J.M.M. Brown, Andreas Schmidt,
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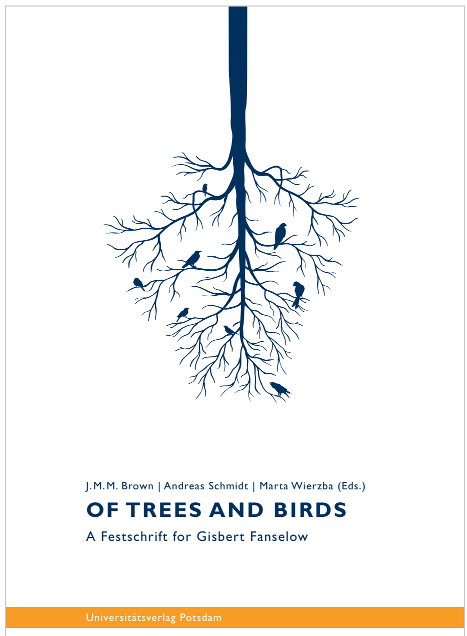

An anthropic principle in lieu of a "Universal Grammar"

Hubert Haider, Universität Salzburg

Among the many unanswered questions in grammar theory, the following figure prominently. *First*, what is it that enables children to successfully cope with the structural complexities of their mother tongue while professional grammarians tend to fail when modelling them? An innateness conjecture would merely beg the question. There is no compelling evidence for specific properties of linguistic expressions to be innate, that is, genetically coded somehow.

Second, what determines the narrow system corridor for human grammars? On the one hand, no two human languages share an identical rule system, but on the other hand, grammars demonstrably do *not* differ from each other "without limit and in unpredictable ways".

Third, are the grammars of human languages the offspring of a single proto-grammar instantiating a "Universal Grammar" (monogenic) or are the shared traits of human grammars the result of *convergent changes* in the grammars of human languages of diverse ancestry (polygenic)?

An analogue of the cosmological Anthropic Principle in combination with the Darwinian theory of evolution applied to replicative cognitive programmes helps clarifying these issues. There is no urge for assuming a "Universal Grammar", but nevertheless, languages will end up sharing fundamental grammatical properties as a result of the predictable *convergent* cognitive evolution of their grammars.

1 Anthropic grammar theory

The Anthropic Principle[1] in cosmology states that by our very existence as carbon-based creatures, we impose a sort of selection effect on a habitable universe. If, for example, just one of the numerous fundamental constants of nature were slightly changed – e.g. the strength of gravity – our life form would not be possible and no human brain could wonder why natural constants have precisely the values they have. The cosmological universe could be entirely different and human beings would not be part of it.

The Anthropic Principle turns the original question – *How come that the fundamental constants in the Universe have precisely the size they have, although their sizes could be different?* – upside down: Since we could not exist in a universe with different fundamental constants, we must not be surprised by the fact that the universe presents us exactly the constants that are necessary for the existence of biological life forms we are familiar with.

The analogue[2] epistemological issue in grammar theory is the question why grammars of natural languages occupy only a small region within the system space of discrete symbol manipulating systems, namely a sub-region of "mildly context-sensitive" languages (see Joshi 1985, Shieber 1985). The universe of grammars for an intelligent species could be entirely different, except that human language grammars arguably would not be part of it because our human processing resources would be either unable to put them to use efficiently or would persistently invite changes towards exploiting the available system potential more effectively. The grammar systems may make the most of the neural processing capacities of brains, but they cannot go beyond them.

Grammars and production systems below or above the threshold of

1. "Anthropic Principle (weak): The observed values of physical and cosmological quantities are not equally probable but they take on the values restricted by the requirement that there exist sites where carbon-based life can evolve and by the requirement that the Universe be old enough for it to have already done so." (Barrow & Tipler 1986: 16)

2. I am very grateful to *Harald Uhlig* (Department of Economics, University of Chicago), who made me aware of the instructive parallel between the *Anthropic Principle* and what I had tried to outline him as an evolutionary alternative to an innateness-based UG (= universal grammar) conjecture (Bonn, June 26, 2018).

"context-sensitive" are known from many other fields, ranging from formal language theory to symbolic logic and complexity theory, but not from languages 'out of the wild'. Intriguingly, many if not all natural languages employ the computational power of context-sensitive languages[3] although, for human communicative purposes, computationally much less powerful systems would suffice. If, for instance, our brain capacities would restrict grammars they are able to process to the format of "regular languages" (Partee et al. 1990: ch. 17), such language would nevertheless serve the communicative and cognitive functions of a human language and cover a potentially infinite set of utterances. We would not be aware of the possible existence of more complex grammars and of their potential but inaccessible advantages.

Human language grammars are but tiny islands in a sea of context-sensitive grammars which in turn is part of an unbounded ocean. Why do other types of grammars not exist in the realm of *human* languages? The cognitive analogue of the Anthropic Principle suggests a specific answering strategy, namely the 'anthropic' one. Natural languages have the properties they have because they reflect the properties which our language-learning and language-using human brain capacities can cope with. Systems beyond this capacity are thereby excluded. A grammar that is not effectively learnable will never become a grammar in use. On the other hand, grammars may develop into luxurious systems when adapting to the system potential of human brains. For instance, morpho-syntactically much more impoverished systems would suffice for the communicative (and also for the cognitive) functions of language, as Chinese and languages similar to Chinese exemplify.

The human language processing resources are recruited brain resources, whose history of evolution is non-verbal. Language processing is parasitic on available brain resources. Therefore, with respect to language processing, the properties of human grammars are contingent on a non-linguistic history of brain evolution. From the standpoint of grammar theory, the properties of human grammars are reflections of an acci-

3. The type of automaton required for its computation is at least a "linear bounded automaton" (LBA), that is, a subset of Turing Machines with specific storage limitations for the input (see Partee et al. 1990: ch. 20).

dental ensemble of processing resources. This, viz. the accidental quality of grammar constants, is parallel to the apparently accidental quality of nature constants.

The original non-anthropic and in fact stipulative answer to the first question by Chomsky (1975) – humans happen to be equipped with an innate "universal grammar" – has been highly improbable from the beginning. The inappropriateness of innateness claims has been re-emphasized in detail from the perspective of language acquisition research (Braine 1994), from a philosophy of science perspective (Lin 2016), as well as from neighbouring fields (Dąbrowska 2015). In the absence of compelling evidence for parallels between the human language capacity and innate information processing capacities of other species in terms of their hereditary and genetic properties, the UG conjecture is merely begging the question.[4]

Findings from studies of the honey bee dance language show that even 'dialects' (in linguistic terminology: cross-linguistic differences in grammar) are *genetically* differentiated (Johnson et al. 2011). So, it would be far from outrageous to insist on a genetic basis of differences between, let us say, indigenous users of PIE languages in comparison to indigenous users of topic-prominent East Asian languages, with a highly impoverished morphological system. No grammarian has ever published such results in the *Journal of Heredity*, and pertinent findings in human genetics are discouraging, as one would have suspected.

According to Chomsky's original UG conjecture, human brains are *endowed* with a singular capacity for acquisition, implementation and use of highly specific rule systems of grammars. As it is a singularity, its properties must be taken for granted as a serendipitous quality of human brains. However, it is highly unlikely and in fact impossible that such

4. If a formally rich system such as the structures of a grammar of a human language were genetically determined in detail, genetic defects should affect circumscribable subparts analogous to brain lesions that knock out narrowly circumscribable language functions. The only evidence we have is that the Forkhead-Box-P2 gene, situated on the long arm of chromosome 7, seems to play a role in inherited SLI. However, this gene has been found to be crucial also in songbird brains (Teramitsu et al. 2004). Mutations may result in disorders of learning or using a given grammar, both in human and avian brains. But birds don't use a human language grammar, so FOXP2, of course, cannot be regarded as the 'grammar gene' of homo sapiens.

a singularity, that is, an extremely complex innate disposition, could fulgurate in a single species. The evolution of a complex innate capacity would proceed step by step and its beginnings would show also in closely related species. The idea that humans are endowed with a richly structured, innate language capacity has served as a tentative solution to the *argument from the poverty of stimulus* in language acquisition, that is, the insight that the grammatical competence attained by a child in first language acquisition is underdetermined by the linguistic intake if learning were a matter of trial & error. Children could not know how to correctly interpret the absence of certain patterns. A given structure might be missing either because it is ungrammatical or because nobody happens to use it.

Here is an example. Multiple *wh*-constructions are infrequent, they cross-linguistically differ sharply, and nevertheless, L1-learners end up with a uniform grammar of these constructions. How can a monolingual child acquiring English arrive at the categorical insight that a particular class of structures is ill-formed without insourcing negative evidence in the form of trials and corrective feedback? But children do not test out rare syntactic variants. Nobody has ever observed a child checking out multiple wh-question patterns. Nevertheless, speakers of English uniformly end up with a steadfast refutation of *how* or *why* in (1a), in place of *therefore* or *completely* in (1b), even if they have never uttered such a question before.

German speakers, on the other hand, would not find fault with the semantically and syntactically corresponding items *weshalb* ('why') and *wie* ('how'), as in (1c).[5] Crucially, this is not a peculiarity of English versus German. It is a cross-linguistically valid phenomenon. English is representative of languages with strictly head-initial verb phrases and a subject position outside of the VP, a.k.a. 'SVO' languages. In other

5.

(i)

Wer	hat	*weshalb*	begonnen,	und	*wer*	reagierte	*wie*	auf	die	der	Gegenseite
who	has	*why*	begun	and	who	reacted	how	on	the	the	opposition

unterstellte	Provokation?
alleged	provocation

(Frankfurter Rundschau – 25.07.2017 http://www.fr.de/politik/meinung/gastbeitraege/g20-krawalle-woher-kommt-die-gewalt-a-1319313 (accessed June 30, 2018)) words, the restriction behind the pattern (1a) is a property of genuine SVO languages. This restriction is neither found in SOV languages nor in languages with variable head-positioning, such as the Slavic languages (see Haider submitted(b), Haider & Szucsich submitted).

(1) a. *Who has *why*/*how* objected? – *It is unclear who has *why*/*how* objected.

b. Google has *therefore completely* denied all accusations.[6]

c. Wer hat *weshalb*/*wie* protestiert? – Es ist unklar, wer
who has why/how objected – it is unclear who
weshalb/*wie* protestierte.
why/how objected

d. *Who objected *why*/*how*? – **Why*/*How* did who object?

There are even cases of unavoidable clashes, as for instance (1d). Since *wh*-fronting in an SVO-type language must neither leave behind an interrogative subject nor a semantically higher-order *wh*-quantifier such as *how* or *why*, and since there is only a single *wh*-slot open for fronting, there is no well-formed ordering for (1d) available (Haider 2013: 138–142; Haider submitted(a), in press). German, Japanese or Russian,[7] to name just three non-SVO languages, are not subject to such a constraint.

The grammatical source of the restriction underlying (1a) is epiphenomenal. It is implicated by a general restriction on head-initial phrases to be explicated below. Children are not misled by the fact that normally, in multiple questions, the second occurrence of an interrogative phrase is left in-situ, that is, in the exact position in which the non-interrogative phrase would occur. This would be the position of *therefore* and *strongly* in (1b). Hence, an obvious question is this. What prevents an English child from entering the German-Japanese-Russian route? The answer

6. https://techengage.com/google-ceo-testimony-delayed/ (Dec. 5th, 2018)

7. In typological surveys, Slavic languages tend to be misclassified as SVO, simply because the linear order of subject-verb-object happens to be a frequent pattern in simple clauses in each of these languages. However, when a sufficiently large set of characteristic SVO properties is systematically scrutinized, it turns out that Slavic languages are not SVO. They are languages with variable head positioning (Haider & Szucsich submitted).

is identical with the answer to the question as to how such constraints have come into being in SVO languages, as will be argued below.

Chomsky (1975) contemplated this kind of decision problems for a learner, but his original solution – an innate language acquisition device resting on an innately preconfigured grammar that excludes constellations as in (1a,d) – has remained unfounded. Nobody has ever been able to produce immediate and compelling evidence in favour of the strong nativist hypothesis. Eventually, even its proponent (Chomsky 2011) prefers to abandon it.[8] The original question was this. What enables children, given their feeble cognitive capacities, to acquire a complex and intricately structured system of symbol manipulation?

Here is the 'anthropic' answer: Grammars that children could not fully grasp would not come into existence, simply because no human brain would acquire and then use them. So, what makes a grammar learnable? The universal constants of the universe of human grammars are constants that characterize learnable grammars for human brains. Our grammar systems are the result of a process of cognitive evolution in which the human language processing resources are the selection environment. Languages are learnable since the grammars of human languages have been selected for learnability by the numerous generations of grammar acquiring brains and there is an enormous amount of grammar variants that did not pass the selection filters, but we are not aware of them.

Such an answer must be framed in terms of the insights we owe to Charles Darwin. Complex systems do not suddenly appear from nowhere. They are the result of evolutionary processes. Such processes shape any self-replicating system, be it genetically or cognitively represented. Cognitive evolution shapes the cognitive 'software' packages or 'apps' for languages, a.k.a. grammars of natural languages. These cognitive systems are subject to the very same principles of evolution that determine genetic evolution: variation + selection = adaptation.

8. "[…]the best answer would be that a sudden and very slight evolutionary event yielded Merge, and that the rest follows from natural law" (Chomsky 2011: 275)

2 The inevitable cognitive evolution of grammars

No zoologist ever had to insist on a "Universal Grammar" of sea-dwelling life, for instance. This does not clash with the fact that many species have independently developed fins, fin-like extremities or webbed feet. We may call them anatomical sea-life "parameters". When mammals re-entered the sea, they developed into orcas, dolphins or seals, to name just a few species, and they developed fin-like arms and legs. In other words, there is no need for a universal grammar of sea-dwelling and surely not for an innate one in order to be able to explain why there are invariants across organisms in the same habitat. The theory of evolution is sufficient. Languages share a habitat, namely the same neuro-cognitive environment for acquisition and use. A language with grammar G can survive only if G happens to enter enough brains and this is why cognitive evolution leads to neuro-cognitive adaptation of grammars to brains. "Overall, language appears to have adapted to the human brain more so than the reverse" (Schoenemann 2012: 443).

Darwinian evolution is not substance-bound, that is, it is not restricted to the genome of biological systems. Evolution inevitably takes place whenever a *self-replicating* system is open for *variation* and is embedded in a context that constantly *sieves out* variants. On the level of cognitive structures, grammars are self-replicating in the same way as a virus[9] is self-replicating on the level of cellular structures (Haider 2015). It needs a host and the host for grammars is our brain.

In the long run, only those variants will survive that are not sieved out. In other words, variants win that happen to turn out as 'fitter' within their selecting environment. Fitness means that more learners ingest and implement this particular variant than other, slightly different ones. The emergent result is better-adapted grammar systems.

9. According to Koonin (2012: 294), a virus is encoding information required for its reproduction and, hence, it possesses a degree of autonomy from the host (genetic) system. Grammar encodes the information for language production and reception by the host organism, *viz.* language users. This is necessary for reproduction of the 'virus' in language acquisition. A virus may be coded genetically or purely informationally (cf. computer virus).

Adaptation to an environment is a consequence of *random* variation of self-reproducing systems exposed to an environment with *constant* selection. The neuro-cognitive apparatus is the constant selector for grammars. Grammars are cognitive programmes. They are neuro-cognitive software packages, or in present day jargon, "apps" for language processing. Grammars manage the handling of particular symbol systems. Of course, languages are used for cognitive and communicative functions, but grammars determine these tools on the basis of the neuro-cognitive capacities that govern their acquisition and use.

A Grammar is – even literally – a cognitive virus programme. The cognitive virus corresponding to the grammar of our mother tongue governs our language production behaviour. At the same time, language usage is the reproduction device for the virus. Children acquire their grammar on the basis of being exposed to language productions and they put it to use. Afterwards, their productions become part of the input for the next generation's acquisition of grammar, and so on.

Such a reproduction process is necessarily imperfect. An inevitable by-product of inaccurate acquisition is variation. Variation – as in the case of mutations in the biological instantiation of evolution – is enhanced by various other factors, including language contact or dialectal segregation. What this scenario amounts to is an instance of Darwinian evolution on the level of cognitive structures and their variants. Researchers interested in the "evolution of language" traditionally focus on the *biological* features and speculate about their *communicative* use.[10] As a consequence, too little is known about the evolution of cognition in general and in particular about the evolution of linguistic capacities as a central part of our cognitive inventory, namely language processing.

Evolution inexorably results in adaptation to the selecting environment.[11] The selecting environment for grammars is the ensemble of cognitive capacities of our brains that has gotten recruited for language

10. "A look at the literature on evolution of language reveals that most of it scarcely even addresses the topic. Instead, it largely offers speculations about the evolution of communication, a very different matter." (Chomsky 2011: 265)

11. This is a corollary of Fisher's theorem: "Assuming that natural selection drives all evolution, the mean fitness of a population cannot decrease during evolution (if the population is to survive)." (Koonin 2012: 8)

processing. Their history of evolution is independent of language. In the evolution of humans, complex grammars of languages are too recent an achievement to be a result of *biological* selection on its own.[12]

Language processing has always been parasitic on already existing computation capacities of the human brain which have existed already before these brains started with language (Christiansen et al. 2009). This set of capacities is a selector in the ongoing adaptation of grammars to their neuro-cognitive processing environment. Grammar variants that can be more easily acquired or more efficiently put to use, will eventually 'infect' more brains than other variants in the long run. As a consequence, grammars will become optimized for learnability and on-line usability.

Here is an example of the recruiting of already available brain resources for language processing. Broca's and Wernicke's area in the language-dominant hemisphere are hotspots in the cortical language processing circuits. But they are no homo-sapiens innovations.

"Our findings support the conclusion that leftward asymmetry of Wernicke's area originated prior to the appearance of modern human language and before our divergence from the last common ancestor." (Spocter et al. 2010: 2165) "Broca's and Wernicke's areas, and the arcuate fasciculus connecting them, were not specially evolved for language." (Schoenemann 2012: 455)[13]

Let us return to the initial example. How can a child find out that (1a) is ill-formed, given that (s)he notices that (1b) and (2a) are in use? It cannot and it need not. It is the processing system that shies away from the kind of structure that (1a) would instantiate in a language with head-initial phrases. (1a) requires the very same structure that would be needed for (2b). Needless to re-emphasize that the counterparts of (2b,c) are fully acceptable in non-SVO languages (2d,e).

12. In comparison to songbirds (Brenowitz 2008), our brains are not *a priori* 'hardwired' for language processing. Each of the brain functions and brain regions recruited for language processing supports other functions, too, and moreover, they are already functioning in the brains of our nearest relatives, as for instance bonobos, who do not use complex grammars.

13. "Functional asymmetries in the brain were initially thought to be uniquely human, reflecting unique processing demands required to produce and comprehend language. Nonetheless, functional and structural asymmetries have been identified in nonhuman primates and many other species." (Toga et al. 2010: 99Toga & Thompson 2003)

(2) a. *Why* did they object? – *How* did they object?

b. *They have *more than twice*/*with great emphasis* objected.[14]

c. It has *more recently* (*than we thought) gained popularity.

d. Sie haben [viel öfter als wir] [mit großem Nachdruck] widersprochen.
they have [much more-often than us] [with great emphasis] objected

e. Es hat sehr viel früher (als wir dachten) Popularität erlangt.
It has very much-more recently (*than we thought) popularity gained

(1a) is ruled out by the very same grammatical restriction that rules out (2b) or the bracketed extension in (2c). It is a restriction on left adjuncts of left-headed phrases (Haider in press). The acceptable versions, such as (2c), are phrases with an adjacent, semantically selecting head. *Wh*-items are non-selecting. They count as phrasal. Therefore, they are disqualified as pre-adjoined adjuncts of head-initial phrases.[15]

In head-final phrases, these items are within the directionality domain of the verb, whence the absence of the particular constraint in German. The overarching constraint is a directionality requirement of 'gluing' non-selected phrases to licensing heads. Left-hand adjuncts of head-initial phrases are outside of the licensing domain of the head of the host phrase, hence they must be 'glued' to the phrase, which amounts to a head-adjacency requirement (Haider in press).

14. The British National Corpus (BNC) of 100 million words contains 166 tokens of `"has therefore"`, but not a single token of `"has why"` or `"has more often than x"` (with x as the target of comparison), although `"has * often"` (`*` as a word joker) is attested 64 times. The respective numbers for CocA (520 million) are: 113 – 0 – 0 – 111.

15. This is confirmed by left-hand attributes of head-initial NPs in otherwise OV-type languages such as German.

(i) ein viel schlechteres (*als dieses) Argument
a much worse (*than this) argument

3 Convergent evolution of grammars under cognitive selection

In biology, convergent evolution is described since the 19th century (Gould 1989, Pearce 2011, Weismann 1893). For the present purpose, Haeckel's biogenetic law of 1866 – *Ontogeny recapitulates phylogeny* – is a good starting point, even if it has been discredited in many details. Von Baer (1828) has been more accurate when claiming that the general characters of a taxonomic group show earlier in an embryo than the specialized characters do. Species diverge from one another as development progresses. He concluded that the stages an embryo passes through during ontogeny only represent *embryonic stages* of other species, not *adult* forms.

As for the evolution of grammars, the analogous situation is the following: The acquisition paths in first language acquisition recapitulate steps in the evolution of grammars in the history of mankind. Von Baer's linguistic version is this: In early stages of language acquisition – until leaving the two and three-word stage – children proceed independently of the patterns of their respective mother tongues. For instance, children may choose V-before-subject orders even in languages in which the subject would invariably precede the main verb (Deprez & Pierce 1994: 64–65). Their behaviour arguably resembles the "embryonic stages" of human languages in the evolutionary history. Another window into the 'embryonic phase' is the isolated emergence of new languages, as in the case of a Nicaraguan sign language (Senghas et al. 2004) or in experimental tasks (Goldin-Meadow et al. 2008). In each of these cases, an SOV word order is preferred for denoting transitive events.

When children enter grammar acquisition, they proceed from "*Me Tarzan*" and "*You Jane*" to end up after a couple of years in a steady state that governs complex utterances such as "*Whether 'tis nobler in the mind to suffer the slings and arrows of outrageous fortune, or to take arms against a sea of troubles, and by opposing end them.*"

It is an educated guess that our human ancestors, just like today's children, have started with two and three word utterances, with little to no restrictions that would deserve the denomination 'grammar'. From then on, cognitive selection has been working steadily and unavoidably and it rewarded and conserved variants that turned out to be more effective and more easy to process and acquire. Of course, the processes of selection were dependent on the existence of variation on the one hand, but on the other hand, selection is non-deterministic. Just as in biological evolution, it is unpredictable which specific step will happen and when. Evolution does not provoke changes. It merely channels changes in terms of sieving out variants. On the other hand, if a system is in a stable and undisturbed equilibrium, it may continue without changes for long periods of time.

Salish languages (Jelinek & Demers 1994) seem to have conserved what appears to be a design that antedates the design of the classical Indo-European languages. In Salish languages, lexical categories apparently do not exist. The arguments of a lexical item are differentiated by morphological markers, not by lexical category or by phrase structure. These markers serve as identifiers for the arguments in the argument-predicate relation.[16]

Lexical categorization is a precondition on the way to phrase structuring, with phrases differentiated by the head categories. First, the lexical categories of heads partition the morphological markers that are attached to them. This design of morphological identification is in turn a precursor of a design in which the *morphological* coding (3a) of grammatical relations got replaced by *structural* coding in terms of head-initial and thus strictly linearized phrase structures (3b) which allow for an efficient *procedural* identification of essential relations without much recourse to morphological marking. Cognitively, this amounts to a shift from declarative memory load to cognitively less costly procedural memory capacities. No language is known that has gone the reverse way, that is, starting with an English-like or Chinese-like grammar and ending up with a grammar like Sanskrit or Latin.

16. Cable (2008):"Salish languages are as close to 1st order predicate logic as natural languages get."

(3) a. Gallia est omnis divisa in partes tres, quarum unam incolunt Belgae [. . .] (Latin; Caesar, De bello Gallico)

b. All Gaul is divided into three parts, one of which the Belgae inhabit [. . .]

From a typological point of view, languages like English, that is, languages with strictly head-initial phrases and a structurally unique subject position preceding the verb are diachronically younger. It is a much more likely end point of diachronic changes than a starting point. In other words, many SVO languages have SOV ancestors, but hardly any SOV language has an SVO ancestor (see Gell-Mann & Ruhlen 2011). The later change is very rare and it is the result of a language contact situation with a dominating SOV language. It is not the result of a gradual change of a language guided by natural (positive) selection.

Let us turn briefly to monogenesis vs. polygenesis issue. Here, the evolutionary perspective invites a new perspective, too. Given the scarcely populated African and Eurasian continent during and after the "*Me Tarzan–You Jane*" millennia, polygenesis of grammars is much more probable than monogenesis. The cross-linguistic invariants of modern languages are the reflex of convergent cognitive evolution (Pearce 2011) by constant selection of grammar variants by the invariant neuro-cognitive processing resources that constitute the human language-processing facility.

Today, linguists are confronted with an apparently domain-specific language capacity. But this impression is merely a tunnel-view perspective on the problem. The specific ensemble of brain resources recruited for language processing may appear to be domain specific. However, its components are not domain-specific at all. They have been recruited from the already existing and therefore available cognitive processing resources of the primate brain. If viewed from this angle, there is no need for an innateness conjecture.

As a simple illustration of this idea, consider for instance your laptop. It is a domain-general device. One may type papers, send e-mails, watch videos, listen to music, calculate statistics, and so on. A text editor is a specific combination of available computation resources of the laptop that amounts to a domain-specific application. The resources it combines are domain general, the specific combination of the resources amounts to a domain specific application. Grammars are cognitive apps for language usage. These apps have been shaped by cognitive evolution. Biological evolution has shaped brains that happen to provide the computational capacities for 'running' such cognitive apps.

Human acoustic decoding, for instance, capitalizes on categorial perception. This capacity of our brain is not species-specific. Chinchillas, monkeys, chicken or rats dispose of it (Kriengwatana et al. 2015). However, as it is an available and useful resource of human brains, too, it got recruited for language processing. The whole ensemble of human computation resources is the selecting background environment for the evolution of grammars. A grammar variant has a chance to occupy more brains if it is better adapted, that is, if it is rewarded by brains that reward structures that can be processed more easily and effectively.

Due to the lack of script in most languages, the historical depth of documented grammar changes is shallow. Nevertheless, what we know is already sufficient for realizing clear effects of ongoing cognitive evolution by variation & selection. Here is just one of the many insights produced by population genetics research that we linguists can readily insource and apply to our domain. Fisher (1930) formulated and proved a fundamental theorem of natural selection, commonly known as *Fisher's theorem*: "The rate of increase in fitness of any organism at any time is equal to its genetic variance in fitness at that time." In other words (Koonin 2012: 7), the *intensity of selection* and hence, the *rate of evolution* due to selection, is proportional to the magnitude of variation in an evolving population, which, in turn, is *proportional to the effective population size.*

This accounts immediately for the fact that Icelandic, Faroese, or Sardinian have changed less and have conserved more of the earlier traits than Swedish, Danish, and Italian, although they are offspring of the very same ancestor languages. A small population confined to a small region produces less variation and therefore less chance for change.

Summary
Darwinian evolution working on cognitive representations of linguistic structures processed by the human brain provides adequate answers to the three questions: Grammars are learnable since learnability is the prime factor of the selecting cognitive environment. Better learnable variants will occupy more brains and spread.

Second, human languages stay within a corridor delimited by originally non-verbal brain resources recruited for actual grammar usage. Third, there is no need for insisting on a 'monogenetic' origin of human grammars. Cognitive evolution accounts for the cross-linguistically convergent as well as divergent traits of human grammars.

Finally, 'universal grammar' turns out as a disposable conjecture. A theory of cognitive evolution provides a more rewarding approach. What is innate is not the grammar format. The brain capacities recruited for language processing are innate and these are the selectors in the permanent cognitive evolution of grammars that has formed our present day languages.

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