive negative sentences (using *min*), in line with what Stavrakaki & Kouvava (2003) claimed on the basis of data obtained from spontaneous speech. In this context, one of the explanations entertained in Koukoulioti (2010: 687) is that of 'slow syntax' (Avrutin 2006): "According to this hypothesis, the aphasic language system is not impaired in terms of representation, but rather in terms of resources available for syntactic operations (such as the operation Merge)". In other words, one way to explain Koukoulioti's findings could be in terms of cumulative complexity that is the result of the co-existence of subjunctivity and negativity. However, Koukoulioti casts serious doubt on this explanation. In her words, "if the number of times that the operation Merge takes place is indeed a relevant complexity factor, one would expect that negative sentences would be more difficult than affirmative ones for all patients" (p. 687), something that her findings did not show.

Another domain of interest in aphasic grammars is that of pronouns and clitics. On the basis of spontaneous speech data, Stavrakaki & Kouvava (2003) reported correct production of strong pronouns and possessive (genitive-marked) clitics and impaired production object (accusative-marked) clitics. As Stavrakaki & Kouvava (2003) notice, object clitics —unlike genitive clitics— need a prominent discourse antecedent to be interpreted: “Associating a clitic pronoun with a discourse referent requires a complex computational procedure; hence the omission of object clitics in agrammatic speech” (pp. 134-135). The Discourse-Linking Hypothesis (Avrutin 2000) seems to be able to explain this dissociation.

Nerantzini et al. (2010) agreed with Stavrakaki & Kouvava (2003) in arguing that the production of object clitics in SMG-speaking agrammatics is impaired. What is more interesting is that the agrammatic participant in the experiment of Nerantzini et al. (2010) recognized that his clitic omissions or misplacements made the utterance unacceptable. This state of affairs strongly suggests a retrieval issue that affects morphological markers.

Last, Fyndanis et al. (2013) investigated morphosyntantic comprehension in agrammatic aphasia. Running a variety of tests in three SMG-speaking agrammatic patients, they found above chance comprehension of reversible passives for one of the three patients and at chance comprehension for the other two. Their results with respect to tense, aspect and agreement confirmed those of previous studies in showing that functional categories associated with the verb morphology may be compromised, while categories that are located higher in the syntactic tree (e.g., CP) are preserved. In light of these findings, Fyndanis et al. (2013) argued that the Distributed Morphology Account (DMA; Dickey et al. 2008) is fit to account for the distribution of the deviations from target that they found.

The DMA was based on the findings of Dickey et al. (2008) who examined English-speaking aphasic patients. Dickey et al. (2008) reported significantly better performance of English-speaking agrammatics on judgments related to the highest nodes of the syntactic tree (CP), rather than of the lower nodes related to inflection. They noticed that their findings were consistent with the division of labor proposed in DM (Halle & Marantz 1993), according to which, elements are supplied with phonological features after morphological operations take place at MS, along the lines shown in figure 3. MS, in figure 3, is a syntactic representation that crucially "serves as part of phonology", that is, "the interpretive component that realizes syntactic representations phonologically" (Halle & Marantz 1993: 114). DMA can also account for the findings of Fyndanis et al. (2013) because what seems to be compromised in that case too is (access to) verb morphology, but not the ability to build a syntactic representation past a specific node.

To sum up, the present section reviewed the findings of 16 studies that investigated different aspects of the grammar of aphasia in Greek-speaking populations through a wide variety of tasks. In all cases, the nature of the impairment was shown to be either extragrammatical (boiling down to access/retrieval issues of morphological markers) or related to the semantics-pragmatics interface. Discourse-related markers that make the processing more 'costly' are more susceptible to impairment. The next section aims to compare this picture with what findings from SMG- and CG-speaking individuals with SLI present as impaired.

4.2 The Grammar of SLI

SLI is a developmental disorder characterized by delays in the process of language acquisition. It is standardly assumed that these delays are manifested in the absence of neurological damage such as hearing difficulties or motor skills disorder and in the presence of otherwise typical cognitive development (Smith et al. 2008). Since the criteria for diagnosing SLI are exclusionary, this is a largely heterogeneous disorder with diverse subtypes that encompass very different populations.

The two most common subtypes presented in Bishop (2004) are *typical SLI* and *pragmatic language impairment*. According to Bishop, the former refers to those cases that involve problems with grammatical development (e.g., omission of paste tense morphemes in English) and the latter refers to the existence of social communication problems (e.g., lack of coherence in conversation). With respect to Greek SLI, as early as the very first studies on this topic, the nature of the impairment has been described in terms of "morphosyntactic errors" (Clahsen & Dalalakis 1999: 1). It is the aim of the present section to review the literature on Greek SLI and to demonstrate that the observed errors do not derive from an impaired syntax; similar to what has been argued in the previous section for aphasia.

Starting off from the early studies on Greek SLI, the two grammatical markers discussed in Clahsen & Dalalakis (1999) are tense and agreement: the same two markers that were the focus of many studies on Greek aphasia, as discussed in the previous section. This is not an accident; many scholars have observed that the language performance of SLIs resembles that of aphasic individuals (Reilly et al. 2004 and references cited therein). On the basis of spontaneous data collected from one child, Clahsen & Dalakakis (1999) report scores for subject-verb agreement that are at chance level and scores for past tense marking that are at ceiling. The majority of subject-verb agreement errors boil down to erroneously overproduced 3rd person singular (SG) forms. This cannot count as a syntactic impairment though, because it is something that can be observed in the course of development of unimpaired children too.

As Clahsen & Dalalakis (1999) notice, such overgeneralizations of the 3rd person SG form have been reported in the literature for very early stages of development in unimpaired Greek-speaking children. More specifically, around age 2;5, typically developing (TD) children stop producing such overgeneralizations, whereas in the case-study of

Clahsen & Dalalakis (1999), Eva produced them at age 5;5. The difference that can be observed here relates more to a delay in acquisition, than to a broken syntax or inaccessible mechanism to establish agreement. In the words of Dalalakis (1996: 15), "a general missing agreement hypothesis, [...] would be too powerful in that it would predict [...] problems that are not attested (such as determiner-noun agreement errors)". Such a hypothesis would also be unable to account for the not so low percentage (45%) of correct subject-verb agreement patterns that were found in Eva's spontaneous speech.

Tsimpli & Stavrakaki (1999) examined spontaneous speech data obtained from same child: Eva. The findings showed correct use of 1st person clitics (81%), at chance performance for 2nd person clitics (50%) and 96% omission of 3rd person clitics. Tsimpli & Stavrakaki (1999) remark that Eva exhibits better mastery of the morphosyntactic features associated with subject-agreement, compared to those associated with object-agreement (i.e. clitics). Moreover, she omits the definite article in 94% of obligatory contexts in subject and object position as well as in prepositional phrases, whereas the use of the indefinite article is almost intact. In an attempt to explain this difference between the definite and the indefinite article, Tsimpli & Stavrakaki (1999) argue that the difference between spared strong pronouns and indefinite articles vs. impaired clitics and definite articles boils down to a dissociation between interpretable and non-interpretable features: "we have shown how the indefinite article and strong pronouns are part of Eva's grammar at this stage precisely due to their feature-specification which also consists of spared, interpretable features" (p. 82).

The same conclusion is supported in Tsimpli (2001) who argued that both the SLI and TD children of her study in the early stage of development "show evidence that features of referentiality and definiteness are part of their grammars in their use of demonstratives, the indefinite article, genitive clitics, and strong pronouns" (p. 443). These are all interpretable at LF, unlike the problematic accusative (i.e. object) clitics and definite article, which are uninterpretable. This pattern is compatible with the long-entertained claim in language acquisition that "elements lexically specified for [LF-interpretable] features should precede the emergence of elements specified for features which are PF-interpretable only" (Tsimpli 2001: 444). It should be highlighted here that this is the opposite side of the argument in Fyndanis et al. (2010, 2012) and Nanousi et al. (2006), where it was proposed that agrammatic patients have problems with the morphophonological realization of LF-interpretable features.

In order to explain the overall picture of feature (un)interpretability in aphasia and SLI, two observations should be made. First, subject-verb agreement is also uninterpretable at LF, as Tsimpli argues following Chomsky (1995), but SLI children do perform fairly well at it. Second, it seems to be the case that —leaving aside the semantics-pragmatics interface— what is impaired in aphasia is the retrieval of morphological realizations of *some* markers that bear interpretable features due to limited processing abilities. What is at stake in SLI is a delayed acquisition of *some* markers that bear uninterpretable features. The variation that is observed in the overall picture of aphasia and SLI with respect to which are the problematic markers is the result of the interspeaker and intraspeaker variation that is individually found within aphasia and SLI.

Intraspeaker variation in what shows up as impaired can be due to both extralinguistic factors and the nature of the administered task, as was argued to be the case in impaired production but intact comprehension of some markers in studies presented in the previous section. Similar claims have been made for SLI; Stavrakaki & van der Lely (2010: 209) report a quite heterogeneous pattern in their participant analysis, when comparing the results of their comprehension task to those of their production task. With respect to interspeaker variation, Tsimpli & Stavrakaki (1999) and Tsimpli (2001) identify object clitics as a 'sensitive' marker in SMG, but as Chondrogianni et al. (2010) notice, the reported rate of omission varies significantly from study to study. The degree of variation is noteworthy: The rate of omission goes from 96% in Tsimpli & Stavrakaki (1999) to 30% in Mastropavlou (2006) to 24% in Smith et al. (2008) and then to 4% in Stavrakaki (2002). In fact, Manika et al. (2010) observe that the robust percentage of object clitic omission reported in the earliest studies in Greek SLI has never been duplicated by subsequent studies. Interestingly, in Manika's et al. (2010) experiment, the 19 SMG-speaking SLI children, ranged from 4;10-8;1 years, performed almost at ceiling (95%) in the production task that aimed to elicit (accusative-marked) object clitics.

Assuming that some agreement markers are indeed largely omitted in the grammar of SLI, the important question is the following: Do omitted markers (bound or free) entail impaired syntax in SLI? Two different strands of evidence suggest that the answer is negative. The first one comes from omitted complementizers. Mastropavlou & Tsimpli (2011) describe a situation that is impossible to obtain if omitted markers (in this case, complementizers) are taken to entail impaired syntax. On the basis of spontaneous speech data, they observe that even if complementizers are omitted, their selectional requirements remain fully operative and are manifested in the grammars of SLI children.

> "Note that in the data presented, use/omission of these complementizers does not seem to affect C-I selectional restrictions. Thus, errors in the use of appropriate verb forms selected by the complementizer *na* are rather few even in the SLI group. This leads to a paradoxical situation where the complementizer may be omitted and, hence, not merged in the syntactic position, whereas its selectional restrictions are still

> operative. This is particularly relevant to the omission cases of *na* which, as mentioned above, is the only complementizer which can introduce tense-dependent verb forms, i.e. the nonpast, perfective form. [...] *We must, therefore, conclude that even in the case of omission, children know the selectional properties imposed by C and fail to access or spell-out the required complementizer*."
>
> (Mastropavlou & Tsimpli 2011: 460; emphasis added)

The second piece of evidence that suggests that syntax is intact is found in Stavrakaki (2002). As the title of her study indicates, Stavrakaki aims to provide evidence for deficits in the syntactic component of language. However, I suggest that in reality her findings do not show the existence of such deficits. Table 4 illustrates quite high percentages of correct use of various markers in the grammar of children with SLI, even for those children who showed omissions of these markers at an earlier stage of development. This at ceiling performance suggests that the earlier performance that involved omissions could be better described as a developmental delay rather than a deficient syntax. The 'delay' account is perfectly compatible with the subsequent development of a grammar that shows correct use of the target markers.

The 'deficient-syntax' account would have troubles to explain both the performance reported in table 4 and the findings of Mastropavlou & Tsimpli (2011).

Marker	Correct use
Past tense	198/200 (99%)
AgrS	78/80 (97.5%)
Definite article	284/290 (97.93%)
Object clitic pronouns (3rd person)	48/50 (96%)
Prepositions	54/60 (90%)
Case	75/75 (100%)

Interrogative words	26/26 (100%)
Complementizers	14/22 (63.64%)
The marker *na* (= to)	35/40 (87.5%)

Table 4: Grammatical markers in Greek SLI (Stavrakaki 2002)

Apart from omitted morphological markers, SLI children may show a number of other problems. In his summary of the linguistic phenotype of SLI, Marinis (2011: 464) notes that several studies have revealed that SLI children show phonological problems as well as problems related to the semantics-pragmatics interface. Indeed, such reports are found in the literature on Greek SLI. For example, Kateri et al. (2005) present a case of an SMG-speaking child that shows a delay in acquiring the phonological component of the target language. Struggles with mastering the pragmatic knowledge of language have also been observed in SMG-speaking children. Okalidou & Kambanaros (2001) report difficulties in initiating or holding conversations, staying on topic, or asking questions.

Turning to another variety of Greek, in one of the very first experimental studies that aimed to shed light to the grammar of CG, Petinou & Terzi (2002) discussed patterns of clitic (mis)placement in typical and atypical development. One of the most studied differences between SMG and CG pertains to clitic placement. Placement patterns are the same across the two varieties in some environments (e.g., imperatives and some forms of negation), but not in others (e.g., indicatives). Object clitic placement in indicatives gives rise to enclisis in CG and proclisis in SMG. The findings of Petinou & Terzi (2002) showed a high rate of clitic misplacement across CG-speaking children with SLI. It is worth noting here that what counts as target clitic placement in CG varies considerably even across TD adults, since CG lacks homogeneity. For example, Petinou & Terzi (2002) present (18) as unacceptable due to the combination of negation and enclisis — and indeed this type of negation usually patterns with proclisis, but Tsiplakou (2004) suggests that this combination is now part of the production of TD young speakers (cf. (19)-(20)). It is then possible that what counts as misplacement is the result of mixed patterns found in adult language and by extension in the input these children receive.

(18)	*En	efaga	to.	[CG]
	NEG	*eat.PAST.3SG*	*CL.NEUT.ACC.3SG*	
	'(I) didn't eat it.'			(Petinou & Terzi 2002: 3)

(19)	E	ðia	mu	to.	[CG]
	NEG	*give.PRES.3SG*	*CL.GEN.1SG*	*CL.NEUT.ACC.3SG*	
	'(He/she/it) doesn't give it to me.'				(Tsiplakou 2004: 4)

(20)	Em	birazi	me.	[CG]
	NEG	*bother.PRES.3SG*	*CL.ACC.1SG*	
	'It doesn't bother me.'			(Tsiplakou 2004: 4)

The important conclusion for the purposes of the present discussion is that Petinou & Terzi (2002) show that CG-speaking children with SLI as young as 4;0 show frequent production of object clitics; a finding that is in agreement with the findings of the latest studies in clitic production in SMG-speaking children with SLI.

Spanoudis et al. (2007) tested 28 CG-speaking children with SLI and 18 children with pragmatic language difficulties. The findings showed that both inferential mental verb tasks (pragmatics) and non-inferential mental verb tasks (semantics) were more difficult for the two language-impaired groups than for the TD peers. This suggests that difficulties in the semantics-pragmatics interface often are part of the symptomatology in Greek SLI.

The above mentioned claim that SLI boils down to a developmental delay rather than some syntactic deficit is fully supported in the case of CG by the findings of Kambanaros & Grohmann (2011). Administering an object and action naming task (based on Kambanaros 2003), they found that children with SLI are slightly less accurate in naming (object naming: 67% for SLI, 77% for TD, action naming: 68% for SLI, 72% for TD) compared to younger TD children, "but interestingly, error type cannot differentiate the two groups. This suggests strongly that children with SLI are delayed — but *not atypical*" (Kambanaros & Grohmann 2011: 239; emphasis in the original). Kambanaros et al. (2013) report on object and action naming in a larger number of CG-speaking children. They found that the quantitative differences on the error distribution between children with SLI and their chronological age-matched TD peers were significant, but did not reach significance when compared to the language-matched TD children. Once more, these findings support the 'delay' account.

Last, Theodorou & Grohmann (2015) investigated the issue of clitic production in SLI and TD Greek Cypriot children through a picture-based elicitation task. Their findings showed no quantitative differences between the two populations in terms of correct clitic production; a result that is in agreement with what has been reported in Manika et al. (2010) for SMG.

To conclude, in this section I have brought together findings from 18 studies that cover different aspects of the SMG and CG grammar as these are manifested in the course of development of SLI children. The argument put forth is that even those studies that aim to present a syntactic deficit in SLI grammar are instead providing evidence for the opposite on both counts: the syntactic component of language is intact and the deficit should rather be called 'delay'. Many studies have reported the omission of morphological markers (bound or free), but even in the presence of such omissions, the selectional requirements of the omitted markers are operative. Moreover, phonological and/or pragmatic differences from age-matched TD peers may characterize some cases of SLI. All in all, variation is manifested in some forms (e.g., retrieval issues, omission of markers, delayed mastery of phonology, pragmatic limitations), but not in others (e.g. syntax).

Having established a picture of the attested variation in aphasia and SLI, the next section will seek to delimit variation in another developmental disorder: Down Syndrome.

4.3 The Grammar of Down Syndrome

Down Syndrome (DS), also known as trisomy 21, is the result of genetic abnormality most often caused from the presence of a third chromosome 21. One of the characteristics of this syndrome is atypical cognitive and linguistic development. The latter has received distinct designations in the literature ranging from 'delayed' to 'different' and 'impaired'.

The grammar of DS is particularly interesting in a context that involves a claim of an invariant syntax that is preserved across pathologies. This happens because many descriptions of the linguistic abilities of people with DS make reference to impaired syntax. For example, Perovic (2001) argued that the process of acquisition of binding in DS may be qualitatively different compared to that in cases of typical development;[39] not simply slower, but different. More specifi-

[39] Following Chomsky (1981), Binding Theory can be defined as a theory that regulates the distribution of referentially dependent elements such as anaphors and pronouns. Binding Principle A requires that the anaphor is locally bound

cally, investigating the comprehension of four English-speaking adolescent girls with DS through a picture-based truth-value judgment task, Perovic (2001) found at ceiling performance on the 'name-pronoun' condition (e.g., "Is Snow White washing her?") and quite high performance (≥ 75%) for the 'quantifier-pronoun' condition (e.g., "Is every bear washing him?"), indicating that whatever the syntactic deficit amounts to, this is not Binding Principle B. The conditions 'name-reflexive' (e.g., "Is Snow White washing herself?") and 'quantifier-reflexive' (e.g., "Is every bear washing himself?") elicited mixed responses with the percentage of correct answers ranging from 12.50% to 100%. These findings beg the following question: Is Binding Principle A in DS an example of deficient syntax?

It is difficult to give a positive answer to this question for at least three reasons.[40] First, it is hard to imagine why individuals with a deficient syntax would be fine with one binding principle, and not with the other, if these principles form part of the same theory and underlie the same grammatical knowledge; a point acknowledged by Perovic (2001) too. Second, the obtained results did not show a unan-

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to an antecedent within the same clause. Binding Principle B requires that the antecedent of a pronoun is not in the same clause as the pronoun. Binding Principle C prohibits that a pronoun/anaphor be higher in the structure than their antecedent.

[40] These three reasons are related to the findings reported in Perovic (2001). As mentioned in the introduction of the present chapter, it is necessary to revisit the findings of the relevant studies and show the implications that these findings bear for the picture of variation that I put forth. In order to do so, I take it for granted that whatever the reviewed study assumes to be syntactic is indeed syntactic, only for the sake of reviewing the findings in depth. However, it should be noted that at a theoretical level, there is no reason to take it for granted that anaphora interpretation is intrinsic to NS (and of course if it is not, there is no sense in talking about this being a possible indication of deficient syntax). To this end, Heinat (2003) derives anaphoricity in the DM framework and writes that there is no need for an anaphor in syntax, "which explains the fact that not all languages have anaphors" (p. 13).

imous pattern of Principle A violations. The average number of correct responses on the condition 'name-reflexive' is above chance (58% according to my calculations based on the percentages reported in table 2 in Perovic 2001), perhaps surprisingly so for individuals whose locus of syntactic impairment is precisely *this* principle but not the other two. The average number of correct responses on the condition 'quantifier-reflexive' is below chance (35.94%), yet as Perovic (2001) noted, two of the participants showed very poor performance even on the *control* condition that involved quantified NPs and no anaphors. It is then possible that these participants had issues with quantification per se and this resulted to errors on some of the tested conditions. Third, the findings from English-speaking people with DS, do not match findings from other language groups. Christodoulou (2011) correctly established the following comparison: Stathopoulou (2009) reported that SMG-speaking adolescents with DS performed at higher rates than what has been argued by Perovic (2001) in terms of accuracy with reflexives.

Turning to findings in Greek DS, Tsakiridou (2006) investigated the production of wh-questions in four SMG-speaking adolescents with DS. She found that target performance on which-S questions was 62.5%, on who-S questions 29.16%, on which-O questions 20.83% and on who-O questions 16.66%. The predominant error was the wrong Case assignment (e.g., accusative-marked subject wh-expression+NP instead of the target nominative). In this context, the main error reported in Tsakiridou (2006) is non-target morphological marking when forming wh-questions and not the inability to form wh-questions per se. Other morphological errors such as tense and gender errors were also observed. Tsakiridou's finding of affected tense marking is in sharp contrast with what Stathopoulou & Clahsen (2010) report for eight SMG-speaking adolescents with DS. They found that perfective past tense formation in the DS group was parallel to that of the TD group. As Christodoulou (2011: 52) remarks, diversity of results is quite evident, but it is difficult to distinguish whether this diversity is the result of deviations from the target that are syntactically conditioned or morphophonologically conditioned.

Another difficulty is to interpret the findings in terms of the 'delay' vs. 'deficiency' account. For example, Tsakiridou (2006) takes her findings to go beyond a simple delay and to support the idea that language development in DS is different from that of typical development. On the contrary, Papaeliou et al. (2011) studied the linguistic and extralinguistic abilities of SMG-speaking children (mean age: 4;8) through vocabulary tests as well as a semi-structured play with their mothers and compared it with that of younger TD children (mean age: 2;6). Their findings led them to a claim that DS children follow a pattern of development that is also found in TD children; thus, the development in DS populations would be better described as delayed, not deficient.

The most detailed study of DS in Greek-speaking populations has been conducted with children that acquire CG by Christodoulou (2011). She examined the linguistic abilities of 16 Greek Cypriot individuals with DS, aged 19;0 to 45;11. The first fact that sets apart the study of Christodoulou (2011) from previous studies is the combination of the elicitation tasks she used. More specifically, she used both controlled and free elicitation tasks (i.e. production, elicited imitation, and storytelling). This combination of tasks proved out to be particularly useful when testing this population because "participants were more comfortable producing certain structures in free elicitation (e.g., subjunctive clauses), while other structures and feature combinations were specifically absent in free elicitation, even though they were used accurately in controlled elicitation" (Christodoulou 2011: 6).

The aim in Christodoulou's study was to see whether the differences between Down Syndrome grammars and typical grammars are (i) syntactically, (ii) morphologically, or (iii) phonologically and phonetically conditioned. Her findings point out to phonetically conditioned differences in DS that boil down to the distinct physiology of the articulation apparatus, coupled with a small residue of morphologically and phonologically conditioned differences. To give just one example of a phonetically conditioned difference, Christodoulou (2011) found 45 instances where final /s/ omission in nominative-marked noun forms resulted in a form accidentally looking like accusative, since without the final /s/ the two forms look the same for some nouns. Moreover, Christodoulou (2001) reports over 95% correct use of tense inflection as well as correctly established subject-verb agreement in the DS group to a level that is comparable to that of the adult control group.[41] Last, it is very interesting for purposes of crosslinguistic comparisons to notice that Christodoulou (2001) offers examples of DS production that show use of both pronouns and anaphors. The overall picture that emerges from these findings is one that supports the claim that much of what appears as non-target in DS has to do with difficulties in the externalization component of language.

The last study conducted with Greek-speaking populations with DS returns to investigating the topic of pronoun use. Sanoudaki & Varlokosta (2015) examined the comprehension of pronouns in 14 SMG-speaking individuals with DS, ranging from 10 to 34 years of age. Their results agreed with the dissociation between pronouns and anaphors that has been earlier reported for other languages (e.g., Perovic 2001). In their words, the "[r]esults replicate previous cross-linguistic findings [...] revealing that individuals with DS have disproportionate difficulties in the interpretation of reflexive pronouns

[41] Similarly, Christodoulou (2013) reports 95.7% accuracy for tense and 97.2% for aspect.

compared with personal pronouns (in this case pronominal clitics)" (Sanoudaki & Varlokosta 2015: 183). However, a look at the raw scores shows high performance for clitics (average: 8/9) and above chance performance for reflexives (average: 5.64/9) with some participants scoring a flawless 9/9. These numbers suggest that binding can be successfully established in Greek DS more often than not.

The different-from-TD character of language acquisition in DS has also been approached in terms of vocabulary development. Ypsilanti et al. (2005) discuss atypicality in word definition among DS and TD populations and provide the following examples produced by children with DS, Williams Syndrome (WS) and the group of TD mental age controls:[42]

(21) *Definition of the word 'mansion'*
WS: 'Big place where rich people live and you can visit'.
DS: 'Very, very, very big long house/has balconies'.
Mental age controls (7/8): 'Don't know'.

(22) *Definition of the word 'acquarium'*
WS: 'Place to keep fish and sharks and sea horses so people can closely see at what's in the sea'.
DS: 'I saw one in France years back/got lots of fish'.
Mental age controls (7/8): 'Don't know'.
(Ypsilanti et al. 2005: 361)

[42] WS is a developmental disorder that is characterized by a specific neurodevelopmental and behavioral profile, varying degrees of intellectual disability, distinctive facial features and a number of other clinical manifestations such as cardiovascular anomalies. The literature on the linguistic abilities of people with WS involves diametrically opposite claims: some argue in favor of typical language development (e.g., Clahsen et al. 2004), while others claim that some aspects of development (for instance, the production of concordant grammatical markers) are atypical (e.g., Karmiloff-Smith et al. 1997).

To sum up, the results of the different studies presented in this section show a great deal of variance in terms of the findings they report. Putting these findings in perspective to the claim pursued in this chapter, at times the syntax of DS has been described as problematic. However, once the relevant findings are studied in depth, the locus of syntactic impairment is nowhere to be found. Is syntax in DS impaired? The most comprehensive study in Greek DS at present suggests that this is not the case (Christodoulou 2011) and so does the review of other studies offered in this chapter. All in all, most language-related problems of individuals with DS are related either to the semantics-pragmatics interface or to phonetics and morphophonology. If they are related to the latter, they are manifested by means of omissions of phonemes and grammatical markers.

Having sketched out the limits of variation in one acquired and two developmental disorders, the next section proceeds to another developmental disorder that is characterized by problems in verbal and non-verbal communication. The topic of the next section is the grammar of autism.

4.4 The Grammar of Autism

The latest edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association 2013) defines autism spectrum disorder (ASD) as "characterized by deficits in two core domains: 1) deficits in social communication and social interaction and 2) restricted repetitive patterns of behavior, interests, and activities" (p. 809). One of the important differences that sets apart DSM-5 from its predecessors is the notion of the *spectrum*: "Autism spectrum disorder is a new DSM-5 disorder encompassing the previous DSM-IV autistic disorder (autism), Asperger's disorder, childhood disintegrative disorder, Rett's disorder, and pervasive developmental disorder not otherwise specified" (DSM-5: 809).[43]

The first detailed description of autism is found the seminal work of Kanner (1943). Linguistic patterns that stepped outside what was considered as target or normal were extensively described in Kanner's first case-study, that of Donald, a 5 year old boy who showed unusual patterns of development before age 2;0. He had an unusual memory for names and faces, a mania for spinning round objects and an indifference towards people around him. Non-typical language use was one of his characteristics. As Kanner (1943: 219) wrote, Donald at age 5 "seemed to have a great pleasure in ejaculating words or phrases, such as, 'chrysanthemum', 'dahlia, dahlia, dahlia', 'business', 'trumpet vine', 'the right one is on, the left one is off', 'through the dark clouds shining'. [...] He always seemed to be parroting what he had heard said to him at one time or another. He used the personal pronouns for the persons he was quoting, even imitating the intonation".

Non-typical use of pronouns is found in many of the examples Kanner provides. When Donald wanted a bath, it is claimed that he said "do you want a bath?" (p. 219) and when he wanted to have his shoe pulled off, he said to his mother "pull off your shoe" (p. 21). Pro-

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[43] Problems with communicative behaviors feature prominently into the symptomatology of all the disorders that are found behind the umbrella term 'ASD':

> "Autism spectrum disorder is characterized by persistent deficits in social communication and social interaction across multiple contexts, including deficits in social reciprocity, nonverbal communicative behaviors used for social interaction, and skills in developing, maintaining, and understanding relationships. In addition to the social communication deficits, the diagnosis of autism spectrum disorder requires the presence of restricted, repetitive patterns of behavior, interests, or activities." (DSM-5: 31)

noun repetitions and reversals are the predominant characteristics of most of the case-studies presented in Kanner (1943). Pronoun reversals are manifested in the form of using the 2nd and 3rd person instead of the 1st person when the autistic children were referring to themselves. However, it would be wrong to conclude that these children were completely unable to use pronouns correctly to refer to themselves and to people around them. For example, Charles, another autistic child that is described by Kanner as speaking of himself in the 2nd and 3rd person, produced "give *me* a pencil" (p. 236; emphasis added) immediately upon entering the therapist's office, and some time later "look at the funny baby. Is *he* not nice? Is *he* not sweet?" (p. 237; emphasis added). This is not the only example in Kanner's case-studies that shows correct use of pronouns. In this context, the conclusion "*[p]ersonal pronouns are repeated just as heard*" (Kanner 1943: 244; emphasis in the original) needs further discussion, because obviously this is not always the case.

Since Kanner's study has been very influential and his conclusions are often evoked when the topic of pronoun use in autism is discussed in recent studies (e.g., in Brehme 2014), it is perhaps useful to be more specific about the above claim of correct use of pronouns in the case-reports he presents. More specifically, the aforementioned correct use of pronouns by Charles is not a marginal phenomenon; it is not an accidentally produced correct pattern that is observed once in just one case-study out of the eleven that Kanner presents. Going through all the relevant productions, I have identified correct use of pronouns in *all* the case-studies of speaking children presented in Kanner (1943). The utterances given in table 5 identify target use of pronouns in the case-studies reported in Kanner (1943). Three of the eleven children reported therein (i.e. Richard M., Virginia M., Herbert B.) were not talking, therefore they do not show up in table 5. The case-report of child 4 (i.e. Paul G.) in Kanner (1943) is not included in table 5 because those utterances of him that involved pronouns were not adequately contextualized, hence it is impossible to tell whether they show correct use of pronouns or pronoun reversal.

Child	**Utterance**
Donald T.	1) I don't know. 2) I am going to stay for two days at the Child Study Home. 3) I want to hug her around the neck. 4) I'll draw a hexagon.
Frederick W.	5) I don't want you.
Barbara K.	6) May I take this home? 7) It's not my pencil. 8) I saw motor transports.
Alfred L.	9) You answer my question, and I'll answer yours. 10) Why do they have to say it?
Charles N.	11) Give me a pencil. 12) Look at the funny baby. Is he not funny? Is he not sweet? 13) What's this? It is a needle.
John F.	14) When are they coming out of the picture and coming in here? 15) We have them near the wall.
Elaine C.	16) I will crush old angle worm, he bites children.

Table 5: Target use of pronouns in autism

Bartolucci & Albers (1974: 131) begin their study of tense in autism with a claim that contradicts the main argument of the present chapter, since it argues in favor of a syntactic problem in ASD: "Certain characteristics of the syntactic structures of the language of autistic children, such as their lack of mastery of pronominalization, have been described". Tager-Flusberg (1981) reviewed the literature on this topic and concluded that the phonological and syntactic development of autistic children follows that of TD children but at a slower rate, while semantic and pragmatic functions are deficient.

Taking into account the different findings that have been uncovered since 1981, I argue that in order to accept the claim that describes pronoun reversals in autistic speech as a case of syntactic abnormality, one would need to see some explanation as to why these patterns are never uniform. Kanner and other subsequent studies indeed offer examples that feature pronoun reversals. At the same time, they offer examples (of the same children, at the exact same stage of development) that show target use of pronouns, in line with what the more recent experiments —that will be reviewed below— report. If pronoun reversals were due to deficient syntactic operations, how is it possible that the target performance emerges at times? To put it in another way, if the disruption is to be found in the innermost component of language (i.e. NS), what makes possible the construction and externalization of the target pattern often in a consistent fashion?

Perhaps another way to look into the issue of pronoun reversals and pronoun avoidance in autism is to contemplate the idea the problem is not linguistic per se. The findings of Lee et al. (1994) are instrumental in evaluating this hypothesis. Lee et al. (1994) found that the autistic subjects they tested were able to comprehend and use the pronouns 'I', 'me' and 'you'. Pronoun reversals were rare and in light of this finding, Lee et al. (1994) argued that what seems to be at stake in autism is a *less-secure* anchorage in self-experience. In their words, "[i]t matters if it is "me" who has achieved something, or "me" who is the object of attention. Such anchorage in self-experience may not be as secure for autistic as for non-autistic individuals." (Lee et al. 1994: 174).[44] This finding is in agreement with what Shield & Meier (2014) found when they showed deaf autistic children and deaf TD children a picture of themselves and a picture of the experimenter. Upon seeing a picture of themselves and being asked 'who is this?', the ASD children either correctly signed the pronoun 'me' pointing to themselves (5/14 children) or produced their name sign or fingerspelled their English name. In other words, they were successful both in identifying themselves and in using the correct pronoun following the identification, whenever a pronoun was used. With respect to the TD group, 15/18 children signed the pronoun 'me' and the rest produced their name sign or fingerspelled their English name. It seems that what really differentiates the two groups is not self-recognition per se, but the fact that the TD children "reacted with a smile or laugh and an emphatic point at his/her own body. The children with ASD had no such emotional reaction." (Shield & Meier 2014: 412). As noted in the discussion of these findings by Shield & Meier (2014), forming a sense of *me-ness* is both an essential part of development in TD children and a key component of social behaviors such as empathy.

It is important to notice that converging lines of research show this sense of me-ness to be less-secure in ASD populations than in TDs. It is even more important to acknowledge that this less-secure anchorage in me-ness is manifested in ways that have nothing to do

[44] Apart from knowing the correct meaning of pronouns, ASD children are able to recognize themselves in the mirror, so indeed one should talk about a less-secure anchorage in *me-ness* vs. *you-ness* and not about a failure to differentiate one's self. Ferrari & Matthews (1983) investigated mirror recognition in 15 children with autism (i.e. severe to profound mental retardation) and found that 53% of the sample showed self-recognition. The rest had mental ages that were below the developmental level that marks self-recognition. These findings led Ferrari & Matthews (1983) to argue in favor of a developmental delay in ASD.

with the use of pronouns; thereby suggesting that the problem is *not* in the use of pronouns. Another piece of evidence that suggests so comes from studies that investigate palm orientation in the signs of deaf children diagnosed with ASD. It was found that native signers of American Sign Language with ASD showed a tendency to reverse palm orientation on signs specified for inward/outward orientation both at a naturalistic setting and on a fingerspelling task, whereas such errors were absent from the production of the TD group (Shield & Meier 2012). These findings suggest that we are not dealing with a syntactic problem, but rather with a more general neurocognitive problem (see also Vulchanova et al. 2015) that at times may acquire a linguistic dress.

Indications that suggest that this proposal might be on the right track come from studies such as Lombardo et al. (2010). In a functional magnetic resonance imaging (fMRI) study, Lombardo et al. (2010) asked participants to reflect on the self or a familiar other (the British Queen) through judging on a 1 to 4 scale how likely they would agree with certain statements presented in the form of questions (e.g. "How likely are you/the Queen to think that keeping a diary is important"). The results showed that the group of neurotypical controls recruited the middle cingulate cortex and the ventromedial prefrontal cortex in response to reflecting on the self. In the ASD group, the "ventromedial prefrontal cortex responded equally to self and other, while middle cingulate cortex responded more to other-mentalizing than self-mentalizing" (Lombardo et al. 2010: 611). On the basis of these findings, Lombardo et al. (2010) talk about an "atypical neural self-representation in autism".

With respect to the linguistic abilities of Greek-speaking populations with ASD, the majority of the relevant research targets the pragmatic abilities of autistics. Vogindroukas (2005) and Vogindroukas & Zikopoulou (2011) report features in the speech of

SMG-speaking children with autism such as production of irrelevant, out-of-context utterances, stereotypicality, absence of politeness markers and difficulties in understanding figurative language. Marinis et al. (2013) investigated the pragmatic abilities of twenty-three SMG-speaking children with ASD and their findings revealed that these children did not differ from the control group of TD children in terms of conversational role taking. However, they did differ in being underinformative in narratives and in not providing temporal information that linked events in the narrative in a coherent way. Pragmatics is a vulnerable domain for ASD in Greek, in line with what has been reported for other languages.

The use of different types of pronouns in SMG-speaking children with ASD is the topic of Terzi et al. (2012, 2014); this being the first large scale study that deals with the morphosyntactic profile of this population. A picture selection task was administered to twenty children with ASD, aged 5;0-8;0 and twenty chronological age-matched TDs. The performance of the group with ASD was high in all types of pronouns: strong pronouns (mean: 94.9%), clitics (mean: 88.3%) and reflexives (mean: 97.5%). The mean equivalent performance of TDs was 93.3%, 99.2% and 99.2% for strong pronouns, clitics and reflexives respectively. The lowest performance of children with ASD was found in the comprehension of clitics for which the most common error was theta-role reversals. However as Terzi et al. (2012, 2014) note, these children were reported to have problems with producing clitic pronouns, so it is not clear whether the lower performance of the ASD group in the clitics condition is the result of a problem with binding or with clitics. For this reason, Terzi et al. (2014) carried out a follow-up study that aimed to clarify this issue. They run a picture-based elicitation task to sixteen children with ASD and an equal number of chronological age-matched TDs as controls. The obtained results showed that the group with ASD produced a high number of clitics (mean: 87.39%), yet lower than that of the controls (mean 97.74%), favoring the scenario that wants clitics rather than binding to be responsible for the lower performance in the clitic condition of the main experiment.

This lower performance of the ASD group in the clitic condition is compatible with the idea that linguistic variation across impaired cognitive phenotypes is mainly manifested in terms of omissions of morphophonological markers or is related to the semantics-pragmatics interface. Clitics are markers of morphological agreement and they are licensed under specific pragmatic conditions. Importantly, Terzi et al. (2014) found that the ASD children that participated in their study performed lower than the TDs in the pragmatics baseline task. In this context, clitics are indeed a vulnerable marker, but for reasons that might have nothing to do with binding.

The linguistic profile of Greek-speaking populations with ASD is a topic that has only recently began to be explored. It is for this reason that in this section, I have chosen to present studies that deal with ASD populations that speak or sign other languages as well. Moreover, it is not an accident that in the very first of these studies, that of Kanner (1943), one of the presented case-studies brought up a disorder other than autism. More specifically, Herbert B., a child diagnosed as autistic, had an unusual course of development. This involved a tremendous fear of running water, making inarticulate sounds and an absence of registering any change of expression, regardless of whether he was spoken to or not. His older sister had an unusual course of development too. It is reported that she made queer sounds with her mouth, ignored people completely with the exception of her mother, and *had difficulties with her pronouns*, exactly as was reported to be the case for the autistic children in Kanner's (1943) study. The diagnosis of this girl was not autism though, it was schizophrenia.

Schizophrenia and autism have been linked to each other from an early point in their history, this being true also in relation to the language delays and/or difficulties that each of these disorders entails (e.g., the aforementioned problems in the use of pronouns). Identifying the extent to which these difficulties are shared across the two disorders requires sketching out the grammar of schizophrenia. This is the topic of the next section.

4.5 The Grammar of Schizophrenia

Schizophrenia is a developmental disorder that is characterized by abnormalities in one or more of the following domains: "delusions, hallucinations, disorganized thinking (speech), grossly disorganized or abnormal motor behavior (including catatonia), and negative symptoms" (DSM-5: 87). The term 'schizophrenia' was defined as a disorder of thought, that is characterized by a 'loosening of associations', in the very same work in which it was first coined (Bleuler 1911). In the examples that Bleuler provides, this loosening of associations is quite evident. One telling example is the excerpt below, which was written by a patient with schizophrenia as a letter to his mother.

> I am writing on paper. The pen which I am using is from a factory called 'Perry & Co'. This factory is in England. I assume this. Behind the name of Perry Co. the city of London is inscribed; but not the city. The city of London is in England. I know this from my schooldays. Then, I always liked geography. My last teacher in that subject was Professor August A. He was a man with black eyes. I also like black eyes. There are also blue and gray eyes and other sorts, too. I have heard it said that snakes have green eyes. All people have eyes. There are some, too, who are blind. These blind people are led about by a boy. It must be very terrible not to be able to see. There are people who can't see and, in addition, can't hear. I know some who hear too much. One can hear too much. There are

> many sick people in [Burghölzli];[45] they are called patients. One of them I like a great deal. His name is E. Sch. He taught me that in [Burghölzli] there are many kinds, patients, inmates, attendants. Then there are some who are not here at all. They are all peculiar people.
>
> (McKenna & Oh 2005: 4 from Bleuler 1911)

A chain of associations between the different parts of this excerpt can be traced (paper → pen → pen factory → factory name → English name → England, etc.). However, statements like "all people have eyes" are not the norm when somebody writes news to their mother. At the same time, a sentence like this is a well-formed sentence of English. It is only peculiar in the context of the above letter and in relation to the things written there. When one observes a pronoun reversal, a missing clitic, or a phoneme substitution, one is in a position to identify the non-target marker immediately. However, there is no non-target marker to be found in "all people have eyes" or "the city of London is in England" or "my last teacher in that subject was Professor August A.". Lorenz (1961: 603) described this state of affairs in the following way: "'Schizophrenic language' poses the problem: What is the form, stripped of its accidental properties of individual content and style, which underlies the use of language by schizophrenic patients?".

If 'schizophrenic language' refers to problems with cohesion and connectivity caused by a loosening of associations, this seems to be an issue related to the semantics-pragmatics interface. Yet, linguists looking at 'schizophrenic language' have made arguments in favor of this language showing "abnormalities [that] were genuinely linguistic in nature" (McKenna & Oh 2005: 85). This was the argument put forth in Chaika (1974).

[45] Burghölzli is the name of the psychiatric hospital of the University of Zürich.

Chaika (1974) argued that the language production of patients with schizophrenia shows syntactic errors, morphological errors and phonological paraphasias. According to her, (23) is an example that shows syntactic and morphological errors and (24) is a case of inappropriate rhyming that resembles a phonological (rhyming) paraphasia.

(23) My teeth are killing me by expert dentistry of Dr. Brown the dentist and must be pulled as soon as possible as I will not live as I am duped by expert dentistry.

(Chaika 1974: 267 from Lorenz 1961)

(24) a. I had a little goldfish too like a clown.
(pause drop to low pitch, as in an aside)

b. Happy Halloween down. (Chaika 1974: 269)

According to Chaika, the syntactic error in (23) is the use of the agentive 'by-phrase' instead of the causative 'because of'. The morphological error is the tense of the predicate 'am duped', which should be 'have been duped'. Interestingly, Fromkin (1975) compared Chaika's examples with examples obtained from corpora of neurotypical populations and argued that errors such as the ones given in (23) are what one finds in 'normal' performance as well.

Going through a number of relevant utterances, Covington et al. (2005) reach two important conclusions. First, they notice that even the 'word salads' of schizophrenics are made of typical syntactic components (25). Second, they suggest that abnormal morphology in schizophrenia is rare. Both conclusions seem to be correct. With respect to the morphological errors in the production of schizophrenics, self-correction is often manifested too, as in (26).

(25) Interviewer: Tell me a bit more about life there.

Patient: Oh, it was superb, you know the trains broke, and the pond fell in the front doorway. (McKenna & Oh 2005: 98)

(26) Patient: I have not eaten since last Thursday evening, and I have not hardly drinken anything, drank anything since last Thursday evening because --

Doctor: Well, why, why is that?

Patient: Because if I eat, or drink, or take medications, the demons will be allowed to kill me. (Steuber 2011: 45)

Although it has been argued that "at the level of syntactic processing, schizophrenic patients' speech is usually normal" (Marini et al. 2008: 145, referring to Andreasen 1979 and Covington et al. 2005), a case for reduced syntactic complexity has also been made (Morice & McNicol 1986, Fraser et al. 1986, Thomas et al. 1990, discussed in Marini et al. 2008). However, if we are able to observe various levels of syntactic complexity, we are essentially arguing that the syntactic component of FL *is* functional. To put this argument in its right dimension, in the grammar of schizophrenia we do not find an inability to syntactically combine different elements, nor an inability to embed clauses or use different tenses,[46] nor a manipulation of syntactic objects in a way that is not licit in unimpaired syntax (e.g., to

[46] The following is said to have been produced during a psychotic episode by a patient with schizophrenia: "Ha, ha, ha. You're offering to put me in hospitals? Hospitals are bad, they're mad, they're sad. One must stay away. I'm God, or I used to be" (Saks 2012). The only 'non-target marker' that can be noticed is the (underlined) rhyming paraphasia.

add negation by moving the third element of the clause to the sentence-initial position). Therefore, another way to describe reduced syntactic complexity has to be found. For example, it is possible that 'word-salads' and reduced syntactic complexity are the cumulative result of the existence of a number of features typical of schizophrenic production (see Andreasen 1979 and more recently McKenna & Oh 2002 for a list of such features) such as clanging, derailment, and semantic paraphasias which arise due to the nature of the schizophrenic semantic network where "loose associations are caused by an unrestrained associations-chain in semantic memory" (Lerner et al. 2012: 5).

The grammar of schizophrenia in Greek-speaking populations is an understudied topic. Testing the ability of schizophrenic patients to choose the target meaning of ambiguous words, Roikou et al. (2003) asked 19 SMG-speaking adults with a diagnosis of schizophrenia to choose the target meaning of an ambiguous word in a given context. Participants were presented with three options: the target option, a semantically-related word that was related to the non-target meaning of the ambiguous word in the given context, and a word that was phonologically similar to the target word. The group with schizophrenia performed worse than controls in both ambiguous verbs and ambiguous nouns and the lowest performance was found in the semantic condition. Roikou et al. (2003) interpreted their results as supporting the existence of problems in the associative memory of patients with schizophrenia.

Bozikas et al. (2005) conducted a large scale study with 119 SMG-speaking adults with a diagnosis of schizophrenia and 150 chronological age-, education-, and gender-matched healthy controls. They administered a verbal fluency task that consisted of two parts: a phonemic part and a semantic part. During the former, Bozikas et al. (2005) asked participants to name as many words as possible that begin with the Greek letters 'X' (chi), 'Σ' (sigma), and 'A' (alpha) in a time-frame of 60 seconds for each. In the semantic part, participants were asked to name animals, fruits, and objects, with 60 seconds for each category. The findings indicated that patients with schizophrenia produced fewer words than controls on both parts of the task, showing poorer performance on the semantic fluency task, thereby granting support to the claim of loose semantic networks in schizophrenia.

Investigating object and action naming abilities, Kambanaros et al. (2010) tested 20 SMG-speaking patients with schizophrenia and 20 demographically matched controls. They found that accuracy in producing both categories was lower in the group with schizophrenia and action names were significantly more difficult to retrieve than object names. In interpreting these findings, Kambanaros et al. (2010) suggested a retrieval issue. More specifically, the absence of a dissociation in comprehension of action and object names coupled with semantic errors in naming for both these two classes was taken by them to suggest intact conceptual-semantic stores, but difficulties with mapping semantics onto the lexicon, that is, access/retrieval problems.

Fine (1999: 85) describes this state of affairs by arguing that "to assess language use and its relationship to a psychiatric entity such as schizophrenia requires that the context be carefully taken into account and that the semantic resources related to contexts be considered". This view that makes reference to both semantic resources and contextual variables (i.e. pragmatics) suggests a need to disentangle the semantics-pragmatics interface in schizophrenic language in order to understand with precision which aspects of language are impaired in these patients and which are not.

Having compared a number of studies that investigate different aspects of grammar across five disorders, the conclusion that can be reached is that certain components of FL consistently show up impaired across cognitive phenotypes whereas others are consistently preserved. It seems to be the case that variation is channeled in some ways but not in others. A similar claim was put forth in chapter 2, while discussing variation across different languages. Interestingly, when one maps the loci of variation across languages to the aspects of language that are susceptible to impairment across pathologies, a strong parallel can be observed: Variation appears present in some parts of FL and absent in other parts, and these parts are the same both across languages and across pathologies. The next section expands on the topic of converging loci of variation across languages and pathologies.

4.6 Converging Loci of Variation

Chapters 2 and 4 reach a similar conclusion with respect to language variation through discussing two different domains of the linguistic literature. In chapter 2, the topic was crosslinguistic variation. It has been argued that even in cases that variation is called 'syntactic' (often when talking about syntactic parameters), such a conception of variation is problematic to maintain. It was also proposed that the attested patterns of crosslinguistic variation seem to favor a decomposition of linguistic operations such as the one proposed within the DM framework. More specifically, the claim that was put forth in chapter 2 is that the earliest that variation can enter the picture is at MS (figure 3 repeated below as figure 13).

In figure 13, the red arrows indicate which aspects of FL vary crosslinguistically. The blue arrows indicate which aspects of FL are susceptible to impairment across pathologies, on the basis of the review of studies presented in the present chapter.

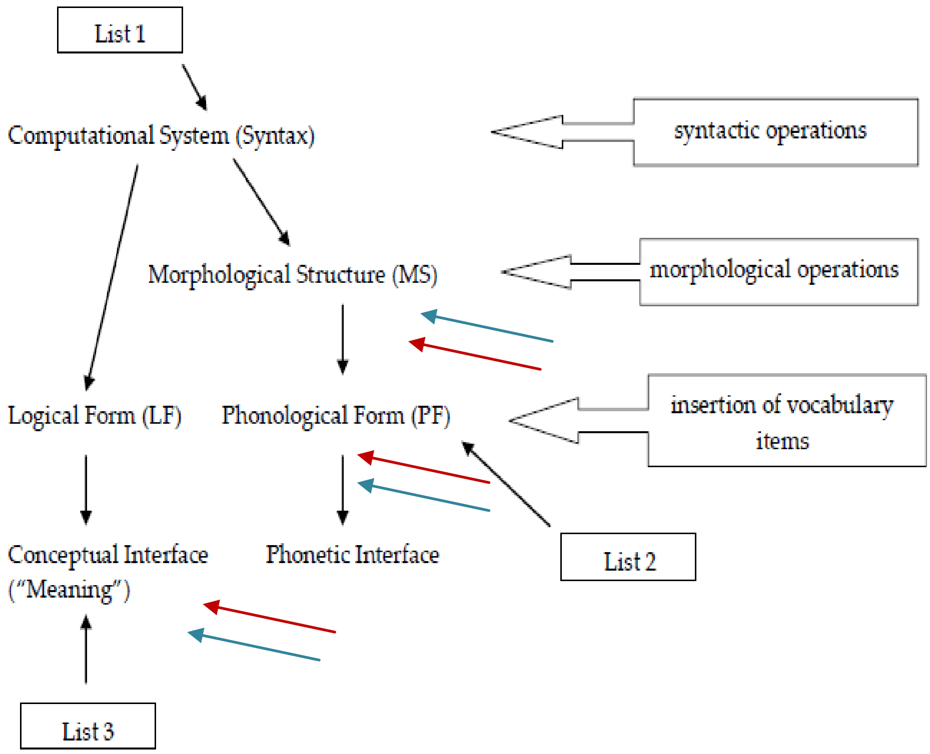

Figure 13: Loci of variation across languages and pathologies

The idea that syntactic operations are invariant has been formally captured under SUT, according to which principles of narrow syntax are not parametrizable (Boeckx 2011a, 2014b). SUT can account for half of the loci of variation that are marked in figure 13. The observation that principles of narrow syntax are not susceptible to impairment and that there is a convergence between the picture of variation that is established across languages and the one established across pathologies can be formally captured under the Universally Preserved Linguistic Loci Hypothesis (UPLH).

(27) *UPLH*

Syntactic operations are impenetrable to variation both across languages and across pathologies. As such, their manifestations appear to be universally preserved across (a)typical cognitive phenotypes.

UPLH is subject to the following realization: It is an undeniable fact that deciding whether an impairment boils down to syntax or morphology or any other component of language essentially depends on the definition of these notions that one accepts. In the present work, the adopted definitions are the ones typically assumed within the mainstream generative framework. On this basis, UPLH was mapped to the distribution of labor put forth in DM (figure 13) in a way that shows that a certain component of grammar does not show variation. Although it is true that one's understanding of the various levels of linguistic analysis affects the answer to the question 'which parts of FL allow for variation?", the idiosyncrasy of this understanding is likely to cause only terminological confusion. Put differently, if a person that assumes a lexicon that includes phonological, morphological, semantic, syntactic and pragmatic clues of word use asks which is the locus of variation in FL, then the answer will obviously be the lexicon.[47] However, when one moves from the surface (i.e. the la-

[47] Although this description of the lexicon is not the one to be found in the generative literature, it nevertheless is one to be found in the literature. For example, Mel'čuk (1995) works within the framework of Meaning-Text Theory and assumes a lexicon that involves entries that specify the following properties for each lexeme or phraseme: (i) its definition and connotations, (ii) its pronunciation, (iii) inflection data, (iv) government pattern (syntactic features that describe its participation in specific constructions), (v) lexical functions, (vi) usage labels (to identify the appropriate speech register), and (vii) pragmatic clues, which pinpoint the real-life situations in which the lexeme is appropriate/inappropriate.

It goes far beyond of the scope of the present discussion to address the theoretical assumptions of this framework in any contentful sense. The very brief description of this framework is given here only to show that the possibility of finding descriptions of certain parts of FL that would seem idiosyncratic bel 'lexicon' and its definition) to a more in depth analysis of the subcomponents of this lexicon, variation will again map to certain primitives of this lexicon but not others, in a way that would adhere to UPLH.

4.7 Conclusions

Several studies have put forth arguments in favor of an impaired grammar that often involves a dysfunctional syntactic component. It was the goal of the present section to review and revisit such claims, mainly dealing with studies that have investigated Greek-speaking populations. Of course, a big number of studies that also support the idea of an impaired syntax in other language groups have been left unaddressed. To this end, this concluding section of the present chapter will provide some more general discussion on what a broken syntax could look like.

One idea with respect to what a broken grammar could look like is given in Boeckx (2015: 177): "What does it mean for grammar to "break down"? Does it mean that grammar users start using Determiners where one would expect Complementizers, Verb Phrases instead of Tense Phrases?" One can expand the list imagining a great variety of indications of a broken syntax: inability to merge elements, inability to go beyond a single level of embedding, manipulation of elements in a way that is not licit in target syntax, formation of word-salads that do not respect syntactic constituency, inability to adhere to the word-order of the target language, etc. To the best of my knowledge, a combination of these features has never been found in any case of impairment. Even the most severe cases do not show such

from a generative perspective is a real one, as such frameworks are found in the literature.

features. For example, one can consider any of the utterances given in table 5, which are part of spontaneous speech production in autistic children. These utterances are quite complex in that they show correct formation of wh-questions, negation, future tense, target use of pronouns (both strong pronouns and clitics), and target use of articles. Similarly, the type of productions by schizophrenic patients examined in section 4.5 cannot be the outcome of a syntax that is broken down, because they show the same type of properties.

What happens with those severe cases of aphasia and schizophrenia that may at times involve alogia? Is absence of language performance in such cases an indication of impaired core linguistic mechanisms or of difficulties with externalization? This question is hard to answer for it deals with the very rare cases of total absence of production. However, there is one indication that even these cases boil down to problems with externalization. This indication comes from those studies presented in the present chapter that have shown a sharp difference between the comprehension and the production of the markers they tested. Numerous studies have argued that even if a marker is not realized in the production tasks that aim to elicit it, its preservation is evident trough the high(er) accuracy rates in the comprehension tasks. This suggests that absent production *is* a matter of externalization, and there is no reason why this should not hold for the very severe cases of alogia.

To conclude the present chapter, the comparative examination of the grammars of aphasia, SLI, Down Syndrome, ASD and schizophrenia suggests that variation is channeled in some ways, but not others. Observing that these ways map to the ways that crosslinguistic variation is manifested, a novel hypothesis was proposed. According to UPLH, syntactic operations are impenetrable to variation both across languages and across pathologies. It is likely that future research in more cognitive phenotypes will shed further light to the domain of predictions of UPLH, possibly through drawing more fine grained distinctions between the components of FL that are penetrable to variation.

5. Outlook

This dissertation discussed the nature and limits of variation across languages and pathologies, showing that a strong parallel exists between these two domains of inquiry. Identifying a convergence across the attested loci of variation provides a bridge between the two research programs: *comparative linguistics* and *comparative biolinguistics*.

Chapter 2 dealt with variation across languages. Theoretical and empirical arguments were provided against assuming the notion of (syntactic) parameter within a generative approach to language. The empirical arguments were based on the results of a semi-automatic program analysis of parametric relations in two pools of data that encompass parameters from the nominal domain in 32 contemporary and 5 ancient languages. Moreover, in chapter 2, syntactic parameters were reconstructed as realizational variants of a morphophonological flavor. I have argued in favor of approaching points of variation (i.e. what is traditionally referred to as 'parameters') as environmentally-driven, emergent properties. This argument was supported through discussing instances of recent language emergence as these are witnessed in specific sign languages (e.g., Al-Sayyid Bedouin Sign Language).

If the notion of parameter is eliminated from our list of linguistic primitives as was suggested in chapter 2, the acquisition process should be re-described. Language acquisition in the absence of a UG that specifies the parametric paths that the child is supposed to navigate in the course of development was the topic of chapter 3. I have sketched out a novel acquisition algorithm that draws its components from statistical approaches to language acquisition, cognitive biases that mediate the process as well as rules that determine how much of noise/exception the learner can tolerate before (re)forming hypothesized rules.

Chapter 4 closed the circle of variation that was opened in chapter 2. The aim of chapter 4 was to delimit variation across different cognitive phenotypes. It has been shown that certain domains of language are particularly vulnerable to impairment, while others are consistently preserved, in line with what has been already proposed in the literature for some disorders (e.g., in Benítez-Burraco & Boeckx 2014). Building on this claim, in chapter 4 I described and compared the grammars of aphasia, SLI, Down Syndrome, autism and schizophrenia, mainly in two Greek-speaking populations. Claims of impaired syntax that were made in the literature on the basis of populations that speak other languages have also been revisited. Through comparatively discussing the nature of linguistic impairment in these five pathologies, I have shown that variation is either confined to the externalization component of language or is related to extragrammatical factors.

This distribution of variation seems to best fit the decomposition of operations assumed in framework like DM (Halle & Marantz 1993). Comparing the results of chapter 2 and chapter 4, it was observed that the same loci of variation stand out across the two domains of inquiry: linguistic phenotypes and atypical cognitive phenotypes. In this context, a novel hypothesis, UPLH, was proposed to capture the fact that one component of language appears to be impenetrable to variation both across language and across pathologies.

This approach to variation was informed by a biolinguistic point of view. My first goal was to show that by adopting a non-parametric approach to UG, one would succeed in approaching UG from below (Chomsky 2007) and in achieving a shift of focus from language-specific, feature-based, UG-represented particularities to principles of general cognitive architecture. I have argued that this shift of focus is highly likely to be progress with respect to what Poeppel & Embick (2005) define as the 'Granularity Mismatch Problem' which refers to the fact that linguistic and neuroscientific research are operating on units of different granularity. It is possible that this mismatch can be dealt with if linguistics operates on a level that makes interdisciplinary research able to progress. My second goal was to provide an actual example of how work done within comparative linguistics can be informed by a biolinguistic point of view. In doing so, I explored the nature and limits of variation across different atypical cognitive phenotypes and then I matched it with the picture of variation that was sketched out in chapter 2 with respect to linguistic phenotypes.

In various points across the preceding chapters, I have affirmed the intention to approach the issues at hand from an interdisciplinary perspective. The first level of discussion dealt with variation at a phenotypic level: observable variation across languages. In the second stage, I pursued an analysis of various disorders, whose clinical signatures shed light to differentially disrupted representations and computations at the cognitive level: the cognome, according to Poeppel's (2012) definition. In his words, "current research should in part focus on the operations and algorithms that underpin language processing. [...] The kinds of operations that might provide the basis for investigation include concatenation, segmentation, combination, labeling, and other elementary (and generic) operations that could be implemented quite straightforwardly in neural circuit" (p. 17). Identifying the preservation of any of these operations (e.g., combination through Merge in the present discussion) across typical and atypical cognitive phenotypes is a contribution towards the development of what Poeppel (2012) refers to as the "linguistic cognome" (p. 14).[48] Defining the cognome has been described as fleshing out "relationships between brain structure, function, and disease" (Voytek & Voytek 2012: 1); reflecting this spirit, the present dissertation focused on making the connection between the last two components as explicit as possible, in the case of language.

The next level that Poeppel refers to is to the connectome: "the wiring diagram of the human brain" (p. 4). Investigating the grammar of various disorders can be telling in this respect: As mentioned already, Terzi (2005: 111) notes that research in language disorders is vital because of "the need to identify detailed physical mechanisms of the brain that correspond to the various domains of grammar and its structure" [...]. The transition to this level was made only in passing when connecting certain brain regions to the various pathologies that were discussed. However, the fact that the transition was not fully made in the present dissertation does not mean that the transition is

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[48] It should be noted that not all work within the biolinguistic enterprise embraces the possibility that some linguistic operations or primitives may ultimately show up in the parts list of the cognome. Poeppel (2012) is explicit about this possibility when he talks about the need "to develop a consensus position on what the 'linguistic cognome' must necessarily contain to begin to get a grip on what is the ontological infrastructure of language research" (p. 14). It is then possible to think that the cognitive faculties (the 'parts' of the human cognome) are "composed of multiple computational subroutines", such as recursion, linearization and constituency (Poeppel 2010). The contributions of Chomsky in Piatelli-Palmarini et al. (2009) are also sympathetic towards this possibility (most characteristically so on pp. 56, 404). Another view is presented in Boeckx & Theofanopoulou (2014), according to which the cognome has a very generic character; generic to the point that no linguistic operations or primitives are likely to survive sui generis the passage from the phenome to the cognome (Cedric Boeckx, personal communication).

not possible. On the contrary, new results are promising: recent findings of a "lesion-symptom mapping" in brain instantiations of various acquired cognitive deficits led to a proposal about the neural wiring of different aspects of language in the brain (Mirman et al. 2015). It is likely that such results will be the bridge that connects the cognome and the connectome. Fleshing out the details of this proposal and its connections to the genome is an ambitious future research project.

There are many issues that merit further investigation in the context of the present take on variation. For example, one could elaborate on how processing biases give rise to consistency across patterns in language that support constraints such as FOFC or many others that are abundant in the linguistic literature. Another topic that should be further discussed is why syntax stands out in the context of UPLH. So far, I have brought together findings from different pathologies to show that it does stand out because, unlike other components of language, it is impenetrable to variation, but I have not discussed the different reasons that are responsible for this impenetrability. A possible future project could try to uncover the reasons behind this phenomenon. Another project could be the extension of the acquisition algorithm. More specifically, the proposed algorithm can be further developed to become more explicit on several matters: for example, how many manifestations of a given phenomenon are necessary before a rule is hypothesized and how does the learner know which rule to change once backtracking is necessary, if multiple candidates are available?

To conclude, one of the guiding claims of the exploration of variation in the present dissertation was the following: Achieving the right levels of abstraction and representation is crucial: the more linguists abstain away from postulating language-specific, fine-grained primitives, the better progress will be made concerning the compatibility of the resolutions of the units that linguistics and neuroscience aim to study. In the grand scheme of things, if interdisciplinarity is promoted, the study of language will benefit from being placed in comparison to other aspects of animal biology as well as to other modules of human cognition. These are comparisons that might not have much descriptive power in terms of discussing grammar particularities across languages, but will have explanatory power in terms of discussing the faculty of language and in providing answers as to why languages vary the way they do.

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Appendix A: Pool of Data I

TABLE A	It	Sal	Sp	Fr	Ptg	Ru	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
(1) ± gramm. person	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
(2) ± gramm. number +1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
(3) ± gramm. gender +2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	-
(4) ± variable person on D +1	-	-	+	-	-	-	?	+	?	-	+	?	?	-	-	-	-	-	-	?	?	-	+	-	-	-	-	+
(5) ± feature spread to N +2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	-
(6) ± numb. on N (BNs) +5	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0	+	+	+	0
(7) ± gramm. partial def	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	+	-	-	-
(8) ± gramm. def +7	+	+	+	+	+	+	0	+	+	+	+	-	+	+	+	+	+	0	0	+	+	+	+	+	+	0	0	0
(9) ± free null partitive Q +6	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	+	-	0
(10) ± gramm. dist. art. -5 or -6 or +7	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-	+	-	0	0	+
(11) ± gramm. top. art. -10	-	+	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-	0	-	0	0	0
(12) ± def checking N +7	-	-	-	-	-	+	0	-	-	-	-	-	-	-	-	+	+	0	0	-	-	-	-	-	-	0	0	0
(13) ± def spread to N +12	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	+	-	0	0	0	0	0	0	0	0	0	0	0
(14) ± def on attrib. +7, -12	-	-	-	-	-	0	0	+	+	-	+	+	-	-	-	0	0	0	0	-	-	+	+	-	-	0	0	0
(15) ± def on relatives +7	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	+	+	-	0	0	0
(16) ± D-controlled infl. on N +5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	0	-	-	-	0
(17) ± gramm. cardinal nouns	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	?	+	+	?	+	+	+	?	-	+	-	-
(18) ± gramm. cardinal adjectives +17	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	?	-	+	?	-	-	+	?	0	+	0	0
(19) ± plural spread from cardinals +5, -17 or +18	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	?	0	+	?	0	0	+	0	-	-	+	0
(20) ± gramm. mass-to-count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	?	+	-	+	-	-	-	-	-
(21) ± N-to-predicate incorporation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	+	-
(22) ± gramm. partial count -5 or -6 or +7, -21	+	+	+	+	+	+	0	-	-	+	+	0	+	+	+	+	+	0	0	-	-	-	-	0	0	0	0	+
(23) ± gramm. count +22	+	+	+	+	+	+	0	0	0	+	+	0	-	+	+	+	-	0	0	0	0	0	0	0	0	0	0	-
(24) ± count checking N +21 or +22	-	-	-	-	-	-	0	0	0	-	-	0	-	-	-	-	-	0	0	0	0	0	0	-	-	0	-	-
(25) ± prepositional Gen	+	+	+	+	+	-	-	-	-	-	-	-	-	+	+	+	+	-	-	+	+	+	+	-	-	-	-	-
(26) ± free inflected Gen -25	0	0	0	0	0	-	+	+	-	-	-	-	-	0	0	0	0	-	-	0	0	0	0	-	-	-	-	-
(27) ± GenO +25 or -26	-	-	-	-	-	-	0	0	+	+	+	+	+	-	+	?	-	+	+	+	+	-	-	+	-	+	+	+
(28) ± GenS +25 or -26	-	-	-	-	-	+	0	0	-	-	-	+	+	+	+	+	-	-	-	-	-	+	+	-	+	+	+	+
(29) ± postpositional Gen +27 or +28	0	0	0	0	0	-	0	0	-	-	-	-	-	+	-	+	0	-	-	-	-	-	-	-	-	-	+	+
(30) ± Gen over DemP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	?
(31) ± poss checking N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	-	-
(32) ± structured APs	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+
(33) ± feature spread to structured APs +32	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	?	+	+	0	-	+	+	-
(34) ± feature spread to pred. APs	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	?	+	+	+	+	+	+	+
(35) ± numb. on A +6, +33 or +34	+	+	+	0	+	+	+	+	+	+	+	+	+	0	+	+	+	+	+	+	?	+	+	0	+	+	+	0
(36) ± D-controlled infl. on A +33	-	-	-	-	-	-	-	-	-	-	-	+	+	0	+	+	-	-	-	-	?	-	-	0	0	-	-	0
(37) ± DemP over relatives	+	+	+	+	+	+	?	?	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	?	-
(38) ± free APs in Mod +32	+	+	+	+	+	-	+	+	+	-	+	+	-	-	-	-	-	-	-	-	-	-	+	0	-	-	-	-
(39) ± APs in Mod -38	0	0	0	0	0	-	0	0	0	-	0	0	+	+	-	-	+	+	+	-	-	+	0	0	-	-	?	?
(40) ± overt Mod° -32 or +38 or +39	-	+	-	-	-	0	-	-	-	0	-	-	-	-	0	0	-	-	-	0	0	-	-	+	0	0	?	?
(41) ± adjectival Gen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	?	-
(42) ± N-raising with pied-piping	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	+
(43) ± N over ext.arg. -42	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	0	0	+	+	+	+	0
(44) ± N over GenO +26 or +27, -30 ,+43	0	0	0	0	0	0	-	-	+	+	+	+	+	0	+	0	0	+	+	+	+	0	0	+	0	-	0	0
(45) ± N over As +32, (-26 or -27, +43) or +44	+	+	+	+	+	+	0	0	-	+	-	-	-	0	-	0	-	-	-	+	+	0	0	0	-	0	-	0
(46) ± N over M2 As +45	+	+	+	+	+	+	0	0	0	+	0	0	0	0	0	0	0	0	0	+	+	0	0	0	0	0	0	0
(47) ± N over M1 As +46	-	+	-	-	-	-	0	0	0	?	0	0	0	0	0	0	0	0	0	+	+	0	0	0	0	0	0	0
(48) ± N over high As +47	0	+	0	0	0	0	0	0	0	?	0	0	0	0	0	0	0	0	0	-	-	0	0	0	0	0	0	0
(49) ± N over cardinals +42 or +48	0	-	0	0	0	0	0	0	0	?	0	0	0	0	0	0	0	0	0	0	0	+	+	?	0	0	0	-
(50) ± strong D (person) +1, +8 or +28	+	+	+	+	+	+	0	+	+	+	+	0	-	-	-	-	+	0	0	-	-	+	+	-	?	0	0	+
(51) ± NP over D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+
(52) ± strong deixis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+
(53) ± strong anaphoricity +52	+	+	-	+	+	-	-	-	-	+	-	-	+	+	+	+	-	+	+	0	0	?	-	+	+	+	+	+
(54) ± DP over Dem -51, +52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	+	?	0	-	-	-	0
(55) ± D checking Dem -5 or -6 or +7, +52	+	+	+	+	+	+	0	-	-	+	-	?	+	+	+	-	+	0	0	0	0	+	-	+	-	0	0	+
(56) ± D-checking poss -5 or -6 or +8, +50 or -28	-	-	+	+	?	-	0	-	-	-	-	0	0	0	0	0	-	0	0	+	+	-	-	+	?	0	0	-
(57) ± feature spread on poss +35 or +34 or +33	+	+	+	+	+	+	+	+	+	-	-	+	+	0	+	+	+	+	+	-	?	-	-	+	-	-	+	-
(58) ± feature spread on postp. Gen +29, +57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	+	0
(59) ± enclitic possessives	-	-	-	-	-	-	-	+	+	+	+	-	-	-	-	-	?	-	-	-	-	-	-	?	-	-	-	-
(60) ± Consisten. Princ. +51 or (-44 or … or -47, +A-Compl)	+	0	+	+	+	+	?	?	?	?	-	?	+	+	+	+	-	-	-	0	0	0	0	?	+	+	0	+
(61) ± null-N-licensing art -5 or-6 or -12, +50 or +51	-	-	+	-	+	0	0	+	+	-	-	0	0	0	0	0	0	0	0	0	0	-	-	?	?	0	0	+
(62) ± obl. def. inh. +7,-22, (-25, +26) or +27,+42 or +45 or -50	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	-	+	+	+	-	0	0	0	0
(63) ± gramm. geogr. art. -5 or-6 or +7, -22 or -23 or +45	+	+	-	+	-	+	0	+	+	+	0	0	0	0	0	0	-	0	0	?	?	-	-	0	-	0	0	-
	It	Sal	Sp	Fr	Ptg	Ru	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba

Table 6: 63 binary parameters within the DP domain (Longobardi & Guardiano 2009)

Appendix B: Pool of Data II

	TABLE A			Sic	Cal	It	Sal	Sp	Fr	Ptg	Rm	BoG	Gri	Grk	E	D	Da	Ice	Nor	Blg	SC	Slo	Po	Rus	Ir	Wel	Far	Ma	Hi	
1	± gramm. person		FGP	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1
2	± gramm. number	+FGP	FGN	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	2
3	± gramm. gender	+FGN	FGG	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	3
4	± NP over D	+FGP	NOD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
5	± feature spread to N	+FGN	FSN	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	5
6	± numb. on N (BNs)	+FSN	FNN	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	6
7	± gramm. partial def		DGP	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	+	+	-	-	-	7
8	± gramm. def	+DGP	DGR	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0	0	0	0	+	+	0	0	0	8
9	± strong person	+FGP, +DGR, -NOD	NSD	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	+	0	0	0	0	-	-	0	0	0	9
10	± free null partitive Q	+FNN	DPQ	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
11	± gramm. dist. art.	-FSN or -FNN or +DGR	DDA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	-	0	0	0	11
12	± def-checking N	+DGR	DCN	-	-	-	-	-	-	-	+	-	-	-	-	-	+	+	+	+	0	0	0	0	-	-	0	0	0	12
13	± def spread to N	+DCN, -NSD	DSN	0	0	0	0	0	0	0	0	0	0	0	0	0	-	+	+	0	0	0	0	0	0	0	0	0	0	13
14	± def on relatives	+DGR	DOR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	-	0	0	0	14
15	± D-controlled infl. on N	+FSN	DIN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
16	± plural spread from cardinals	+FSN	CPS	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	+	16
17	± gramm. boundedness		CGB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	17
18	± strong article	+DGR, +FNN, -CGB	CGR	+	+	+	+	+	0	+	+	+	+	+	+	+	+	-	+	-	0	0	0	0	-	-	0	0	0	18
19	± bounded.-checking N	+CGB	CCN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	-	-	19
20	± null-N-licensing art	-FSN or-FNN or -DCN, +NOD or +NSD	DNN	-	-	-	-	+	-	+	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
21	± structured APs		AST	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	21
22	± feature spread to struct. APs	+FSN, + AST	FFS	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+	+	22
23	± feature spread to pred. APs	+FGN	FSP	+	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	-	-	-	+	+	23
24	± D-controlled infl. on A	-NSD, +FFS	ADI	0	0	0	0	0	0	0	0	0	0	0	0	+	+	+	+	0	0	0	0	0	-	0	0	0	0	24
25	± DP over relatives		ADR	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	25
26	± relative extrap.	-ADR	AER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	+	26
27	± free reduced rel	+AST	ARR	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	27
28	± N-raising with obl. pied-piping	+AST	NPP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28
29	± free Gen		GFR	+	+	+	+	+	+	+	-	-	-	-	+	+	+	+	+	+	-	-	-	-	+	+	+	+	+	29
30	± uniform Gen	+GFR	GUN	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-	-	-	0	0	0	0	-	-	-	-	-	30
31	± DP over free Gen	+GFR, +ADR	GFR	+	+	+	+	+	+	+	0	0	0	0	+	+	+	+	+	+	0	0	0	0	+	+	+	0	0	31
32	± GenO	¬+GUN	GFO	-	+	-	-	-	-	-	-	+	+	+	-	+	-	+	-	-	+	+	+	+	+	+	+	-	-	32
33	± Gen-feature spread to N		GFS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33
34	± D checking poss.	+DGR, +NSD or ¬+CGR	PDC	-	-	-	-	+	+	?	-	-	-	-	0	0	0	+	0	-	0	0	0	0	+	+	0	0	0	34
35	± adjectival poss.		APC	+	+	+	+	+	+	+	-	-	-	-	-	+	-	-	-	+	+	+	+	+	-	-	-	-	-	35
36	± post-affix poss.	+DCN	PAP	0	0	0	0	0	0	0	+	0	0	0	0	0	-	+	+	+	0	0	0	0	0	0	0	0	0	36
37	± clitic poss.		PCL	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	37
38	± N-feat. spr. to pron. poss.	+FFS or -AST, +PAP or +PCL	PHS	0	0	0	0	0	0	0	+	-	-	-	0	0	0	+	+	-	0	0	0	0	0	0	0	0	0	38
39	± N-feature spread to free Gen	+FFS, +GFR, ¬-PHS	GSP	-	-	-	-	-	-	-	0	0	0	0	0	-	-	-	-	0	0	0	0	0	-	0	0	+	+	39
40	± adjectival Gen	+APO	AGE	-	-	-	-	-	-	-	0	0	0	0	0	-	0	0	0	+	+	+	-	+	0	0	0	0	0	40
41	± Poss°-checking N	-GFS	GCN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41
42	± Strong partial Locality	¬+CGR, -FSN or +FNN	TPL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	+	+	+	+	+	-	-	+	+	+	42
43	± Strong Locality	¬-TPL	TSL	+	+	+	+	-	+	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	0	0	+	+	+	43
44	± D Checking Dem	¬-TPL, -FSN or +DGR	TDC	+	+	+	+	+	+	+	+	?	+	-	+	+	+	+	+	+	0	0	0	0	0	0	0	0	0	44
45	± N over cardinals		NOC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45
46	± N over ordinals	-NOC	NOO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	46
47	± N over M1 As	-NOO, -NPP	NM1	+	+	-	+	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	+	+	0	-	-	47
48	± N over M2 As	-NM1	NM2	0	0	+	0	+	+	+	+	0	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	-	-	48
49	± N over As	-NM2	NOA	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	-	-	49
50	± N over GenO	¬-GFO, -NOA or -AST	NGO	0	0	0	0	0	0	0	0	0	0	+	0	+	0	+	0	0	+	+	+	+	0	0	0	0	0	50
51	± N over ext. arg.	-NGO or (-GFO, -NOA or -AST)	NOE	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	-	+	0	0	0	0	0	0	0	+	+	51
52	± free MOD	-NOA	AFM	0	0	0	0	0	0	0	0	0	0	+	-	-	-	-	-	-	-	-	-	-	0	0	0	-	-	52
53	± class MOD	-AFM	ACM	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	+	+	0	0	0	-	-	53
54	± def on APs	+DGP, *+postnom. APs*	DOA	-	-	-	-	-	-	-	-	+	-	+	-	0	0	0	0	0	0	0	0	0	-	-	0	0	0	54
55	± gramm. AP marker	*+postnom. APs*	AMO	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	-	-	-	-	+	0	0	55
56	± Cons. Pr.	(-NM1,+A-Cpl) or (+NPP or ¬-NM2, +Cpl-A)	ACP	0	0	+	0	+	+	+	+	0	0	-	+	+	+	+	+	-	-	-	-	-	0	0	-	0	0	56
				Sic	Cal	It	Sal	Sp	Fr	Ptg	Rm	BoG	Gri	Grk	E	D	Da	Ice	Nor	Blg	SC	Slo	Po	Rus	Ir	Wel	Far	Ma	Hi	

Table 7: 56 binary parameters within the DP domain (Longobardi et al. 2013)

Appendix C: Tabularized Results for Pool of Data I

Reading key: 1 signals the availability of the corresponding setability path in the relevant language, whereas 0 signals the unavailability (e.g., if a language reaches [5set] on the basis of [2+], the [2+] setability path under parameter 5 is marked with 1 for all languages that are able to set parameter 5 on the basis of having parameter 2 set to + and with 0 for all languages that have 2 is in any other state: uncertain, neutralized, or set to the opposite value). When a node has an attached parenthesis on its right (e.g., 2+(1+)), the node inside the parenthesis is the analysis of the node outside the parenthesis. A boldfaced vertical line of markings in a language column indicates that multiple setability paths are available in the corresponding language.

The setability paths are ordered within parameters in terms of number of nodes in the dependency, starting from the least complex one. If a setability path in the first column appears in dark gray, this means that the path is not realized by any language in this pool of data (i.e. the relevant line is marked exclusively with ‘0’ for all languages). If a dependency in the first column appears in light(er) gray, this means that the path is realized in some language(s), however in this/these language(s), a simpler path for reaching setability is also available. If mutually exclusive values are traced in a dependency, the path is marked with an asterisk. Finally, if there is a discrepancy between the program output that is reported in the following tables and what appears as set(able) in L&G (appendix A), the relevant marking appears underlined and explained below the table in which it occurs.

Parameter 10: ± *Grammaticalized Distal Article*

3 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NTG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
7+	1	1	1	**1**	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	**1**	1	0	0	0
5-(2+(1+))	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	1
6-(5+(2+(1+)))	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0

Parameter 11: ± *Grammaticalized Topic Article*

3 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
10-(7+)	1	1	1	**1**	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	0	0	0
10-(5-(2+(1+)))	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-(6-(5+(2+(1+))))	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter 19: ± *Plural Spread from Cardinals*

2 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NTG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
17-, 5+(2+(1+))	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	<u>0</u>	0	0	<u>0</u>	0	0	0	0	1	0	1	0
18+(17+), 5+(2+(1+))	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	<u>0</u>	0	1	<u>0</u>	0	0	1	0	0	1	0	0

For Blg and Ir, the parameter is marked with '?' in L&G and as neutralized here. These languages have parameters 17 and 18 marked with '?', which is an uncertain state, treated by the program as 'non-target'. Since a part of the dependency is not satisfied, paths are marked as unavailable.

Parameter 22: ± *Grammaticalized Partial Count*

3 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
7+ , 21-	1	1	1	**1**	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	0	0	0	0
5-(2+(1+))), 21-	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
6-(5+(2+(1+)))), 21-	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

For Got, the parameter is marked as neutralized in L&G and as settable/non-neutralized here. It is settable on the first path, since Got is marked with [7+] and [21-] according to the pool of data in appendix A.

Parameter 23: ± *Grammaticalized Count*

3 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
22+(7+, 21-)	1	1	1	**1**	1	1	0	0	0	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
22+(5-(2+(1+)), 21-)	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22+(6-(5+(2+(1+))), 21-)	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter 24: ± *Count-Checking N*

4 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
21+	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
22+(7+, 21-)	1	1	1	**1**	1	1	0	0	0	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
22+(5-(2+(1+))), 21-)	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22+(6-(5+(2+(1+)))), 21-	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter 27: ± *Genitive O*

2 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
25+	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	0	0	0	0	0
26-(25-)	0	0	0	0	0	1	0	0	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1

Parameter 28: ± *Genitive S*

2 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
25+	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	0	0	0	0	0
26-(25-)	0	0	0	0	0	1	0	0	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1

Parameter 29: ± *Postpositional Genitive*

4 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
27+(25+)	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	0	**1**	0	0	0	0	1	1	0	0	0	0	**0**	**0**	**0**
28+(25+)	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	1	**1**	1	0	0	0	0	0	1	1	0	0	**0**	**0**	**0**
27+(26-(25-))	0	0	0	0	0	0	0	0	1	1	1	**1**	**1**	0	**0**	0	0	1	1	0	0	0	0	1	0	**1**	**1**	**1**

28+(26-(25-))	0	0	0	0	0	1	0	0	0	0	0	**1**	**1**	0	**0**	0	0	0	0	0	0	0	0	0	1	**1**	**1**	**1**

Parameter 35: ± *Number on A*

2 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NTG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
34+, 6+(5+(2+(1+)))	**1**	**1**	**1**	0	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	0	0	**1**	**1**	**1**	**1**	**1**	<u>0</u>	**1**	**1**	0	1	**1**	**1**	0
33+(32+), 6+(5+(2+(1+)))	**1**	**1**	**1**	0	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	0	1	**1**	**1**	**1**	**1**	**1**	<u>0</u>	**1**	**1**	0	0	**1**	**1**	0

For Wel, the parameter is marked with '?' in L&G and as neutralized here. It is shown as neutralized because parts of the dependency (parameters 33 and 34) are uncertain for Wel.

Parameter 40: ± *Overt Mod°*

3 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NTG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
32-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	<u>0</u>	<u>0</u>
38+(32+)	1	1	1	1	1	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	<u>0</u>	<u>0</u>
39+(38-(32+))	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	1	0	0	0	0	<u>0</u>	<u>0</u>

For Hi and Ba, this parameter is marked with '?' in L&G and as neutralized here. The first two paths are unavailable because both languages set parameters 32 and 38 to the opposite values from the target ones specified by the dependency. The third path involves an uncertain state, therefore 40 is marked as neutralized for both languages.

Parameter 44: ± *N over Genitive O*

3 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NTG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
30-, 43+(42-), 26+(25-)	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-, 43+(42-), 27+(25+)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0
30-, 43+(42-), 27+(26-(25-))	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0

Parameter 45: ± *N over Adjectives*

6 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NTG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
32+, 43+(42-), 26-(25-)	0	0	0	0	0	**1**	0	0	**1**	**1**	**1**	**1**	**1**	0	0	0	0	**1**	**1**	0	0	0	0	0	**1**	1	1	0
32+, 43+(42-), 27-(25+)	1	1	1	1	1	**0**	0	0	**0**	**0**	**0**	**0**	**0**	0	0	0	1	**0**	**0**	0	0	0	0	0	**0**	0	0	0
32+, 43+(42-), 27-(26-(25-))	0	0	0	0	0	**1**	0	0	**0**	**0**	**0**	**0**	**0**	0	0	0	0	**0**	**0**	0	0	0	0	0	**1**	0	0	0
32+, 44+(30-, 43+(42-), 26+(25-))	0	0	0	0	0	**0**	0	0	**0**	**0**	**0**	**0**	**0**	0	0	0	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0
32+, 44+(30-, 43+(42-), 27+(25+))	0	0	0	0	0	**0**	0	0	**0**	**0**	**0**	**0**	**0**	0	1	0	0	**0**	**0**	1	1	0	0	0	**0**	0	0	0
32+, 44+(30-, 43+(42-), 27+(26-(25-)))	0	0	0	0	0	**0**	0	0	**1**	**1**	**1**	**1**	**1**	0	0	0	0	**1**	**1**	0	0	0	0	0	**0**	0	0	0

For Fin, this parameter is marked as neutralized in L&G and as settable/non-neutralized here. It is settable on the first path, since Fin sets to target all the relevant values.

Parameter 46: ± *N over Manner 2 Adjectives*

6 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NTG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
45+(32+, 43+(42-), 26-(25-))	0	0	0	0	0	**1**	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45+(32+, 43+(42-), 27-(25+))	1	1	1	1	1	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45+(32+, 43+(42-), 27-(26-(25-)))	0	0	0	0	0	**1**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45+(32+, 44+(30-, 43+(42-), 26+(25-)))	0	0	0	0	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45+(32+, 44+(30-, 43+(42-), 27+(25+)))	0	0	0	0	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
45+(32+, 44+(30-, 43+(42-), 27+(26-(25-))))	0	0	0	0	0	**0**	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter 47: ± *N over Manner 1 Adjectives*

6 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
46+(45+(32+, 43+(42-), 26-(25-)))	0	0	0	0	0	**1**	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46+(45+(32+, 43+(42-), 27-(25+)))	1	1	1	1	1	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46+(45+(32+, 43+(42-), 27-(26- (25-))))	0	0	0	0	0	**1**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46+(45+(32+, 44+(30-, 43+(42-), 26+(25-))))	0	0	0	0	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46+(45+(32+, 44+(30-, 43+(42-), 27+(25+))))	0	0	0	0	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
46+(45+(32+, 44+(30-, 43+(42-), 27+(26- (25-)))))	0	0	0	0	0	**0**	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter 48: ± *N over High Adjectives*

6 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
47+(46+(45+(32+, 43+(42-), 27-(25+))))	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47+(46+(45+(32+, 43+(42-), 26-(25-))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47+(46+(45+(32+, 43+(42-), 27-(26-(25-)))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47+(46+(45+(32+, 44+(30-, 43+(42-), 26+(25-)))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47+(46+(45+(32+, 44+(30-, 43+(42-), 27+(25+)))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
47+(46+(45+(32+, 44+(30-, 43+(42-), 27+(26-(25-))))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

For Gri, this parameter is marked with '?' in L&G and as neutralized here. It is shown as neutralized because the dependency involves [47+] in all paths and Gri has 47 marked with '?', treated by the program as non-target.

Parameter 49: ± *N over Cardinals*

7 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
42+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1
48+(47+(46+(45+(32+, 43+(42-), 27- (25+)))))	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48+(47+(46+(45+(32+, 43+(42-), 26-(25-)))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48+(47+(46+(45+(32+, 43+(42-), 27-(26- (25-))))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48+(47+(46+(45+(32+, 44+(30-, 43+(42-), 26+(25-))))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48+(47+(46+(45+(32+, 44+(30-, 43+(42-), 27+(25+))))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

48+(47+(46+(45+(32+, 44+(30-, 43+(42-), 27+(26- (25-)))))))	0	0	0	0	0	0	0	0	0	<u>0</u>	0	0	0	0	0	0	0	0	0	0	0	0	0	<u>0</u>	0	0	0	0

For Wo, this parameter is marked with '?' in L&G and as neutralized here. It is neutralized because Wo has 48 as neutralized and sets 42 to the opposite value than the one required by the dependency, so none of the paths is available. For Gri, this parameter is marked with '?' in L&G and as neutralized here. It is shown as neutralized because Gri shows 48 as uncertain in L&G, whereas 42 that is required in the first path is set to the opposite value.

Parameter 50: ± *Strong D (Person)*

3 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NTG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
1+, 8+(7+)	1	1	1	1	1	**1**	0	1	1	1	1	0	**1**	**1**	**1**	**1**	1	0	0	1	1	**1**	**1**	1	**1**	0	0	0
1+, 28+(25+)	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	**1**	**1**	**1**	0	0	0	0	0	**1**	**1**	0	**0**	0	0	0
1+, 28+(26- (25-))	0	0	0	0	0	**1**	0	0	0	0	0	<u>1</u>	**1**	**0**	**0**	**0**	0	0	0	0	0	**0**	**0**	0	**1**	<u>1</u>	<u>1</u>	1

For Fin, Hi, and Got, this parameter is marked as neutralized in L&G and as settable/non-neutralized here. It is settable on the third path in all three cases, since Fin, Hi, and Got set to target all the relevant values.

Parameter 55: ± *D-Checking Demonstratives*

3 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
52+, 7+	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
52+, 5-(2+(1+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
52+, 6-(5+(2+(1+)))	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter 56: ± *D-Checking Possessives*

15 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
8+(7+), 28-(25+)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0
5-(2+(1+)), 28-(25+)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8+(7+), 28-(26-(25-))	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
8+(7+), 50+(1+, 8+(7+))	1	1	1	1	1	1	0	1	1	1	1	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0
5-(2+(1+)), 28-(26-(25-))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
6-(5+(2+(1+))), 28-(25+)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8+(7+), 50+(1+, 28+(25+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
5-(2+(1+)), 50+(1+, 8+(7+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

6-(5+(2+(1+))), 28-(26-(25-))	**0**	**0**	**0**	**0**	**0**	**0**	0	0	**0**	**0**	**0**	0	0	0	0	0	**0**	0	0	0	0	**0**	**0**	**0**	0	0	0	0
5-(2+(1+)), 50+(1+, 28+(25+))	**0**	**0**	**0**	**0**	**0**	**0**	0	0	**0**	**0**	**0**	0	0	0	0	0	**0**	0	0	0	0	**0**	**0**	**0**	0	0	0	0
8+(7+), 50+(1+, 28+(26-(25-)))	**0**	**0**	**0**	**0**	**0**	**1**	0	0	**0**	**0**	**0**	0	0	0	0	0	**0**	0	0	0	0	**0**	**0**	**0**	0	0	0	0
6-(5+(2+(1+))), 50+(1+, 8+(7+))	**0**	**0**	**0**	**1**	**0**	**0**	0	0	**0**	**0**	**0**	0	0	0	0	0	**0**	0	0	0	0	**0**	**0**	**0**	0	0	0	0
6-(5+(2+(1+))), 50+(1+, 28+(25+))	**0**	**0**	**0**	**0**	**0**	**0**	0	0	**0**	**0**	**0**	0	0	0	0	0	**0**	0	0	0	0	**0**	**0**	**0**	0	0	0	0
5-(2+(1+)), 50+(1+, 28+(26-(25-)))	**0**	**0**	**0**	**0**	**0**	**0**	0	0	**0**	**0**	**0**	0	0	0	0	0	**0**	0	0	0	0	**0**	**0**	**0**	0	0	0	1
6-(5+(2+(1+))), 50+(1+, 28+(26-(25-)))	**0**	**0**	**0**	**0**	**0**	**0**	0	0	**0**	**0**	**0**	0	0	0	0	0	**0**	0	0	0	0	**0**	**0**	**0**	0	0	0	0

For Hu, this parameter is marked with '?' in L&G and as neutralized here. It is shown as neutralized because none of the available paths is realized due to either uncertain states or a parameter in the dependency being set in the non-target value.

Parameter 57: ± *Feature Spread on Possessives*

4 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
34+	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	1	1	1	1	1
33+(32+)	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	1	1	0
35+(6+(5 +(2+(1+))) , 34+)	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	0	1	1	1	0
35+(6+(5 +(2+(1+))) , 33+(32+))	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	1	1	0

For Wel, this parameter is marked with '?' in L&G and as neutralized here. It is shown as neutralized because none of the paths is realized due to uncertain states in the dependency.

Parameter 58: ± *Feature Spread on Postpositional Genitives*

16 Setability Paths	It	Sal	Sp	Fr	Ptg	Rum	Lat	ClG	NTG	Gri	Grk	Got	OE	E	D	Nor	Blg	SC	Rus	Ir	Wel	Heb	Ar	Wo	Hu	Fin	Hi	Ba
57+(34+), 29+(28+(25+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
57+(34+), 29+(27+(2 5+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57+(34+), 29+(27+(2 6-(25-)))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
57+(34+), 29+(28+(26-(25-)))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
57+(33+(3 2+)), 29+(27+(2 5+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

57+(33+(32+)), 29+(28+(25+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	**0**	0
57+(33+(32+)), 29+(27+(26-(25-)))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**1**	0
57+(33+(32+)), 29+(28+(26-(25-)))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**1**	0
57+(35+(6+(5+(2+(1+)))), 34+), 29+(27+(25+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**0**	0
57+(35+(6+(5+(2+(1+)))), 34+), 29+(28+(25+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	**0**	0
57+(35+(6+(5+(2+(1+)))), 34+), 29+(27+(26-(25-)))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**1**	0
57+(35+(6+(5+(2+(1+)))), 34+), 29+(28+(26-(25-)))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**1**	0
57+(35+(6+(5+(2+(1+)))), 33+(32+)), 29+(27+(25+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**0**	0

57+(35+(6+(5+(2+(1+)))), 33+(32+)), 29+(28+(25+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	**0**	0
57+(35+(6+(5+(2+(1+)))), 33+(32+)), 29+(27+(26-(25-)))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**1**	0
57+(35+(6+(5+(2+(1+)))), 33+(32+)), 29+(28+(26-(25-)))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**1**	0

Parameter 60: ± *Consistency Principle*

23 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NTG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
51+	**0**	0	**0**	**0**	**0**	**0**	0	0	**0**	**0**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	1	**0**	0	0	1
43-(42-)	**0**	0	**0**	**0**	**0**	**0**	0	0	**0**	**0**	0	0	0	1	0	1	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0
44-(30-, 43+(42-), 26+(25-))	**0**	0	**0**	**0**	**0**	**0**	1	1	**0**	**0**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0
44-(30-, 43+(42-), 27+(25+))	**0**	0	**0**	**0**	**0**	**0**	0	0	**0**	**0**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0
45-(32+, 43+(42-), 26-(25-))	**0**	0	**0**	**0**	**0**	**0**	0	0	**1**	**0**	1	1	1	0	0	0	0	**1**	**1**	0	0	0	0	0	**1**	0	1	0
45-(32+, 43+(42-), 27-(25+))	**0**	0	**0**	**0**	**0**	**0**	0	0	**0**	**0**	0	0	0	0	0	0	1	**0**	**0**	0	0	0	0	0	**0**	0	0	0

44-(30-, 43+(42-), 27+(26-(25-)))	**0**	0	**0**	**0**	**0**	**0**	0	0	**0**	**0**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	**0**	1	0	0
45-(32+, 43+(42-), 27-(26-(25-)))	**0**	0	**0**	**0**	**0**	**0**	0	0	**0**	**0**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	**1**	0	0	0
46+(45+(32+, 43+(42-), 26-(25-)))	**0**	0	**0**	**0**	**0**	**1**	0	0	**0**	**1**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0
46+(45+(32+, 43+(42-), 27-(25+)))	**1**	1	**1**	**1**	**1**	**0**	0	0	**0**	**0**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0
45-(32+, 44+(30-, 43+(42-), 26+(25-)))	**0**	0	**0**	**0**	**0**	**0**	0	0	**0**	**0**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0
45-(32+, 44+(30-, 43+(42-), 27+(25+)))	**0**	0	**0**	**0**	**0**	**0**	0	0	**0**	**0**	0	0	0	0	1	0	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0
46+(45+(32+, 43+(42-), 27-(26-(25-))))	**0**	0	**0**	**0**	**0**	**1**	0	0	**0**	**0**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0
47-(46+(45+(32+, 43+(42-), 26-(25-))))	**0**	0	**0**	**0**	**0**	**1**	0	0	**0**	**0**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0
47-(46+(45+(32+, 43+(42-), 27-(25+))))	**1**	0	**1**	**1**	**1**	**0**	0	0	**0**	**0**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0

47-(46+(45+(32+, 43+(42-), 27-(26-(25-)))))	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-(32+, 44+(30-, 43+(42-), 27+(26-(25-))))	0	0	0	0	0	0	0	0	**1**	0	1	1	1	0	0	0	0	**1**	**1**	0	0	0	0	0	0	0	0	0
46+(45+(32+, 44+(30-, 43+(42-), 26+(25-))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46+(45+(32+, 44+(30-, 43+(42-), 27+(25+))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
46+(45+(32+, 44+(30-, 43+(42-), 27+(26-(25-)))))	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47-(46+(45+(32+, 44+(30-, 43+(42-), 26+(25-)))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47-(46+(45+(32+, 44+(30-, 43+(42-), 27+(25+)))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

47-(46+(45+(32+, 44+(30-, 43+(42-), 27+(26-(25-))))))	**0**	0	**0**	**0**	**0**	**0**	0	0	**0**	**0**	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	**0**	0	0	0

For Sal, Ir, Wel, and Hi, this parameter is marked as neutralized in L&G and as settable in all four cases here. It is settable in all four cases, three out four on different paths.

Parameter 61: ± *Null N-Licensing Article*

12 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NTG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
12-(7+), 51+	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	1	0	0	0	**0**
5-(2+(1+)), 51+	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	1	0	0	0	**1**
6-(5+(2+(1+))), 51+	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	**0**
12-(7+), 50+(1+, 8+(7+))	1	1	1	**1**	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	**1**	**1**	0	0	0	0	**0**
12-(7+), 50+(1+, 28+(25+))	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**1**	0	0	0	0	**0**
5-(2+(1+)), 50+(1+, 8+(7+))	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	**0**
5-(2+(1+)), 50+(1+, 28+(25+))	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	**0**

6-(5+(2+(1+))), 50+(1+, 8+(7+))	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	**0**
12-(7+), 50+(1+, 28+(26-(25-)))	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	**0**
6-(5+(2+(1+))), 50+(1+, 28+(25+))	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	**0**
5-(2+(1+)), 50+(1+, 28+(26-(25-)))	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	**1**
6-(5+(2+(1+))), 50+(1+, 28+(26-(25-)))	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	**0**

For Hu, this parameter is marked with '?' in L&G and as neutralized here. It is shown as neutralized because none of the paths is realized due to either uncertain states or a parameter in the dependency being set in the non-target value.

Parameter 62: ± *Grammaticalized Geographical Article*

36 Setability Paths	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**Lat**	**ClG**	**NTG**	**Gri**	**Grk**	**Got**	**OE**	**E**	**D**	**Nor**	**Blg**	**SC**	**Rus**	**Ir**	**Wel**	**Heb**	**Ar**	**Wo**	**Hu**	**Fin**	**Hi**	**Ba**
7+, 22-(21-, 7+)	0	0	0	**0**	0	**0**	0	1	1	**0**	0	0	0	0	0	0	0	0	0	**1**	**1**	1	1	0	0	0	0	0
7+, 23-(22+(21-, 7+))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	1	0	0	0	1	0	0	**0**	**0**	0	0	0	0	0	0	0

5-(2+(1+)), 22-(21-, 7+)	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
7+, 22-(21-, 5-(2+(1+)))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
6-(5+(2+(1+))), 22-(21-, 7+)	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
7+, 22-(21-, 6-(5+(2+(1+))))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
5-(2+(1+)), 23-(22+(21-, 7+))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
7+, 23-(22+(21-, 5-(2+(1+))))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
7+, 45+(32+, 43+(42-), 26-(25-))	0	0	0	**0**	0	**1**	0	0	0	**1**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
7+, 45+(32+, 43+(42-), 27-(25+))	1	1	1	**1**	1	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
5-(2+(1+)), 22-(21-, 5-(2+(1+)))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
6-(5+(2+(1+))), 23-(22+(21-, 7+))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0

7+, 23-(22+(21-, 6-(5+(2+(1+)))))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
7+, 45+(32+, 43+(42-), 27-(26-(25-)))	0	0	0	**0**	0	**1**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
5-(2+(1+)), 22-(21-, 6-(5+(2+(1+)))) *predicted but im-possible, mutually exclusive values of 5	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
6-(5+(2+(1+))), 22-(21-, 5-(2+(1+))) *predicted but im-possible, mutually exclusive values of 5	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
5-(2+(1+)), 23-(22+(21-, 5-(2+(1+))))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	1
6-(5+(2+(1+))), 22-(21-, 6-(5+(2+(1+))))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0

5-(2+(1+)), 45+(32+, 43+(42-), 26-(25-))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
5-(2+(1+)), 45+(32+, 43+(42-), 27-(25+))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
7+, 45+(32+, 44+(30-, 43+(42-), 26+(25-)))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
7+, 45+(32+, 44+(30-, 43+(42-), 27+(25+)))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**1**	**1**	0	0	0	0	0	0	0
5-(2+(1+)), 23-(22+(21-, 6-(5+(2+(1+))))) *predicted but im-possible, mutually exclusive values of 5	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
6-(5+(2+(1+))), 23-(22+(21-, 5-(2+(1+)))) *predicted but im-possible, mutually exclusive values of 5	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0

5-(2+(1+)), 45+(32+, 43+(42-), 27-(26-(25-)))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
6-(5+(2+(1+))), 45+(32+, 43+(42-), 26-(25-))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
6-(5+(2+(1+))), 45+(32+, 43+(42-), 27-(25+))	0	0	0	**1**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
7+, 45+(32+, 44+(30-, 43+(42-), 27+(26-(25-))))	0	0	0	**0**	0	**0**	0	0	0	**1**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
6-(5+(2+(1+))), 23-(22+(21-, 6-(5+(2+(1+)))))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
6-(5+(2+(1+))), 45+(32+, 43+(42-), 27-(26-(25-)))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0
5-(2+(1+)), 45+(32+, 44+(30-, 43+(42-), 26+(25-)))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	0

5-(2+(1+)), 45+(32+, 44+(30-, 43+(42-), 27+(25+)))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	<u>0</u>	0	0	0
6-(5+(2+(1+))), 45+(32+, 44+(30-, 43+(42-), 26+(25-)))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	<u>0</u>	0	0	0
6-(5+(2+(1+))), 45+(32+, 44+(30-, 43+(42-), 27+(25+)))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	<u>0</u>	0	0	0
5-(2+(1+)), 45+(32+, 44+(30-, 43+(42-), 27+(26-(25-))))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	<u>0</u>	0	0	0
6-(5+(2+(1+))), 45+(32+, 44+(30-, 43+(42-), 27+(26-(25-))))	0	0	0	**0**	0	**0**	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**	0	0	0	<u>0</u>	0	0	0

Some paths are not realizable in any language due to the existence of conflicting values. For Hu, this parameter is marked as settable in L&G and as neutralized here. It is neutralized because none of the paths is realizable.

Appendix D: Tabularized Results for Pool of Data II

Reading key: The same reading instructions given in appendix C apply here.

Parameter 11: ± *Grammaticalized Distal Article*

3 Setability Paths	Sic	Cal	It	Sal	Sp	Fr	Ptg	Rum	BoG	Gri	Grk	E	D	Da	Ice	Nor	Blg	SC	Slo	Po	Rus	Ir	Wel	Far	Ma	Hi
8+(7+)	1	1	1	1	1	**1**	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0
5-(2+(1+))	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-(5+ (2+(1+)))	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter 20: ± *Null N-licensing Article*

6 Setability Paths	Sic	Cal	It	Sal	Sp	Fr	Ptg	Rum	BoG	Gri	Grk	E	D	Da	Ice	Nor	Blg	SC	Slo	Po	Rus	Ir	Wel	Far	Ma	Hi
5-(2+(1+)), 4+(1+)	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12-(8+(7+)), 4+(1+)	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-(5+(2+(1+))), 4+(1+)	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-(2+(1+)), 9+(1+, 8+(7+), 4-(1+))	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

12-(8+(7+)), 9+(1+, 8+(7+), 4-(1+))	1	1	1	1	1	**1**	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-(5+(2+(1+))), 9+(1+, 8+(7+), 4-(1+))	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter 34: ± *D-checking Possessives*

2 Setability Paths	**Sic**	**Cal**	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**BoG**	**Gri**	**Grk**	**E**	**D**	**Da**	**Ice**	**Nor**	**Blg**	**SC**	**Slo**	**Po**	**Rus**	**Ir**	**Wel**	**Far**	**Ma**	**Hi**
8+(7+), 9+(1+, 8+(7+), 4-(1+))	1	1	1	1	1	1	<u>1</u>	1	1	1	1	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
8+(7+), 18¬+(8+(7+), 6+(5+(2+(1+))),17-)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**1**	0	0	0	0	1	1	0	0	0

For Ptg, the parameter is marked with ? in Longobardi et al. (2013). This is not a real discrepancy because [?] corresponds to an uncertain but settable state.

Parameter 38: ± *N Feature Spread to Possessive Pronouns*

4 Setability Paths	**Sic**	**Cal**	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**BoG**	**Gri**	**Grk**	**E**	**D**	**Da**	**Ice**	**Nor**	**Blg**	**SC**	**Slo**	**Po**	**Rus**	**Ir**	**Wel**	**Far**	**Ma**	**Hi**
21-, 37+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21-, 36+(12+(8+(7+)))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22+(5+(2+(1+)), 21+), 37+	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

22+(5+(2+(1 +)), 21+), 36+(12+(8+(7+)))	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0

Parameter 39: ± *N Feature Spread to Free Genitives*

4 Setability Paths	**Sic**	**Cal**	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**BoG**	**Gri**	**Grk**	**E**	**D**	**Da**	**Ice**	**Nor**	**Blg**	**SC**	**Slo**	**Po**	**Rus**	**Ir**	**Wel**	**Far**	**Ma**	**Hi**
22+(5+(2+(1 +)), 21+), 29+, 38¬- (21-, 37+) *predicted but impossible, mutually exclusive values of 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22+(5+(2+(1 +)), 21+), 29+, 38¬- (21-, 36+(12+(8+(7+)))) *predicted but impossible, mutually exclusive values of 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22+(5+(2+(1 +)), 21+), 29+, 38¬- (22+(5+(2+(1 +)), 21+), 37+)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22+(5+(2+(1 +)), 21+), 29+, 38¬- (22+(5+(2+(1+)), 21+), 36+(12+(8+(7+))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0

Sic, Cal, It, Sal, Sp, Fr, Ptg, D, Ir, Ma, Hi have the parameter settable in Longobardi et al. (2013). The first two paths are not realizable in any language due to the existence of conflicting values. The parameter is not settable in the 3rd path because Sic, Cal, It, Sal, Sp, Fr, Ptg, D, Ir, Ma, Hi have [37-]. It is not settable in the 4th path because in all these languages 36 is not-settable [0-]. In Da the 3rd and 4th paths are not available because of non-target states; [37-] and [36-] respectively.

Parameter 42: ± *Strong Partial Locality*

2 Setability Paths	**Sic**	**Cal**	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**BoG**	**Gri**	**Grk**	**E**	**D**	**Da**	**Ice**	**Nor**	**Blg**	**SC**	**Slo**	**Po**	**Rus**	**Ir**	**Wel**	**Far**	**Ma**	**Hi**
18¬+(8+(7+), 6+(5+(2+(1+))),17-), 5-(2+(1+)) *predicted but impossible, mutually exclusive values of 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	0	0	<u>0</u>	<u>0</u>	<u>0</u>
18¬+(8+(7+), 6+(5+(2+(1+))),17-), 6+(5+(2+(1+)))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	1	1	<u>0</u>	<u>0</u>	<u>0</u>

The first path is not realizable in any language due to the existence of conflicting values. SC, Slo, Po, Rus, Far, Ma and Hi are shown to have the parameter settable in Longobardi et al. (2013). The parameter is shown as neutralized here for all these languages, because they all have 8 as not-settable [0].

Parameter 43: ± *Strong Locality*

2 Setability Paths	Sic	Cal	It	Sal	Sp	Fr	Ptg	Rum	BoG	Gri	Grk	E	D	Da	Ice	Nor	Blg	SC	Slo	Po	Rus	Ir	Wel	Far	Ma	Hi
42¬- (18¬+(8+(7 +), 6+(5+(2+(1 +))),17-), 5- (2+(1+))) *predicted but impossi-ble, mutually exclusive values of 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42¬- (18¬+(8+(7 +), 6+(5+(2+(1 +))),17-), 6+(5+ (2+(1+))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0

The underlined languages show the parameter realized in Longobardi et al. (2013). The first path is not realizable in any language due to the existence of conflicting values. The second path is not available in Sic, Cal, It, Sal, Sp, Ptg, Rum, Bog, Gri, Grk, E, D, Da and Nor because these languages have [18] in a non-target state. Fr has [6] in a non-target state. SC, Slo, Po, Rus, Far, Ma and Hi have [8] as neutralized.

Parameter 44: ± *D-checking Demonstrative*

4 Setability Paths	Sic	Cal	It	Sal	Sp	Fr	Ptg	Rum	BoG	Gri	Grk	E	D	Da	Ice	Nor	Blg	SC	Slo	Po	Rus	Ir	Wel	Far	Ma	Hi
42¬- (18¬+(8+(7 +), 6+(5+(2+(1 +))),17-), 5- (2+(1+))), 8+(7+)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

42¬-(18¬+(8+(7+), 6+(5+(2+(1+))),17-), 5-(2+(1+))), 5-(2+(1+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42¬-(18¬+(8+(7+), 6+(5+(2+(1+))),17-), 6+(5+(2+(1+)))), 8+(7+)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
42¬-(18¬+(8+(7+), 6+(5+(2+(1+))),17-), 6+(5+(2+(1+)))), 5-(2+(1+))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The underlined languages show the parameter realized in Longobardi et al. (2013). All paths involve [18¬+]. Sic, Cal, It, Sal, Sp, Fr, Ptg, Rum, Bog, Gri, Grk, E, D, Da and Nor have [18] in a non-target state.

Parameter 50: ± *N over Genitive O*

2 Setability Paths	**Sic**	**Cal**	**It**	**Sal**	**Sp**	**Fr**	**Ptg**	**Rum**	**BoG**	**Gri**	**Grk**	**E**	**D**	**Da**	**Ice**	**Nor**	**Blg**	**SC**	**Slo**	**Po**	**Rus**	**Ir**	**Wel**	**Far**	**Ma**	**Hi**
32¬-(30¬+(29+)), 21-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32¬-(30¬+(29+)), 49-(48-(47-(46-(45-), 28-(21+))))	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0

The underlined languages show the parameter realized in Longobardi et al. (2013). Both paths involve [29+]. Grk, SC, Slo, Po and Rus have [29] in a non-target state.

Parameter 51: ± *N over External Argument*

4 Setability Paths	Sic	Cal	It	Sal	Sp	Fr	Ptg	Rum	BoG	Gri	Grk	E	D	Da	Ice	Nor	Blg	SC	Slo	Po	Rus	Ir	Wel	Far	Ma	Hi
32-(30¬+(29+)),21-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50-(32¬-(30¬+(29+)),21-)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32-(30¬+(29+)),49-(48-(47-(46-(45-),28-(21+))))	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	1	1
50-(32¬-(30¬+(29+)),49-(48-(47-(46-(45-),28-(21+)))))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter 56: ± *Consistency Principle*

3 Setability Paths	Sic	Cal	It	Sal	Sp	Fr	Ptg	Rum	BoG	Gri	Grk	E	D	Da	Ice	Nor	Blg	SC	Slo	Po	Rus	Ir	Wel	Far	Ma	Hi
28+(21+)	0	0	0	0	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47-(46-(45-),28-(21+))	0	0	1	0	**1**	**1**	**1**	**1**	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1
48¬-(47-(46-(45-),28-(21+)))	0	0	1	0	**1**	**1**	**1**	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Longobardi et al. (2013) show the parameter as neutralized for Ma and Hi. It is settable on the second path in both languages. Far is shown settable in Longobardi et al. (2013), whereas it is shown neutralized here. It is not settable on the first path because Far has 28 in a non-target state. It is not settable on the second or third path because Far has 47 neutralized.

Appendix E: Code for Pool of Data I

```
package Language_Analyser;

import java.util.HashMap;
import java.util.Iterator;
import java.util.Map;

public class ChildPath
{
  // List all the dependencies that comprise this path
  private HashMap dependecyTable;
  private String LanguageInput[];

  // The language input data table
  public ChildPath(String langData[])
  {
    this.dependecyTable = new HashMap();
    this.LanguageInput = langData;
  }

  public boolean ScanChildPath()
  {
    boolean result = true;
    Iterator setList = this.dependecyTable.entrySet().iterator();

    while(setList.hasNext())
    {
      Map.Entry tempEntry = (Map.Entry)setList.next();

      String tempKey = (String)tempEntry.getKey();
      // Search the language parameter state
```

This code is an updated version of the one presented in Boeckx & Leivada (2013).

```
            String LangVal = this.searchLangData(tempKey);

            // If the state does not equal the target symbol
            // The whole path is unsettable so break the loop and return false
            //System.out.println("Comparing
<"+tempEntry.getValue()+","+LangVal+">");
            if (!tempEntry.getValue().equals(LangVal))
            {
                result=false;
                break;
            }
        }
        //System.out.println("Final result:"+result);
        return result;
    }

    // Searches in the table that was created by the input Language File
    private String searchLangData(String i)
    {
        int index = Integer.parseInt(i);
        return this.LanguageInput[index-1];
    }

    // All the dependencies will be stored in HashMap
    // We will have pairs of <Key,Value> where Key=parameter_ID && Val-
ue=symbol
    public void addNewDependency(String parameter_ID,String symbol)
    {
        this.dependecyTable.put(parameter_ID, symbol);
    }

}

package Language_Analyser;

import java.io.*;

public class Language_Analyser{

    public static ChildPath[] ParameterPaths;
    public static String[] fileInputValues;
```

```
public static void main(String[] args) throws IOException
{
  File folder = new File("Input_Language_Data"), tmpFile;
  File[] listOfFiles = folder.listFiles();
  fileInputValues = new String[62];

  if(listOfFiles == null )
  {
    System.out.println("Folder with input data was not found!");
    File cwd = new File(".");
    System.out.println("Working Directory:" + cwd.getAbsoluteFile());
    return;
  }

  for (int i = 0; i < listOfFiles.length; i++)
  {
     if (listOfFiles[i].isFile() &&
       listOfFiles[i].getName().endsWith(".txt"))
     {
       tmpFile = listOfFiles[i];
       ReadFileContents(tmpFile,fileInputValues);

       // =============== EDITABLE CODE SECTION
================ //

         // Sample code: Parameter 10

         // The parameter has three setability paths so you have to
         // specify this in the next line inside the parenthesis
         ParameterPaths = Language_Analyser.createPaths(3);

         // For each path, define its number and
         // subtract 1 each time. In the following lines
         // we are going to set the first path so in the
         // brackets we specify zero (path_index - 1 = 1 - 1 = 0)
         // The realization of each path depends on the status of the relevant
input nodes
         // For each dependency, specify first the number of the input
node(s) and
         // then the state(s), as shown in the
         // following example
         ParameterPaths[0].addNewDependency("7", "+");
```

```
            // For the second path we have to change the index to 1
            // (path_index -1 = 2 - 1 = 1)
            ParameterPaths[1].addNewDependency("5", "-");
            ParameterPaths[1].addNewDependency("2", "+");
            ParameterPaths[1].addNewDependency("1", "+");

            // Finally, the index for the third path is 2 (path_index -1 = 3 - 1 =
2)
            ParameterPaths[2].addNewDependency("6", "-");
            ParameterPaths[2].addNewDependency("5", "+");
            ParameterPaths[2].addNewDependency("2", "+");
            ParameterPaths[2].addNewDependency("1", "+");


          // =========== END OF EDITABLE CODE SECTION
============= //


          Language_Analyser.showResults(tmpFile);
        }
      }
    }

   public static ChildPath[] createPaths(int numberOfPaths)
   {
     ChildPath Parameter_Paths[] = null;

     if (!(numberOfPaths > 0))
         {
       System.out.println("The number of paths you specified is invalid");
       System.exit(-1);
     }
     else
     {
       Parameter_Paths = new ChildPath[numberOfPaths];

       for (int i=0;i<numberOfPaths;i++)
       {
          Parameter_Paths[i] = new
ChildPath(Language_Analyser.fileInputValues);
       }
```

```
    }

    return Parameter_Paths;
  }

  public static void ReadFileContents(File f, String v[]) {
        BufferedReader br = null;
        try
        {
          br = new BufferedReader(
                new InputStreamReader(
                  new DataInputStream(
                    new FileInputStream(f))));
        }
        catch (FileNotFoundException ex)
        {
          System.out.println("File was not found!");
        }

        for (int i = 0; i<62; i++)
        {
          try
          {
            v[i] = br.readLine().toString();
          }
          catch(IOException ex)
          {
            System.out.println("Error while reading file: "+f.getName());
            System.out.println("File is corrupted");
          }
        }

    }

  public static void showResults(File inputFile)
  {
    int numberOfPaths = Language_Analyser.ParameterPaths.length;
    String fName = inputFile.getName();
    // Trim the file extension
    String fNameReverse = (new
StringBuffer(fName).reverse().toString()).substring(4);
    fName = new StringBuffer(fNameReverse).reverse().toString();
```

```
      System.out.print("Language:" + fName + "\t ");
      for (int i=0; i<numberOfPaths; i++)
      {
         boolean result = Lan-
guage_Analyser.ParameterPaths[i].ScanChildPath();
         System.out.print("Path["+i+"]={ " + result +" } \t");
      }
      System.out.println("");
   }
}
```

Appendix F: Code for Pool of Data II

```
package language_analyser;

import java.util.HashMap;
import java.util.Iterator;
import java.util.Map;


public class ChildPath
{
   // List all the dependencies that comprise this path
   private HashMap dependecyTable;
   private String LanguageInput[];

   // The language input data table
   public ChildPath(String langData[])
   {
      this.dependecyTable = new HashMap();
      this.LanguageInput = langData;
   }

   public boolean ScanChildPath() throws Exception
   {
      boolean result = true;
      Iterator setList = this.dependecyTable.entrySet().iterator();
      String tempKey, LangVal;

      while(setList.hasNext())
      {
         Map.Entry tempEntry = (Map.Entry)setList.next();

         tempKey = (String)tempEntry.getKey();
```

```
        if(tempKey.charAt(0) == '~')
        {
          tempKey = tempKey.substring(1);

          LangVal = this.searchLangData(tempKey);

          //Here we are interested for the negation.
          // If the state DOES equal the target symbol then the path is invalid
          if (tempEntry.getValue().equals(LangVal))
          {
            result=false;
            break;
          }

        }
        else
        {
          LangVal = this.searchLangData(tempKey);

          // If the state does not equal the target symbol
          // The whole path is unsettable so break the loop and return false
          //System.out.println("Comparing
<"+tempEntry.getValue()+","+LangVal+">");
          if (!tempEntry.getValue().equals(LangVal))
          {
            result=false;
            break;
          }
        }


      }

      return result;
    }

    // Searches in the table that was created by the input Language File
    private String searchLangData(String i)
    {
      int index = Integer.parseInt(i);
      return this.LanguageInput[index-1];
    }
```

```
    // All the dependencies will be stored in HashMap
    // We will have pairs of <Key,Value> where Key=parameter_ID && Val-
ue=symbol
    public void addNewDependency(String parameter_ID,String symbol)
    {

        if(this.dependecyTable.containsKey(parameter_ID))
        {
            System.out.println("**Warning: Path unsettable path.**");
        }

        this.dependecyTable.put(parameter_ID, symbol);
    }
}
```

```
/*
 * To change this template, choose Tools | Templates
 * and open the template in the editor.
 */
package language_analyser;

import java.io.*;

public class Language_Analyser
{
    public static final int TOTAL_PARAMETERS = 56;

    public static ChildPath[] ParameterPaths;
    public static String[] fileInputValues;

    public static void main(String[] args) throws IOException, Exception
    {
        File folder = new File("Input_Language_Data"), tmpFile;
        File[] listOfFiles = folder.listFiles();
        fileInputValues = new String[TOTAL_PARAMETERS];

        if(listOfFiles == null )
        {
            System.out.println("Folder with input data was not found!");
```

```
        File cwd = new File(".");
        System.out.println("Working Directory:" + cwd.getAbsoluteFile());
        return;
    }

    for (int i = 0; i < listOfFiles.length; i++)
    {
        if (listOfFiles[i].isFile() &&
            listOfFiles[i].getName().endsWith(".txt"))
        {
            tmpFile = listOfFiles[i];
            ReadFileContents(tmpFile,fileInputValues);

            // =============== EDITABLE CODE SECTION
================ //

                // Sample code: Parameter 42

                // The parameter has two setability paths so you have to
                // specify this in the next line inside the parenthesis
                ParameterPaths = Language_Analyser.createPaths(2);

                // For each path, define its number and
                // subtract 1 each time. In the following lines
                // we are going to set the first path so in the
                // brackets we specify zero (path_index - 1 = 1 - 1 = 0)
                // The realization of each path depends on the status of the relevant
input nodes
                // For each dependency, specify first the number of the input
node(s) and
                // then the state(s), as shown in the
                // following example

                // In case a state of the dependency is negated then add the charac-
ter '~' before
                // the dependency's number.
                ParameterPaths[0].addNewDependency("~18", "+");
                ParameterPaths[0].addNewDependency("5", "-");
                ParameterPaths[0].addNewDependency("17", "-");
                ParameterPaths[0].addNewDependency("7", "+");
                ParameterPaths[0].addNewDependency("8", "+");
                ParameterPaths[0].addNewDependency("6", "+");
```

```
            ParameterPaths[0].addNewDependency("1", "+");
            ParameterPaths[0].addNewDependency("2", "+");


            // For the second path we have to change the index to 1
            ParameterPaths[1].addNewDependency("~18", "+");
            ParameterPaths[1].addNewDependency("6", "+");
            ParameterPaths[1].addNewDependency("5", "+");
            ParameterPaths[1].addNewDependency("1", "+");
            ParameterPaths[1].addNewDependency("2", "+");
            ParameterPaths[1].addNewDependency("8", "+");
            ParameterPaths[1].addNewDependency("17", "-");
            ParameterPaths[1].addNewDependency("7", "+");


           // =========== END OF EDITABLE CODE SECTION
============= //

          Language_Analyser.showResults(tmpFile);
        }
      }

  }



  public static ChildPath[] createPaths(int numberOfPaths)
  {
     ChildPath Parameter_Paths[] = null;

    if (!(numberOfPaths > 0))
    {
      System.out.println("The number of paths you specified is invalid");
      System.exit(-1);
    }
    else
    {
      Parameter_Paths = new ChildPath[numberOfPaths];

      for (int i=0;i<numberOfPaths;i++)
      {
```

```
          Parameter_Paths[i] = new
ChildPath(Language_Analyser.fileInputValues);
        }
      }

      return Parameter_Paths;
    }

    public static void ReadFileContents(File f, String v[]) {
          BufferedReader br = null;
          try
          {
            br = new BufferedReader(
                    new InputStreamReader(
                      new DataInputStream(
                        new FileInputStream(f))));
          }
          catch (FileNotFoundException ex)
          {
            System.out.println("File was not found!");
          }

          for (int i = 0; i <TOTAL_PARAMETERS; i++)
          {
            try
            {
              v[i] = br.readLine().toString();
            }
            catch(IOException ex)
            {
              System.out.println("Error while reading file: "+f.getName());
              System.out.println("File is corrupted");
            }
          }

      }

    public static void showResults(File inputFile) throws Exception
    {
      int numberOfPaths = Language_Analyser.ParameterPaths.length;
      String fName = inputFile.getName();
      // Trim the file extension
```

```
      String fNameReverse = (new
StringBuffer(fName).reverse().toString()).substring(4);
      fName = new StringBuffer(fNameReverse).reverse().toString();
      System.out.print("Language:" + fName + "\t ");
      for (int i=0; i<numberOfPaths; i++)
      {
         boolean result = Lan-
guage_Analyser.ParameterPaths[i].ScanChildPath();
         System.out.print("Path["+i+"]={ " + result +" } \t");
      }
      System.out.println("");
   }
}
```