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Principles, Parameters, and Schemata
A radically underspecified UG[1]

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Abstract

Parametric models have been the only viable alternative to unsuccessful theories of the language faculty based on evaluation metrics for grammars. In this article I show that parametric analyses can attain a high degree of *typological* and *historical* adequacy, though they raise serious problems for *explanatory* and *evolutionary* adequacy. I propose to replace the Principles&Parameters theory by a simplified model of the language faculty, which eliminates parameters altogether from the initial state of the mind, replacing them with few abstract variation schemata, and, in the absence of positive evidence in the primary *corpora*, eliminates them even as open questions in the course of acquisition in the absence of positive evidence. In this model, 'parameters' only arise as positive answers to yes/no questions of limited form. Attained I-languages can be represented as simple strings of positive and neutralized values of different lengths. The new research program (Principles&Schemata) is capable of retaining the advantages warranted by a system of heavily constrained binary choices for language acquisition, variation, and history, while underspecifying UG and simplifying the acquisition path and the representation of the steady state of each I-language: it promises to be able to return to a feasible question-based model of syntax acquisition triggered by positive evidence only, though without the shortcomings emerged from the classical Principles&Parameters theory.

1. Parametric linguistics

This article develops some programmatic ideas about the study of language diversity and refines a model of grammatical variation first sketched in Longobardi (2005a).

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Since the 1960s, generative grammar has tried to pursue the twin goals of descriptive and explanatory adequacy (Chomsky 1964), but the large amount of attested grammatical variation among natural languages has brought to light a remarkable tension between the two goals.

The crucial issue for the success of the whole generative approach is indeed attaining *explanatory adequacy*, i.e. accounting for the fact that humans acquire natural languages given the (constricted) empirical conditions under which they do. Solving the problem of language acquisition is a crucial standard for claims that linguistics is a theory of mind and plays a role among the cognitive sciences. Obviously, the main obstacle to build up a universally valid theory of language acquisition is represented by language diversity. For, the shared human ability to acquire one from a wide variety of possible languages cannot be trivially circumvented by simply appealing to rigid theories of innate knowledge.

The classical generative theory (developed between Chomsky 1957, especially ch. 6, and the *Aspects* model, Chomsky 1965) viewed the Language Acquisition Device (LAD, i.e., the idealized initial state S_0 of the linguistic mind) as consisting of:

(1) a set of universal principles (Universal Grammar, UG) + an Evaluation Metrics for grammars

the latter was supposed to rank grammars constructed *freely* by the language learner within the bounds posed by the universal principles and the observed primary data. To work efficiently, this linguistic theory presupposed that grammars subject to evaluation should be, in each case, finite, limited and sufficiently scattered in form: if many (or even infinitely many) grammars are indeed compatible with the universal constraints and the data, there is no guarantee that different learners would subject to evaluation the same candidates, thus leaving the crucial uniformity of certain subtle linguistic intuitions within communities of speakers unexplained.

Within such a model, the existence of variation is potentially explained in terms of minimization of the genetic endowment: the 'freedom' of variation allowed can be construed as inversely proportional to the restrictive principles made available by UG (the more such constraining principles, the higher the number of languages prohibited). Therefore, the broadness of attested linguistic diversity could be due to the fact that the amount of universal restrictions made available by human nature is limited by a sort of "load" constraint on genetic transmission of cognitive information; this would be a conceivable "economy" condition on the architecture of the LAD, active through evolutionary history.

This model has been progressively abandoned since the 1970s, mainly as the result of the failure in finding out a sufficiently general evaluation metrics and in restricting grammars to finite and well scattered sets (indeed, many natural languages differ minimally), along with other conceptual considerations about generative capacity and learnability. The model of Principles and Parameters arose as an answer to such issues: "Before the P&P framework crystallized, the assumption within the Generative Enterprise was that UG provided a format for (infinitely many) possible grammars (I-languages), and an evaluation measure to select among them, given the data available. It was well understood that this approach has fundamental deficiencies. I know of no coherent alternative to these two approaches."(Chomsky 2015, 145).[2]

In the P&P model (Chomsky 1981), the LAD consists of a UG with *both* universal principles and parameters:

(2) UG = Principles + Parameters. Open parameters at S_0, closed parameters at S_S

For convenience, in this article I will take "parameters" to refer in a broad sense to any discrete, ideally binary, question about the grammar of a specific I-language which is raised by the learner/linguist, and has one or more empirical consequences in the E-language. This notion, for example, includes all yes/no choices that learners makes on their native grammars, e.g., of the type discussed by Epstein et al. (2017) and Lightfoot (2017), whether they are called "parametric" or not in other works.

For 35 years now parametric linguistics has been regarded as the main framework to resolve the tension between descriptive and explanatory adequacy and to provide a privileged testing ground for theories about the interaction between biologically shaped structures and culturally variable information.

However, as stressed in Chomsky (1995, 7), the Principles-and-Parameters model (P&P) was and still is "… in part a bold speculation rather than a specific hypothesis. Nevertheless, its basic assumptions seem reasonable.... and they do suggest a natural way to resolve the tension between descriptive and explanatory adequacy").

Here, I will consider the balance of advantages and of problems characterizing classical P&P theories, and will highlight the sense in which the latter caused the P&P model to remain mostly 'a bold speculation'; then I will try to sketch a partly different model of language diversity and language acquisition, which might eventually better resolve the tension between different levels of adequacy.

2. Parameters: variation, acquisition, history, and evolution

At least four general questions could guide the search for more adequate parametric models:

(3) a. What are the actual parameters of UG?
b. How are these parameters set in language acquisition?
c. Are parameter values distributed in time and space in any significant way?
d. What is the form of possible parameters?

Slightly adapting the terminology proposed in Chomsky (1964), we can say that answering question (3)a guarantees a level of "typological adequacy" (a *crosslinguistic* sort of descriptive adequacy): it is a higher level of adequacy than just classical "descriptive adequacy": the latter concerns the description a single I-language, which should minimize the primitives (rules, principles, categories...) necessary to correctly represent the competence of a speaker; typological adequacy is attained by a theory of several I-languages, in principle all possible I-languages, which minimizes the number of primitive differences among all of them.

However, even the best possible answer to (3a) does not necessarily achieve "explanatory adequacy." The latter can be attained only by providing an answer to (3b) (at least for a substantial set of parameters): the hundreds of excellent case studies proposing all sorts of morphosyntactic parameters over the past twenty years, especially since Rizzi (1978), Taraldsen (1978), have mostly (and rather successfully) focused just on question (3a). In other words, they have often failed to define the conditions under which learners set the relevant parameters. To begin answering (3b), any good parametric proposal should try to specify which data set a parameter to one value or the other, and in principle should do so for all language types defined by the possible combinations of settings of the other parameters; and these data should be plausibly accessible in primary corpora of language learners.

Crucial as it ultimately is, problem (3b) is not the easiest line to start addressing a theory of parameters, however. In this article, I will sketch a way to tackle the problems starting from questions (3c) and (3d).

Addressing (3c and d) can be construed as one way to pursue two further levels of adequacy with respect to those proposed in Chomsky (1964) (and to what was defined as "typological adequacy" above). They were termed "evolutionary adequacy" and "historical adequacy" in Longobardi (2003). There, it was argued that an effective way to evaluate parameter systems could be trying indeed to assess their historical adequacy.

Historical adequacy is, by definition, a property of systems of *historically related*[3] I-languages (not of a single I-language) which may successfully answer questions of the form:

(4) Why (i.e., by which combination of language faculty principles and *actual historical antecedents*, i.e., previous I-languages) do we have precisely the I-languages we observe?

To attain evolutionary adequacy, instead, a linguistic theory should ultimate contribute to elucidate a question like the following:

(5) Why has the human language faculty come to display precisely the design it does?

Issues like the latter are obviously among the central concerns of the minimalist program (Chomsky 1995, Boeckx and Piattelli Palmarini 2005).

3. Parametric data

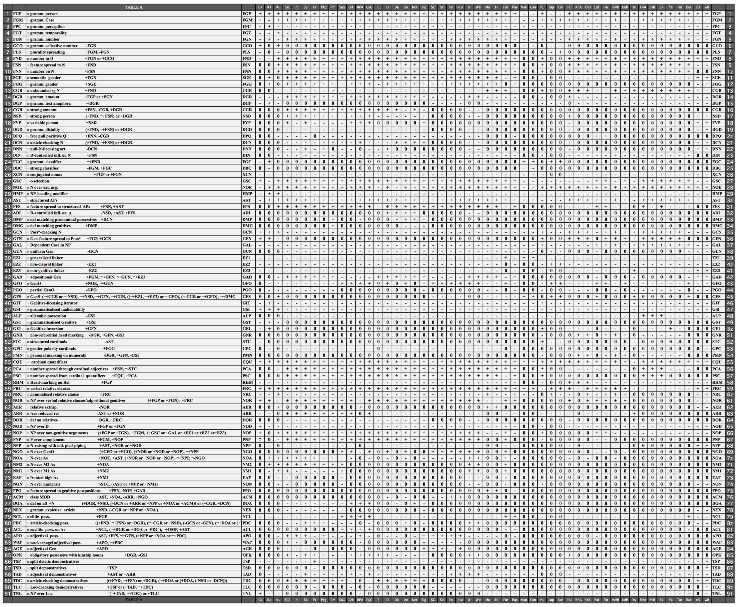
A necessary, though neglected, prerequisite to assess any general theory of parameters is a sufficient collection of structured data about grammatical diversity and a way of representing such information in a perspicuous parametric form.

To approach this objective, Longobardi (2003) has suggested one should adopt the strategy of Modularized Global Parametrization (MGP).[4] Trivializing matters to some extent, this method can be summarized in the following formula: studying relatively *many* parameters across relatively *many* languages within a *single* module of grammar.

Considering a certain number of parameters together is obviously necessary to attempt any sensible generalization; observing more than just a pair of contrasting languages for each parameter is required of a theory with some ambition of typological completeness; and concentrating on a single module makes the enterprise more realistically feasible but also allows one to explore a major formal feature of parameter sets, as already emerging from the works of Fodor (2000), Baker (2001), and most explicitly from Longobardi and Guardiano (2009), namely their pervasive interdependence (cf. below). The MGP method seems thus to be an appropriate compromise between depth and coverage.

Following this method, a grid of 91 parameters affecting the internal structure of Determiner Phrases has been set up within the ERC Advanced Grant LanGeLin research project (http://www.york.ac.uk/language/research/projects/langelin/) and used for various computations and correlations, mostly devoted to establish if formal grammar can be a science of human history; the values of these parameters have been empirically stated in over 50 languages (Table A below, from Ceolin et al. 2017, indeed reports the states of such 91 parameters for 50 of them, belonging to at least 9 distinct genealogical stocks) and their partial dependencies; the latter encode the frequent situations in which choosing one of the two values of a parameter neutralizes the relevance of valuing another parameter. All such parameters could be formulated as binary and their values have been marked in the adopted formalism as + and –. When the state of a parameter depends entirely on the state of other parameters it is marked with a 0. This approach and formalism produce parametric grids summarizing large amounts of empirical information and theoretical hypotheses, highly valuable for further speculation on the theory of parameters itself.

Fig.1: Table A



#	Code	Parameter	Conditions
1	FGP	± gramm. person	
2	FGM	± gramm. Case	
3	FPC	± gramm. perception	
4	FGT	± gramm. temporality	
5	FGN	± gramm. number	
6	GCO	± gramm. collective number	-FGN
7	PLS	± plurality spreading	+FGM, -FGN
8	FND	± number in D	+FGN or +GCO
9	FSN	± feature spread to N	+FND
10	FNN	± number on N	+FSN
11	SGE	± semantic gender	+FGN
12	FGG	± gramm. gender	+SGE
13	CGB	± unbounded sg N	+FND
14	DGR	± gramm. amount	+FGP or +FGN
15	DGP	± gramm. text anaphora	¬+DGR
16	CGR	± strong amount	+FSN, -CGB, +DGR
17	NSD	± strong person	(+FND, ¬+FSN) or +DGR
18	FVP	± variable person	+NSD
19	DGD	± gramm. distality	(+FND, ¬+FSN) or +DGR
20	DPQ	± free null partitive Q	+FNN, -CGB
21	DCN	± article-checking N	(+FND, ¬+FSN) or +DGR
22	DNN	± null-N-licensing art	-DCN
23	DIN	± D-controlled infl. on N	+FSN
24	FGC	± gramm. classifier	¬+FND
25	DBC	± strong classifier	-FGM, +FGC
26	XCN	± conjugated nouns	+FGP or +FGN
27	GSC	± c-selection	
28	NOE	± N over ext. arg.	
29	HMP	± NP-heading modifier	
30	AST	± structured APs	
31	FFS	± feature spread to structured APs	+FSN, +AST
32	ADI	± D-controlled infl. on A	-NSD, +AST, +FFS
33	DMP	± def matching pronominal possessives	+DCN
34	DMG	± def matching genitives	+DMP
35	GCN	± Poss°-checking N	
36	GFN	± Gen-feature spread to Poss°	+FGP, +GCN
37	GAL	± Dependent Case in NP	
38	GUN	± uniform Gen	-GCN
39	EZ1	± generalized linker	
40	EZ2	± non-clausal linker	-EZ1
41	EZ3	± non-genitive linker	-EZ2
42	GAD	± adpositional Gen	+FGM, ¬+GFN, ¬+GUN, ¬+EZ3
43	GFO	± GenO	+NOE, ¬+GUN
44	PGO	± partial GenO	-GFO
45	GFS	± GenS	(¬+CGR or ¬-NSD), ¬+NSD, ¬+GFN, ¬+GUN, ((¬+EZ1, ¬+EZ2) or ¬-GFO), (¬-CGR or ¬+GFO) , ¬+DMG
46	GIT	± Genitive-licensing iterator	
47	GSI	± grammaticalised inalienability	
48	ALP	± alienable possession	-GSI
49	GST	± grammaticalised Genitive	+GSI
50	GEI	± Genitive inversion	+GFN
51	GNR	± non-referential head marking	-DGR, +GFN, -GSI
52	STC	± structured cardinals	-AST
53	GPC	± gender polarity cardinals	+FGG
54	PMN	± personal marking on numerals	-DGR, +GFN, -GSI
55	CQU	± cardinal quantifiers	
56	PCA	± number spread through cardinal adjectives	+FSN, ¬-STC
57	PSC	± number spread from cardinal quantifiers	+CQU, +PCA
58	RHM	± Head-marking on Rel	+FGP
59	FRC	± verbal relative clauses	
60	NRC	± nominalised relative clause	+FRC
61	NOR	± NP over verbal relative clauses/adpositional genitives	(+FGP or +FGN), +FRC
62	AER	± relative extrap.	-NOR
63	ARR	± free reduced rel	-AST or +NOR
64	DOR	± def on relatives	+DGR, +FRC
65	NOD	± NP over D	+FGP or +FGN
66	NOP	± NP over non-genitive arguments	(+FGP or +FGN), +FGM, (+GSC or +GAL or +EZ1 or +EZ2 or+EZ3)
67	PNP	± P over complement	+FGM, +NOP
68	NPP	± N-raising with obl. pied-piping	+AST, +NOR or +NOD
69	NGO	± N over GenO	(+GFO or +PGO), (+NOR or +NOD or +NOP), ¬+NPP
70	NOA	± N over As	+NOE, +AST, (+NOR or +NOD or +NOP), ¬+NPP, ¬-NGO
71	NM2	± N over M2 As	+NOA
72	NM1	± N over M1 As	+NM2
73	EAF	± fronted high As	+NM1
74	NON	± N over numerals	¬-STC, (-AST or +NPP or +NM1)
75	FPO	± feature spread to genitive postpositions	+FSN, -NOP, +GAD
76	ACM	± class MOD	+AST, -NOA, -ARR, +NGO
77	DOA	± def on all +N	(+DGR, +NSD, (+DCN or +ARR or +NPP or +NOA or +ACM)) or (+CGR, +DCN)
78	NEX	± gramm. expletive article	+NSD, (-CGR or +NPP or +NOA)
79	NCL	± clitic poss.	+FGP
80	PDC	± article-checking poss.	((+FND, ¬+FSN) or +DGR), (¬+CGR or +NSD), (-GCN or -GFN), (¬+DOA or (+
81	ACL	± enclitic poss. on As	+NCL, (¬+DGR or +DOA or -PDC), ¬+DMP, +AST
82	APO	± adjectival poss.	+AST, +FFS, ¬+GFN, (+NPP or +NOA or ¬+PDC)
83	WAP	± wackernagel adjectival poss.	+APO, ¬+PDC
84	AGE	± adjectival Gen	+APO
85	OPK	± obligatory possessive with kinship nouns	+DGR, -GSI
86	TSP	± split deictic demonstratives	
87	TSD	± split demonstratives	+TSP
88	TAD	± adjectival demonstratives	+AST or +ARR
89	TDC	± article-checking demonstratives	((+FND, ¬+FSN) or +DGR), (¬+DOA or (+DOA, (-NSD or -DCN)))
90	TLC	± Loc-checking demonstratives	+TSP or (+TAD, ¬+TDC)
91	TNL	± NP over Loc	(¬+TAD, ¬+TDC) or +TLC

Legend. Fig. 1, Table A. (For a more legible version of this chart, please copy and paste the following URL in your browser <https://raw.githubusercontent.com/AndreaCeolin/The_probability_of_language_relatedness/master/Fig1.%20TableA.jpg>). Each parameter is identified by a progressive number (in the first column) and, additionally, by a combination of three capital letters (in the third column). The order of the parameters is not motivated except for ease of expression of cross-parametric dependencies (see directly below), which are organized to proceed top-down. The alternative parameter states are encoded as '+' and '–'. The symbol '0' encodes the neutralizing effect of implicational dependencies across parameters, i.e., those cases in which the content of a parameter is entirely predictable, or irrelevant altogether. The conditions that must hold for each parameter to be relevant (i.e., not neutralized) are indicated in the second column after the name of the parameter itself. They are expressed in a Boolean form, i.e., either as simple values of other parameters, or as conjunctions (written ','), disjunctions ('or'), or negation ('¬') thereof.

As a space-saving convention, in the implications, disjunctions (which are all inclusive) are always meant to be parsed first, conjunctions later, unless parentheses are used to explicitly signify the opposite order of embedding. Thus, as an example of how to read the notation, the implicational condition of parameter 17 (NSD) should sound as follows: p17 (NSD) can be set if and only if p8 (FND) is set to + and p9 (FSN) is not set to +, or if and only if p14 (DGR) is set to + (or both disjoined conditions hold: the disjunction is always meant to be non-exclusive); otherwise it will be neutralized (0).

Especially within compact modules of grammar, the set of implicational relations across parameters turns out impressively intricate, as witnessed by the consequences e.g., of parameters p5 (FGN), p14 (DGR), p30 (AST).

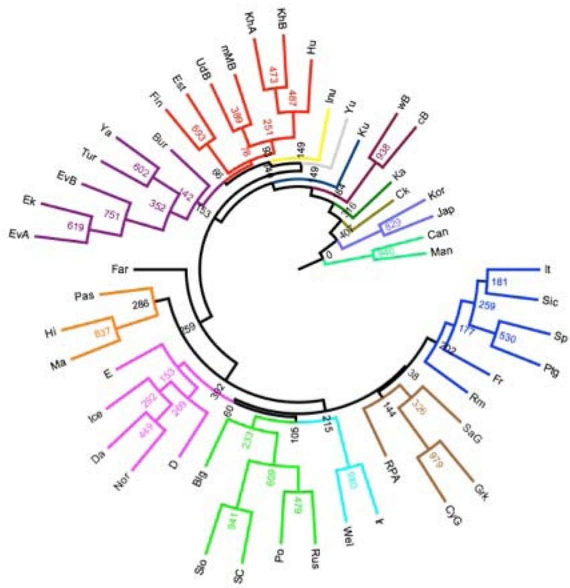
4. Advantages of parametric analyses: typological and historical adequacy

In the terminology adopted above, clear support for parametric theories comes from their success with respect to 1) typological adequacy, and 2) historical adequacy. Consider some properties of the Table A dataset above, a condensed example of parametric analyses.

First, as noticed, it accounts for detailed differences in the behavior of nominal syntax in 50 languages, including minimally differing varieties along with very distant ones; furthermore, it was calculated that the statement in descriptive terms of all these differences amounts to at least 200 manifestations, meaning that on the average each binary parameter potentially accounts for over 2 descriptive differences which appear to cluster together typologically.

Second, such a set of parameters can be shown to provide surprisingly accurate and plausible reconstructions of known phylogenies of languages. Consider the phylogenetic tree below automatically generated from language distances calculated from the data of Table A above through the Kitsch algorithm (from Ceolin et al. submitted; bootstrap: 1000 replicas):

Fig. 2



Legend for the language acronyms in Fig. 2. (For a more legible version of this chart, please copy and paste the following URL in your browser <https://raw.githubusercontent.com/AndreaCeolin/The_probability_of_language_relatedness/master/Fig2.%20KITSCH%20%20Phylogenetic%20Tree.png>). E Indo-European: Romance: French (Fr), Italian (It), Portuguese (Ptg), Romanian (Rm), Sicilian (Sic), Spanish (Sp). Greek: Cypriot Greek (CyG), Standard Modern Greek (Grk), Romeyka Pontic (RPA), Salento Greek (SaG). Germanic: Danish (Da), English (E), German (D), Icelandic (Ice), Norwegian (Nor). Slavic: Bulgarian (Blg), Polish (Po), Russian (Rus), Serbo-Croat (SC), Slovenian (Slo). Celtic: Irish (Ir), Welsh (Wel). Indo-Iranian: Farsi (Far), Hindi (Hi), Marathi (Ma), Pashto (Pas); Uralic: Estonian (Est), Finnish (Fin), Hungarian (Hu), Khanti (aka Ostiak, two varieties sampled: KhA, KhB), Meadow Mari (aka Cheremiss: mM), Udmurt (aka Votiak: Ud); Turkic: Turkish (Tur), Yakut (Ya); Mongolian: Buryat (Bur); Tungusic: Even (two varieties: EvA, EvB), Evenki (Ek); Inuit: Inuktitut (Inu): Japonic: Japanese (Jap); Korean: Korean (Kor); Yukaghir: Yukaghir (Yuk); Basque: Basque (two varieties, Western and Central: wB and cB); Sino-Tibetan: Mandarin (Man) and Cantonese (Can), Guaicuruan: Kadiweu (Ka); Carib: Kuikuro (Ku); Muskogean: Chickasaw (Ck).

The tree of Fig. 2 is supported by the fact that it matches nearly all the well-established results provided by the methods relying on vocabulary: 1) the unity of such families as Indo-European, as Uralic and as Altaic, respectively, is recognized; 2) their internal articulations (with the minor exceptions of the outlying position of Bulgarian within Slavic and of Farsi with respect to the rest of Indo-European) are all well retrieved; 3) the two Sinitic and the two Basque languages of the sample form two correct clusters; 4) no known family is disrupted by any of the remaining language isolates. This result expands on Longobardi et al. (2013) which runs counter to widespread negative or skeptical expectations about the historical value of parameters (Newmeyer 2005, Lightfoot 2006) and century-long ones about that of syntax more generally (cf. Anderson 2017).

Especially given that 50 taxonomic units potentially generate 49!! different rooted binary branching trees, it would be hard to obtain this result if the model of parametric representation in Table A were not, at least in part, correct.

5. Problems with parametric analyses

On the other hand, it has been correctly remarked that parametric analyses, especially when laid down as explicit wide-range hypotheses like Table A, raise some problems which can make P&P theories implausible models of grammatical diversity for the purpose of capturing cognitive reality and ultimately attain explanatory adequacy (cf. Lightfoot this volume). Consider the three issues below:

(i) First, still at the crosslinguistic descriptive level, hardly any significant module of grammar has so far attained a degree of parametrization with pretension of typological exhaustiveness. Yet, proposed or conceivable parameters seem to already run in the hundreds, more likely in the thousands, and in a P&P model all of them must be attributed in some sense to speakers' minds at the initial state S_0.

(ii) Second, even the simplest attempts to lay down a relatively large set of parameters in a non-trivial number of languages (as started e.g. in Longobardi and Guardiano 2009 and exemplified by Fig. 1 above) have had to face an extremely intricate system of implicational interactions among parameters and among surface properties setting them; this leads to overly complex and specific postulations about the grammatical structure of human mind (Boeckx and Leivadá 2013) at S_0, which must include a high amount of redundant information that will never be activated at successive states of maturation (see below). This situation raises some doubts not only about the learnability of parameters (Fodor 2000, Wexler 2015, Fodor and Sakas 2017), but also about the very plausibility of the 'basic assumptions' of a classical P&P theory.

(iii) Third, P&P theories have so far failed to answer general evolutionary questions like:

(6) a. Why is grammatical variation so wide (i.e. why are there so many parameters)?
b. Why is there grammatical variation (i.e. parameters) at all?

In fact, problems like (6) have become more acute precisely with the development of parametric approaches (cf. Longobardi 2003 and below); for, here, in principle, grammatical variation is also innately given (exhaustively given, at the appropriate level of idealization), under the form of a presumably finite amount of discrete possibilities: variability is already present at the initial state of the mind S_0 in the form of open parameters, actual varieties are represented by closed parameters at the steady state SS. In this model the existence of variation is hardly explained, and certainly cannot be explained through the previous line of reasoning: for, limiting the amount of transmittable genetic information, i.e., the size of the LAD, should presumably reduce the number of possible parameters as well; therefore, it should increase, rather than decrease, the degree of invariance of the language faculty observable across individual languages .

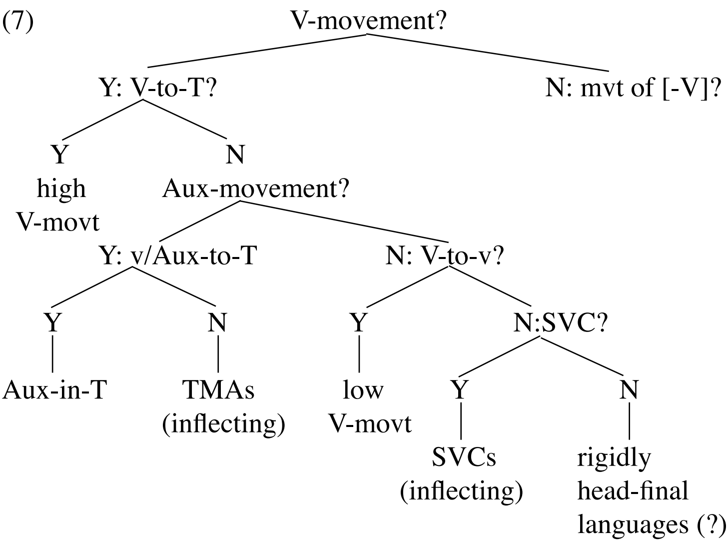
To sum up, owing to these problems, parametric analyses seem to fail some important criteria for explanatory adequacy (Chomsky 1964, Rizzi 2017a) and evolutionary adequacy (in the sense defined above).

In the following section I will clarify some further aspects of problem (ii) above; then I will propose potential ways to solve all of problems—(i), (ii), and (iii).

6. Dependencies in the data: Table A and parameter hierarchies

To fully appreciate the import of problem (ii), recall that the interdependence of parameters has gained much wider attention since the time of Baker (2000) or Longobardi and Guardiano (2009). For instance, principled hierarchical systems, well exemplified in the format of simple binary trees like the following one on Verb movement parameters (from Biberauer and Roberts 2012, 281), have been pervasively pursued by research in the ERC project ReCoS (http://recos-dtal.mml.cam.ac.uk/):

(7)



In the latter cases, the relevance of one parameter depends on one and not the opposite value of a single other parameter, potentially in a recursive fashion.

However, as soon as a sufficient number of parameters is investigated with the explicit goal of pursuing large typological and historical adequacy within a real-size module of grammar, many parametric implications fall well beyond this format. As illustrated in Table A above, a parameter can often only be settable depending 1) on the conjunction of values of more than one parameter at a time; 2) on the disjunction of values of other parameters, i.e., either on the value of another parameter or on the value of a third parameter; 3) on the absence of a certain value from another parameter (i.e., on the presence of either the opposite value or also of 0, expressible through the negation of a value). Furthermore, the value of one parameter can be implicationally dependent on many other parameters.

As noted in the legend of Fig. 1, such more complex and realistic feature geometry can be coded in a Boolean form, i.e., representing implicational conditions either as simple states (+ and –) of another parameter, or as conjunctions (written ','), disjunctions (or) or negation (¬) thereof, as shown in Table A above. The appealing simplicity of the tree hierarchy format of (7) is certainly the goal that we would like to achieve in formal typology, but at present it seems to be rather the result of idealizing the scope of crosslinguistic theoretical inquiry, focusing only on very simply related parameters. A less idealized account of observed diversity, like the one sketched in Table A, on the other hand, appears too complex to provide a realistic decision path for learners in the process of acquisition of parameter values.

Indeed, the argument that a realistic parametric UG does not seem to provide a plausible model for acquisition, owing especially to the intricacy of redundancies and overspecifications, has been forcefully made by Boeckx and Leivadá (2013), precisely on databases of Table A type. Some quantitative considerations can help achieve full appreciation of the scope of the redundancy problem.

In Table A above, out of 50x91=4550 cells (parameter states), 2045 are null (contain 0), i.e., 44.9% of the information is redundant.

To pursue this point also in a different way, consider a system of *n* independent parameters. A priori, the number of potential grammars generated by such a system should be 2^n. Let us consider instead a simple, though pervasive, implicational structure like that suggested in (7): each parameter depends on one setting of the previous one, otherwise it cannot be set. The cardinality of the set of generated grammars is now $n+1$.

These two cases represent simple extremes along a continuum of implicational constraints on possible grammars. An empirical, real-world model, as sketched in Table A, seems now to fall in between, hence its properties are less trivial to compute. So, specially designed algorithms are needed, even to just approximate to the cardinality of the languages generated by a realistic system of parameters.

Bortolussi et al. (2011) have worked out an algorithm to calculate the number of possible strings of parameter values (languages) generated according to a system of parametric implications. According to this algorithm, the first 30 parameters from Table A (less implicationally constrained than the successive ones) generate less than 219 admissible grammars (Ceolin et al. submitted), a reduction of at least eleven orders of magnitude compared to the 230 expected under total independence.

Such a hiatus provides another way to quantify the impressive amount of irrelevant information encoded in fully specified grammatical systems based on parameters. Within a P&P model, information about all parameters must be supposed to be present at some state of every speaker's mind, even that which will never be used to natively acquire their particular language.

On the other hand, the identification of this pervasive structure of interdependence (the best realization of Meillet's 1903 and *passim* claim that language is *un système où tout se tient*) is obviously an important contribution to the predictive power of syntactic theory, and potentially even toward attaining explanatory adequacy, because it reduces the number of possible grammars.

The interdependence structure of parametric variation has another relevant corollary for biolinguistic theories. Through this structure any axiom of the theory of grammar becomes "proteiform" on the surface, in the sense of its theorems or "physical" manifestations being relativized to the whole set of parameter values of the specific language (Guardiano and Longobardi 2017). Therefore, it is possible for the human faculty of language to possess a number of invariant properties (conceivably, all the implications notated in Figure 1 are universal as implicational principles), though it is hardly the case that they emerge in the data with the same visible manifestations.

Thus, even if it were true that "there are vanishingly few universals of language in the direct sense that all languages exhibit them," as claimed by Evans and Levinson (2009:429), this would not conflict, as they hint, with the hypothesis that "languages are all built to a common pattern."

Anyway, the amount of irrelevant information which should be in the mind of speakers under the hypothesis that all parameters are present from the start, and need to be checked at some point, (the "Twenty question model" of parameter setting, in Fodor's 2000 terminology; also see Fodor and Sakas 2107) is very high.

Considering these issues, it is worth exploring alternatives to the classical P&P model. In the rest of this article I will sketch a research program and diversity model that, if implemented successfully, will be able to reconcile the advantages of parameters reported in § 4 above with potential solutions to the problems noticed in § 5 and 6.

7. Parametric minimalism

Precisely on the grounds of the empirical material on parameters collected over the years and of a database such as Table A, it becomes finally possible to raise a more general methodological question, such as (8):

(8) Can we subject parameters and their formats to minimalist critique?

The best-known restriction proposed on the format of parameters is the conjecture, stemming from Borer (1984), that parameters are always properties of functional heads of a language's vocabulary. Accepting this insight as a point of departure, in what follows I will suggest the possibility of a more articulated restrictive theory of parameters and point out its desirable consequences.

Longobardi (2005a) proposed that the format of most parameters can be reduced to a set of abstract parameter schemata. An updated proposal (resulting also from Gianollo, Guardiano, Longobardi 2008, and Longobardi 2014) about such schemata is presented below, where *F* and *X,Y* are variables over features and functional categories, respectively, and *f* is a feature value:

(9) a. Is F, F a feature, grammaticalized?
  b. Does F, F a grammaticalized feature, Agree with X, X a category (i.e., probes X)?
  c. Is F, F a grammaticalized feature, "strong" (set in the terminology of Chomsky (1995), i.e., overtly attracts X, or equivalently probes X with an EPP feature)?
  d. Is F, F a grammaticalized feature, spread on X, X a category?
  e. Does a functional category (a set of lexically cooccurring grammaticalized features) X have a phonological matrix Φ?
  f. Does F, F a grammaticalized feature, probe the minimal accessible category of type X (or is pied-piping possible)?

g. Are f1 and f2, the respective values of two grammaticalized features, associated on X, X a category?
h. Are f1 and f2, two feature values associated on X, optionally associated?
i. Does a functional feature (set) exist in the vocabulary as a bound/free morpheme?

The 9 schemata define, then, 9 corresponding types of parameters:

(10) a. Grammaticalization parameters
b. Probing parameters
c. Strength (or EPP) parameters
d. Spreading parameters
e. Null category parameters
f. Pied-piping parameters
g. Association parameters
h. (Inclusive) Disjunction parameters
i. Availability parameters

Let us now briefly examine the 9 schemata.

By "grammaticalized" in (9a), it is meant that the feature must obligatorily occur and be valued in a grammatically (generally) rather than lexically (idiosyncratically) definable context, e.g., the definite/indefinite interpretation of D is obligatorily valued and marked in argument DPs in certain languages, say English or Spanish, not in others, say Latin or Polish (also cf. below). This does not mean that even the latter languages cannot have lexical items usable to convey the semantic meaning of definiteness (presumably demonstratives and universal quantifiers can convey such a meaning in every language), but in this case the feature "definiteness" would be regarded as a lexical, not a grammatical one.

(9b) asks whether a certain feature requires establishing a relation with a specific (optionally or obligatorily present) category in the structure, creating a dependency (acts as *probe* searching a certain syntactic space for a *goal*, in Chomsky's 2001 terminology). Optimally, the domain of probing (i.e., the scope of application of Agree) should be determined by universal properties of grammaticalized features and categories, and from variation affecting the latter (arising from schemata such as (9g) and h); hence (9b) could perhaps be eventually eliminated from parameter schemata and the relative labor divided e.g., between (9a) and (9c). However, some dimension of variation in that spirit probably has to be maintained at the level of externalization properties, especially governing whether head movement takes place in a language to form, say, N+*enclitic article* or V+T clusters. Further questions arise with respect to clitics in general (Roberts and Roussou 2003, Roberts 2010, Biberauer and Roberts 2012).

(9c) corresponds to the traditional schema inaugurated by Huang (1982) for *wh*-questions, asking whether a dependency of the type mentioned in (9b) involves overt displacement of X, i.e., re-merging of X next to F, or not. Innumerable cases of crosslinguistic variation of this type have been pointed out.

(9d) asks if a feature which is interpreted in a certain structural position also has uninterpretable occurrences, depending in value on it, or on other categories. This is meant to cover the widespread phenomenon of concord, e.g., in phi-features; attributive adjectives agree in gender and number with determiners and head nouns in, say, Italian, though not in English, or nouns agree in number with determiners in English, though not in Basque. Though ultimately morphological, these differences may trigger salient syntactic consequences: e.g., determinerless argument nominals are possible in English and Italian, where number is a shared feature between at least some determiners and nouns, though not in Basque where it is only represented on determiners (also cf. the behavior of Maori, on this point, Pearce 1997; and especially see Delfitto and Schroten 1993, who first formulated this important generalization observing the history of French); and determinerless argument substantivized adjectives are possible in, say, Italian but impossible in English, where they don't share number with any category.

(9e) is taken to define whether some bundle of universal meaning features is always null in the lexicon of a certain language: for example *wh*-operators in comparative clauses seem to be null in English, overt in Italian (*John was smarter than I expected he could be/John è stato più intelligente di quanto mi aspettassi che potesse essere*; *John arrived before I expected he would show up/Gianni è arrivato prima di quando mi aspettassi che sarebbe comparso*). Similarly, English seems to have a null version of complementizer that (in both declaratives and relatives) which is unknown in French or German. Work by Kayne (2005) has made several inspiring proposals in this sense.

It is still to be understood whether the schema can be unified with classical variation cases where an X drops its phonological matrix Φ in a subset of environments (e.g., null arguments, V-projection deletion etc., among very many examples: cf. Taraldsen 1978 and especially Rizzi 1986, Sigurdsson 2011, and Lightfoot 2006; or deletion of relative *wh*-operators under recoverability conditions in English/Romance, though not in German: Chomsky and Lasnik 1977). Such phenomena, e.g., null arguments, are obviously parametrized, but it remains to be seen if the variation of these environmental conditions is a parametric choice, or is always predictable for each language from other possible sources: first of all, schema (9a) (i.e., non-grammaticalization of certain features, as is plausible for several properties of East-Asian languages, in the spirit of Kuroda 1988, or in the case of article systems in DPs, in light of Crisma's 2011 proposals); but also independent morphological properties, related to schema (9c), or even to phonological/prosodic conditions, as hinted at, e.g., in Longobardi (1996) for null pronominal genitives of construct-state constructions.

(9f) is inspired by work by Biberauer and Richards (2007) in addition to many traditional observations, going back to Ross (1967). If pied-piping is allowed in a specific construction, then ideally other conditions (on movement and bounding) should establish whether it occurs optionally or obligatorily (probably with a general marked status of optional pied-piping). For example, adnominal possessives cannot be relativized with pied-piping in French (*la femme, dont je connais la fille* vs. **la femme dont la fille je connais*), but can and actually must in English (**the woman whose I know the daughter* vs. *the woman whose daughter I know*).

As for (9g) and its specification (9h), Gianollo, Guardiano and Longobardi (2008: 120) suggested that a further "… candidate for schema status is represented by parametrization about the encoding of some universally definable functional features—say, [+pronominal], [+anaphoric], [+variable], [+definite], [+deictic] and so on—in different categories. This latter schema was in fact used by Sportiche (1986), to account for the peculiarities of Japanese *zibun* and *kare* as opposed to English anaphors and pronouns." Sportiche (1986) suggested that different languages may distribute certain valued features on different bundles of other valued features (basically, the feature +Bound Variable seems associated also with –Anaphoric, +Pronominal in English, but only with +Anaphoric, –Pronominal in Japanese).

Longobardi (2014) made use of both (9g) and (9h) schemata to explain some differences in negative words systems, first distinguishing English negative quantifiers from the Romance ones (the *nobody*/*anybody* doublet vs. *nadie*, *personne*, *nessuno*, somehow corresponding to both); then, through the second schema, the distinction was made between the Spanish and the (high-register) Italian negative words (*nadie* vs. *nessuno* in preverbal position) (cf. Rizzi 1982, Longobardi 1991 and Español-Echevarría 1994).

(9i) asks which features from our encyclopedia, apart from the grammaticalized ones (which will be obligatory in defined contexts) can be expressed by a functional, closed-class (bound or free) morpheme in a given language, whether or not it has other consequences, e.g., probing. For instance what kind of Case morphemes or Auxiliaries a language may make available can be reduced to a set of binary questions about a list of plausible features (also cf. Biberauer 2016).

8. The restrictive potential of a schemata theory

Let us then suppose, very speculatively, that these are the only possible "core" parameter schemata; from this approach it already follows that certain conceivable types of variation are excluded. There follows, e.g., a conclusion with far-reaching consequences, such as (11):

(11) The locus of interpretation of each grammatical feature is universal, not parametrized

most other conceivable variations are disallowed: e.g., if grammaticalized at all, a feature is *first-merged* into a universally defined position and moved, if necessary, under universal conditions on checking (i.e., on Agree). Also, Gianollo, Guardiano and Longobardi (2008, 120) note that under the schemata above even the locus of *interpretation* of each grammatical feature must be universal, not parametrized, a welcome conclusion which can be called the *Topological Mapping Theorem* (Longobardi 2005b, Hinzen and Sheehan 2011, 2012, Martín and Hinzen 2014). In other words, such a schemata model may easily incorporate/derive a theory of the universality of both D-structure (Kayne 1994) and Logical Form, to use traditional terms, or of well-corroborated cartographies of functional heads.

9. A set of parameters and their schemata

The 9 schemata above certainly fall short of covering the whole amount of syntactic diversity among the world's languages, but they could well represent most of the core of parametric variability.

Let us consider as a first empirical approximation that 89 out of the 91 parameters of Table A in Fig. 1 above suggest themselves as plausible or at least tentative candidates for one or the other of the schemata above, and have been assigned to their hypothetical schema, indicated with the abbreviation of the parameter types (10), in the column immediately to the left of the parameter names and their implications in the subTable A of Fig. 3 below:

Fig. 3

Fig. 3. (For a more legible version of this chart, please copy and paste the following URL in your browser <https://raw.githubusercontent.com/AndreaCeolin/The_probability_of_language_relatedness/master/Fig3.%20Parameter%20Schemata.jpg>). A couple of others

are still very unclear in their schema status and require much more work. Of course, two important points must be stressed for future research: first, it is not always obvious into which schema a particular parameter may fall (some cases of ambiguity are determined by incomplete knowledge of UG Principles interacting with Schemata; particularly it may not be straightforward to decide when some variation falls under a Probing or a Strength parameter, or sometimes a Grammaticalization one); second, the very limit between parametric variation and lexical variation is not fully defined, and presents some grey zone, especially with respect to Availability parameters (also cf. Biberauer and Roberts' 2012 notion of nano-parameter).

10. Schemata, parameters, and the speaker's mind: a constructivist UG

This way, parameter schemata of the sort sketched in (9) derive actual parameters, which can be literally constructed out of functional features, lexical categories, and indeed schemata, and set under usual assumptions.

The inventory of features that can be grammaticalized is probably very wide, and perhaps open at the margins (this may be one aspect of an emergentist notion of UG: Biberauer 2016): some features are part of the core and often grammaticalized, others are only rarely; some are found in many languages, others are infrequent or very areal, exactly as is the case for members of phonological inventories. Classical phi-features (person, number and some variant of gender) are widespread like some common vowels, for instance. In some native American languages the perceived position and direction of the reference of an argument nominal must be spelled out, rather in the way the categories expressed by articles in many European languages, in order to prevent the noun from having a general interpretation, akin to that of bare plural and mass nouns in Western Europe (Carlson 1977). The rarity and areal confinement of this type of NP-saturating features recalls the similar situation with such phonological properties as clicks, instead.

The distinction into schemata and domains of categories/features to which they apply seems to realize the perspicuous distinction proposed in Rizzi (2017b) between format (schemata) and locus (domain of application) of parameters.

If this approach is correct in its essentials, it becomes unnecessary to suppose that the initial state of the mind consists of highly specific parameters, but just of an incomparably more restricted amount of parameter schemata, which combine with the appropriate functional elements of the lexicon (features and categories) of a language under the relevant triggers in the primary data to both yield all and only the necessary parameters for that language (i.e. raise the relevant binary questions) and set their values:

(8) Principles&Schemata model: UG = principles and parameter schemata. Parameter schemata at S_0, closed parameters at S_S

It is then conceivable that parameters which are set to 0 (according to the formalism of TableA above) in a particular I-language have actually not been present in the initial state of the mind attaining that I-language, so that this approach frees our model of that mind from a salient amount of redundancy.

The enormous number of possible core parameters depends, in principle, on the more limited numbers of functional features F and of lexical categories X, Y, combined with the tiny class of parameter schemata. Notice, however that it is not necessary for all parameter schemata to be realized for every possible functional feature and all potentially relevant categories: specific principles of UG might forbid variation of an a priori admitted format for particular combinations of features and categories. The descriptive claim, for example, that the so called EPP feature in clauses is 'universally strong' amounts to preventing a widespread schema of variation among languages from determining differences as to whether the Spec of T is overtly filled or not.

11. Speculations on variation and evolution

Accepting the Principles&Schemata model immediately determines the possibility of huge arithmetic simplification in the primitive axioms of the theory of grammatical variation: exactly like parameters were adopted (also) as cross-constructional generalizations, significantly reducing the amount of apparently atomic points of variation, parameter schemata, in the intended sense, are more abstract, cross-parametric entities, allowing further simplification of the set of primitives. This begins to provide a sensible answer to problems (3d) and ultimately (5), because the amount of variation itself to be explained is drastically reduced: it will be sufficient to justify the existence of a certain parameter schema through justification (e.g., reduction to "virtual conceptual necessity," in Chomsky's 1995 sense) of a single parameter of that schema, in order to explain the possibility (ultimately, the evolutionary rise) of the whole family of parameters of the same format.

But such an approach already relieves the burden of the explanation for the very existence of language diversity (issue (2b)) as well: for, within the proposed model, variation could largely be explained as in the first, pre-P&P, generative model. As we have just noted, once the introduction of a parameter schema into the language faculty is justified (e.g., evolutionarily explained, perhaps reducing it to conditions of efficiency on language transmission and use) for one case, that schema will be admitted and cause proliferating potential variation for all possible combinations of relevant entities of the lexicon (features and categories). This, unless a further particular principle of UG prohibits certain types of variation: in other words, once a schema has entered UG, then reducing variation essentially requires adding to the size of LAD, exactly as in the Aspects model. The kind of explanation in terms of 'economy of UG size' implicit in that model can therefore be reproposed in the Principles&Schemata approach.

Of course, in order for a full minimalist program to be pursued within this approach it is necessary to show each of the parameter schemata to be indispensable, i.e. reducible to virtual conceptual necessity, or at least to be significantly related to architectural/ computational properties present in other biological systems.

This whole, crucial, part of the program cannot be seriously addressed now, especially within the limits of the present work. Only some exemplification of the required direction of research can be provided.

For example, (9a) could be motivated again by 'economy' constraints (cf. § 1 above) on cognitive load or performance (no language could grammaticalize the full set of conceivable functional features), to be spelled out by specific research; (9d) could perhaps be ultimately related to an acquisition strategy of formal preservation of morphological content under the pervasive diachronic phenomenon of category shift or reanalysis (say, of a lexical item from a class where the occurrence of certain features is interpretable to another one where it is not), then resulting in easing perception and parsing of strings.

12. Implications: schemata and hierarchies

Pervasive parametric implications of the type formalized in any simple version of TableA above appear as one of the most salient universal aspect of grammar. It is possible in this sense that implicational rather than absolute universals (in Greenberg's 1963 terms) constitute the majority of the content of principles of UG in a Principles&Parameters model. It is interesting to see, then, if, in a Principles&Schemata model, it is possible to proceed to some minimalist reduction of such Principles governing implications.

Some implications appear specific to the relation between features and categories and must probably be stipulated as substantive Principles on their own: for instance, the implicational hierarchy encoded in Table A above between p5 and p11, p12, i.e., the grammaticalization of the phi-features Number and Gender, is tentatively motivated by empirical typology, going back to Greenberg (1963).

But other implications appear to carry a "general," virtually analytical component, and much of this can probably be stated at the level of schemata, not of single parameter clusters. The implication of (9g) by (9h) is indeed analytical, but if it is a peculiarity of functional features that they can probe and be strong/weak in the relevant sense, then parameters of Probing, Strength and possibly Spread (schemata (9b), (9c) and (9g) about a certain feature F will also imply the positive setting of a corresponding Grammaticalization parameter of schema (9a) for that feature .

This way, some of the implicational universals which are likely to represent a good amount of what is termed the Principles of UG do not need to be stipulated, as they are reducible to general, often logical, conditions on the relations among schemata. Thus, that p17 +strong Person implies + at p1 +grammaticalized Person (through transitivity in the defined implications of Table A) should follow from the two parameters being of schemata (9c) and (9a), respectively.

Similarly, definiteness being one crucial feature value f to satisfy the requirements of + at p14 +grammaticalized Amount (Crisma 2011), it is natural for +p14 to be a condition to set many parameters of other schemata involving definiteness, e.g., p64, p80, p89 of Table A, governing the spread of definiteness from the head noun to relative clauses, the use of definiteness to value the relevant feature of D through a demonstrative or a possessive. In addition, p16 +strong Amount, as the corresponding Strength parameter, depends on +p14 (cf. below). These implications which can be reduced to general relations of between pairs of parameter schemata rather than to idiosyncratic relations between individual parameters may greatly further simplify the load imposed to the initial state of the mind: they should, typically, represent themselves frequently in the formulations of parameter hierachies of the type advocated e.g., in Biberauer and Roberts (2012 and following work) and constitute the ideal interface between a theory of hierarchies and a theory of schemata.

13. Schemata as heuristics for parameters

In Gianollo, Guardiano, Longobardi (2008) the notion of completeness (and of completeness table) was introduced for parameter values: a set of parameters is complete if and only if all admissible (given implications and other possible universal constraints) combinations of values for that set is instantiated by at least one known language. This concept may act as a sort of Mendeleev periodical table of value combinations and as a heuristic for language types (or for reasons why certain types are unattested).

The present proposal about schemata raises the interesting possibility of a completeness table for parameters rather than parameter values, acting as a heuristic for parametric variation over schemata. We should not expect completeness even here, owing to potential absolute universal constraints, possibly descending from Third Factor considerations (Chomsky 2005), and to particular, empirical implicational universals. However, some reflections may be suggestive.

We noticed that a doublet of Grammaticalization/Strength parameters (p1, p17) has been postulated for the feature Person (Longobardi 2008), connected in Table A by an implication (though embedded in a transitivity implicational chain). Independently, it turned out finally that the parameters p14 and p16 about articles can also be understandable as instantiating the same type of doublet asking about the Grammaticalization (hence the obligatory valuing) and then the possible Strength of a feature (Known) Amount (Crisma 2011 and forthcoming), The pair p1, p17, is instantiated on the surface of E-languages by differences in complex sets of manifestations, defined in the Appendix.

An intriguing question now is if at least other analogous features for which we identified grammaticalization parameters, exhibit a corresponding strength parameter. We may speculate on how to address the issue with respect to other features represented and perhaps interpreted in D such as Number, whose grammaticalization and distribution is governed at least by p5, p8 and p10. Can there exist a +strong Number parameter and can it be found already within Table A?

A hint which may connect Number to a crosslinguistic movement alternation (a Strength parameter) may come from the fact that spread of phi-features from D to N (crucially including concord in Number: Person is probably universally not marked on nouns, Gender is a feature intrinsic to nouns) is absent in some languages in which the NP complement of D raises to the Spec of the latter, giving rise to a systematic D-final DP; indeed, in Table A the two languages raising NP to SpecD (Basque and Wolof) are also languages with no Number concord between N and D. This correlation is apparently not true in all other languages, but it is anyway suggestive to try regard p65, governing overt raising of the complement of D to its Spec, as underlyingly having to do with Number, and actually being the secondary effect of a Number feature on D that is so "strong" as to overtly attract NP to D, rather than establishing the relation through concord and without movement. Hence, p65 could perhaps instantiate a +strong Number parameter.

Also thanks to the heuristic power of a schemata theory, it is possible to begin to tentatively extract from Table A some revealing parametric hierarchies, reported here as simplified idealizations in the binary ramification format used by Biberauer and Roberts (2012), connecting various parameters ultimately to the fundamental ones about Grammaticalization of Person, proposed in Longobardi (2008) and of Number:

(12) **Grammaticalized Person**

- –: Japanese, Korean, Chinese
- +: IE, Semitic, Basque, Uralic, Altaic, Wolof (Niger-Congo), Chickasaw (Muskogean)[12]…

Strong Person

- –: Germanic, Celtic?, Wolof?
- +: Romance, Greek, Bulgarian, Arabic, Basque

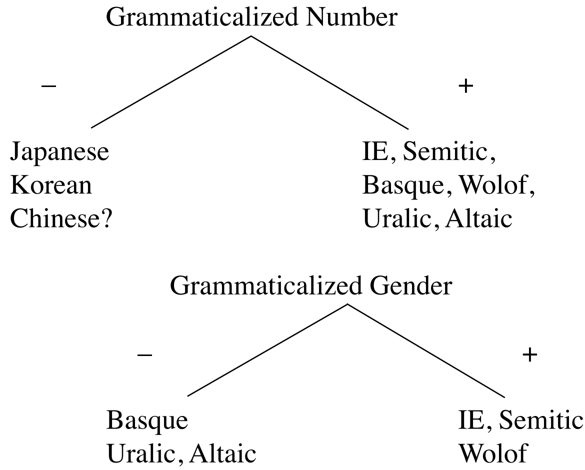
(13) **Grammaticalized Number**

- –: Chickasaw?
- +: IE, Semitic, Basque, Wolof, Uralic, Altaic

Strong Number

- –: IE, Semitic
- +: Basque, Wolof

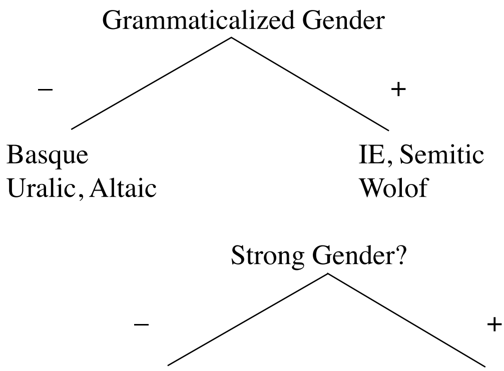
(14)



In the spirit of MGP and of TableA, these parameters all have salient manifestations in the nominal system, especially affecting the system of determination, as reported in the manifestation table of the Appendix. However, since they affect such basic entities as the main phi-features, their role in grammar can be expected to be pervasive: indeed, they probably extend to affect some properties of clausal structures, like pronominal variable binding; bound variable interpretation, notoriously impossible for expressions like Japanese *kare* (Sportiche 1986 and references cited), could be governed by +grammaticalized Person, as the latter feature might be responsible for the existence and distribution of personal pronouns with the semantic and distributional characteristics familiar from IE languages: raising to D even in languages in which proper names do not (English: Postal 1969, Longobardi 2008; or Slavic: Progovac 1998, Rutkowski 2002), and indeed acting as bound variables rather than R-expressions. Furthermore, it has been proposed (Longobardi 2008) that even +strong Person, in addition to governing the raising of proper names to D and the interpretation of bare common nouns, might affect the realization of clausal null subjects in different languages. Thus, it would interestingly interact with a possible clausal parameter of schema (9f) Equally null subject languages like Italian and German might differ in that German null subjects are only impersonal, while the Italian ones are notoriously understood as fully personal empty pronouns: this may follow from German being a regular Germanic language in setting its value to –strong Person, as opposed to Romance. Notice that instead a Romance language like French, even if it is plausibly +strong Person, cannot by this have null subjects if the latter are not independently licensed by a specific parameter of the appropriate schema.

The next natural heuristic question looking at the hierarchies above is if also a corresponding +strong Gender parameter can be identified, in TableA or beyond:

(15)



Although some suggestive candidates for this parameter could perhaps be considered already within Table A, e.g., inspecting certain crosslinguistic correlations between grammaticalization of Gender and partial Noun-raising (Bernstein 1991, 1992, 1993, Crisma 1991, 1993, Valois 1991, Cinque 1994 and subsequent work) over other constituents, a full examination of this issue cannot yet be conclusive and certainly exceeds the limits of the present discussion.

Of course many of these speculations require more typological inquiry, but if they withstand further investigation, they can provide evidence of how a system of schemata may generate hints and driving questions for establishing the nature of parameters and for a partial deduction of their pervasive interdependence.

14. Parameters after S_0 and an underspecified UG

A well-implemented theory of schemata could then begin to provide some answer to problem i) and perhaps to aspects of problem iii) of § 6, removing parameters from the initial state of the mind S_0 altogether. A further refined model of parameter setting should now be conceived to provide an answer to the problem in ii).

Among other things, the introduction of schemata suggests a principled definition of each parametric question, hence the + and – values can be regarded as having some ontological value, not as freely interchangeable and oppositional. Owing to this restrictive property of UG, it is no longer possible to freely twist a parameter formulation, assigning a + or – value arbitrarily, or according, say, to criteria of typological frequency: +grammaticalized F necessarily means that the relevant feature must appear in the relevant context. This restriction is general and sometimes may lead to non-trivial decisions about what should be coded by a – and what by a + in binary syntactic variation.

Thus, the introduction of schemata allows, among other things, a principled definition of what is a + and what is a – in any parameter. An empirical expectation that seems to be suggested by this model is that, indeed, the + value of a parameter will be represented by visible evidence in the extensional language generated, while in several cases the – value will be manifested by lack of evidence (default value or default state of UG).

In Fig. 4 in the Appendix, a table of manifestations for the parameters mostly discussed in the text is presented; it is easy to see that the expectation above is met for these parameters, and so it is more widely. We can thus suppose that no + value will be settable just as default.

Under this approach, the stimulus-based acquisition task reduces in principle to setting + values when the learner is met with positive evidence for them. Therefore, not only will the learner not need to worry about parameters which are neutralized in his/her language as the result of not being deduced from the schemata present at S_0; in principle s/he will never be concerned at any stage with any parameter to be set to – ; they are all just the default state of UG, in principle unchanged from S_0 through S_S.

After setting + upon exposure to positive evidence, the only other task to be accomplished to attain the correct grammar at the steady state S_S (i.e., for the linguist to attain descriptive adequacy) is deducing the E-language manifestations of other parameters neutralized by the distribution of + values acquired for the target language. Now consider that 0s in a parametric format like Table A of Fig. 1 normally correspond to two types of manifestations. One type is identical to those that would appear if the parameter were actually used and set to +: let us call this type of implied information 0+, for convenience.

In other cases the implied information has the surface manifestation of the potential – value (call it 0-). If – always corresponds to the default state of UG, then in order to achieve a complete grammatical specification of a language, it is only necessary to deduce the 0+ values from the implications. Everything else will be a – or a 0-, a distinction irrelevant for descriptive adequacy.

In this sense, parameters would only be activating operations in the path from S_0 to S_S, setting positive values from positive evidence, so providing a radical simplification of the acquisition path. To execute this model in better detail some technical problems need to be addressed.

Thus, consider the first step of parameter setting as the setting of positive values (+) on the basis of positive evidence only. Then, in order to achieve descriptive adequacy (i.e., in our case, attain the right string of parameter states defining the whole language), it would be necessary to deduce all (and only) the 0 values that have some reflex on the language structure, i.e., a manifestation different from the default state of UG for the relevant parameter. In our terminology above, these should be the 0+ states. In order to do so straightforwardly, it is necessary to be able to deduce such 0+ states from positive evidence only. Therefore, ideally, we expect all 0+ states to be ultimately predictable from + or 0+ states of other parameters, the ones we are sure are represented by unequivocal positive evidence in the data . Is this a realistic assumption or objective?

A parameter which can be set only if another parameter is set to – is one whose value will be 0 (i.e., potentially a 0+) if the other parameter is instead + (or 0+). This case will never be problematic: a 0+ will be inserted from the positive specification of another parameter. To stay on the safe side in terms of learnability, what should be eliminated from the Table is dependencies inserting a 0+ from a – or a 0-. This case is probably rare: using the first 26 parameters of the Table A in Fig. 1 (about functional features and determiner systems) as a toy Table for idealized experiments, it seems that no 0+ is assigned as the result of a negative value to another parameter.

Therefore, no conceptual reformulations of parameters seems likely to be necessary to obtain a system in which deducing 0+ states simply from positive evidence of the corpora (that encoded as straight + or 0+) is perfectly feasible.

At this point it is possible in theory to close the acquisition task without adding any other specification: UG will not have to reset any of its default aspects, to become a S_S of a natural language. As remarked above, a descriptively adequate grammar could just be a string of + states (some set from the data, others actually 0+, deduced from other + states); setting – in this model is completely unnecessary and meaningless from the viewpoint of descriptive and explanatory adequacy. So, there should be no space for a distinction between – and 0-. Yet, if there are implications which determine 0-states, they are definitely relevant from the viewpoint of typological adequacy; even if we could exactly describe and explain the ontogenetic development of every possible I-language (full descriptive and explanatory adequacy), we would like to capture all the limits which define the class of such languages. A 0- state means that a certain cluster of properties e.g., cannot occur in any natural language. Thus, in principle, there may arise some apparent tension between explanatory adequacy (which requires the shortest path toward acquisition) and typological adequacy, as well. It would be difficult to accept the existence of universal constraints on possible languages which have no justification in the structure of mind at any stage (for a similar argument about constraints on diachrony see Longobardi 1978). Therefore residual 0- values must be dealt with in some way. The easiest one is reversing the parametric implications; rather than having +semantic Gender (p11) depend on +gramm. Number (p5) (-p5 determining 0- at p11) in order to encode Greenberg's typological generalization, we should say that it is +p11 that determines 0+ at p5.

In other cases a typologically motivated 0– may be determined by general or logical implication among schemata (e.g., if a category is neither Available nor Grammaticalized, then any further hierarchy of parametric questions about it will be meaningless, also see Roberts 2012) or finally by functional considerations on overloaded grammatical space (a likely Third Factor limitation in Chomsky's 2005 sense more than a strictly grammatical one).

Let me exemplify a case of both types in Table A. The specification (~+FSN) affecting the implications of p17, p19 and p21 (and indirectly p22) basically amounts to stating that those parameters, which are about articles, are only to be set in languages with visible articles, otherwise the language will not ask any other questions about articles, such as the ones encoded in p17, p19, p21, and p22. Hence, this is a logical property of the system, not one to be stated as a specific instruction for the acquisition process. Instead, the dependency from –CGB (p13) in the implications corresponding to parameters p16 and p20 amounts to stating that languages with unbounded (number-neutral) readings for singular count nouns (e.g., Hungarian, Farkas and De Swart 2003, or Hindi, Dayal 1992, 2011) will not have indefinite articles with the properties and distribution of modern Romance and Germanic languages (i.e., distinguishing count vs. mass interpretation for singular indefinites, Borer 2004, Crisma forthcoming) or a use of partitive Case akin to that found in Finnish. In either case, this seems to be related to some natural upper bound to the overload of specifications on non-definite nominal expressions: if you need to overtly mark singularity (as opposed to number neutrality), you do not use a similar (let alone the same) device to mark just countability or partitivity (non-maximality).

15. Conclusion: a twenty(-one!) question model again?

In any event, it appears that there are no conceptual obstacles against a model in which syntax acquisition consists only of setting + values in response to positive corpus evidence and deducing 0+ states from them (with few cases in which perhaps general principles may *a priori* prevent the choice of +, i.e., so called 0- states).

This way, the actual definition of an individual language on the basis of external evidence may reduce to a much smaller set of questions than those apparently defined by complex systems like Table A of Ceolin et al. (submitted) and of Fig. 1: the 50 languages included there contain 1092 values relevantly set to +, i.e., an average of just 21,84 questions per language is necessary to establish most core properties of their nominal syntax.

In a sound Principles&Schemata theory, the goal of a “Twenty question model” discussed by Fodor (2001) is, after all, not completely beside the point.

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Appendix

Fig. 4

P1. ±Grammaticalized Person (FGP)		
	+	- (D)
a. An expression used to refer to an entity in the world can also be bound (either a bound variable or a Principle B pronoun).	YES	
b. Person features appear in non-interpreted positions, e.g. at least some verb forms agree with an argument for person.	YES	
c. There is at least one context that does not allow pronouns and common nouns to occupy the same position, esp. pronouns may appear in a position where common nouns are excluded:		
c1. Card-N and *N-Card and Pro-Card	YES	
c2. Adj-N and *N-Adj and Pro-Adj	YES	
c3. N-Card and *Card-N and Card-Pro	YES	
c4. N-Adj and *Adj-N and Adj-Pro	YES	
d. Argument/non-argument asymmetries in the licensing of pronouns	YES	
P5. ±Grammaticalized Number (FGN)		
	+	-
a. At least in some contexts, either (i) in order to get a plural reading, a nominal argument requires special marking or agreement, or (ii) a singular marking (or no marking, contrasting to plural marking) or agreement necessarily entails singular interpretation of a nominal argument.	YES	NO
b. Features related to singularity/plurality are spread to non-interpreted positions outside the nominal (e.g. number agreement on verb forms).	YES	
c. Features related to singularity/plurality are spread to non-interpreted positions within the nominal (e.g. to adjectives).	YES	
P65. ±Strong Number in D (NOD)		
	+	- (D)
a. The word for 'a(n)' or for numeral 'one' is the last element of a nominal while higher numerals are not.	YES	
b. The definite article is the last element of a nominal after adjectives or complements.	YES	
P8. ±Grammaticalized Gender (FGG)		
	+	- (D)
a. There is agreement in Gender between nouns and adjectives.	YES	
b. There is agreement in Gender between nouns and verbs.	YES	
c. There is agreement in Gender between nouns and determiners.	YES	
P14. ±Grammaticalized Amount (DGR)		
	+	- (D)
a. There is an obligatory dedicated marker on nominals denoting maximal entities whose presence is inferred from the previous context (e.g., *I met a couple; the woman was wearing (red)*).	YES	NO
b. There is an obligatory dedicated marker on common nouns denoting maximal specific entities considered unique by speaker and hearer (e.g., *God created the sun.*).	YES	NO
c. There is an obligatory dedicated marker on sg. count common nouns denoting the whole kind named by that noun (e.g. *The dodo is extinct.*).	YES	
d. There is an obligatory dedicated marker on mass/plural common nouns denoting the whole kind named by that noun (e.g., *I dinosauri sono estinti; La miglior cosa è l'acqua.*).	YES	
P16. ±Strong Amount (CGR)		
	+	- (D)
a. There is an obligatory marker for singular count indefinite argument nominals at least for preverbal subjects.	YES	NO
b. There are non-numerical generic uses of an indefinite singular count marker.	YES	
c. There are non-numerical existential uses of an indefinite singular count marker.	YES	NO
d. A non-initial genitive values a nominal argument for definiteness.		YES
e. A definite enclitic on a non-initial element values a nominal argument for definiteness.		YES
f. An internal (non-initial and non-final) demonstrative values a nominal argument for definiteness.		YES
g. A morpheme homophonous with the numeral for 'one' cannot have a generic interpretation.		YES
P17. ±Strong Person (NSD)		
	+	-
a. Argument proper names can occur in the nominal phrase after an adjective and no determiner (and there is an obligatory marker for singular count indefinite argument nominals in the language).		YES
b. Argument proper names occur initially in the nominal phrase before some element X (e.g. an adjective or a possessive) that common nouns must necessarily follow.	YES	
c. Argument proper names must be introduced by some phrase-initial/final element that at least some common nouns do not require.	YES	
d. Argument proper names must occur initially in the nominal phrase before some element X that some non-argument proper names can follow?	YES	
e. There is an element X such that in initial position in all argument nominals the paradigm [Proper Name X] & [Det X Proper Name] & [*Det Proper Name X] holds.	YES	
f. There is an element X such that in final position in argument nominals the paradigm [X Proper Name] & [Proper name X Det] & [*X Proper Name Det] holds.	YES	
g. There is an element X such that in initial position in argument nominals the paradigm [Proper Name X] & [X Common Noun] & [*X Proper Name] holds.	YES	
h. There is an element X such that in final position in argument nominals the paradigm [X Proper Name] & [Common Noun X] & [*Proper Name X] holds.	YES	
i. Argument proper names must be used with some morpheme that at least some common nouns do not require.	YES	
j. There is an element X such that in initial position in all argument nominals the paradigm [Proper Name X] & [*X Proper Name] holds while in some non-argument nominals [X Proper Name] is possible.	YES	
k. Argument proper names must occur finally in the nominal phrase after some element X that some non-argument proper names can precede.	YES	
l. Argument proper names must be introduced by some phrase-initial/final element that at least some non-argument proper names do not require.	YES	
m. Bare plural/mass can occur as kind referring (e.g., *'Dinosaurs are extinct', 'Water is the best thing.'*)?	NO	YES
n. There are argument bare nominals always valued for definiteness by a prenominal Genitive.		YES
o. There are definite suffixes enclitic on attributive adjectives.	YES	
p. There are definite suffixes enclitic on non-initial constituents of bare argument nominals (*stora boken*).		YES
q. Possessives occur without a determiner in argument phrases without a nominal head (*mine is better*).		YES
r. There are different inflections of attributive adjectives controlled by the choice of the determiner (*ein gutes Buch/das gute Buch*).		YES

Legend. Fig. 4. (For a more legible version of this chart, please copy and paste the following URL in your browser <https://raw.githubusercontent.com/AndreaCeolin/The_probability_of_language_relatedness/master/Fig4.%20Manifestation%20Table.jpg>). Any testable parametric theory should be able to explicitly state, in a vocabulary compatible with assumptions of epistemological priority about observable data, which combination of utterances (manifestation) has been sufficient to set one value of every parameter for the languages analyzed, and to at least assign a Default state to the opposite value. In this sense a manifestation may be a complex set of utterances which should all be present at som point in a primary corpus to constitute evidence for one setting. In Fig. 4, for each parameter, manifestations used to set the value + or the value – in some of the languages of Fig. 1 are reported in the first column; in the second column, concerning the setting of the value +, a YES or a NO means that + is set in the presence or absence, respectively, of the manifestion of the corresponding row. The same is true for the value – in the the third row. It is obvious already from this small sample how some positive evidence (the presence of a YES in the second row) is always present for the value + (NO is irrelevant in this sense, because it represents direct negative evidence, presumably only available to linguists, not relevantly present in children's primary corpora). The value – can instead in some cases only set in the presence of NO, so that in several instances it will be marked as the default case (indicated by a D in parenthesis).