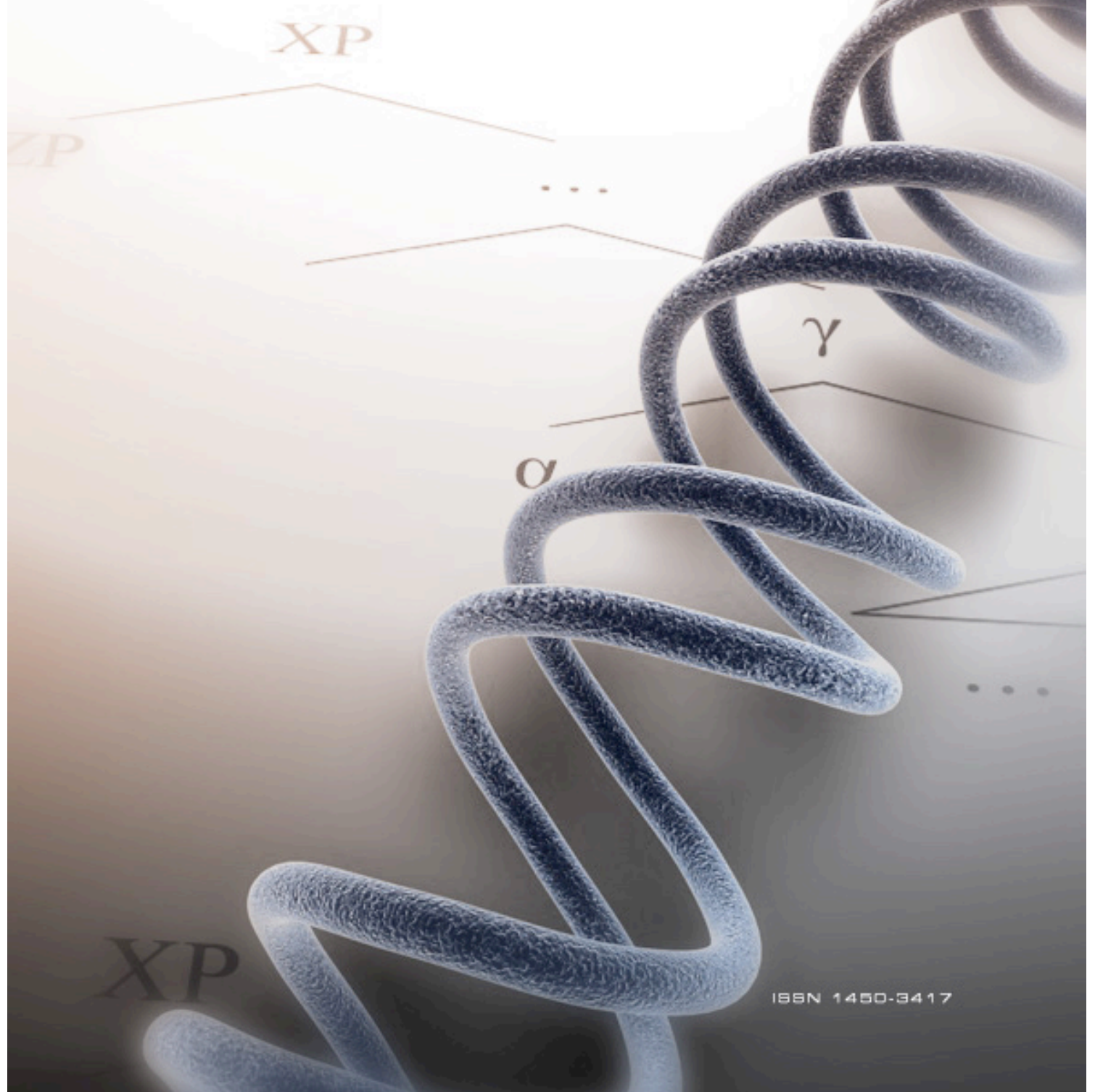




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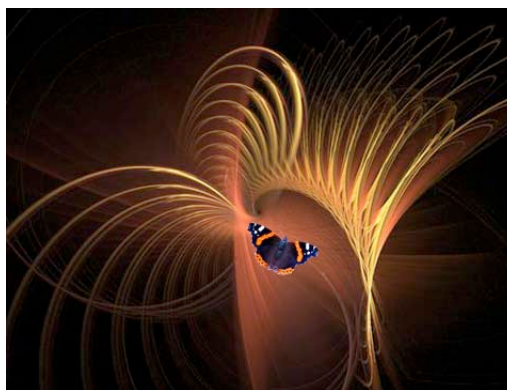
In Memoriam Ursula Kleinhenz

Kleanthes K. Grohmann

The fourth volume of *Biolinguistics* comes to an end and with it another year — and with it also, very sadly, the passing of a good friend, a wonderful human being, a hard-working editor, and a tremendous loss to the linguistic community. Goodbye, Ursula!

This is not an obituary; Ursula's colleagues from Mouton de Gruyter already were so kind as to post a very touching message on Linguist List (<http://linguistlist.org/issues/21/21-5026.html>). To those of us who knew her, Ursula's death did not come as a surprise, after a long battle with cancer — but as a shock nevertheless, and it does not make the loss any easier to cope with. Ursula died at age 45 in the final editing process of this issue, on 9 December 2010, hence the inclusion of this brief note here.

I got to know Ursula very well in the summer of 1999, when I spent three months in Berlin at [ZAS](#). We became good friends very quickly, after having met previously at conferences, thanks to her open, friendly attitude which I always admired. How can you not — with that laughter?! We stayed in touch, met at irregular intervals at conferences, offices, cafés — and as so often in situations such as this, I wish we had done so more intensely, especially in the past few years. *I cannot change that, I cannot turn back the time, but I can wish you all the best wherever you may be or go, Ursula.*



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Evo-Devo — Of Course, But Which One? Some Comments on Chomsky's Analogies between the Biolinguistic Approach and Evo-Devo

Antonio Benítez-Burraco & Víctor M. Longa

In some recent papers, Chomsky has suggested some non-trivial analogies between the biolinguistic approach and evolutionary developmental biology (Evo-Devo). In this paper, the point is made that those analogies should be handled with caution. The reason is that the Evo-Devo version chosen by Chomsky in order to build the analogies fully assumes a gene-centric perspective. Although providing genes with a special power fits in well with the Principles-and-Parameters model, it does not agree at all with the reduction of the power attributed to genes that the Minimalist Program has placed on the agenda. Nevertheless, other Evo-Devo approaches exist that seem more accurate than the particular version adopted by Chomsky — approaches therefore which are more promising for fulfilling the minimalist biolinguistic approach.

Keywords: evolutionary developmental biology; gene-centrism; Minimalist Program; Principles-and-Parameters Theory

1. Introduction

From its origins, Generative Grammar has compellingly argued that language is biologically seated. Therefore, Chomsky has repeatedly claimed that linguistics should be thought of as a branch of biology (apart from Chomsky 1980, see e.g. Chomsky 1975: 123, 1986: 27, 2000: 90, 2005: 2 for wide discussion). To be more precise, as Freidin & Vergnaud (2001: 648) put it, a branch of theoretical developmental biology, because a core concern of Generative Grammar is to explain language growth in the individual.

Within this context, Chomsky has recently pointed out (see Chomsky 2007, 2008, 2010) non-trivial analogies between the biolinguistic approach (henceforth, BA) and evolutionary developmental biology (Evo-Devo). Our paper makes the point that Chomsky's analogies should be handled with caution. As Hall & Olson

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(2003: xv) write, “no unified theory of evodevo exists”. This means that the Evo-Devo perspective, according to which “[e]volution is biased by development” (Raff 2000: 78), can be implemented through different theories and assumptions. Chomsky’s analogies between the BA and Evo-Devo raise the problem that they are based on an Evo-Devo theory which is directly linked to developmental genetics and which, accordingly, takes genes to have a core or special power, as represented by Carroll (2005). To our mind, Chomsky’s analogies may be accurate as regards Principles-and-Parameters Theory (henceforth, PPT), but they do not sit properly with a truly minimalist BA. Therefore, for those analogies to be sustained, we suggest that the need exists to consider other Evo-Devo theories which reject gene-centrism or primacy of the genes.

2. Chomsky’s Analogies

According to Chomsky (2010: 45), there are “some analogies between ‘the Evo Devo revolution’ in biology and ideas that have been lurking in the background of biolinguistics since its origins [...]”. The first one refers to the PPT.¹ In that model, the principles of Universal Grammar (henceforth, UG), or linguistic genotype, were considered to be ‘open’, in such a way that enabled a narrow range of parametric variation. The setting of a principle P in the parameters A or B was considered to be triggered by the linguistic environment the learner is exposed to (Turkish, Spanish, etc.). Thus, grammars are the result of fixing the same principles in different positions. This view has been nicely expressed by means of the well-known ‘switch metaphor’:

We may think of the language faculty as a complex and intricate network of some sort associated with a switch box consisting of an array of switches that can be in one of two positions. [...]. The fixed network is the system of principles of universal grammar; the switches are the parameters to be fixed by experience.

(Chomsky 1988: 62–63)

In the same vein, Evo-Devo has shown that “the same regulatory genes were shared by animals with different body plans (for example, insects and vertebrates)” (Raff 2000: 75). Minor changes in regulatory mechanisms produce very different results on the surface (see Carroll 2005 for a wide discussion).² In fact, Chomsky (2007: 3) points out that PPT “was also suggested by major developments in general biology, specifically François Jacob’s account of how slight changes in the hierarchy and timing of regulatory mechanisms might yield great superficial differences — a butterfly or an elephant, and so on” (see also Chomsky 2010: 49). For obvious reasons, that model “seemed natural for language as well; slight changes in parameter settings might yield superficial variety,

¹ Anyway, that analogy is not new; it can be traced back to Chomsky (1980: 66–67), although at that time the label ‘Evo-Devo’ had not yet been coined.

² Carroll (2005: 111) also adopts the switch metaphor; he speaks of genetic switches, the switches controlling how genes are used, and which are crucial in the models of genetic expression and regulation. Thus, the same genes/linguistic principles are arranged differently in different organisms/languages.

through interaction of invariant principles with parameter choices" (Chomsky 2007: 3).³

That situation meant the discovery, both in biology and in linguistics, of deep homologies among organisms on one side, and among languages on the other. Such a discovery reversed the traditional assumption of an "endless variation" (Boeckx 2009: 88) held by both disciplines. As regards language, Joos's (1957: 96) claim that languages "can differ from each other without limit and in unpredictable ways" is well known. Generative Grammar showed that assumption to be untenable. In biology, the prevailing assumption was very similar; as Mayr (1963: 609) put it, "[m]uch that has been learned about gene physiology makes it evident that the search for homologous genes is quite futile except in very close relatives". That is, different genes for different animals. As Carroll (2005: 9) points out, "[f]or more than a century, biologists had assumed that different types of animals were genetically constructed in completely different ways". Evo-Devo has shown, in the same vein as PPT, that such a contention was unjustified.

Chomsky's (2010) second analogy between the BA and Evo-Devo has to do with third factor conditions, that is, "[p]rinciples not specific to the faculty of language" (Chomsky 2005: 6). According to Chomsky (2007: 3), "some of the third factor principles have the flavor of the constraints that enter into all facets of growth and evolution, and that are now being explored intensively in the evo-devo revolution" (see also Chomsky 2010: 51). Therefore, Evo-Devo discoveries point to "architectural constraints that limit adaptive scope and channel evolutionary patterns" (Chomsky 2010: 51).

Chomsky (2010: 45) asserts that "the analogies have been suggestive in the past, and might prove to be more than that in the years ahead". This assertion suggests that both analogies apply to any stage of the BA, that is, both to the PPT and to the Minimalist Program (henceforth, MP). We contend, though, that whereas the first analogy is applicable to PPT, none of them can aptly characterize the minimalist BA. The reason is that the Evo-Devo approach referred to by Chomsky is a strictly gene-centered theory, and gene-centrism is explicitly rejected by MP. To sum up, we will aim to show that the Evo-Devo version derived from developmental genetics is not an accurate analogy for the BA which MP has brought to the fore.

3. On the Status of Evo-Devo

The so-called Modern Synthesis (and the Neo-Darwinism which emerged from it) was undoubtedly a fundamental hallmark in biology: It gave rise to modern biology. However, some of their effects were clearly undesirable. One of them was gene-centrism (for criticism, see Goodwin 1994, Oyama 1985, Moore 2001, and our discussion below). Another undesirable outcome of Modern Synthesis

³ Chomsky (1981: 3–4) already made the same point: "[T]he languages that are determined by fixing their values one way or another will appear to be quite diverse" (see also Chomsky 1980: 66).

(and Neo-Darwinism) was to ignore development or, at least, leave it aside, thus favouring the dissociation between phylogeny and ontogeny (a wide consensus exists on this topic; see Griffiths & Gray 2001: 195, Robert *et al.* 2001: 954, Weber & Depew 2001: 239, Wimsatt 2001: 219; Robert 2002: 592, Gilbert 2003: 470–471, Gilbert & Burian 2003: 68–69, Carroll 2005: 6–8, and Jablonka & Lamb 2005: 27; for an in-depth analysis of the causes, see Robert 2004 and Amundson 2007). Two reasons underlie that dissociation: First, since Modern Synthesis, population genetics has become the core discipline of Evolutionary Biology (Wimsatt 2001: 219). Population genetics studies the gradual change of genetic frequencies at the population level. Therefore, the definition of evolution within Modern Synthesis as a process affecting populations, not individuals, led to a non-developmental theory (Moore 2001: 167). Second, since Modern Synthesis, it has been considered (as pointed out above) that development involved different explanations for different animals (see Carroll 2005: 6).

This disagreement between evolution and development has been reversed by Evo-Devo, which has bridged the gap between both levels in such a way that evolution is accounted for by means of developmental factors. Indeed, Gould (2002: chap. 10) defines Evo-Devo as the evolution of development. More concretely, Evo-Devo aims “to unveil how developmental processes and mechanisms become modified during evolution” (Baguñá & García Fernández 2003: 705).⁴ It is for that reason that, according to Fodor & Piattelli-Palmarini (2010: 30), Evo-Devo has made it possible to turn around Dobzhansky’s (1973) claim that “nothing in biology makes sense except in the light of evolution”; as Fodor & Piattelli-Palmarini put it, Evo-Devo “tells us that it’s the other way around: nothing in evolution makes sense except in the light of developmental biology”.

However, it should be noted that Evo-Devo is a general perspective, rather than a specific theory or model. This means that any theory which reliably links evolution and development will be an Evo-Devo theory, no matter how concretely that relation will be implemented and approached. Accordingly, Hall & Olson (2003: xv) argue, as stated above, that “no unified theory of evodevo exists”, whereas Robert (2002: 597) makes the same point: “Like any field of biology, evo-devo commands a diverse range of theoretical perspectives and experimental approaches”. Indeed, Balari & Lorenzo (2009: 7) characterize at least three types of different (and even conflicting) Evo-Devo theories: (i) those assuming the ‘genetic program’ metaphor, (ii) those which extend the metaphor beyond genes and assume a developmental program, and (iii) those which completely abandon the idea of ‘program’, and take development to be the outcome of a developmental system. To sum up, all those approaches share “the idea that evolution is strongly constrained by the very same factors that strongly constrain the development of individuals” (Balari & Lorenzo 2009: 3); however, each concrete approach implements the same idea very differently.

Most of the disagreements among the several implementations of Evo-Devo are to do with one of the main problems theoretical biology is concerned

⁴ In the opinion of Robert *et al.* (2001: 956), the general objective of Evo-Devo can be deconstructed as follows: (i) the relationship between embryonic development and evolution; (ii) how changes in developmental processes affect evolutionary change, and (iii) how development itself has evolved (see also Hall 2000: 177).

with, that is, to integrate developmental biology within genetics and evolutionary theory, as pointed out by Weber & Depew (2001: 239)⁵:

The field has been left to contestations between molecular reductionists, who assume that the problem of development is simply the problem of turning structural genes on and off, and those who identify in one way or another with the contemporary ‘developmentalist challenge’, who are confident that what genes do is far from the whole story.

Let us note that the geneticist Evo-Devo approach (henceforth, Evo-Devo_{GEN}), finely represented by Carroll (2005), still assumes the primacy of genes which characterized Neo-Darwinism.⁶ And it should also be noted that this Evo-Devo_{GEN} is the approach taken by Chomsky in order to build the analogies with the BA (indeed, Chomsky 2007: 3 himself cites Carroll 2005, a leading practitioner of Evo-Devo_{GEN}, as a representative instance of Evo-Devo).

4. The Evo-Devo Approach Chosen by Chomsky

As pointed out, Chomsky’s analogies between Evo-Devo and the BA are based on Evo-Devo_{GEN}. Although, as Gould (2002: chap. 10) discusses, Evo-Devo_{GEN} has changed relevant assumptions of orthodox Neo-Darwinism (which assumed that genes of different animals were different as well), in another respects Evo-Devo_{GEN} still accepts core Neo-Darwinian premises; for instance, the prominent role attributed to genes (and the notion of genetic program). However, it is our opinion that this primacy of the genes is in conflict with the reduction of the genetic endowment that MP has brought to the fore (see Chomsky 2005 for more discussion as well as sections 5 and 6 below).

The genetic primacy is clearly perceived in Carroll (2005). In fact, Carroll’s (2005: 8) initial claim that “genes must be at the center of the mysteries of both development and evolution” advances the content of the whole book. Carroll (2005: 9) reduces Evo-Devo to “the comparison of developmental genes between species”, an assumption which is denied by other Evo-Devo theories. More concretely, Carroll’s book is built around the notion of ‘genetic tool kit’, which is common to complex organisms. Therefore, the diversity of animal forms is not to do with different genes, but with how the same genes are used differently. According to Carroll (2005: 11), the development of form “depends upon the turning on and off of genes at different times and places in the course of development”. That is, Carroll’s framework is entirely based on genes.

For that reason, Carroll’s recurrent references to the genome as the source of form (which point to the prominence of the notion of genetic program), do not come as a surprise. Carroll’s (2005) own words illustrate:

⁵ See Walsh (2007) and Pigliucci (2007) as interesting attempts to widen the Modern Synthesis in the light of the findings raised by developmental biology.

⁶ Evo-Devo_{GEN} derives from developmental genetics which emerged in the eighties (Raff 2000: 75; Gilbert 2003: 473, Griffiths & Gray 2005: 421; see Gould 2002: chap. 10). For that reason, Goodman & Coughlin (2000) or Baguña & García-Fernández (2003) conflate Evo-Devo with developmental genetics.

[...] the species-specific instructions for building an animal are encoded in its DNA [...] (p. 11)

Evolutionary changes within this regulatory DNA lead to the diversity of form (p. 12)

This regulatory DNA contains the instructions for building anatomy (p. 12)

Where do we look these rules and instructions [for generating animal form]? In DNA. In the entire complement of DNA of a species (the genome), there exists the information for building that animal. The instructions for making five fingers, or two eyespots, or six legs, or black and white stripes are somehow encoded in the genomes of the species that bear these traits (p. 35).

Therefore, according to Carroll (2005: 35), “[e]volution of form is ultimately then a question of genetics.” Balari & Lorenzo (2009: 6) argue that this understanding of Evo-Devo_{GEN} “can safely be judged a constructive enlargement of the strictly genocentric model of the MES [Modern Evolutionary Synthesis — ABB & VML]”. That is, as the quotes above make clear, Evo-Devo_{GEN} clearly assumes the Neo-Darwinian genocentrism (or dictatorship of the genes, following Goodwin 1994), which means, in words of Oyama (2001: 177–178), to attribute a special directive power (both formative and informative) to the genes.

To make this point clearer, we should notice the great resemblance between Carroll’s assumptions and those of Neo-Darwinian scholars, like Dawkins (1976) or Maynard-Smith & Szathmáry (1999), who also argue for the existence of master plans within the genes:

[...] the genes are not only the Andromedans [i.e. the devices — ABB & VML] who sent the coded instructions; they are also the instructions themselves (Dawkins 1976: 54).⁷

[...] each egg contains, in its genes, a set of instructions for making the appropriate adult. [...] it is the information contained in the genes that specifies the adult form (Maynard-Smith & Szathmáry 1999: 2).

The basic picture, then, is that the development of complex organisms depends on the existence of genetic information, which can be copied by template reproduction. Evolution depends on random changes in that genetic information, and the natural selection of those sets of instructions that specify the most successful organisms (Maynard-Smith & Szathmáry 1999: 2).

To sum up, we believe that Robert *et al.* (2001: 959) accurately contend that Evo-Devo “continues to show a tendency toward reductionism and genocentrism; developmental mechanisms are ultimately genetic”.⁸ Therefore, Evo-Devo_{GEN} does not run the risk of being gene-centric, as argued by Robert (2003a: 479); indeed, Evo-Devo_{GEN} is clearly gene-centric.

⁷ See Dawkins (1976: chap. 3) for a wide exposition presenting genes as a collection of instructions for building the body.

⁸ For instance, Raff (2000: 74) writes that “[d]evelopment is genetically programmed”. Such a claim is strongly rejected by those who ‘take development seriously’, quoting Robert (2004) (see Blumberg 2005, Moore 2001, and Oyama *et al.* 2001a for wide discussion).

5. Is Evo-Devo_{GEN} a Good Analogy for the Minimalist BA?

The take-home message of the above discussion is the following: Evo-Devo_{GEN} may be a fine analogy for the BA derived from the PPT. However, it is not an accurate analogy as regards the minimalist BA. We develop both claims in turn.

As pointed out in Section 2, Evo-Devo_{GEN} shows clear parallelisms with PPT. Besides from those raised by Chomsky, we would like to add another one: PPT shared the strong geneticism held by Evo-Devo_{GEN}. PPT, and the remainder of the generative models previous to MP, took for granted the need to postulate the notion of ‘genetic program for language’ (Chomsky 1980: 234) or equivalent notions for characterizing UG.⁹ Lightfoot (1982: 22) illustrates that position:

The genotypical principles responsible for language acquisition can be viewed as a theory of grammar, sometimes called Universal Grammar. This represents the genetic equipment that makes language growth possible.

That is, (non-minimalist) Generative Grammar considered the genes to be the primary or central cause, in the same way as in Evo-Devo_{GEN}. The linguistic plan of the organism would lie in the genome, and this assumption has a clear parallelism in Evo-Devo_{GEN}: The source of the form or body plan would lie in the genome, as Carroll’s previous statements made it clear (see Longa 2006, 2008, and Lorenzo & Longa 2009 on the generative gene-centrism).

For those reasons, we have argued before that Evo-Devo_{GEN} could be an interesting analogy for PPT and for the BA arising from it. However, we do not share Chomsky’s (2010: 45) statement that “the analogies have been suggestive in the past, and might prove to be more than that in the years ahead”. Those analogies are not valid for characterizing the BA arising from the minimalist agenda. That is because the minimalist BA abandons core assumptions of the previous models, like gene-centrism itself, and the notion of UG, which is reduced to a minimum. Thus, we do not really expect Evo-Devo_{GEN} to inspire the minimalist research.¹⁰ We will justify the reasons (see Longa & Lorenzo 2008 for an extensive analysis of differences between PPT and MP).

As specified above, all the models previous to MP, and PPT paradigmatically, assumed the need for postulating a “genetically determined initial state” (Chomsky 1980: 233) for explaining language growth in the individual. Such a

⁹ Some of these notions being ‘linguistic genotype’ (Chomsky 1980: 65, Lightfoot 1982: 21, 1999: 52, 2006: 45–46), ‘blueprint’ (Hyams 2002: 229), ‘genetic endowment’ (Anderson & Lightfoot 2002: 22, Guasti 2002: 271, Lightfoot 1982: 56), ‘genetic equipment’ (Guasti 2002: 18, Lightfoot 1982: 22), or ‘genetic make-up’ (Thornton & Wexler 1999: 1). Given that framework, Jenkins (1979: 106) characterized Generative Grammar as belonging to the “traditional study of the genetics of organisms”.

¹⁰ This means we consider that MP is not a mere extension of PPT nor does it presuppose its validity, as opposed to the ‘consensus view’ held by Boeckx (2006), Hornstein (2009), or Hornstein *et al.* (2005). The ‘consensus view’ contends that when agreement is reached about PPT as an optimal format to characterize Plato’s Problem, “an opening is created for simplicity, elegance, and naturalness to emerge from the long shadow cast by Plato’s problem” (Hornstein *et al.* 2005: 5). MP would be “the concrete application of such criteria to the analysis of UG” (Hornstein *et al.* 2005: 6). Thus, Hornstein (2009: 116) considers that MP does not replace the previous theory, but presupposes its validity, MP being a mere extension of PPT/GB. It seems to us that this analysis is based on a methodological minimalism instead of a really ontological one, following Martin & Uriagereka’s (2000) divide.

state, or UG, was conceived of as a body of specifically linguistic knowledge, that is, principles which “do not arise in other cognitive domains” (Tracy 2002: 656). According to that perspective, it is safe to say that “a strong background of genetic instructions is supposed to govern the acquisition of grammars” (Lorenzo & Longa 2009: 1302).

MP, though, has sustained a great reduction of the role given to genetic endowment (such a reduction fitting in well with the analysis of alleged ‘genes of language’; see the wider discussion in Benítez Burraco 2009). Minimalism has therefore originated a new way of understanding the Faculty of Language (henceforth, FL), which is specially connected to the issue of language specificity: How specific or unspecific is language? The minimalist answer to that question is the opposite of the one suggested by the previous models.

Pre-minimalist models assumed as a basic statement that “the functioning of the language faculty is guided by special principles specific to this domain” (Chomsky 1980: 44), that is, principles of a purely grammatical nature, and “encoded in the genes of the children” (Smith 1999: 173). According to those models, FL was endowed with a high specificity. However, MP rejects that format, and assumes a language architecture which is characterized by its opposing statement, unspecificity in FL. Minimalism considers that the mind does not require a specific grammatical system. From the view of the strongest minimalist thesis (Chomsky 2000), the best minimalist version is the version postulating the most direct connection (i.e. optimal) between the two external modules. That amounts to saying that the best minimalist version is the version containing a minimum of specific grammatical machinery (Lorenzo & Longa 2003), because that machinery would ‘disturb’ the direct nature of the relationship.

From that perspective, the structure of FL would be minimal, with no hints of specific principles; its mechanisms would have to do (i) with requirements imposed by the external modules, or (ii) with principles derived from conceptual necessity, which ‘come for free’, that is, the simplest solutions amongst all conceivable ones, for which there is no need to postulate special stipulations in the form of grammatical principles arising from genetic instructions. For instance, movements of constituents are as short as possible not because that condition is stipulated by an autonomous grammatical module, as in GB, but because it is the most economical and efficient way for a computational system to operate. To summarize, from the viewpoint of MP, FL is the simplest way to productively link sounds and meanings. Thus, the specificity thesis argued for by the previous generative models and the unspecificity thesis sustained by MP are conceptually in conflict (for a wider analysis, see Longa & Lorenzo 2008).¹¹

The unspecificity thesis has been made especially clear in Chomsky’s recent papers (Chomsky 2004 *et seq.*), which consider that the abandonment of grammatical machinery will let us go “beyond explanatory adequacy” (Chomsky 2004), thus reaching a true principled explanation of language design. Chomsky (2005: 6) proposes three factors in language growth: genetic endowment, external data

¹¹ In fact, Chomsky (2000: 113) clearly contends, as regards GB, that “a basic assumption of the work in [PPT], with its impressive achievements, is that everything just suggested [by MP; ABB & VML] is false: That language is ‘highly imperfect’ in these respects.” MP assumes quite the opposite: The optimal or perfect design of language.

(experience), and “principles not specific to the faculty of language” — those principles comprising, amongst others, principles of structural architecture, efficient computation, etc. The point in order is that MP’s unspecificity thesis leads to the primacy of the third factor; as Chomsky (2005: 9) points out, “we need no longer assume that the means of generating expressions are highly articulated and specific to language. We can seriously entertain the possibility that they might be reducible to language-independent principles”.

This way, the minimalist proposal of reducing the role of genes in language growth leads to reducing the UG to a minimum. That means, as clearly stated by Chomsky (2005: 9), that MP crucially implies “shifting the burden of explanation from the first factor, the genetic endowment, to the third factor, language-independent principles of data processing, structural architecture, and computational efficiency”. It is in this sense that the notion of (a rich) genetic program for language seems to be ill-suited from a minimalist perspective.¹² To sum up, we claim that, if the minimalist unspecificity thesis is seriously considered, the assumption of a highly detailed structure of purely linguistic knowledge, as sustained by GB, should be replaced by another according to which the initial state should be freed from any grammatical residue (Lorenzo & Longa 2003). This means the abandonment of gene-centrism by MP.

To summarize the discussion, if the differences opposing *Evo-Devo_{GEN}* (based on the notion of genetic program), and the minimalist BA (which avoids that notion), are considered, *Evo-Devo_{GEN}* does not seem an accurate analogy for the minimalist BA.

6. Are There Analogies between the Third Factor and *Evo-Devo_{GEN}* Constraints?

As pointed out above, Chomsky’s second analogy between *Evo-Devo* and the BA refers to the third factor conditions. According to Chomsky (2007: 3), “some of the third factor principles have the flavor of the constraints that enter into all facets of growth and evolution, and that are now being explored intensively in the *evo-devo* revolution”, because *evo-devo* discoveries point to “architectural constraints that limit adaptive scope and channel evolutionary patterns” (Chomsky 2010: 51). However, to our mind, this analogy is not accurate either, if referred to *Evo-Devo_{GEN}*.

It is safe to argue that *Evo-Devo_{GEN}* has shown that not every organic design is feasible. This topic is emphasized by Gould’s (2002: chap. 10) discussion of *Evo-Devo*. This author claims that Neo-Darwinism attributed an excessive power to natural selection. If this mechanism had the power it is usually endowed with, more than 500 million years of independent evolution should suffice to erase any trace of genetic homology, that is, adaptive evolution should have reconstructed every locus over and over again to face the changing requirements of changing environments (see Goodwin 1994: 116–121 for a similar argument related to the

¹² As Lorenzo & Longa (2009: 1306) point out, even if a minimal version of UG were found to be necessary for explaining language growth, its residual character would prevent to consider it as an articulated blueprint of language.

models of phylotaxis). Therefore, Gould considers natural selection to have a restricted scope, as opposed to Neo-Darwinist expectations.

That said, we believe that the minimalist third factor conditions and the architectural constraints brought to the fore by Evo-Devo_{GEN} cannot be conflated or compared: Practitioners of Evo-Devo_{GEN} attribute those constraints to purely genetic factors. For instance, Carroll (2005: 64) claims that “these Hox genes were so important that their sequences have been preserved throughout this enormous span of animal evolution [since the Cambrian to the present — ABB & VML]”. A quite similar statement is made by Raff (2000: 76): Those architectural constraints are due to “deeply conserved gene expression patterns”, which in turn are motivated by the fact that “the same regulatory genes have conserved roles in development” (Raff 2000: 75). As we can appreciate, the explanation raised by Evo-Devo_{GEN} to account for those architectural constraints is merely genetic, the evolutionary novelties arising because “conserved genes and gene pathways can be and are co-opted to new functions” (Raff 2000: 76). (This issue is widely analyzed in Carroll (2005) by means of the genetic switches of the genes, which can augment in number but where switches already existing are preserved.)

We think that Evo-Devo_{GEN}’s geneticist view of constraints on animal form is very different from what third factor effects actually mean: Third factor principles are based on the opposite premise, conditions which spontaneously arise, with no role for genetic specifications. Furthermore, it should be noted that these principles do not depend on the environment, but derive from the dynamics of the system itself (in this case, language). However, Evo-Devo_{GEN}’s opinion on that matter is different. For instance, Carroll (2005: 165) states that genes from the toolkit represent possibilities, but the actual fulfillment of potential is ecologically guided. More specifically, “the realization of this power is shaped, of course, by natural selection” (Carroll 2005: 287). Sincerely, we do not find many differences from the Neo-Darwinian view on natural selection. According to Carroll, gene stability and gene expression patterns are due to their functionality.¹³

That is, again, the opposite of the meaning of the third factor effects argued for by the minimalist BA. Therefore, Chomsky’s analogy does not seem to be valid. It could well be valid if Chomsky referred to an Evo-Devo approach different from the geneticist one. If this were the case, though, Chomsky should explicitly point that out. In fact, one of the research programs that Müller (2007: 943) recognizes in Evo-Devo points to “properties of development that are not directly genetically determined, such as self-organization or geometric and physical factors.” This view would agree with Chomsky’s position; however, such a view seems absent from Evo-Devo_{GEN}.

7. Therefore: Which Evo-Devo — If Any?

We have argued that Chomsky’s election (i.e. Evo-Devo_{GEN}) in order to draw an-

¹³ This seems to cast doubt on Fodor & Piattelli-Palmarini’s (2010: 32) claim that Evo-Devo findings on gene conservation imply internal filters in the phenotypes on which exogenous selection operates.

alogies between Evo-Devo and the BA does not fit in at all with MP. Does this mean that we should avoid any kind of analogy between the minimalist BA and Evo-Devo? Not really. We should keep in mind that the Evo-Devo perspective can be implemented through several theories; any theory reliably linking evolution and development will undoubtedly be an Evo-Devo theory, even although it does not share Evo-Devo_{GEN}'s strongly geneticist assumptions.

If the reduction of the role of genetic endowment raised by MP is considered, in order to draw analogies between Evo-Devo and the minimalist BA an Evo-Devo theory rejecting gene-centrism and the notion of genetic program should be chosen. Such an Evo-Devo theory could well be Developmental Systems Theory (henceforth, DST; see Oyama 1985, 2000, Oyama *et al.* 2001b; see also Longa 2008 and Lorenzo & Longa 2009 for a implementation of the minimalist framework from the DST view).

DST is a general theoretical perspective on development, heredity, and evolution, according to which the need exists to reduce the importance that genes were traditionally given. According to DST, development does not entail any kind of pre-existing genetic program; genes are not the source of the form. Quite the opposite: Genes are just one of many developmental resources. Therefore, DST rejects the idea that genes are endowed with any special directive power.¹⁴ The main notion of DST is that of 'developmental system', which is to be understood as the overall collection of heterogeneous influences on development.

DST's key idea is represented by the so-called 'parity thesis': "Parity is the idea that genes and other material causes are on a par" (Griffiths & Gray 1998: 254), this thesis having its source in Oyama's (1985: 201) 'parity of reasoning'. According to DST, development arises from interaction between a wide number of heterogeneous resources and factors, all of them necessary (not only genetic ones) for development to take place.¹⁵ Accordingly, it is not possible to provide genes with any special formative power, nor is it possible to consider that genes contain the master plan of the organism either (on DST features, see Oyama *et al.* 2001a, Robert *et al.* 2001, Robert 2003b, or Longa 2006, 2008). DST contends that phylogeny is simply the derivational history of developmental systems (Oyama 1985: 179), and is explainable through a progressive modification of those systems.

We think that DST seems more promising than Evo-Devo_{GEN} for drawing analogies with the minimalist BA. Anyway, DST is not the only Evo-Devo theory suitable for approaching such an objective. Other Evo-Devo theories could be suitable for such a task; for instance, the view represented by West-Eberhard (2003), which relies on the concept of phenotypic plasticity. According to Walsh (2007: 193), such an approach "reverses the causal priority of genotype over phenotype in evolution that is the cornerstone of sub-organismal, replicator interpretation of the modern synthesis. Phenotypic novelties are initiated in development and not by mutation."

¹⁴ As Oyama (2000: 118) puts it, "a gene is a resource among others rather than a directing intelligence that uses resources for its own ends".

¹⁵ In this sense, the third factor deserves careful consideration because it widens the 'conventional interactionism', to put it in Oyama's (2000) term, between genes and environment which traditionally characterized Generative Grammar; see Lorenzo & Longa (2009).

8. Conclusion

This paper has aimed to show that the analogies between the minimalist BA and the Evo-Devo version adopted by Chomsky (Evo-Devo_{GEN}) do not seem applicable to the minimalist BA. Evo-devo_{GEN} is a gene-centric theory, and its essence does not agree at all with the reduction of the power attributed to genes that MP has placed on the agenda. In order to establish more productive analogies, it would be necessary to adopt another Evo-Devo version that, at least, assumes the parity thesis. This is not made by the approach represented by Sean Carroll. If the minimalist BA is to be seriously considered, our conclusion is clear: Evo-Devo, of course, but not Evo-Devo_{GEN}.

To put it in other words, Boeckx (2006: 10) wrote that minimalism “may well turn out to provide remarkable support for a silent revolution in biology (often called the Evo Devo revolution)”. We strongly agree, but we believe that minimalism will not provide any kind of support for Evo-Devo_{GEN}.

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The Cartography of Ibero-Romance Agrammatic Deficits

Silvia Martínez-Ferreiro

This paper aims at examining whether grammatical errors produced by Broca's aphasics are a consequence of a selective impairment of functional categories in three closely related Ibero-Romance languages — Catalan, Galician, and Spanish — for which almost no work had hitherto been done. In addition, a reinterpretation will be proposed under cartographical terms (Cinque 1999, 2002, 2006, Belletti 2004, Rizzi 2004) of previous structural neurolinguistic models of agrammatic production, more specifically the Tree-Pruning Hypothesis (Friedmann 1994, Friedmann & Grodzinsky 1997, and subsequent work). Cartography has been applied to the field of language variation. However, the present article constitute a completely new use. Since the Tree-Pruning Hypothesis was based on a model of monolithic nodes, the application of the cartographic tree structure provides us with further insights about the degree of structural preservation or damage of functional categories.

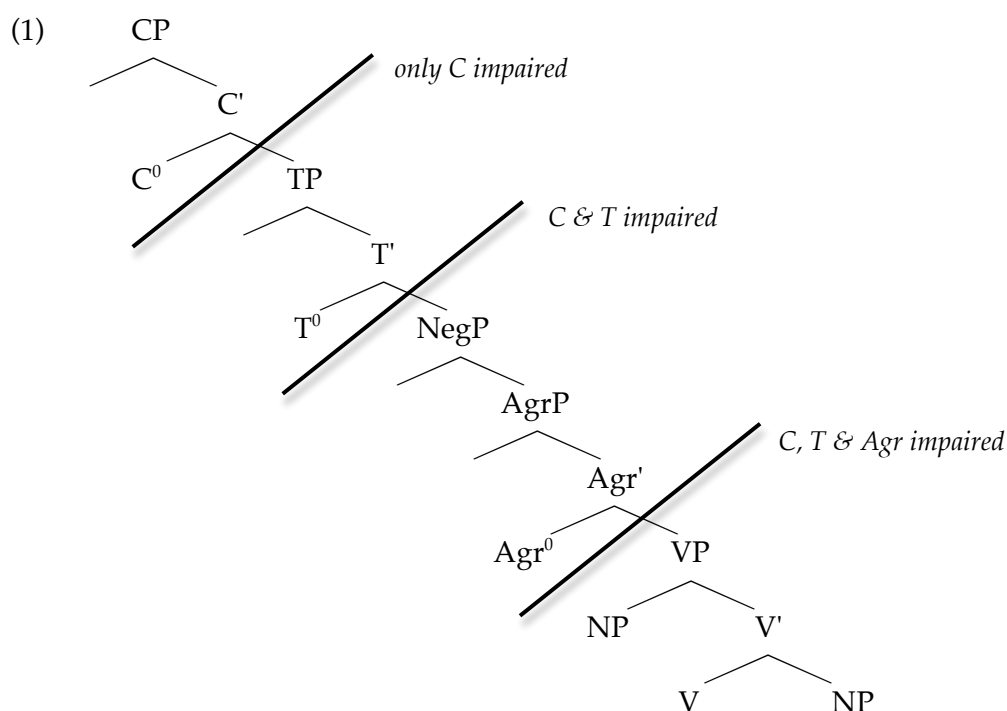
Keywords: Broca's aphasia; cartographic syntax; Catalan; functional categories; Galician; mild and moderate agrammatism; Spanish

1. The Departure Point

The departure point is the Tree-Pruning Hypothesis (TPH) of Friedmann (1994, 1998), Friedmann & Grodzinsky (1997, 2000), and much subsequent work. This hypothesis was first proposed after the observation of a clear dissociation between tense and agreement production in Hebrew and Palestinian Arabic agrammatic speakers. While tense was found to be impaired, agreement turned out to be spared in agrammatic subjects. This dissociation was accounted for in structural terms. According to the TPH, the functional heads C, T, or Agr may be underspecified in agrammatism. According to the authors, an underspecified node cannot project any higher (Friedmann & Grodzinsky 1997: 420). The possible sites of the deficit are represented in (1).

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In this study, the tree structure illustrated above will be enriched according to cartographic proposals. Consequently, the traditional CP and TP nodes will be seen as complex arrays of functional projections as illustrated in (2) for the IP-field, in (3) for the clause-internal periphery, and (4) for the CP-field.

(2) *Cinque's (2006) inflectional hierarchy*

MoodP_{speech act} > MoodP_{evaluative} > MoodP_{evidential} > ModP_{epistemic} > TP_(past) >
 TP_(future) > Mood_{irrealis} > ModP_{alethic} > AspP_{habitual} > AspP_{delayed (or 'finally')} >
 AspP_{predispositional} > AspP_{repetitive (I)} > AspP_{frequentative (I)} > ModP_{volitional} >
 AspP_{celerative (I)} > TP_(Anterior) > AspP_{terminative} > AspP_{continuative (I)} > AspP_{perfect} >
 AspP_{retrospective} > AspP_{proximative} > AspP_{durative} > AspP_{progressive} > AspP_{prospective} >
 AspP_{inceptive (I)} > ModP_{obligation} > ModP_{ability} > AspP_{frustrative/success} >
 ModP_{permission/ability} > AspP_{conative} > AspP_{completive (I)} > VoiceP > PerceptionP >
 CausativeP > AspP_{inceptive (II)} > (AspP_{continuative (II)}) > AndativeP > AspP_{celerative (II)} >
 AspP_{inceptive (II)} > AspP_{completive (II)} > AspP_{repetitive (II)} > AspP_{frequentative (II)}
 (Cinque 2006: 12, 76, 82, 93)

(3) *Belletti's (2004) clause internal periphery*

TopP > FocP > TopP > *v*P

(4) *Rizzi's (1997, 2002) CP-field*

ForceP > (*TopP >) IntP > (*TopP >) FocP > (*ModP >) (*TopP >) FinP

2. Participants

To get the relevant data for our approach, 23 mild agrammatic speakers of Catalan, Galician, and Spanish plus one moderate Catalan agrammatic took part in a battery of tasks assessed to test different portions of a fully fledged functional structure; all participants were diagnosed as Broca's, mixed transcortical, and global aphasics. The battery of tests, which included eight tasks, was run in two experimental sessions involving 15 mild agrammatics (five per language), 15 controls (again, five 5 per language) and the one Catalan moderate agrammatic.¹

In session one, negation of simple tenses, negation of compound tenses and verbal periphrases, question production, and the production of relative clauses were tested. With the exception of CM, treated as a case study to control for the role of severity in agrammatic deficits, the participants in session one (10 men and five women) were classified as mild agrammatics by clinical consensus and varied in age between 27 and 83 years, with an average of 55 years. Time post-onset varied from one month to 11 years.

In session two, we tested clitic production, clitic comprehension, tense comprehension and comprehension of questions. 12 men and four women, all right-handed and with an age ranging from 29 to 82 years (mean age: 55.5), participated in the study: 15 mild agrammatic subjects plus one Catalan moderate agrammatic. Again with the exception of CM, all subjects were diagnosed as mild agrammatics with a time post-onset varying from one month to 9 years.

Despite the fact that all experimental subjects declared themselves bilingual Catalan-Spanish or Galician-Spanish to a varying degree, they were tested as monolinguals in the language of their choice. Consequently, no bilingual data is presented here. However, possible interferences were taken into account in the analysis of the results. Individual profiles including age, gender, education, etiology, time post-onset, and diagnosis have been plotted in the appendices A and B.

In addition to the brain-damaged group, 15 control subjects (five Catalan, five Galician, and five Spanish speakers) were recruited from the areas of Barcelona and Pontevedra, all right-handed; eight men and seven women. The age ranged from 45 to 85 years old (mean: 53.6) and the level of education also varied across subjects. Four subjects had completed primary school, seven secondary school, and four had received university education. All subjects declared themselves to be bilingual Catalan-Spanish or Galician-Spanish.

3. The IP-Field

In order to get a better insight into the inner organization of the IP-field and to check how agrammatic data can contribute to further confirm the ordering restrictions of the functional categories proposed by cartographic proposals, we have analyzed data involving different sections of the IP-area. Despite a major

¹ Only seven mild agrammatic participants could participate in both experimental sessions. Control subjects and the moderate agrammatic subject were kept constant for the entire battery of tests.

focus on production, some comprehension tasks have also been run to assess participants' performance aiming at a unified account across modalities.

3.1. *Negation*

Contrary to what is observed for multiple functional elements, where evidence shows a very robust pattern cross-linguistically, negation in agrammatism has given rise to a lot of debate due to conflicting evidence documented in the literature. While it has been found to be spared in Japanese (Hagiwara 1995), Hebrew and Palestinian Arabic (Friedmann & Grodzinsky 2000), and French (Lonzi & Luzzatti 1993), some studies report that it is damaged in English (Rispen *et al.* 2001).

To check the degree of preservation of negation in agrammatic Ibero-Romance, we ran a production task including 25 items containing simple tenses (simple present, imperfect, simple future) plus 25 items with complex forms and verbal periphrases. Such a design allowed not only to test production skills with respect to negation but also to check repetition skills for tense and agreement as well as complex verbal clusters.

As illustrated in examples (5) and (6) from Galician, subjects were asked to negate the declarative sentence produced by the experimenter. To do so, a negative marker had to be added to the given structure with no other modification required.

- (5) Os nenos actuaban o martes. *Galician*
the boys perform.IMP.3.PL the Tuesday
 'The boys were performing on Tuesday.'

Target answer:

Os nenos non actuaban o martes.
the boys not perform.IMP.3.PL the Tuesday
 'The boys were not performing on Tuesday.'

- (6) Vós destes en frega-los pratos. *Galician*
you take.PRET.2.PL in wash.INF-the dishes
 'You took to washing the dishes.'

Target answer:

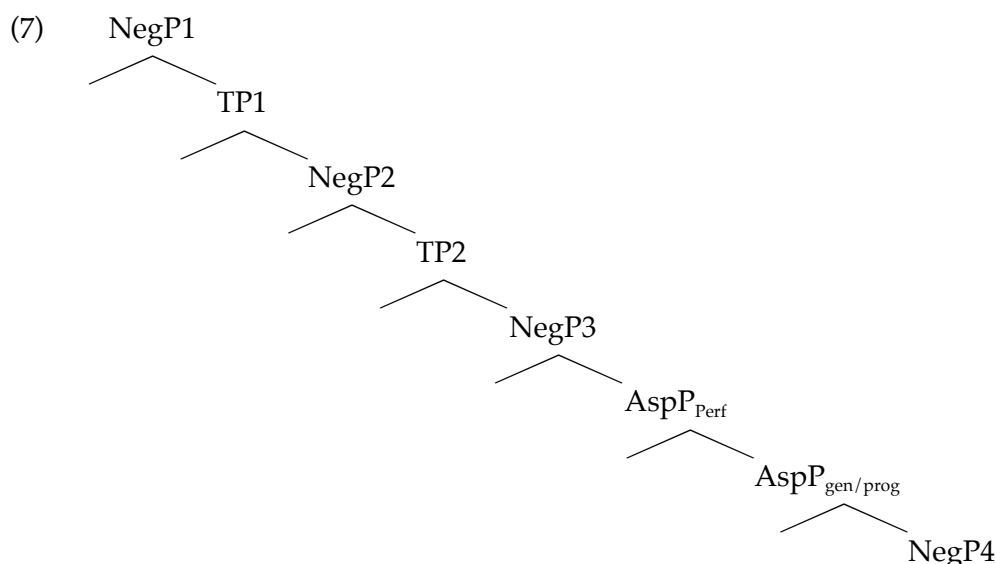
Vós non destes en frega-los pratos.
you not take.PRET.2ND.PL in wash.INF-the dishes
 'You didn't take to washing the dishes.'

The results of these tasks, summarized in Table 1, show that, despite its functional nature, negation is mostly spared for mild agrammatics. Though cross-linguistic differences with the control group proved to be significant, correct responses in the experimental group were as high as 97.5%.

	<i>Simple tenses</i> (correct/total)	<i>Complex tenses</i> (correct/total)
Catalan	99.2% (124/125)	99.2% (124/125)
Galician	97.6% (122/125)	96.8% (121/125)
Spanish	98.4% (123/125)	93.6% (117/125)
Total	98.4% (369/375)	96.5% (362/375)

Table 1: Negation of simple and compound tenses

The main error type we documented was the omission of the negative marker. To account for our results under the terms given by the TPH, we have to adopt an account based on the low generation position of negation, thus justifying its preservation. To do so, we will assume the complex system of positions postulated by Zanuttini (2001) and claim that agrammatic subjects can construct their negative structures relying on NegP4, situated in the lower portions of the IP-field.



3.2. Tense and Agreement

After testing negation, we proceeded with immediately close portions of the IP-area, those for tense. In order to assess the performance of the agrammatic participants on tense and agreement, we analyzed the results of the negation task as for participants' accuracy in repeating the finite tense (simple present, imperfect, and simple future with first and third person singular and plural agreement) in sentences containing four to five words. The production results, summarized in Table 2, show that, while tense is damaged (with an error rate of 14.6% across languages), agreement is spared (2.5%). This dissociation turned out to be significant in a Wilcoxon signed rank test ($Z = -3.318$, $p < 0.01$). No differences were found across languages. As for agreement, statistically significant differences with the control group were not found.

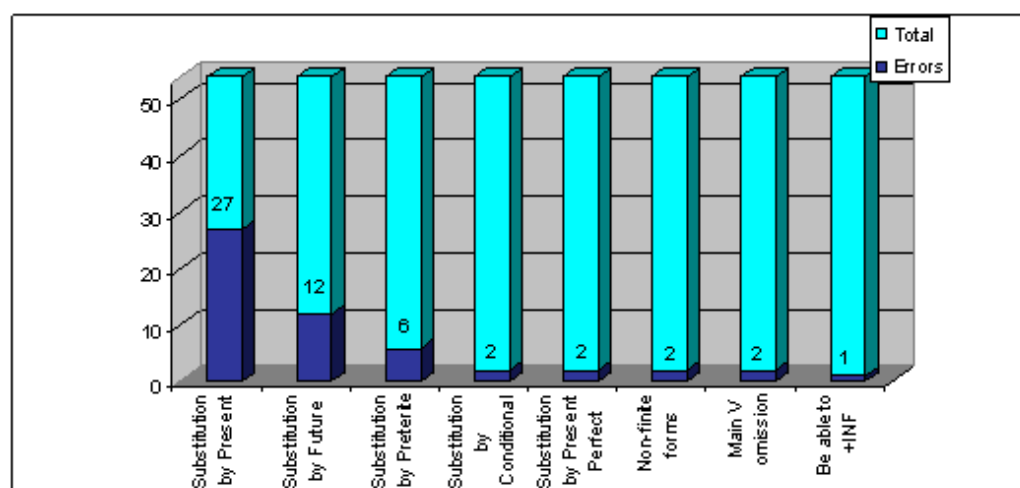
	<i>Tense</i> (correct/total)	<i>Agreement</i> (correct/total)
Catalan	85.5% (106/124)	94.3% (117/124)
Galician	84.4% (103/122)	99.2% (121/122)
Spanish	86.4% (108/125)	99.2% (124/125)
Total	85.4% (317/371)	97.5% (362/371)

Table 2: Repetition of tense and agreement

Despite being extracted from a repetition task, the results show a clear parallel with those documented in previous studies (Martínez-Ferreiro 2003, Gavarró & Martínez-Ferreiro 2007). The TPH provides us with exact predictions regarding the behavior of agreement, which is expected to be relatively spared. The fact that agreement is cross-linguistically less impaired than tense indicates that the two functional categories behave differently in agrammatism. In this work, along with Chomsky (1995 *et seq.*), we assume that AgrP is no longer an independent functional node but rather an operation taking place in a designated position lower than TP_(past) (Gavarró & Martínez-Ferreiro 2007).

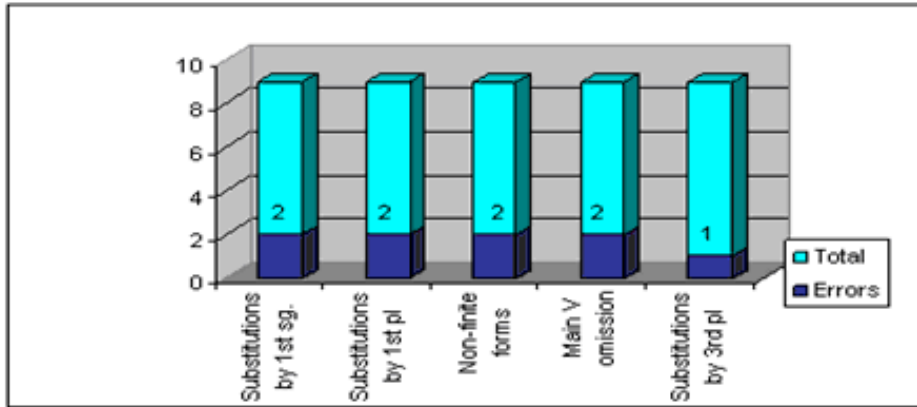
Regarding the nature of the errors, most were substitution errors being omissions restricted to the drop of the complete verbal form.² While tense errors revealed a consistent tendency towards the forms of the simple present (see Graph 1 below), the number of agreement errors was so scarce, that no default form was documented (as in Graph 2).

In addition to these results, substitutions of a finite verb by a non-finite verb form and main verb omissions were strikingly scarce. No non-finite forms were detected in Galician or Spanish and, in the case of Catalan, only two examples were registered. Participants also produced two omissions of lexical main verbs: one in the Catalan sample and the other in the Galician sample (representing 0.5% of the total number of errors).



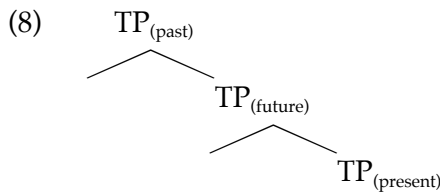
Graph 1: Tense substitutions in agrammatic Ibero-Romance

² Since the three languages under investigation display a stem-based morphology, omission of tense or agreement markers is banned (Grodzinsky 1990).



Graph 2: Agreement substitutions in agrammatic Ibero-Romance

Going back to tense errors, the present was not only the better preserved form (6% errors in Catalan and 2% in Galician and Spanish) but also the most productive form for substitution (62.8% of errors), followed by the future (27.9% of errors) and the past tense (9.3% of errors).³ Structurally, although Cinque's hierarchy does not provide us with a specific functional head for present tense, the results seem to point to the ordering in (8), where the present would occupy a low position in the TP-field. The assumption of the present as the default form in a framework just sensitive to the [\pm past] distinction would not predict the preference for future forms vs. past forms.⁴



In addition to the production results, we also tested participants' abilities for tense recognition by means of a comprehension task which included 25 items with simple tenses (simple present, imperfect, simple future). Items paralleled the structure of those included in the repetition task with a length of four to five words. After hearing a sentence read by the experimenter, participants were asked to select the right match among the stimulus visually presented; both example sentence and stimulus picture are provided in (9).

- (9) El chico abrió el bote.
the boy open.PAST.3.SG the jar
 'The boy opened the jar.'

Spanish



³ This error pattern (present > future > past) has also been documented for other languages such as Greek (Koukouloti & Bastiaanse 2010).

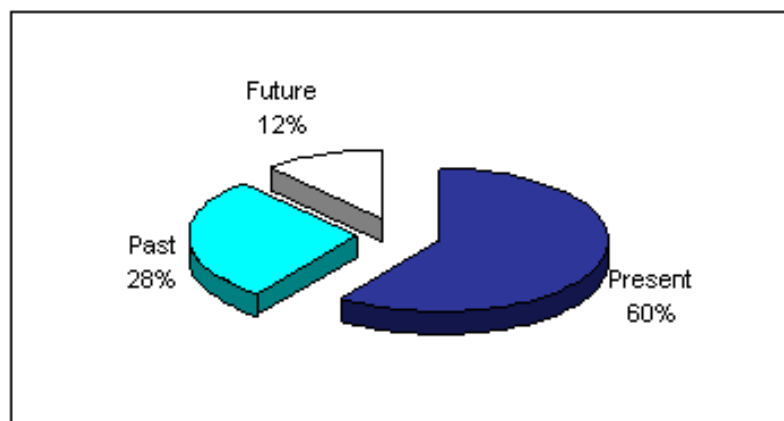
⁴ I am grateful to one of the reviewers for comments on this issue.

The results indicate that comprehension is also affected in mild agrammatics.

<i>Tense Comprehension</i> (correct/total)	
Catalan	82.4% (103/125)
Galician	86.4% (108/125)
Spanish	83.2% (104/125)
Total	84.0% (315/375)

Table 3: *Tense comprehension*

As illustrated in Table 3, out of 125 responses per language, there were 17.6% errors in Catalan, 13.6% in Galician, and 16.8% in Spanish. Misidentifications, as in the case of production, mainly leaned towards the present according to the ordering $TP_{(past)} > TP_{(future)} > TP_{(present)}$. This is illustrated in Graph 3:



Graph 3: *Tense misidentifications in Ibero-Romance agrammatic comprehension*

The statistical analysis revealed no significant differences between production and comprehension (Wilcoxon Signed Rank test, $p > 0.05$) even though the chance of providing the correct answer varied across tasks. While in the repetition tasks, subjects could opt for up to 6 simple tenses in indicative — simple present, simple past (except for Catalan in which this form is analytic), imperfect, pluperfect (only in Galician), simple future, and simple conditional — in the comprehension task, the chance probability was one in three (i.e. simple present, simple future, simple past).

3.3. *Modals, Aspectuals, and Temporal Auxiliaries*

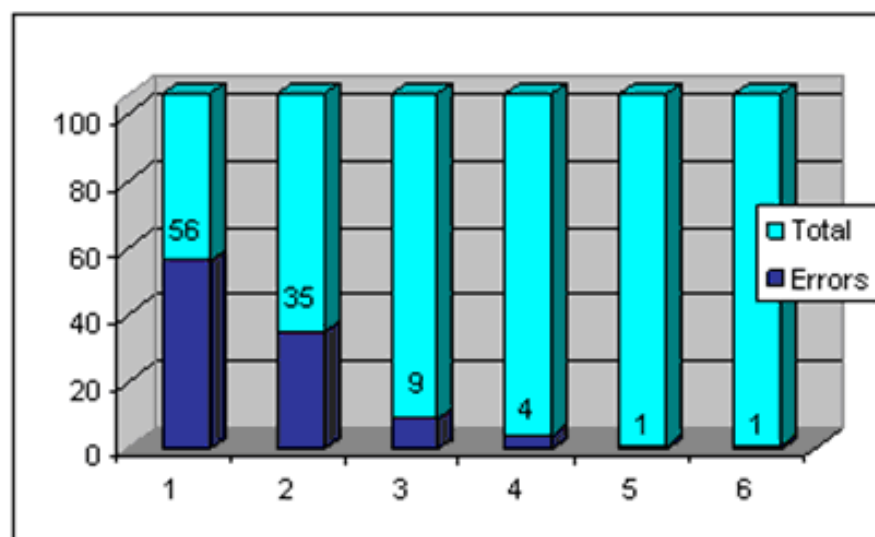
The next step towards the characterization of the agrammatic Ibero-Romance IP-field was to observe the repetition skills displayed by both our pathological and our control sample with respect to complex verbal forms. To that aim, we took our evidence from the negation task. Since Galician lacks compound tenses, the

	<i>Verbal periphrases</i> (correct/total)
Catalan	51.7% (31/ 60)
Galician	56.0% (70/125)
Spanish	63.3% (38/ 60)
Total	56.7% (139/245)

Table 5: Repetition of verbal periphrases

The results indicate a clear increase in the number of errors with modal and aspectual auxiliaries (57% preserved across languages, 138 out of 245 responses) with respect to tense (15% errors) and with respect to temporal auxiliaries (18.5% errors), even though statistical differences (at a 5% level) were only found for Galician.

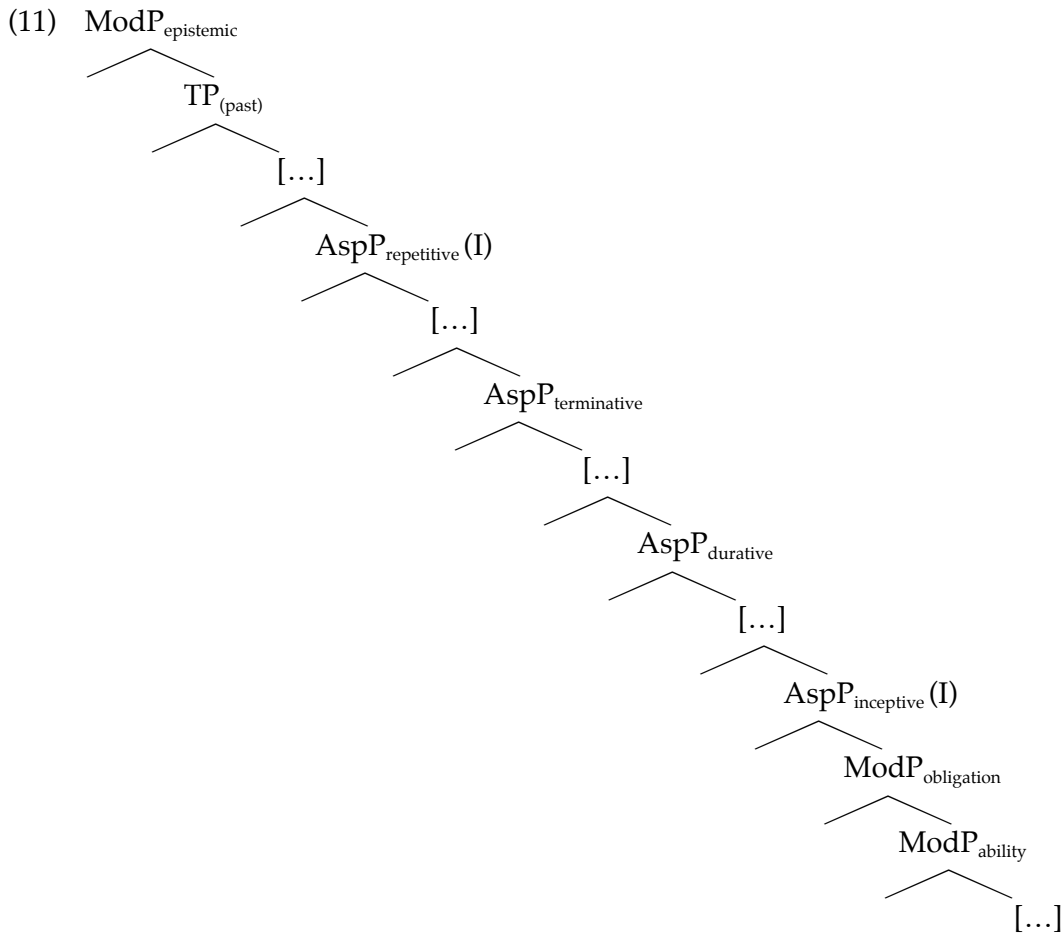
Regarding the nature of errors, 79.2% had to do with a simplification of the verbal cluster. A detailed analysis according to frequency is given in Graph 4:



1. Simplification of complex verbal clusters
2. Simplification of complex verbal clusters + T substitution
3. "Don't know" responses
4. Tense substitutions
5. Simplification + T/Agr substitution
6. T/Agr substitution

Graph 4: Errors in the repetition of periphrastic forms

Items included in the experimental design covered the categories illustrated in (11) following Cinque (2006). In the Catalan and Spanish tests, 12 items denoting aspect terminative (n=4), durative (n=2), inceptive (n=1), mood obligation (n=3), mood ability/possibility (n=1), and a mixed form mood/aspect were included. In the Galician version, items were distributed as follows: aspect repetitive (n=4), aspect terminative (n=5), durative (n=3), inceptive (n=5), mood obligation (n=6), mood ability/possibility (n=1), and a mixed form mood/aspect.



Errors were broken down by category and summarized in Table 6:

		5 Catalan & 5 Spanish subjects (correct/total answers)	5 Galician subjects (correct/total answers)
Aspectuals	Repetitive	—	60.0% (12/20)
	Terminative	67.5% (27/40)	60.0% (15/25)
	Durative	30.0% (6/20)	40.0% (6/15)
	Inceptive	70.0% (7/10)	60.0% (15/25)
Modals	Obligation	60.0% (18/30)	53.3% (16/30)
	Ability/Possibility	50.0% (5/10)	40.0% (2/ 5)
Modals/ Aspectuals		60.0% (6/10)	80.0% (4/ 5)

Table 6: Modals and aspectuals

These results do not seem to support Cinque's hierarchy with respect to modal and aspectual heads. However, it might also be the case that portions of the structure including immediately consecutive functional categories (as in the case of modals and aspectuals) may be damaged 'as a block' without reflecting an increasing level of difficulty — in line with Chinellato's (2002) Field Damage Hypothesis. Further testing may provide a better understanding on this specific issue.

3.4. Clitics

The last category observed in the IP-area was that constituted by clitics, including both object clitics and reflexive forms. In order to check how agrammatic deficits affected the highest portions of the IP, we tested both our experimental and our control populations for their production and comprehension skills.

The languages under investigation show considerable formal variation at this respect. While in Catalan and Spanish, reflexive and non-reflexive clitics appear in pre-verbal position with finite and post-verbally with non-finite forms and imperatives (12), in Galician, they tend to appear in post-verbal position (13).

- (12) a. *Reflexive:*
S'ha vist. / Veure's. Catalan
Se ha visto. / Verse. Spanish
 'She has seen *herself*.' / 'To see *herself*.'
- b. *Non-reflexive:*
La vigilava. / Vigilar-la. Catalan
La vigilaba. / Vigilarla. Spanish
 'I/He/She watched over *her*.' / 'To watch over *her*.'
- (13) a. *Reflexive:*
Viuse. / Verse. Galician
 'She has seen *herself*.' / 'To see *herself*.'
- b. *Non-reflexive:*
Vixiábaa. / Vixiala. Galician
 'I/He/She watched over *her*.' / 'To watch over *her*.'

Exceptions to the Galician enclitic pattern can be found with negation, with most subordinate constructions, with quantifiers, and with focalizations. In addition, in infinitival clauses, there are contexts in which both patterns appear in free variation (Uriagereka 1995, Raposo & Uriagereka 2005).

In order to be properly uttered, clitics, with independence of their position in relation to the verb, crucially depend on the projection of a functional projection residing between the CP- and the IP-areas — namely F (Ledgeway & Lombardi 2005, Raposo & Uriagereka 2005). To obtain production data that allow us to test the behavior of these forms in agrammatic speech, we ran an elicited production task with the support of pictures that included 13 items aimed at eliciting object clitics (14) plus 12 items for reflexive forms (15).

- (14) Quéfai o mozo co coche? Galician
what do-PRES.3RD.SG the teenager with-the car
 'What is the teenager doing with the car?'
- Target answer:
 (O mozo) lávao.
the teenager) wash-PRES.3RD.SG-IT
 'The teenager/He is washing it.'

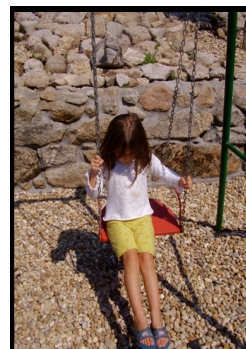


- (15) Qué fai a nena co bambán?
what do-PRES.3RD.SG the girl with-the swing
 'What is the girl doing with the swing?'

Galician

Target answer:

- (A nena) bambéase.
the girl swing-PRES.3RD.SG-herself
 'The girl/She is swinging.'



The comprehension task was a sentence-picture matching task again including 13 items for object clitics and 12 items for reflexive forms supported by pictures. These items were parallel in structure to those included in the production task as for number of words and clitic position. An example is given in (16):

- (16) La hermana mayor la suena.
the sister older her blow-PRES.3RD.SG
 'The older sister is blowing her (younger) sister's nose.'

Spanish



The general results have been summarized in Tables 7 and 8:

	<i>Object clitics</i> (correct/total)	<i>Reflexive pronouns</i> (correct/total)
Catalan	40.0% (26/ 65)	83.3% (50/ 60)
Galician	53.8% (35/ 65)	83.3% (50/ 60)
Spanish	30.8% (20/ 65)	88.3% (53/ 60)
Total	41.5% (81/195)	85.0% (153/180)

Table 7: Clitic production

	<i>Object clitics</i> (correct/total)	<i>Reflexive pronouns</i> (correct/total)
Catalan	92.3% (60/ 65)	93.3% (56/ 60)
Galician	81.5% (53/ 65)	93.3% (56/ 60)
Spanish	93.8% (61/ 65)	90.0% (54/ 60)
Total	89.2% (174/195)	92.2% (166/180)

Table 8: Clitic comprehension

Clitics were found to be compromised, albeit to a varying degree. A significant dissociation was found between object clitics and reflexives in production: While reflexives reached a maximum correctness rate of 85% for all three languages, object clitics were more severely impaired. Significant differences between object clitics and reflexive pronouns ($Z = -3.409$, $p < 0.01$) were found in a Wilcoxon Signed Rank test.

Comprehension results show that, despite impairment with respect to controls, the percentages of correct responses are higher than those for production. But, as happened with the results for tense, the fact that the pattern of errors is shared — with 3rd person object clitics more severely affected than reflexive forms — has implications for the picture of agrammatism offered in studies like Grodzinsky (1990, 2000) or Friedmann & Grodzinsky (1997), where production is characterized in a way completely different from comprehension. In agreement with Luzzatti & Guasti (2000) and Friedmann (2006, 2008), the proper description of the deficit should hold across modalities.

However, a possible strategy allowed by the design can have favored the interpretation of object clitics. As shown in (16), the materials included a picture with one participant and a picture with two participants. If it was the case that participants suffer from a general deficit across reflexive and non-reflexive forms, they would not get any information regarding the clitic and be left with a partial utterance (e.g., *the girl wash* — neither her nor herself). Such a move would have favored the selection of the option with the two participants and, as a consequence, fewer errors in object pronouns and a higher number of errors in the interpretation of the reflexive forms would have been detected. Nevertheless, our production task indicates that reflexive forms are preserved cross-linguistically up to 85%, meaning that participants would have more chances to correctly identify the reflexive form than the object clitic (e.g., *the girl wash* — either her or \emptyset). This would explain the 92.2% correct comprehension of reflexive forms and, since the absence of clitic would still lead to the selection of the picture with two participants (in this case the correct answer), the dissociation in between object clitics in production and comprehension.⁶

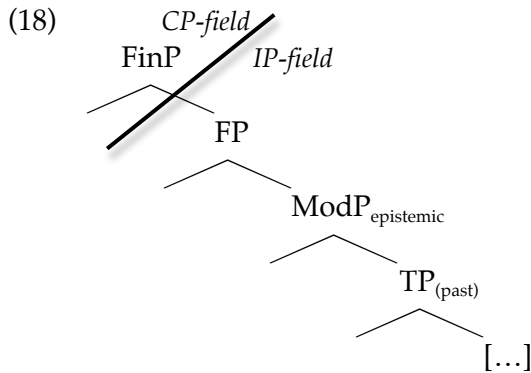
As for the nature of errors, out of the 141 errors, 82% of the agrammatic responses lacked a clitic. A list of errors in order of decreasing frequency is provided in (17):

- (17)
- | | | |
|----|-------------------------------------|---|
| 1. | Repetition of the given DP (53/141) | |
| 2. | Clitic omission (46/141) | Object clitics (29/46)
Reflexive pronouns (17/46) |
| 3. | Wrong clitic selection (17/141) | |
| 4. | Wrong answer (14/141) | |
| 5. | Clitic doubling (5/141) | |
| 6. | Clitic reduplication (4/141) | Duplication of the reflexive (3/4)
Reflexive <i>se</i> + DO clitic (1/4) |
| 7. | “Don’t know” responses (2/141) | |

⁶ I am grateful to one of the anonymous reviewers for useful comments on this issue.

Additionally, despite the fact that these forms are attached to the verb enclitically in the case of Galician and proclitically in Catalan or Spanish, neither differences among languages nor ordering errors were attested.

The high structural portions of the syntactic tree involved in the production of clitics (18) — relatively higher than verb morphology — make them susceptible to impairment, as predicted by the TPH (Friedmann 1994 *et seq.*).

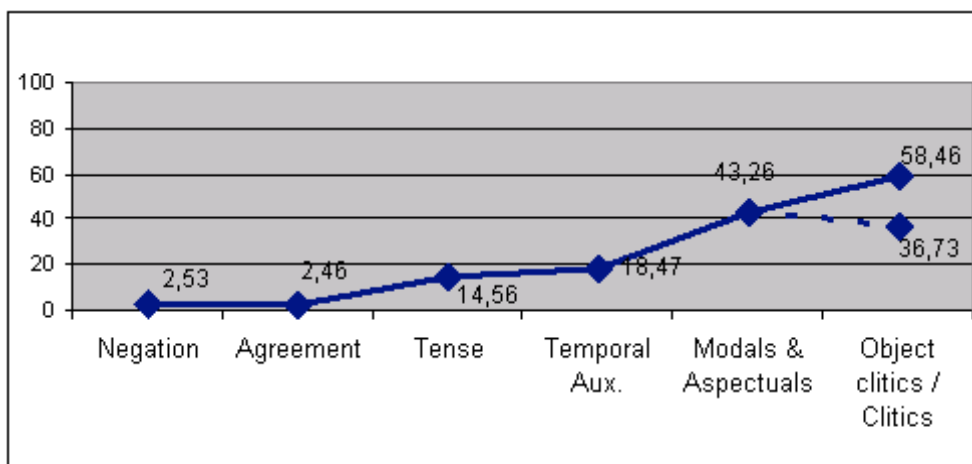


However, structural considerations would not explain the dissociation observed between clitic forms. Since the structural position would be the same for reflexives and object clitics (Uriagereka 1995) — be they enclitic or proclitic —, the dissociation may be attributed to: (i) absorption of one argument in the case of reflexive forms (Belletti 1982, Grimshaw 1982, among others), (ii) the licensing of a *pro*-object in the case of 3rd person object clitics (e.g. Jaeggli & Safir 1989), or (iii) the existence of inherently reflexive lexical entries for some verbs (Reinhart & Reuland 1993) or the cluster reflexive + verb as a result of a lexical operation (not a syntactic one, hence not susceptible to impairment in agrammatism).

4. Summary of Findings — IP-Field

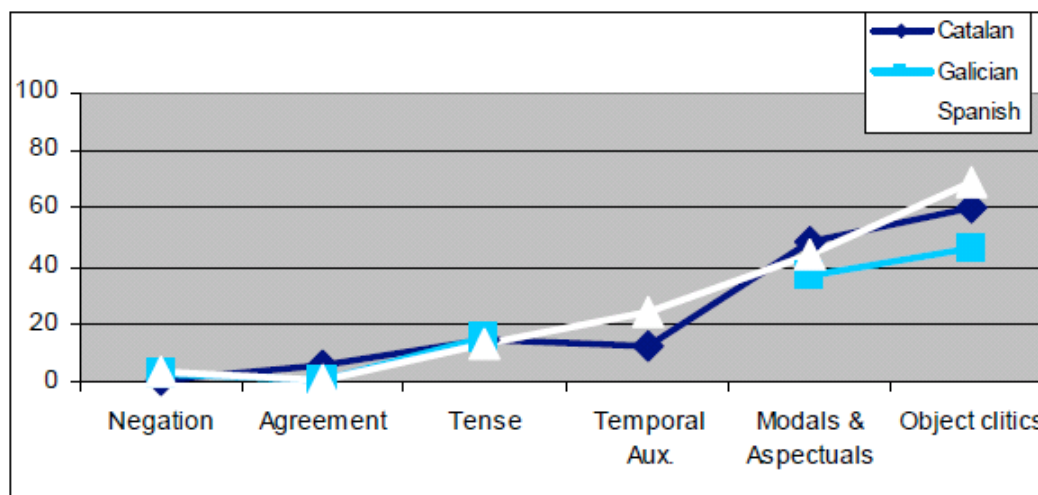
At this point, before abandoning the IP-domain, we can draw some interim conclusions. According to the summary of the mild agrammatic data represented in Graph 5, the IP-field of Ibero-Romance agrammatics is selectively impaired. The pattern of damage, attributed to syntactic factors, can be accounted for in structural terms.

Graph 5: Ibero-Romance mild agrammatic errors in the IP-field



*The dotted blue line indicates combined results for object clitics and reflexive forms.

The results also show a striking similarity among Ibero-Romance varieties, confirmed by statistical tests (Graph 6). This is attributed to the similarity in the grammatical system of the three languages under investigation.



Graph 6: Ibero-Romance mild agrammatic production

Both Graph 5 and Graph 6 confirm that there is an increasing percentage of errors as a function of the structural position an element occupies in the syntactic tree, with relatively low functional categories better preserved than higher ones. For mild subjects, almost completely spared abilities were detected for sentential negation and agreement, but high error rates were documented for modals, for aspectuals, and for object clitics.

The data are consistent with a structural account along the following lines — with agreement as an operation taking place in positions lower than $TP_{(past)}$:

- (19) Clitics > Mod_{epistemic}
 > Asp_{durative}
 > Asp_{terminative}
 > Mod_{permission/ability}
 > Mod_{obligation}
 > Asp_{inceptive}
 > Asp_{repetitive}
 > T_(past) [temporal auxiliaries]
 > Neg

Agrammatism offers an argument for the low position of both $T_{(pres)}$ and Neg in a cartographically developed tree structure.

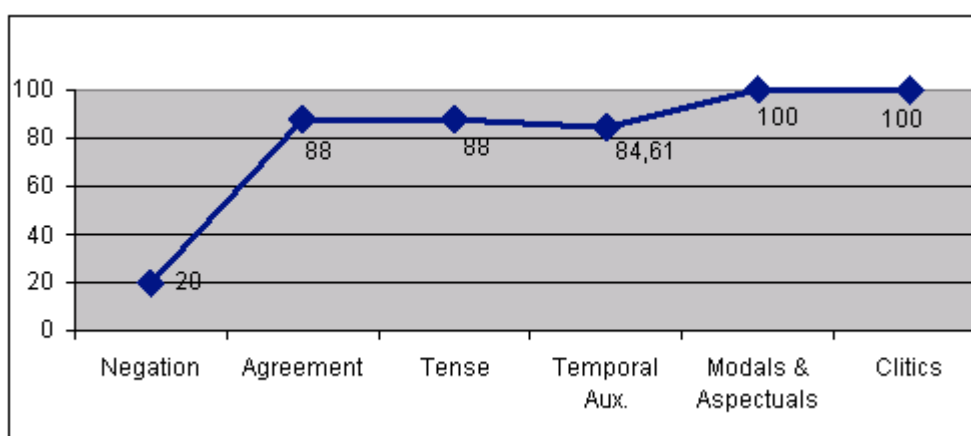
Our findings were also replicated with a moderate agrammatic subject. As expected by hypothesis, the pattern of deficit turned out to be the same as that for his mild agrammatic counterparts but with increased percentages of errors. The results are summarized in Table 9 and Graph 7.⁷

⁷ Notice that, as in sections 6 and 7 below, the performance of the moderate population is only based on the data from one Catalan moderate agrammatic speaker.

PRODUCTION			
	<i>% errors</i>	<i>Main error type</i>	<i>Task</i>
Negation	20.0%	"Don't know"	elicited production
Agreement	88.0%	MV omissions	repetition
Tense	88.0%	MV omissions	repetition
Temporal auxiliaries	84.6%	MV omissions	repetition
Modals & aspectuals	100%	MV omissions	repetition
Clitics	100%	omissions	elicited production

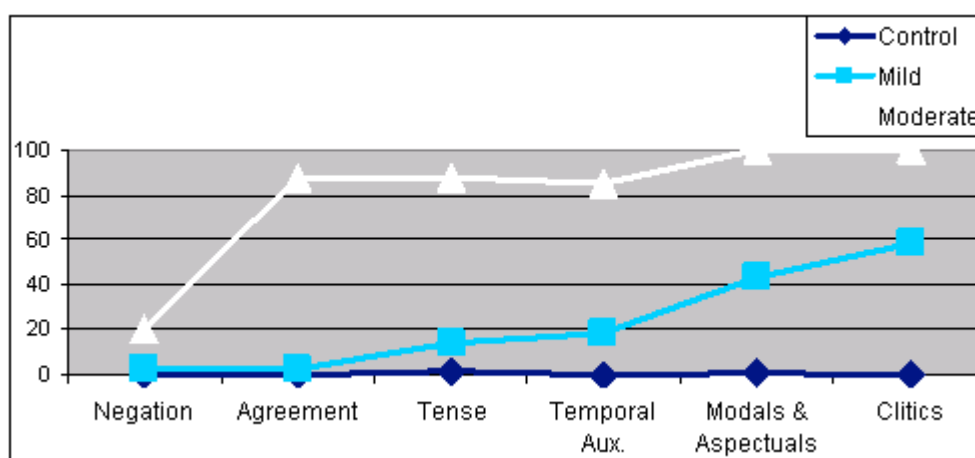
COMPREHENSION			
	<i>% errors</i>	<i>Main error type</i>	<i>Task</i>
Tense	52.0%	select wrong picture	sentence-picture matching
Clitics	36.0%	select wrong picture	sentence-picture matching

Table 9: Moderate agrammatic IP-field



Graph 7: Ibero-Romance moderate agrammatic errors in the IP-field

Graph 8, finally, summarizes the IP-field of the three populations under investigation.



Graph 8: Degrees of severity in agrammatic Ibero-Romance

5. The CP-Field

So far, we have assumed the TPH and sentential structure proposed by cartographic approaches to the syntactic representation (Cinque 1999 and further collected in Cinque 2002, 2006, Belletti 2004, and Rizzi 2004, for example) and provided evidence for the inner structure of the IP-field based on agrammatic Ibero-Romance. In this section, we will focus on the structures crucially depending on the left peripheral area. Two constructions will be investigated: interrogatives and subject embeddings.

5.1. Interrogative Sentences

In order to obtain data on question production, we ran an elicitation task which included 25 items: 13 aimed at eliciting a *wh*-question and 12 designed to force yes/no-questions. In addition, *wh*-questions were controlled for their distribution in seven adjunct and six argument questions as well as for the methodology used to elicit them.

Two types of tokens were introduced in the design. Based on Friedmann & Grodzinsky (2000), type I tokens did not include the *wh*-word in the instructions given by the experimenter (20), while in type II tokens, inspired by Crain & Thornton (1998), participants were presented with the *wh*-word (21). An example of the elicitation method for yes/no-questions is reproduced in (22).

- (20) Vou ir a algures e ti queres sabe-la data.
go.PRES.1.SG go.INF to somewhere and you want.PRES.2.SG know-INF-the date
 'I am going to go somewhere and you want to know the date.'

Target question:

Galician

Cando vas ir?
when go.PRES.2.SG go-INF
 'When are you going to go?'

- (21) Juan busca una cosa y tú quieres saber lo qué.
John search.PRES.3.SG a thing and you want.PRES.2.SG know-INF CL what
 'John is looking for something and you want to know what.'

Target question:

Spanish

¿Qué busca Juan?
what search.PRES.3.SG John
 'What is John looking for?'

- (22) Puede que Pedro toque el piano, pregúntamelo.
maybe that Peter play.PRES.SUBJ.3.SG the piano ask.IMP.2.SG.CL.CL
 'Maybe Peter plays the piano, ask me.'

Target question:

Spanish

Toca el piano?
play.PRES.3.SG the piano
 'Does he play the piano?'

In addition to the production task, a comprehension task aimed at checking participants' command of *wh*-words was run. The 25 tokens of the picture-sentence matching task included 13 pictures for (subject and object) question comprehension (23) and 12 tokens for *wh*-word comprehension (24).

- (23) A qui ajuda el policia? Catalan
 To who help.PRES.3.SG the policeman
 'Who is the policeman helping?'

Target response:

Subject points to the tourist.



- (24) Què va menjar en Joan? Catalan
 what AUX.PAST.3.SG eat the John
 'What did John eat?'

Target response:

Subject points to the plate of food.

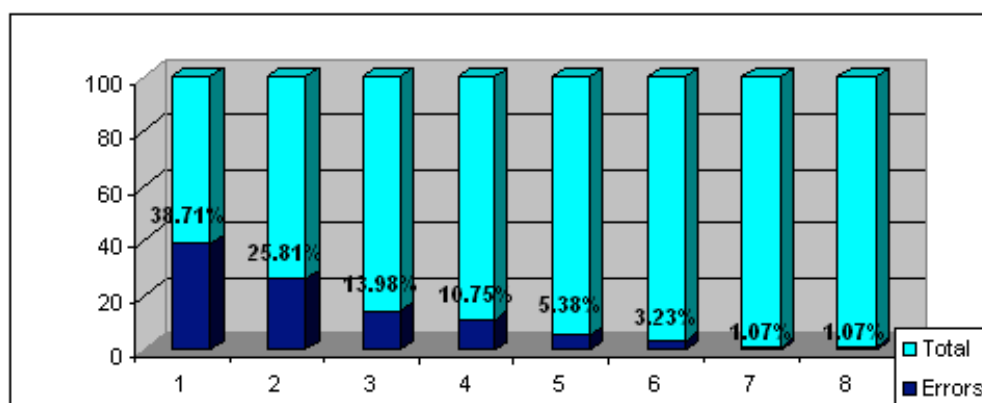


Our results show that production and comprehension skills in both *wh*- and yes/no-questions differ between agrammatics and control speakers. The general production results for the agrammatic participants have been plotted in Table 10:

	Wh-questions (correct/total)	Yes/no-questions (correct/total)
Catalan	60.0% (39/ 65)	71.7% (43/ 60)
Galician	44.6% (29/ 65)	51.7% (31/ 60)
Spanish	52.3% (34/ 65)	80.0% (48/ 60)
Total	52.3% (102/195)	67.8% (122/180)

Table 10: Interrogative sentence production

Table 11 shows a dissociation between question types which turned out to be statistically significant at 5% ($p < 0.05$, $Z = -1.993$). Damage was seen to be more severe in the case of *wh*-questions than in yes/no-interrogatives. Moreover, the most frequent strategy used by subjects to overcome problems in *wh*-question formation was replacing them with a yes/no-question (see Graph 9). Neither methodology nor the argument/adjunct distinction affected the outcome significantly.

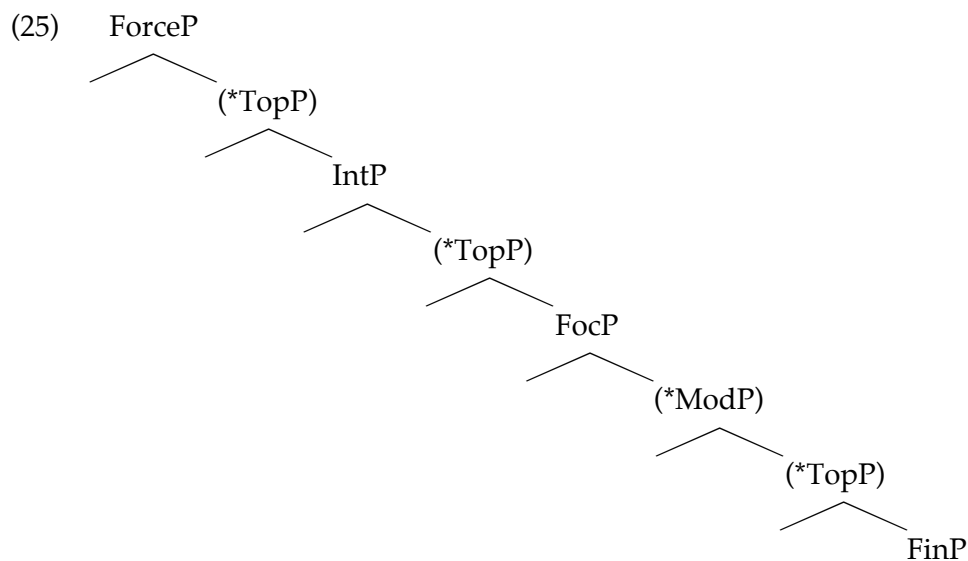


1. Y/N questions substitute for wh- questions
2. Wrong wh- morpheme selection
3. Declarative sentences
4. Unexpected question
5. "Don't know" responses
6. Wh- + DP
7. Wh- substituted by *why*
8. Wh- in situ

Graph 9: Distribution of errors in wh-questions

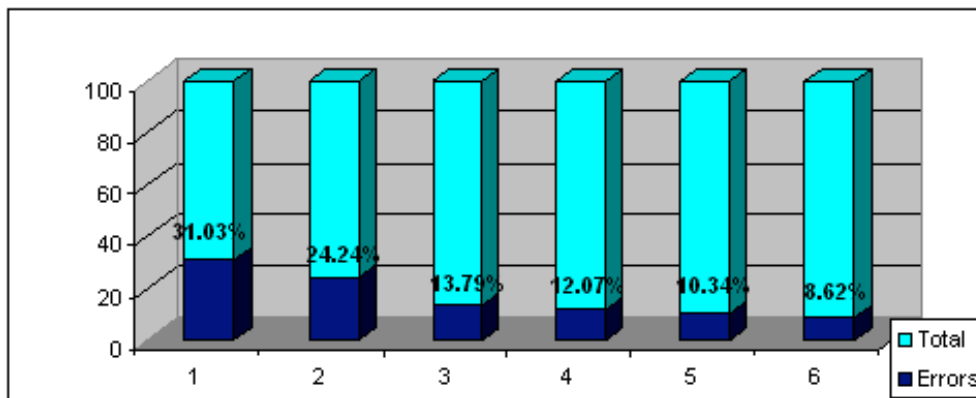
Friedmann & Grodzinsky account for this dissociation in terms of presence vs. absence of CP, with yes/no-questions claimed to be rooted in TP and hence more accessible for agrammatical participants. However, according to Suñer (1994), a non-overt element heads every yes/no-question in Spanish (correctly produced at 67.8% cross-linguistically in our mild agrammatical sample). The phonetically unrealized operator is claimed to be rooted in the CP-area. In addition, for the population under investigation, *wh*-questions were correctly produced at 52.3%, indicating that access to CP is not completely banned.

Rizzi (2002), for example, provides us with arguments for a dissociated position for the two question types included in the CP-area, with Int(errogative)P and Foc(us)P as the crucial nodes (25).



According to Cruschina (2007), the interrogative operator would occupy the position Int (higher than Foc — landing site for *wh*-elements) where it is base-generated together with other elements such as *why*. Nevertheless, the claim that null interrogative operators in polar questions are base-generated in Int is problematic for a truncation account, since it would attribute a higher position to yes/no-questions than to *wh*-questions (Int > Foc).

Regarding the errors in yes/no-questions (illustrated in Graph 10), the agrammatic results showed a revealing pattern indicating a clear trade-off in between yes/no- and *why*-questions.



1. *Why* substitutes for y/n questions
2. Declarative sentences
3. “Don’t know” responses
4. Unexpected questions
5. *Wh*- questions substitute for y/n questions
6. *How is it* substitutes for y/n questions

Graph 10: Distribution of errors in yes/no-questions

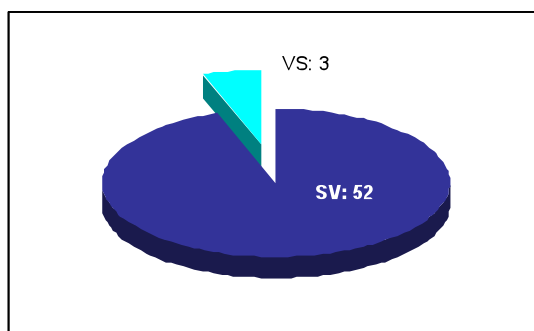
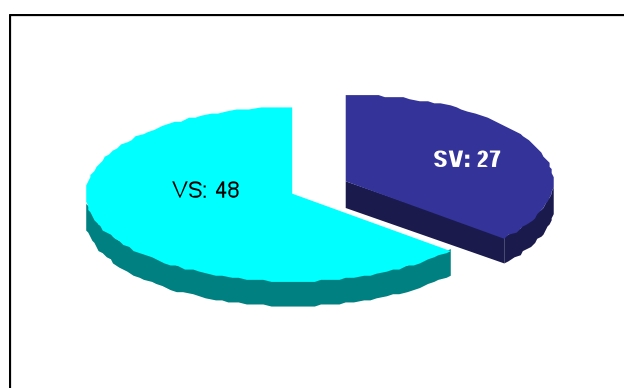
The cartographic approach predicts the use of *why* questions in substitution for yes/no-questions in Catalan (5/58 errors in our data) and Galician (13/58) straightforwardly. The fact that only *why*, but no other *wh*-operator, enters into competition with the production of yes/no-questions may indicate that the null operator in yes/no-questions and *why* compete for the same structural position, and that this position is different from the one for ordinary *wh*-operators. In our Ibero-Romance sample, the overt operator *why* seems preferable for some agrammatic participants with respect to the null operator of a yes/no-question, raising the question of the role of overt vs. null elements. This also applies to the uses of *Com és que* ‘how is it that’ found in the Catalan data.

In addition to the wrong responses, an analysis of correct answers including an overt subject revealed that there is a clear dissociation in between experimental and control subjects with respect to the strategy used to formulate yes/no-questions. Agrammatic subjects favor SV over VS, contrary to the pattern displayed by control subjects. Tables 11 and 12 summarize, respectively, the experimental and control data, illustrated in Graphs 11 and 12.

	<i>Correct</i>	<i>Overt subject</i>	<i>S-V</i>	<i>V-S</i>
Catalan	70.8% (34/ 48)	44.1% (15/34)	100% (15/15)	0% (0/15)
Galician	50.0% (25/ 50)	48.0% (12/25)	83.3% (10/12)	16.7% (2/12)
Spanish	78.7% (37/ 47)	75.7% (28/37)	96.4% (27/28)	3.6% (1/28)
Total	66.2% (96/145)	57.3% (55/96)	94.5% (52/55)	5.4% (3/55)

Table 11: *Subject-verb inversion (experimental subjects)*

	<i>Correct</i>	<i>Overt subject</i>	<i>S-V</i>	<i>V-S</i>
Catalan	100% (47/ 47)	48.9% (23/ 47)	43.5% (10/23)	56.5% (13/23)
Galician	100% (46/ 46)	56.5% (26/ 46)	32.0% (8/26)	69.2% (18/26)
Spanish	97.9% (47/ 48)	55.3% (26/ 47)	34.6% (9/26)	65.4% (17/26)
Total	99.3% (140/141)	53.6% (75/140)	36.0% (27/75)	64.0% (48/75)

Table 12: *Subject-verb inversion (control subjects)*Graph 11: *Subject-verb inversion in yes/no-question production (agrammatic subjects)*Graph 12: *Subject-verb inversion in yes/no-question production (control subjects)*

The inversion of subject and verb seems to be systematically avoided either by using the non-inverted option (in the case of yes/no-questions) or through the insertion of some element compatible with the order SV (such as *Com és que* 'how is it that' to substitute for *wh*-questions). Evidence for difficulties with VS structures in agrammatism can also be found in the studies by Garraffa (2008) or Beretta *et al.* (1996).

According to Belletti (2001, 2004), there are two requirements for inversion to take place: (i) a *pro*-element and (ii) a right-peripheral focus position located in the higher portions of the VP-field. Since the verb would occupy the same tense position in the TP domain, avoidance of the order VS can be attributed to a deficit in licensing a *pro*-element in pre-verbal position. Agrammatics may be opting for the alternative with an overt element in pre-verbal position in order to avoid the use of an expletive element. Avoidance of VS accounts for 94.5% of the correct answers with overt subjects in the data from our experimental group. Expletives (overt or null) do not contribute to the meaning of a sentence being susceptible to impairment in agrammatic speech.

Regarding comprehension results, even though comprehension of *wh*-questions might have benefited from a non-syntactic structure based on the selection of the figure not addressed in the question (such as “Look for a figure other than the policeman” in the context of a question like *Who does the policeman help?*),⁸ the results, summarized in Table 13, show that agrammatic participants have preserved knowledge of *wh*-words.

	Wh-questions (correct/total)	Wh-words (correct/total)
Catalan	92.3% (60/ 65)	96.7% (58/ 60)
Galician	90.8% (59/ 65)	93.3% (56/ 60)
Spanish	93.8% (61/ 65)	96.7% (58/ 60)
Total	92.3% (180/195)	95.5% (172/180)

Table 13: Comprehension of *wh*-words

5.2. Embedded Sentences

The last piece of evidence included in our testing battery comes from the production of subject embeddings, another construction that crucially depends on the left periphery, tested by means of an elicitation task with pictures. The 25 tokens specifically designed for that aim included 24 subject relatives (26) plus one object relative (27).

- (26) Éstes son os plátanos que custan tres euros.
these be.PRES.3.PL the bananas that cost.PRES.3.PL three euros
 ‘These are the bananas that cost three euros.’

Target utterance:

Catalan

Éstes son os plátanos que custan dous euros.
these be.PRES.3.PL the bananas that cost.PRES.3.PL two euros
 ‘These are the bananas that cost two euros.’



⁸ I am grateful to one of the reviewers for the comments on this specific issue.

- (27) Aquestes són les flors que veu en Joan
these be.PRES.3.PL the flowers that see.PRES.3.SG the John
 des de la seva finestra.
from the his window
 'These are the flowers that John sees from his window.'

Target utterance:

Catalan

Aquest és l'arbre que veu en Joan
this be.PRES.3.SG the.tree that see.PRES.3.SG the John
 des de la seva finestra.
from the his window
 'This is the tree that John
 sees from his window.'



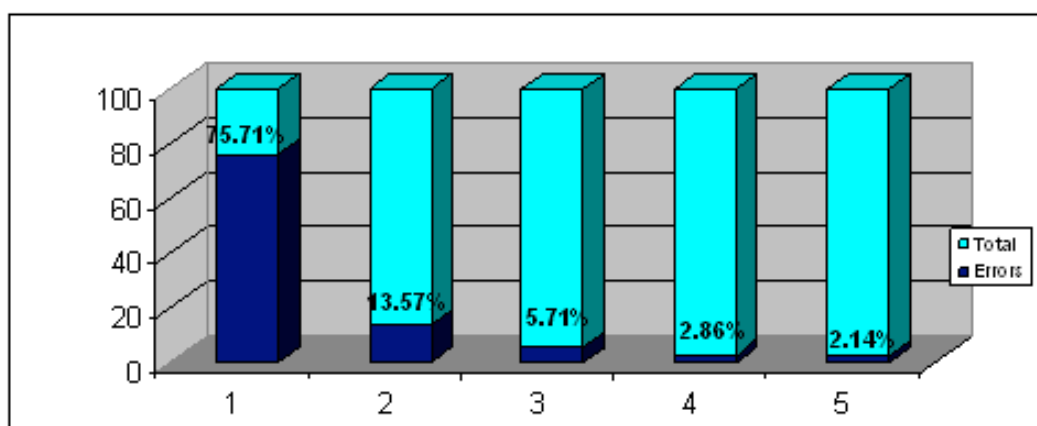
The general results are summarized in Table 14.

	<i>Embedding production (correct/total)</i>
Catalan	74.4% (93/125)
Galician	45.6% (57/125)
Spanish	68.0% (85/125)
Total	62.7% (235/375)

Table 14: Subject-embedding production

Our results indicate that the production of subject relatives was impaired. Significant differences were found in the contrast between experimental and control subjects (Mann-Whitney U test: $p < 0.01$, $Z = -4.904$). Even though the mean rate of errors was 36.39%, inter-subject variation was prominent (it ranged from 20% to 96% correct responses). Regarding error distribution, the classification of errors according to frequency has been illustrated in Graph 13 below.

With the scant data we have to date, we can only conclude that our Ibero-Romance agrammatic subjects either avoid or fail to produce well-formed embedded structures (at the level of non-pathological subjects) when these require the involvement of the CP-layer. In the case of embedded structures such as those under investigation, since the projection of ForceP — according to Rizzi (2002), the highest functional projection of the left-peripheral area — is required, structural accounts would straightforwardly predict the observed deficit.



1. Relative omission
2. Relative omission + Verb omission
3. Errors with the object relative
4. "Don't know" responses
5. Verbless relatives

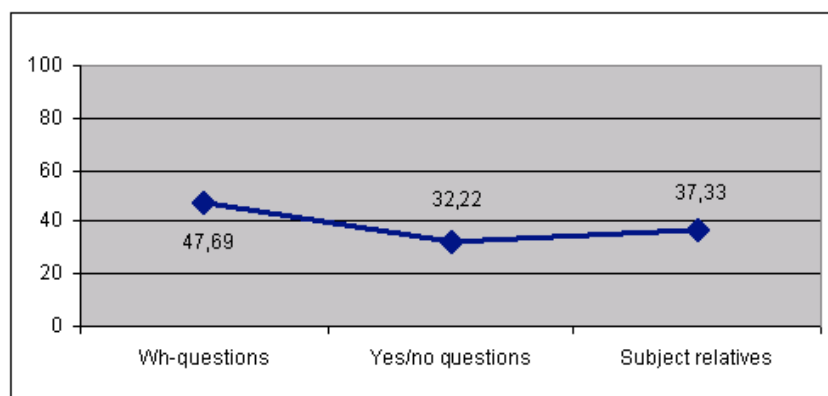
Graph 13: Distribution of Errors in Embedded Structures

6. Summary of Findings — CP-Field

Assuming (28), Ibero-Romance agrammatics suffer from a consistent syntactic deficit which affects structures crucially dependent on the left periphery. The homogeneous behavior among Ibero-Romance varieties is statistically confirmed. This is predicted under structural terms, since the CP-field constitutes the left end of the syntactic representation and is therefore expected to be the most severely impaired area.

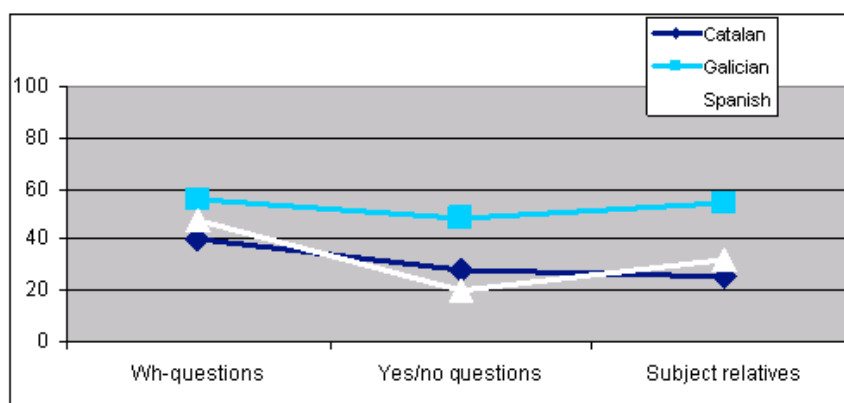
(28) ForceP > IntP > FocP

However, this structure makes us predict subject relatives (crucially dependent on the projection of ForceP) to be the most severely impaired category, followed by yes/no-questions (in IntP) and *wh*-questions (in FocP). Our results do not support this, as summarized in Graph 14, since *wh*-questions were found to be the most difficult for participants, while yes/no-questions were better preserved.



Graph 14: Ibero-Romance mild agrammatic errors in the CP-field

As with the IP-field, cross-linguistic differences were not found.

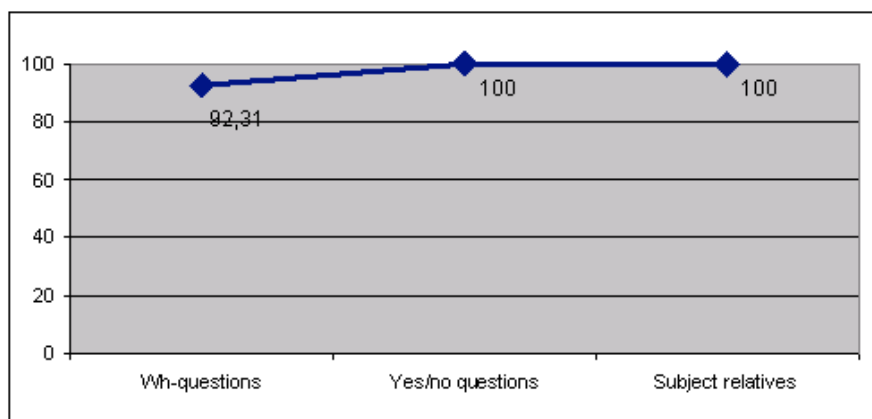


Graph 15: Ibero-Romance mild agrammatic production

Even though access to the left-peripheral area is restricted, mild participants may present a certain degree of preserved abilities. This is observable through the contrast with the results for our moderate agrammatic who failed, for example, to produce a single subject embedding. However, in contrast to the mild agrammatic sample, the Catalan moderate agrammatic does what we would expect under the TPH (Table 15, Graph 15).

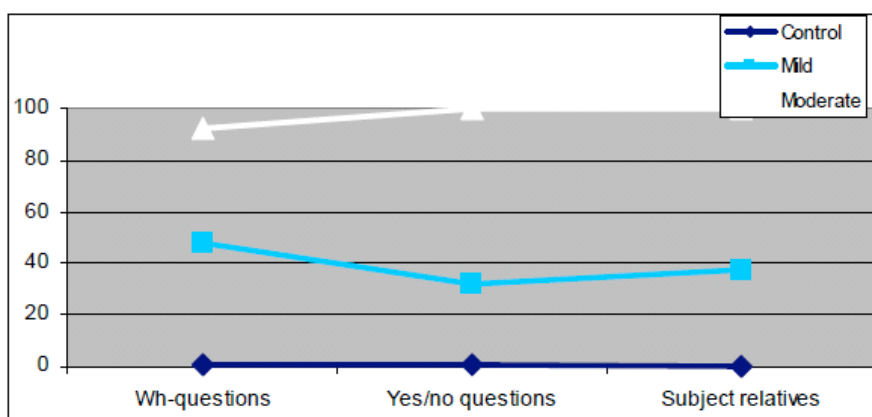
PRODUCTION			
	% errors	Main error type	Task
Wh-questions	92.3%	substitution with yes/ no	elicited production
Yes/No questions	100%	substitution with <i>why</i>	elicited production
Subject relatives	100%	relative omission	elicited production
COMPREHENSION			
	% errors	Main error type	Task
Wh-question comp.	38.5%	select wrong picture	forced-choice task
Wh-word comp.	7.7%	select wrong picture	forced-choice task

Table 15: Moderate agrammatic CP-field



Graph 16: Ibero-Romance moderate agrammatic errors in the CP-field

Finally, Graph 17 summarizes the IP-field of the three populations under analysis.



Graph 17: Degrees of severity in agrammatic Ibero-Romance

With the limited data available, we can only conclude that our Ibero-Romance agrammatic subjects either avoided or failed to produce well-formed structures (at the level of non-pathological subjects) when such structures required the participation of the CP layer. However, a proper account for our results must involve some additional factors.

7. Conclusion

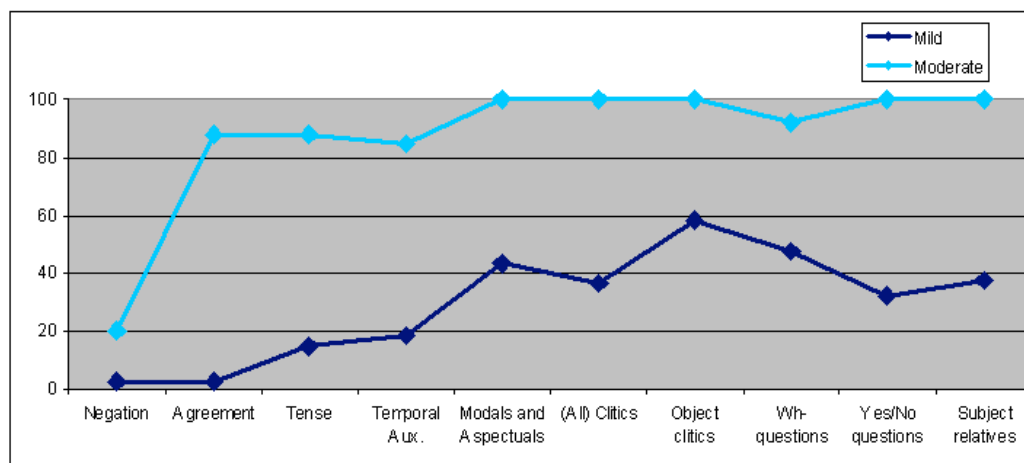
Our results indicate that most functional categories under investigation were not completely damaged in our sample of agrammatic participants. We account for both across-subject variation and within-subject variation in the following terms:

- (A) Non-pathological adult subjects are endowed with the resources to complete structures up to the left end of the left periphery.
- (B) In the case of deficit, the ultimate height they reach decreases; however, this does not necessarily entail that it is constant to the same exact extent

for every participant or that the same participant does not display a variable behavior across answers.

- (C) The more severe the agrammatic deficit is, the less high they can reach in the tree structure (Friedmann 2005).

Graph 18 illustrates that the number of errors made by the agrammatic sample is related to the structural position of the error type, with a tendency to greater errors as one moves up from the IP- to the CP-field.



Graph 18: Ibero-Romance agrammatic production errors

However, this correspondence is not perfect. Elements dependent on the higher portions of the IP-field (e.g., object clitics) can be seen to be more severely damaged than some elements in the left periphery (e.g., yes/no-questions).

In all, this approach to agrammatic results constitutes the first implementation of cartographic models to account for pathological data. Our results have the following implications for a super developed tree-structure:

- (A) Negation and $T_{(present)}$ must occupy a relatively lower portion, thus justifying the high degree of preservation.
- (B) If agreement is taken as an operation, it must take place lower than $T_{(past)}$.
- (C) The special status of *why* as compared to other *wh*-elements seems to be confirmed.
- (D) The tight relationship between yes/no- and *why*-questions also seems to be proved.

The experiments already conducted raise many new questions and leave others open for further exploration. This is the case for the low frequency of use of non-finite forms in the experimental conditions resulting from our design, which raises questions regarding their compatibility with results from other Romance varieties (Italian; Miceli *et al.* 1989, Garraffa 2003). The behavior of modals and aspectuals, and the degree of relative preservation or impairment as a function of their exact location on the tree, deserves further investigation too.

Appendix A: Background Information on Experimental Subjects — Session 1

Subject	Gender/age (years)	Edu.	Etiology	TPO	Aphasia classification (severity)
Catalan					
C1	m/63	3	Ischemic CVA Left fronto-insular ²⁰ infarction	5	Motor aphasia (mild)
C2	m/66	1	Ischemic CVA Left middle cerebral artery	4	Mixed Transcortical (mild)
C3	m/69	1	Ischemic CVA Left infarction affecting middle cerebral artery region	2	Motor aphasia (mild)
C4	m/70	3	Ischemic CVA Left middle cerebral artery	7	Global (mild)
C5	m/70	2	Ischemic CVA Left temporo-medial infarction	5	Mixed Transcortical (mild)
CM	m/28	2	Hemorrhagic CVA Left intraparenchymatous ²¹ hemorrhage affecting basal ganglia	6	Motor aphasia (moderate)
Galician					
G1	f/76	1	Ischemic CVA Left middle cerebral artery	0.9m	Motor aphasia (mild)
G2	f/83	1	Ischemic CVA Left, cardio-embolic	0.5m	Motor aphasia (mild)
G3	f/55	1	Hemorrhagic CVA Left intraparenchymatous hemorrhage affecting basal ganglia	3	Motor aphasia (mild)
G4	m/74	2	Ischemic CVA Left infarction affecting middle cerebral artery region	1.7m	Mixed Transcortical (mild)
G5	f/56	2	Hemorrhagic CVA Left intraparenchymatous hemorrhage	2	Motor aphasia (mild)
Spanish					
S1	m/27	2	Cranial-Encephalic Traumatism Left fronto-temporal	3	Motor aphasia (mild)
S2	m/74	1	Ischemic CVA Left Infarction affecting pre-central area	0.4m	Motor aphasia (mild)
S3	m/61	3	Hemorrhagic CVA Left intraparenchymatous hemorrhage affecting basal ganglia	11	Motor aphasia (mild)
S4	m/64	1	Hemorrhagic CVA Left middle cerebral artery affecting basal ganglia	0.1m	Motor aphasia (mild)
S5	f/38	2	Ischemic CVA Left middle cerebral artery	7	Motor aphasia (mild)

m = male; f = female; 1 = Primary education; 2 = Secondary education; 3 = University education; TPO = Time post-onset: years, months (m); CVA = Cerebrovascular accident; CVD = Cerebrovascular disease

Appendix B: Background Information on Experimental Subjects — Session 2

Subject	Gender/age (years)	Edu.	Etiology	TPO	Aphasia classification (severity)	
Galician						
G6	f/80	1	Ischemic CVA Left middle cerebral artery	0,4m	Mixed (mild)	Transcortical
G7	f/50	1	Hemorrhagic CVA Left temporo-occipital	0,2m	Mixed (mild)	Transcortical
G8	f/77	1	Ischemic CVA Left middle cerebral artery	0,1 m	Motor aphasia (mild)	
G9	m/64	2	Hemorrhagic CVA Left intraparenchymatous hemorrhage	0,3m	Motor aphasia (mild)	
G10	m/30	3	Ischemic CVA Left middle cerebral artery	1	Mixed (mild)	Transcortical
Spanish						
S6	m/65	1	Ischemic CVA Multiple left infarctions affecting Sylvian region	9	Motor aphasia (mild)	
S7	m/82	3	Ischemic CVA Left middle cerebral artery	0,1 m	Motor aphasia (mild)	
S8	m/42	2	Hemorrhagic CVA intraparenchymatous hemorrhage	3	Motor aphasia (mild)	

1 = Primary education; 2 = Secondary education; 3 = University education; TPO = Time post-onset: years, months (m); CVA = Cerebrovascular accident

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A Naturalist Reconstruction of Minimalist and Evolutionary Biolinguistics

Hiroki Narita & Koji Fujita

Kinsella & Marcus (2009; K&M) argue that considerations of biological evolution invalidate the picture of optimal language design put forward under the rubric of the minimalist program (Chomsky 1993 *et seq.*), but in this article it will be pointed out that K&M's objection is undermined by (i) their misunderstanding of minimalism as imposing an aprioristic presumption of optimality and (ii) their failure to discuss the third factor of language design. It is proposed that the essence of K&M's suggestion be reconstructed as the sound warning that one should refrain from any preconceptions about the object of inquiry, to which K&M commit themselves based on their biased view of evolution. A different reflection will be cast on the current minimalist literature, arguably along the lines K&M envisaged but never completed, converging on a recommendation of methodological (and, in a somewhat unconventional sense, metaphysical) naturalism.

Keywords: evolutionary/biological adequacy; language evolution; methodological/metaphysical naturalism; minimalist program; third factor of language design

1. Introduction

A normal human infant can learn any natural language(s) he or she is exposed to, whereas none of their pets (kittens, dogs, etc.) can, even given exactly the same data from the surrounding speech community. There must be something special, then, to the genetic endowment of human beings that is responsible for the emergence of this remarkable linguistic capacity. Human language is thus a biological object that somehow managed to come into existence in the evolution of the human species.

In a recent issue of *Biolinguistics*, Kinsella & Marcus (2009; K&M) argue that 'evolvability' should be a central constraint on linguistic theorizing, both in terms of methodology and empirical content. They specifically argue that evolution in

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the natural world is known to create all sorts of imperfect and redundant organisms, and thus human language should also be expected to fall in this major category of imperfection. They pose their evolutionary argument in opposition to the minimalist program for linguistic theory advanced by Chomsky (1993 *et seq.*), which seeks signs of optimality in the computational mechanism of human language. K&M's position is also in opposition to the thesis that the theory of language evolution very much depends on the theory of language, for which we can find various resonances in the linguistic literature (see, e.g., Chomsky 1980, Jackendoff 2010).

We totally agree with K&M in that our theory of language must achieve evolutionary plausibility or meet the evolvability condition. Unfortunately, however, their conception of this notion is not a legitimate one, ignoring many aspects of biological evolution that are not readily captured by their biased view on adaptation. In this paper, we will reject K&M's framing of these issues and argue that there should not be any stipulated or presumed asymmetric dependency between the theory of language and the theory of evolution. We will critically examine K&M's counterarguments to biolinguistic minimalism, and point out that (i) they fail to discuss the third factor of language design, which plays a central role in biolinguistic minimalism (Chomsky 2005), and that (ii) K&M's adherence to the Neo-Darwinian dogma of gradual adaptation by natural selection is in exact opposition to their otherwise sound warning that we should not be trapped by any aprioristic presumptions regarding the nature of the object of inquiry. We will also discuss how these considerations relate to methodological naturalism originally put forward by Chomsky (1995a, 2000b).

2. The Minimalist Program and the Third Factor of Language Design

K&M point to various corners of natural language and suggest that human language cannot be regarded as either perfect or optimal. According to K&M's view, not only countless superficial performance errors like slips of the tongue and garden-path parsing but also various aspects of the core architecture of grammatical competence such as morphological redundancy and irregularity, lexical and structural ambiguity, and other apparently unnecessary complexities constitute ample evidence for the imperfection of human language. K&M claim that inelegance and inefficiency are traits that we usually expect biological objects to have, given the overall tendency for evolution to fall short of ideal architectural designs. They adduce these facts against the *strong minimalist thesis* (SMT) of biolinguistic minimalism (Chomsky 2000a *et seq.*), according to which human language is an optimal solution to the usability conditions imposed by the neighboring performance systems (see also Narita 2009a, 2009b). They claim that the SMT is quite at odds with the above-mentioned facts of linguistic imperfection. They further claim that 'evolvability' should be a central constraint on linguistic theorizing, and that an evolutionarily plausible theory of human language should provide much more room for imperfect constituents than does the minimalist endeavor to seek optimality and perfection in the linguistic system.

K&M further argue that because minimalist notions like optimality and

perfection are never clarified in the minimalist literature, they cannot put any meaningful and realistic constraint on linguistic theorizing. Building on Pinker & Jackendoff's (2005: 27) remark that "nothing is 'perfect' or 'optimal' across the board but only with respect to some desideratum", K&M go on to examine various possible criteria of optimality, including ease of production, ease of comprehension, ease of acquisition, efficient brain storage, efficient communication, efficient information encoding, and minimization of energetic costs. None of these criteria strike them as plausible or promising, and so they draw the conclusion that, "unless there is some clear, *a priori* criterion for optimality, claims of optimality have little force" (K&M: 198).

It is curious to note that, despite their forceful attempt to undermine the content of optimality and economy in the minimalist conception of human language, K&M fail to discuss (either involuntarily or deliberately) the source of optimality and efficiency that has been repeatedly (if not thoroughly) discussed in the minimalist literature: The *third factor of language design* (Chomsky 2005, 2007a, 2007b, 2008). Chomsky (2005) reminds us of a virtual truism that the design of the faculty of language (FL), or of any biological system for that matter, should be attributed to three factors: (i) genetic endowment, (ii) external stimuli from the environment, and (iii) physical principles that are not specific to FL. Chomsky repeatedly emphasizes that among the third factor constituents is the principle of computational efficiency, which is expected to be of particular significance for discrete generative systems such as human language.¹ K&M examine many candidates for the measure of economy (asking, "optimality for what?"), but strangely, they completely fail to discuss the third factor, a central concept of the minimalist program that is claimed to be *the* criterion of computational optimization of human language.

The nature of the third factor that enters into the SMT, let alone what kind(s) of energy or cost it is optimizing human linguistic computation for, is admittedly quite ill-understood at this early stage of minimalist inquiry, but there are already some promising proposals. For example, it is likely that the *principle of economy of derivation* (Chomsky 1995b: 138–145) will come to play a significant role in the undertaking of the SMT. It requires that syntax choose the least costly derivation to reach the interfaces, where the cost of derivation is determined solely by some syntax-internal metric, such as the number of derivational steps. This principle can be arguably regarded as a linguistic analogue of Hamilton's Principle of Least Action; see Fukui (1996) for much relevant discussion. It is moreover conceivable that such an inherently global principle of computational optimization further forces syntactic derivation to adopt some sort of computational cycles, such as *phases* (Uriagereka 1999, Chomsky 2000a, 2007, 2008), constituting a kind of heuristic 'computational trick' (Chomsky 1995b: 162, Fukui 1996) that syntax uses for restricting computational domains locally and thus reducing the computational load. Importantly, such a move toward optimization of

¹ In addition to the principle of computational efficiency, Chomsky also adds the constraints that enter into all facets of development and evolution of any organisms to the (forthcoming) catalog of the third factor principles. Such principles are now explored intensively in the so-called "evo-devo revolution" (Chomsky 2007a: 3).

syntactic derivation is also corroborated by certain empirical considerations, as discussed in Chomsky (2000a *et seq.*) and Uriagereka (2009). Note further Uriagereka's (2009) claim that the *Chomsky Hierarchy* of strong generative capacity figures in any computational system so naturally that it "can be understood as a primitive for the purposes of the SMT" (p. xvii). Uriagereka also makes the claim, following Hinzen & Uriagereka (2006), that syntax (as well as semantics) has formal structural bases akin to number theory and topology, hinting at the possibility of comparative study of these human-unique capacities. Quite relevant to this future comparative research is Kuroda's (2009) discovery that there exists a formal procedure for transforming the Euler product representations of certain ζ -functions (a fundamental concept in number theory) into phrase-structure representations, an intriguing result that should be readily translated into the Merge-based generative system, as pointed out by Fukui (forthcoming); see also Fukui (1996, 2008), Uriagereka (1998, 2002, 2009), and Narita (2009a, 2009b, 2010a) for related discussion.

Needless to say, none of these proposals receive wide acceptance in the literature. They are rather under serious empirical scrutiny, and controversy arises as to how (or whether) these hypotheses can be refined or modified to accommodate apparent counterexamples. But this is the nature of any scientific inquiry, and we can only hope that we can eventually revise or refine the proper formulation of the relevant computational principles through empirical examinations not only in linguistics proper but also language-external domains.

Contrary to such a normal research attitude toward the eventual refinement of theoretical constructs, however, K&M claim that biolinguistic inquiry must meet a stringent requirement: That it attains some *a priori* content of the linguistic criteria of optimality before it can investigate the effect of such optimization. Such a peculiar constraint upon possible lines of empirical inquiry is unheard of elsewhere in natural sciences. Rather, as is familiar with any other natural science, "we have to learn about the conditions that set the problem in the course of trying to solve it" (Chomsky 2008: 135–136). In such a naturalistic inquiry, the research task is bound to be interactive, in that it must seek to "clarify the nature of the interfaces and optimal computational principles [i.e. third factor principles — HN & KF] through investigation of how language satisfies the conditions they impose" (p. 136). Inquiry into these problems is, further, naturally and ordinarily benefitted by posing the SMT as a working hypothesis: The research decision to investigate the effect of third factor principles in the domain of FL entails the expectation that there are indeed some such third factor principles which are operative in the architecture and working of FL, and which we can hope to discover eventually.

K&M repeatedly accuse biolinguistic minimalism of the "presumption of perfection in language" (p. 187, 197, 201, 207). However, now we can conclude that their condemnation is primarily based on their misunderstanding of the SMT. As we have recapitulated above, the third factor and its efficient optimization in the domain of FL is something that minimalism is searching for, not something that it presumes. The SMT is *not* aprioristic presumption of perfection, but a working hypothesis that is adopted to (hopefully) enhance the eventual discovery of some real substance in these notions. Optimality is just a nickname for

what we want to discover, not what we aprioristically insist on by vacuous speculation.² It is trivially true that we have not come up with a proper and complete characterization of the relevant optimization principles, but that does not constitute any reason for us not to hope for one.

3. Evolvability, Adaptationism, and Minimalism

Let us stress at this point that our position is in perfect agreement with K&M's in several important respects. First and foremost, we firmly believe that our theory of language, if it is to be a biolinguistic one, must be compatible with what is known about biological evolution, of which language evolution represents a recent example. In fact, we have independently discussed and emphasized the importance of this kind of evolutionary plausibility constraint on linguistic theorizing under the rubrics of 'evolutionary adequacy' (Fujita 2007, 2009) and 'biological adequacy' (Narita 2010a), which we take to be conceptually equivalent to K&M's evolvability condition understood in the most general sense; see also Boeckx & Uriagereka's (2007) discussion of 'natural adequacy'.³ We also agree with K&M (and with every evolutionary biologist) that gradual adaptation by natural selection is a major element of biological evolution and that for familiar reasons it often yields only sub-optimal solutions, absolute optimality or perfection being rare cases.

That being said, we can point out several flaws in K&M's arguments against minimalism. To begin with, as K&M themselves admit, "evolution sometimes achieves perfection or near-optimality" (p. 188). So it is rather self-contradictory that they reject from the start the possibility that language is one instance of such perfection. By doing so, they are actually claiming that language is very special in the biological world, contrary to their own belief that it is not. In fact, many instances of biological design can be shown to obey some optimization principles. A classic case is bone structure, which achieves maximal strength with minimal material (Roux's maximum-minimum law; see Gierse 1976). Likewise, blood vessels are known to have an architecture that ensures efficient blood flow with minimum energy consumption. Also, Christopher Cherniak's work on brain wiring minimization, often cited in Chomsky's recent writings (Chomsky 2005 *et seq.*), points to the fascinating conclusion that neural optimization is a ubiquitous biological property derived "for free, directly from physics" (Cherniak 2005, 2009, Cherniak *et al.* 2004). In fact, there is a long history of debate among biolo-

² However, see section 4 for our own assessment of the current minimalist literature.

³ More technically, evolvability can be defined as "the organism's capacity to facilitate the generation of nonlethal selectable phenotypic variation from random mutation" (Gerhart & Kirschner 2003: 133) or "how probable [...] it is that a species, or life form in general, will evolve into something new" (Ridley 2004: 587). It is therefore somewhat misleading to claim that language is evolvable in order to express the truism that language is a product of biological evolution. Precursors of language, or our ancestors who had them, were evolvable, but whether language itself is evolvable (according to the strict definition given above) even today is another matter. See also Masel & Trotter (2010) for an in-depth examination of the notion of evolvability.

gists with respect to the extent to which biological design can be said to be optimized for relevant functions. The theory of 'symmorphosis', for example, claims that a biological structure is economically designed, to an extent that is just sufficient to satisfy its functional need (Weibel 1998, Weibel *et al.* 1991). Given this state of affairs, we need to realize that at least conceptually, the evolvability condition on language does not preclude the possibility that (part of) the human language faculty also instantiates such optimal design found elsewhere in the biological world.

It is interesting to note in this context that already in the famous Chomsky–Piaget debate in 1975 (see Piattelli-Palmarini 1980), Piaget criticized the highly complex ('imperfect') model of transformational generative grammar which was then under development as "biologically inexplicable" (Piaget 1980: 31; we may justifiably rephrase it as 'un-evolvable'). In his reply to Piaget, Chomsky (1980) had no problem in admitting that the evolution of human language is "biologically unexplained", but he added that this situation is generally true for any other biological organisms, and that, correspondingly, any criticism of biological implausibility/'inevolvability' cannot carry much empirical force in natural science. The evolution of an organism is, like anything else in the biological world, a result of complex interplay among the three factors of design mentioned in the last section, and without sufficient understanding of their delineation, jumbling such massive interaction effects under the broad name of evolution or evolvability cannot be really helpful or informative. Nor, in the absence of a precise understanding, can it reasonably be defended as a constraint on any biological theorizing, be it the highly complicated model of transformational grammar in the late 1970's or the currently developing minimalist inquiry.

K&M observe, ostensibly correctly, that perfection and optimality do not very often result from adaptation by natural selection, but then they hastily conclude, incorrectly, that evolvability considerations do not tolerate the optimality of language design that minimalism is searching for. While surely adaptation by natural selection is one major aspect of evolution, it must also be admitted that natural selection does not work in a vacuum, and a full understanding of biological evolution requires taking into account many factors other than natural selection, including random genetic drift, genetic assimilation, exaptation, self-organization, canalization, etc., all of which are presumably governed by the physical laws of nature. In other words, a theory of natural selection needs to be supplemented by those mechanisms if it is to explain anything about evolution.

As we saw in the previous section, minimalism is essentially a research program that seeks to identify the (optimizing) effect of physical laws of nature in the domain of human language. K&M's rejection of the minimalist endeavor, then, essentially amounts to making a very unrealistic claim that we had better disregard the relevance of all such effects (*viz.* the third factor) from biolinguistic theorizing, prioritizing the notion of gradual adaptation. We hold that this position is not tenable for language, or indeed in any evolutionary studies. It is quite possible that K&M themselves fail to appreciate their commitment to this unrealistic claim, but this is again due to their failure to recognize minimalism as a quest for the third factor.

It can be pointed out that the above-mentioned unrealistic view can be seen as a particular instantiation of what Godfrey-Smith (2001) calls ‘empirical adaptationism’, a very strong empirical hypothesis which holds that it is possible to predict and explain the outcome of evolutionary processes by attending only to the role played by natural selection (p. 336). According to this view, no other evolutionary factor has the degree of causal importance that natural selection assumes, so that we can safely ignore all other non-selective factors, if any, and focus on adaptation by natural selection for the purpose of understanding evolution. Empirical adaptationism understood as such is easy to refute, for which we regard the references cited above as providing ample evidence.

Incidentally, Godfrey-Smith points out that it is important to appreciate the difference between empirical adaptationism and at least two other kinds: explanatory adaptationism and methodological adaptationism. According to Godfrey-Smith, ‘explanatory adaptationism’ is the position which holds that adaptedness of the design of organisms to environments is the most important problem to be addressed in evolutionary biology and that natural selection should be the primary solution to understanding it. According to this view, natural selection keeps its central role in evolutionary biology even if its effect eventually turns out to be scarce in the actual world. Thus, if some trait exhibits adaptedness to an environment, it is regarded by explanatory adaptationism as primarily a result of natural selection, but there is no implication here that all traits are adaptations, nor that natural selection always yields adaptive traits. In contrast, ‘methodological adaptationism’ only makes the claim of heuristic interest that adaptation and good design fashioned through it are the first things biologists should seek in evolutionary studies. According to this third view, the idea of adaptation is a good “organizing concept” (p. 337), and the search for it offers the best methodological guideline for the study of evolutionary biology, by and large independent of the actual privilege natural selection assumes in evolution. Godfrey-Smith points out that most of the perplexing controversy concerning the (in)validity of the adaptationist program derives from failure to differentiate these three kinds of empirical adaptationism: Some argue in favor of one kind, while others try to refute them when in fact they are only arguing against another kind of adaptationism. Misunderstandings of this sort should be regarded as a harmful barrier to the development of evolutionary biology and in particular to the sound progress in biolinguistic studies of language evolution. See Godfrey-Smith (2001), and also Shanahan (2004), for relevant discussion. Needless to mention, our refusal of adaptationism does not in itself imply that we discount the potential of the adaptationist research program to bear fruit along the other two research guidelines.

If only for the sake of understanding the real force of K&M’s criticism, it might be advisable to entertain a parallel categorization of the oft-noted different interpretations of minimalism, which can be achieved basically by replacing ‘adaptation’ and ‘natural selection’ in the above discussion with ‘optimality/simplicity’ and ‘the third factor’, respectively.⁴ On one hand, science is guided by

⁴ However, let us stress from the outset that we are *not* claiming that the three aspects of mini-

a research methodology that seeks to eliminate redundancies in assumptions as much as possible, and thus calls for parsimony and simplicity in theory constructions — the usual ‘Occam’s razor’ considerations, indeed a general feature of any theoretical inquiry. In the case of biolinguistic inquiry, this generic research methodology substantiates itself in what is often referred to as ‘methodological minimalism’. It takes the notion ‘simplicity of language’ primarily as a good “organizing concept”, and regards the search for simplicity and optimality in this object of inquiry as offering the best research heuristics for biolinguistic inquiry, largely independent of claims about the actual relevance of the third factor to the design of FL. On the other hand, minimalism is also understood as a substantive empirical hypothesis about language design, that language is in fact optimally designed for elegance, thus taking the concept ‘simplicity/optimality of language’ as having substantive empirical content. This position is what is often called ‘substantive minimalism’. We may further say that substantive minimalism in principle allows at least two different interpretations. Let us say that ‘empirical minimalism’ is the empirical hypothesis which holds that it is possible to predict and explain the entirety of the architecture of FL by attending only to the role played by the third factor, and that we can safely ignore all other factors and focus on optimization by the third factor for the purpose of understanding the whole design of FL. ‘Explanatory minimalism’, by contrast, holds that optimal design is the most theoretically interesting *explanandum* in biolinguistics and that the third factor should be the primary solution to understanding it. Thus, the third factor remains to be a central concept in explanatory minimalism even if its optimizing effect may eventually turn out to govern only a fraction of language design.

We must concede that empirical minimalism is plainly implausible — it seems indeed “too much to expect” (Chomsky 2004: 106) at the current stage of understanding. First of all, empirical minimalism in its strongest interpretation amounts to denial of any significant relevance of the first factor (genetic endowment) and the second factor (external stimuli from the environment) to language design. This cannot be right, if only because language is a genetically grounded, species-specific trait, and its maturation in a particular individual requires at least three to four years of complex social interaction with the speech community.

Moreover, even if we grant a weaker interpretation of empirical minimalism as a claim of explanatory priority of the third factor and its optimizing effect, it is still a rather daunting hypothesis, *prima facie* easy to refute. Arguably, it is primarily to this refutation that K&M make a rather sound contribution by citing various signs of imperfection in language design. However, just as rejection of empirical adaptationism does not entail exclusion of the other two

malism discussed below are mutually incompatible. Rather, they should be regarded as mutually supporting *dimensions* of one and the same research program (see below). The everlasting centrality of the notion of simplicity that figures in various aspects of the generative grammatical research since its earliest stage of development is explicitly acknowledged by Chomsky (1955). The earlier work by Nelson Goodman (and also W.V.O. Quine) on the general notion of simplicity is particularly influential in this respect (see Tomalin 2003 for related discussion).

kinds of adaptationist research, K&M's refutation of empirical minimalism by no means justifies their conclusion that the whole minimalist enterprise is unwarranted. It is rather regrettable to observe that K&M seem to regard their criticism of minimalism as completed just by simply referring to a small set of ill-understood drawbacks of language design. Even more puzzling is the observation that K&M's relatively sound criticism of the current minimalist literature is invalidated by their unmindful (if not deliberate) adoption of empirical adaptationism. Incidentally, K&M's misinterpretation of the minimalist enterprise is quite reminiscent of the oft-made mistake in philosophy of biology that Godfrey-Smith identifies. That is, just as the adaptationist research program in its entirety should not be frowned upon solely by attending to apparent counterevidence to empirical adaptationism, methodological and explanatory minimalism cannot be disproved simply by citing examples of apparent imperfections in language design.

Let us emphasize, along with Godfrey-Smith, that the three forms of adaptationism and minimalism are not so much mutually exclusive partitions as mutually supporting *dimensions* of the shared research program (see footnote 4). In this context, it can be somewhat puzzling to admit that one can make a legitimate decision to put forward claims of empirical adaptationism or empirical minimalism *as effective research heuristics*, thus utilizing the very empirical thesis for methodology's sake. Indeed, this is the reading that Godfrey-Smith proposes to grant to, for example, the strong adaptationist take by Richard Dawkins. Minimalism's advancement of the SMT can and should be understood in a similar vein, too. Thus, it often happens that postulations of unwarranted redundancies or questionable stipulations in the model of FL are refuted as not deducible from the SMT — a very weak argument in itself, if only because we have only a partial understanding of the third factor at present, but nevertheless of some heuristic value. If anything, K&M's misunderstanding of minimalism as presumption of optimality in language may be partially rooted in their failure to appreciate the legitimacy of such options. Of course, K&M and others can question the fruitfulness of this sort of approach, again perfectly legitimately.

By acknowledging the current weakness of empirical adaptationism and empirical minimalism, we are only restating the virtual truism that the factors entering into biological evolution cannot be exhausted either by natural selection or physical constraints. Pluralism, instead of the belief in the omnipotence of natural selection, is the norm in evolutionary biology today. Reference to evolvability is justified in every respect in a biological study of language, but K&M miss the point that evolvability cannot be defined solely in terms of adaptation by natural selection. Obviously, natural selection only serves as a filtering condition on pre-existing variations, and the primary question is how these variations first came into existence. In other words, arrival of the fittest, instead of survival of the fittest, is the core issue in any evolutionary study. It is in this context that the primacy of physical constraints on possible forms is emphasized in modern biology as well as in biolinguistic minimalism (the third factor). Thus, Chomsky (2004: 105) stresses that "natural selection can only function within a 'channel' of options afforded by natural law", which is essentially a restatement of Stephen Jay Gould's remark on the importance of physical channels. Chomsky (2002: 140–

141) also suggests the possibility that “the whole of evolution is shaped by physical processes in a deep sense, yielding many properties that are casually attributed to selection”. More recently, Fitch (2010) points to the tight connection between selection and constraints (developmental and otherwise) in his discussion on evolvability; “the mutually informative roles of selection and constraints are now accepted by most biologists as important aspects of biological and evolutionary explanation” (p. 63). The central role played by natural laws in evolution is discussed in detail also by Fodor & Piattelli-Palmarini (2010), who argue intensively that natural selection does not have strong explanatory force in naturalistic studies of evolution, and if their observations have attracted harsh criticism from biologists (see, for example, Futuyma 2010), that is so because they sound as if they are just attacking a straw man of empirical adaptationism, which cannot reasonably be called “What Darwin Got Wrong” because Darwin never believed it in the first place. He concluded his Introduction to *The Origin of Species* by explicitly writing that he was “convinced that Natural Selection has been the main but not exclusive means of modification”.

Needless to say, whether or not the other versions of adaptationism (methodological and explanatory) are promising is a totally different matter, and without doubt many biologists remain strongly committed to them, still attending to natural selection as a primary explanatory concept. It seems justifiable to say that biolinguistic minimalism departs from this tradition, in the sense that it puts forward the SMT both as a heuristic working hypothesis and as an empirical conjecture, primarily focusing on advancing the discovery and demonstration of the third factor principles and the sense in which they optimize the design of FL (and of biological organisms in general). The choice between methodological/explanatory adaptationism and methodological/explanatory minimalism cannot be made *a priori*, and we hope that both positions have their own contributions to make for the future progress of biolinguistics; perhaps a successful reconciliation or unification of the two approaches will be a key factor for our comprehensive understanding of human language, and we are more enthusiastic than anyone else to learn about an adaptationist account, if any, of the origin and evolution of the computational system of language, whose internal mechanism is most unlikely to fit in with the notion of adaptive fitness.

Recall also that the new framework of evo-devo is characterized, in part, by its shift of focus from adaptation to constraints on developmental processes in explaining evolution (and also by its departure from genetic determinism). The reemerging strong interest in morphology and laws of form, which dates back to the days of Goethe, is changing our view of how new biological species and traits emerge. Perhaps a simplistic dichotomy of adaptation vs. constraints is inappropriate, and a pluralistic approach to evolution is called for more than ever today. This standpoint of New or Expanded Synthesis is fully compatible with the minimalist view on language design and language evolution that proposes to take the third factor into fuller consideration.⁵

⁵ Let us add in this connection that K&M’s sympathy with an optimality-theoretic account of parametric variation among languages stands in direct opposition to their own standard of

Before closing this section, we would like to note that the notion of evolvability is to be regarded with more or less the same status as that of optimality (recall the discussion in section 2) since at present, we have little understanding of laws and principles that constrain the class of possible evolutionary (and developmental) processes, of which attested specimens might be only a tiny accidental fraction. If we are hoping for a better understanding of biological and language evolution, we have to “learn about the conditions that set the problem in the course of trying to solve it”; that is, we have to seek insights into the conditions on evolution and development, imposed by natural law (i.e. the third factor), in our theoretical inquiry into the nature of any biological mechanism, including human language. To this end, we need to reject any aprioristic adherence to a particular framing of the relevant issues, empirical adaptationism being a typical example.

In this section, we have pointed out that current understanding of evolutionary processes in the biological world requires all sorts of theoretical explanations as well as speculations that are by no means exhausted by adaptation by natural selection, and hence that the notion of evolvability, if defined solely in terms of adaptation, cannot serve as a legitimate constraint on linguistic theorizing. Instead, it has to be framed from a pluralistic viewpoint, in conformity with the emerging new picture of biological evolution. Correspondingly, K&M’s rejection of minimalist inquiry into the relevance of the third factor to language design, which amounts to empirical adaptationism, cannot be tolerated as a rational and naturalistic approach to the evolution of human language. We conclude that although K&M’s call for an evolvability constraint on linguistic theory is sound and fair in itself, it is exactly because of this constraint, properly understood in light of modern evolutionary thinking, that minimalism stands as a promising research agenda.

4. Emancipating Biolinguistics from Methodological Dualism

We saw in the previous sections that K&M’s criticism of the minimalist endeavor was largely based on (i) their misunderstanding of the minimalist program as aprioristic presumption of perfection, and (ii) their unbalanced formulation of the constraint of evolvability. We regard it as rather unfortunate that these serious flaws render their objection to the recent minimalist work almost invalid. In this section, however, we would like to express our sincere regard for K&M’s otherwise sound and reasonable criticism of recent work in the purported minimalist framework.

evolvability. They favor OT because it “captures the facts as a result of relaxing the demands of perfection and economy” (p. 206). According to OT, knowledge of language is seen as a set of competing constraints, with different rankings among them giving rise to different types of grammar. This kind of theorizing fares well if one’s sole concern lies in a neat description of language variation. The problem is, of course, that those OT constraints, and their rankings, because of their highly language-specific composition, are not something one can expect to find a biological and evolutionary explanation for, particularly if one is committed to the kind of adaptationist program K&M tacitly recommend.

We noted that the minimalist program seeks signs of optimality in human language only as an intermediate step toward the attribution of them to third factor principles that are yet to be discovered.⁶ However, it is admittedly the case that most practitioners of minimalism rarely present serious discussion on the third factor of language design. In fact, the scarceness of pertinent discussion in the minimalist literature may partially justify K&M's failure to notice the importance of this fundamental concept. It is a regrettable fact that minimalism is often misconstrued, sometimes even by those researchers who count themselves as practitioners of this research program, as a dogmatic or authoritarian excuse to disrespect empirical problems and take advantage of vaguely and arbitrarily invoked notions of simplicity and optimality in favor of their favorite descriptive technologies.

The worrisome descriptive tools put forward in self-described minimalist work include, to mention a few, the proliferating cartography of functional categories,⁷ an intractable number of parameters (micro or macro) distributed over different modules of FL,⁸ countless uninterpretable features ('viruses') that are stipulated to selectively attract neighboring X⁰s and XPs,⁹ and massive stipulations of head- and phrasal (remnant) movement to accommodate, for example, the universal linear order template (Specifier–Head–Complement) of Kayne's (1994) LCA.¹⁰ We regard these descriptive technologies as a residue of the earlier pre-minimalist practice of enriching UG from descriptive pressures. To the extent that they are claimed (admittedly on questionable premises and with auxiliary assumptions) to achieve some descriptive adequacy, we should regard them not as a final explanation but as a first descriptive approximation of the data to be explained in terms of the three factors in the language design (Chomsky 2005). Whether we really need to live with these *prima facie* imperfections is purely an empirical question, but little discussion is provided regarding how these constructs relate to the third factor or, if not, how they are ever acquirable from the impoverished primary linguistic data. Discussion of learnability and/or biological plausibility is really a *must* for the advocates of these technical concepts, and the apparent scarceness of any such justification must have made K&M and others queasy. 'Conceptual' arguments from arbitrarily defined notions of optimality are occasionally provided for these constructs in the literature, but most of them are largely irrelevant to, and, even worse, rather noticeably contradict, the real concern of evolutionary/biological adequacy.

⁶ This is not to deny the possibility that adaptation by natural selection can be one of the decisive optimizing factors for some particular aspects of the biological world.

⁷ See Cinque (1999, 2002), Rizzi (2004), Cinque & Rizzi (2010), and references cited therein. See Narita (2010a) for criticism.

⁸ See Newmeyer (2005, 2006, 2008) for serious criticism. See also an inconclusive reply to Newmeyer by Roberts & Holmberg (2005).

⁹ See Boeckx (2010, to appear) and Narita (2010a) for criticism of the unconstrained use of features.

¹⁰ See Kayne (1994, 2004, 2009). See Fukui & Takano (1998), Chomsky (2004), Richard (2004), Narita (2010a, 2010b), and references cited therein for criticism of the LCA. Incidentally, Kayne is right in admitting, in response to Chomsky's (2004) charge that the LCA is an 'imperfection': "It might alternatively be the case that our initial intuitions about perfection vs. imperfection (in this technical sense) are not fully reliable" (Kayne 2004: 4–5).

In a nutshell, stipulating arbitrarily formulated conceptions of ‘optimality’, let alone presuming them, is very much at odds with the minimalist quest for an evolutionarily or biologically adequate theory of FL (see Fujita 2007 and Narita 2010a). We completely agree with K&M on this point. More generally, we take the essence of K&M’s suggestion to be that we should not be trapped by any prejudices or arbitrary anecdotes regarding the nature of the object of inquiry, a sound warning that supports K&M’s criticism of the actual practice of purported minimalists, while it simultaneously invalidates K&M’s own adherence to anti-minimalist imperfectionism.

This discussion leads us to a natural conclusion: We had better not commit ourselves to what Chomsky (1995a, 2000b) calls *methodological dualism*, a view that “we must abandon scientific rationality when we study humans ‘above the neck’ (metaphorically speaking), becoming mystics in this unique domain, imposing arbitrary stipulations and *a priori* demands of a sort that would never be contemplated in the sciences” (Chomsky 2000b: 76). So-called semantic externalism (Putnam 1975, Dummett 1986, among many others) was originally subsumed under this methodological category, but it rather straightforwardly applies to such research doctrines that are entangled in mystic presumption or terminological manipulation of vague and arbitrary notions of optimality or evolvability (see Kuroda 1999, 2009, Hinzen 2006, and Narita 2009b for related discussion). This insidious doctrine is counterposed to *methodological naturalism*, a naturalistic approach to the mind that “investigates mental aspects of the world as we do any others, seeking to construct intelligible explanatory theories, with the hope of eventual integration with the ‘core’ natural sciences” (Chomsky 2000b: 76). Specifically, at the current stage of understanding, where little is known about the three factors of language design and their interactions, we should proceed to study human language as it is, without any preconception about what we can eventually learn from this domain of inquiry. This naturalistic inquiry may be benefited by adopting the SMT as a conjecture or as a heuristic working hypothesis, but only to the extent that it is reasonable.

Contrast this overall picture of naturalistic inquiry with the dualistic speculation that apparently underlies K&M’s discussion. The speculation is to the effect that biology is different from physics, with language exclusively belonging to the domain of the former. Marcus (2008: 115), in expressing his discontent with minimalism, explicitly states: “[W]hat works for physics may well not work for linguistics. Linguistics, after all, is a property of biology — the biology of the human brain — and as the late Francis Crick once put it, ‘[i]n physics, they have laws; in biology, we have gadgets’”. He continues that “evolution is often more about alighting on something that happens to work than what might in principle work best or most elegantly; it would be surprising if language, among evolution’s most recent innovations, was any different”.¹¹ The kind of alighting effect

¹¹ And because language is such a recent innovation, K&M argue, there must have been little time for “debugging” (p. 190). We take this to mean nothing more than that natural selection did not have enough time to modify the design specification of language. The two sides agree that optimality of language design cannot be explained by natural selection. From this, K&M reason that language cannot be optimal; our alternative reasoning is that natural

mentioned here has been known as tinkering or bricolage (*à la* François Jacob) and it is an important facet of biological evolution, but still it has to be emphasized that tinkering is still constrained by the laws of physics. To say that biology and physics are categorically distinct and unrelated, that there is nothing in biology (and linguistics) that can be understood in terms of natural laws, is plainly a dualistic attitude which hinders the progress of a highly interdisciplinary project like biolinguistics. In fact, as Dawkins (1988: 15) once put it:

The biologist tries to explain the workings, and the coming into existence, of complex things, in terms of simpler things. He can regard his task as done when he has arrived at entities so simple that they can safely be handed over to physicists.

Thus the division of labor between biology and physics must be pursued with the eventual goal that biological issues will someday turn into physical issues (though probably not by simple reduction), rather than adopting the ungrounded belief that biology will never come into contact with physics; the development of biophysics in the domain of morphogenesis is a clear exemplar of the still-developing progress of scientific unification of precisely the type for which we advocate. Biolinguistic minimalism can be seen as nothing more than a linguistic version of modern biology which is making every endeavor to disentangle the surface complexities of the biological organ which we call language, so that those complexities may eventually be explained by simple primitives and universal laws of nature.

5. Remarks on the Metaphysics of Minimalist Biolinguistics

Before concluding the discussion, we would like to remark that methodological naturalism, if couched in minimalist terms, is closely connected to naturalism of a *metaphysical* sort, too, which is quite reminiscent of the fact that methodological dualism was historically contingent on the corresponding metaphysical mind–body dualism of the Cartesian sort.

At the time of Descartes, at least, there was a naturalistic definition of the physical, which was based on ‘mechanical philosophy’, a metaphysical doctrine dominant in the 17th century. The physical (body, matter, etc.), as conceived of in mechanical philosophy, was defined as any material substance with three-dimensional spatial extension; such material, and only such material, could move and participate in Descartes’ contact mechanics. In pushing this hypothesis, Descartes categorically rejected the relevance to physics of any mystical forces or powers, “occult qualities” of sympathy, antipathy, and so on, presumed in the then-dominant Scholastic and Aristotelian view of the world, and put forward a very strong empirical hypothesis that all phenomena of motion are to be explained strictly in terms of immediate contact of contiguous materials. The Carte-

selection alone is therefore unable to explain language evolution or, for that matter, biological evolution in general.

sian mechanical philosophy was quite congenial to our common-sense understanding of the world (folk physics), so intuitively appealing and intelligible to our common-sense understanding of the world that we often forget that this mechanical conception of the physical was effectively demolished by one of Newton's discoveries in the late 17th century. Specifically, Newton's notion of gravity affects objects at a distance, without any medium of body. Thus, his proposal was regarded by the leading scientists of the day as a reintroduction of an "immaterial", "occult" cause that Cartesian contact mechanics had eliminated long before. The mechanical philosophical conception of the material world, where causality among the physical is confined to immediate contact of the physical as a matter of principle, thus turned out to be a wrong scientific hypothesis.

When metaphysical mind-body dualism declined, we were explicitly told by Newton's discovery that we have no valid, metaphysically closed framework of the physical that partitions off the domain of application of physical laws as a matter of principle. This conclusion troubled Newton and his contemporaries a lot, and he was often accused of reintroducing an immaterial occult force to the domain of physics. But, at least for the purpose of pursuing cognitive sciences, we can regard this Newtonian conclusion as advantageous: Thanks to Newton, there is no longer a well-defined boundary for the coherent physical domain in the post-Newtonian era, and correspondingly, there is no longer any principled reason to exclude the possibility that the set of laws of physics, chemistry, mathematics, and other natural sciences are also applicable to the domain of the mind as well. We can only conjecture, as Descartes did, that the creative aspect of language use (Chomsky 2000, 2009a; see also McGilvray 2009a, 2009b, and Narita 2009b) still somehow resists explanation in terms of these natural laws, but the possibility becomes an open empirical question for mental computational mechanisms discovered by contemporary biolinguists and carefully delineated from the boundless creativity of language use. There are indeed quite a few general laws of nature that have been discovered and independently justified by physicists, mathematicians, and other scientists as empirically necessary in their domains of inquiry. Some of these empirically necessary postulates might eventually turn out, probably with the help of further abstraction and refinement, to be operative in the design of FL, too, in which case such principles will enter into the category of the third factor of language design. Indeed, the null hypothesis is that the general laws of nature are also applicable to the mental aspects of the world. The *inapplicability* of them to a certain domain, say of language, would be a non-trivial empirical finding that calls for explanation.

Taking this null hypothesis seriously, investigation into the third factor of language design regards even mental phenomena like language as sources of data that might turn out to be susceptible to accounts in terms of general laws of nature. Along these lines, we would like to point out that minimalist inquiry can be seen as proposing a somewhat unconventional variety of 'metaphysical naturalism'. Metaphysical naturalism, whose essence basically amounts to denial or non-employment of metaphysical dualism, is almost always equated with the reductionist thesis called 'physicalism' or 'materialism' in the philosophical tradition, which holds that only the physical (or the observable) is real and that the mental can and should be reduced to entities of those categories (see, e.g., Chom-

sky 2000b: 79ff. and 143ff. for discussion of varieties of alleged naturalism and materialism). However, the equation is only illusory. The upshot of the above-mentioned Newtonian conclusion is that we no longer have any scientifically coherent definition of the 'physical' to which we can reasonably entertain any meticulous reduction. Thus, unless some alternative characterization of the physical (body, matter, etc.) is provided, any statement of the form "everything there exists in the world is physical" diminishes to an uninteresting proverb of little empirical import (see Stoljar 2000, 2001, 2006, Chomsky 2009b, and Narita 2009b for related discussion). Rather, the notion of physicality, just like optimality and evolvability, is not something that can constrain, let alone serve as the 'reduction base' for, the study of the mental. It is instead something that we must study through investigation into various aspects of the world, mental and otherwise. Time will tell how feasible such research is, but there is no reason to discredit the fact that human language constitutes an interesting specimen of the natural world that happens to admit scientific exploration to some extent, and the hope is that we can eventually find laws and principles that are operative in the design of FL as well as the other aspects of the world. Furthermore, to the extent that we can make any empirical progress in this line of approach, we are heading toward the eventual unification with other natural sciences that biolinguistics, as well as earlier Cartesian studies of the mind, have long been looking for, an overarching desideratum that amplifies the contemporary significance of minimalism, especially of the 'explanatory' dimension mentioned above.

This kind of research is methodologically naturalist in that it does not admit any stipulated differentiation of the methods of inquiry. Moreover, it is metaphysically naturalist in that it does not allow itself to be entangled in any stipulated preconceptions or partitions of the world ("evolution yields imperfection", "language is (im)perfect", "the mental is reduced to the physical", etc.), and it searches for overarching laws and principles whose effects crosscut both physical and mental aspects of the world. No success is guaranteed, but this is again a familiar feature of naturalistic inquiry.¹²

6. Concluding Remarks

As we saw in the previous sections, K&M's insistence that evolvability should be a central constraint on linguistic theorizing, though sound in principle, cannot carry much force unless it reflects the full range of complex factors that drive biological evolution, many of which remain rather unclear at the current stage of understanding. We pointed out that K&M's conception of evolvability is specifically prejudiced toward Neo-Darwinian adaptationism and fatally flawed by what we have called the fallacy of empirical adaptationism, and that imposing such a presumptuous framework on biolinguistics might not foster empirical discoveries in

¹² See also Chomsky (2007a) and Narita (2009a, 2009b) for related discussion on Hinzen (2006) and Uriagereka's (2009) approach to the issue of 'naturalization of meaning'. See also McGilvray (2009b).

the domain of inquiry. We noted that it is quite unfortunate that K&M's otherwise reasonable and partially justifiable objection to the body of current minimalist literature is marred by (i) their misunderstanding of the SMT as an aprioristic presumption of optimality and (ii) their adherence to anti-minimalist imperfectionism based on their biased view of evolution. Notwithstanding these flaws, we remain obliged to K&M in that their criticism has illustrates exactly why practitioners of the minimalist enterprise should stop inventing stipulative technologies without scrutinizing their biological plausibility, and that we must also be careful not to make use of undefined notions of optimality as unwarranted justifications for arbitrary conclusions. This amounts to just another recommendation of methodological naturalism (Chomsky 1995a, 2000b), which we may hope to invest with some metaphysical import, too, as future biolinguistic inquiry under the guidance of the SMT might reveal.

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The Evolving Science of Language Evolution

Fitch, W. Tecumseh. 2010. *The Evolution of Language*. Cambridge: Cambridge University Press.

by Bridget Samuels

Concomitant with the ascendance of biolinguistics on the research agenda, the evolution of language has garnered considerable interest in the past decade. *The Evolution of Language* by cognitive biologist W. Tecumseh Fitch rides this current wave of popularity, surveying and synthesizing a broad range of recent developments in the field, yet one of the major currents which runs throughout the work is that interest in this strand of human cognitive evolution was strong throughout the twentieth century (and before), contrary to those who cite the 1861 Paris Linguistics Society ban as enforcing silence only broken a good 130 years later by Bickerton (1990) and Pinker & Bloom (1990). Another welcome theme which Fitch stresses repeatedly (see especially p. 175–176) is that we must look past the false dichotomy between “continuist” and “discontinuist” theories of language evolution, seeking a middle ground which acknowledges parts of the language faculty which we share with our primate ancestors as well as those which we do not.

Fitch approaches what Christiansen & Kirby (2003) have called “the hardest problem in science”, that of determining how humans developed the unique capacity for language, from the perspective that modern linguistics and biology have made it possible to refine earlier proposals but have not generated many truly new ideas. All the modern theories can be roughly categorized in terms of which type of proto-language they posit — lexical, gestural, or musical — each of these views being rooted in older speculation. One of the major strengths of the book is the overview of these historical and contemporary proposals. In section 4 (the last of the volume’s four sections, each including at least three chapters), Fitch does an excellent job of presenting the views on proto-language held by Herder, Darwin, Müller, Monboddo, Jackendoff, Lieberman, Deacon, Arbib, Tallerman, Wray, and others. The strengths and shortcomings of each proposal are weighed in a “dispassionate survey of the available hypotheses” (p. 4), with an emphasis on the plausibility in each scenario of language emerging through mechanisms of natural selection, particularly kin selection. Fitch stresses that kin selection is the only way to circumvent the ‘free-rider problem’: Cooperation, in this case information sharing via communication, is not an evolutionarily stable strategy, so the emergence of cooperation in any species poses explanatory difficulty. In light of this, Fitch suggests in chapter 14 (following Dissanayake 1992



and Falk 2004) that a musical proto-language emerged as a way for mothers to remain in contact with infants who, largely due to bipedalism, could not easily be carried at all times. This music-as-motherese scenario is consistent with the intricate relationship between music and language in the brain, the extent of which is still being explored (see Patel 2008 for an excellent overview of the present state of the art). Such a view stands in sharp contrast to those like Pinker (1997) who consider music to be “auditory cheesecake” with no adaptive value.

Another distinct strength of *The Evolution of Language* is section 2, which traces human ancestry all the way back to single-celled organisms. Fitch’s insistence on drawing such a comprehensive family tree is largely rooted in the emphasis he places on convergent evolution across lineages: Similar solutions to a common problem arising in multiple clades serve to highlight the constraints on evolution within which the problem can be solved. Moreover, the articulatory, perceptual, and conceptual systems which serve human language have lengthy evolutionary histories, and Fitch admirably summarizes this heritage (largely shared with other vertebrates). The overview is broad in scope, including material on genetics, geological history, physiology, neuroanatomy, and various other topics which help to shed light on the origins of the human language faculty and genetic endowment more generally.

Unfortunately, the discussion of the *FOXP2* gene, delayed until section 3, which focuses on the evolution of speech, is somewhat lacking. Nowhere does Fitch discuss the fact that mouse models (which antedate the association of mutated *FOXP2* with disordered language in the KE family; Lai 2001) have shown that *Foxp2* is expressed in numerous organs other than the brain, including the lung, intestine, and cardiovascular system (Shu *et al.* 2001). The associations between single nucleotide polymorphisms in *FOXP2* and autism also deserve mention, though they remain controversial (see Shu *et al.* 2005, Stromswold 2008, and references therein). One cannot fault Fitch for omitting discussion of Vernes *et al.* (2008) and Stromswold’s (2008) accompanying commentary, which likely went to press too late to make their way into *The Evolution of Language*, but it is worth noting here that our understanding of *FOXP2* is now beginning to extend to the network of genes which it regulates; among these are *CNTNAP2*, which has been implicated in a number of neurodevelopmental disorders, and the *WNT* gene family, which has been associated with autism, Alzheimer’s Disease, and schizophrenia. Finally, discussing the findings of Shu *et al.* (2005) on mice subjected to knockout of *Foxp2*, Fitch reports that “although vocal production is reduced in these knockout mice, the vocalizations that are produced appear to be normal”, (p. 360). This glosses over crucial differences between homozygous and heterozygous genotypes. A more accurate reflection of the 2005 findings would report that mice with two disrupted copies of *Foxp2* produced virtually no ultrasonic whistles and a dramatically reduced number of clicks compared to both wildtype and heterozygous knockout mice, while those with one damaged copy produced a normal number of clicks but a significantly reduced number of whistles compared to wildtype mice.

From a linguist’s perspective, I found the weakest part of *The Evolution of Language* to be section 1, and in particular the introduction to linguistics in chapter 3. For example, a sub-heading in this chapter purports to discuss “the chal-

lence and complexity of syntax" (p. 102) but only mentions syntactic structure in passing; instead, Fitch asks us to contemplate the different meanings of *take* in 'taking a cookie from a jar', 'taking someone prisoner', and 'taking something for granted'. The descriptions of phrases, phrase structure, and self-embedding (p. 104) could also be better illustrated for a non-specialist audience. Furthermore, Fitch commits a couple of serious factual errors in describing the history of Chomskyan syntax: Government & Binding Theory was the first incarnation of a Principles-and-Parameters based syntactic theory, not its precursor (p. 105), and it is incorrect to state categorically that linguists who work within the Minimalist Program hold Universal Grammar to be syntax-specific (p. 88); see for example Samuels (2009) and Samuels *et al.* (to appear). The discussion of syntactic autonomy also mischaracterizes the aims of formalism: Calling the formalist approach a "gambit" that holds appeal "despite the obvious fact that any complete model of language will eventually have to grapple with meaning" (p. 106–107) belies the fact that semantics, too, can be formal. Just because the study of meaning falls outside the purview of syntax in formalist theories does not mean that the relevance of semantics has been completely discounted. A glaring omission in the discussion of syntax, considering the amount of controversy in this area over the past decade, is any substantial discussion of recursion. Nowhere does Fitch even acknowledge this debate, which is all the more striking considering that one of his own co-authored papers (Hauser *et al.* 2002) sparked the controversy.

The treatment of phonology is idiosyncratic, citing Browman & Goldstein (1986) to an unusual degree. One particularly striking quote comes on p. 96, where Fitch states that "[t]here is little doubt that, eventually, [phonetics and phonology] will be joined seamlessly by a set of bridging principles, much as physics and chemistry are today". Yet one of the defining characteristics of phonology is that it is highly dependent on language-specific history and, as such, can synchronically be quite phonetically arbitrary (see Blevins 2004 and Samuels 2009, *inter alia*). And while Fitch discusses both categorical perception of segments and the possible origins of articulatory gestures, discussion of phonological/phonetic features is virtually absent (see Samuels 2010 for one way animal models can inform our understanding of features).

In multiple places, the approach to phonology could be informed by recent work on Al-Sayyid Bedouin Sign Language (ABSL; Aronoff *et al.* 2008), which emerged over the past few generations in an isolated community in the Negev desert with a high rate of hereditary deafness. For example, Fitch states that a "productive, combinatorial process is a necessity for the generation of complex signals of speech or sign" (p. 100). Yet Israel & Sandler (2009) have argued that not only does ABSL — which is indisputably a full, natural human language — lack a discernible segment inventory and phonotactic restrictions, it also displays a much higher rate of lexical variation than in other sign languages. Where one would typically expect only a small amount of variation (think *tom[ej]to* versus *tom[a]to*), instead Sandler finds many more than a handful of signs, and quite common ones at that, with many more than a handful of variants. Furthermore, researchers report an absence of minimal pairs in the language (Aronoff *et al.* 2008), which supports the conclusion that, particularly among older speakers of ABSL, no true phonological system is in place. Discussing the possibility that hu-

man language has gestural origins, Fitch (p. 467) finds difficulty in transitioning from an iconic gestural system to a language which exhibits duality of patterning in Hockett's (1960) sense. But this transition from iconicity to conventionality is exactly what we see occurring in ABSL, and indeed in assimilatory and compounding processes across signed languages (Israel & Sandler 2009).

Overall, the shortcomings of *The Evolution of Language* do not detract greatly from its enjoyability or utility. It would serve well as an introduction to the study of language ontogeny for researchers in a variety of biolinguistic disciplines, and I can easily imagine it being useful in a classroom setting. Because of the reservations about section 1 discussed above, one should use caution in relying on the text as an introduction to generative linguistics. Additionally, one should keep in mind that the state of the art in such fields as genetics, neuroscience, and evolutionary biology changes rapidly, as I have also mentioned; already there are places where the volume does not represent the most current literature available. These concerns notwithstanding, *The Evolution of Language* provides one of the broadest and most up-to-date surveys of its subject matter, and should prove both informative and thought-provoking for all those interested in biolinguistics.

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An Outline of the Fodor & Piattelli-Palmarini Argument against Natural Selection

Norbert Hornstein

Jerry Fodor and Massimo Piattelli-Palmarini have recently argued that the theory of natural selection (NS) fails to explain how evolution occurs (Fodor & Piattelli-Palmarini 2010; F&PP). Their argument is not with the fact of evolution but with the common claim that NS provides a causal mechanism for this fact. Their claim has been greeted with considerable skepticism, if not outright hostility.¹ Despite the rhetorical heat of much of the discussion, I do not believe that critics have generally engaged the argument that F&PP have actually presented. It is clear that the validity of F&PP's argument is of interest to biolinguists. Indeed, there has been much discussion of late concerning the evolution of the faculty of language and what this implies for the structure of Universal Grammar.

To facilitate evaluation of F&PP's proposal, the following attempts to sketch a reconstruction of their argument that, to my knowledge, has not been considered.

1. 'Select' is not 'select for', the latter being intensional.²
2. The 'free-rider problem' shows that NS *per se* does not have the theoretical resources to distinguish between 'select' and 'select for'.
3. If not, then how can NS causally explain evolutionary change?
4. There are two ways of circumventing the free-rider problem.³
 - a. Attribute mental powers to NS, i.e. NS as Mother Nature, thereby endowing NS with inherent intensionality and so the wherewithal to distinguish 'select' from 'select for'.
 - b. Find within NS a law supporting counterfactuals, i.e. laws of natural selection/evolution, which also would suffice to provide the requisite intensionality.

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¹ See, for example Block & Kitcher (2010), Futuyma (2010), and Pigliucci (2010).

² Intensional contexts are ones in which extensionally identical expressions are not freely interchangeable. Thus, if John intends to kiss Mary and Mary is the Queen of the Night, we cannot conclude that John intends to kiss the Queen of the Night.

³ F&PP develop this argument in chapter 6. The classic locus of the problem is Gould & Lewontin (1979).



5. The first option is clearly nuts, so NS accounts must be presupposing (4b).
6. But NS contains no laws of evolution — a fact that seems to be widely recognized!
7. So, NS can't do what it purports to do: give a causal *theory* that explains the facts of evolution.
8. Importantly, NS fails *not* because causal accounts cannot be given for *individual* cases of evolution. They can be and routinely are. Rather, the accounts are individual causal scenarios, natural histories specific to the case at hand, and there is nothing in common across the mechanisms invoked by these individual accounts besides the fact that they end with winners and losers. This is, in fact, often acknowledged. The only relevant question then is whether NS might contain laws of NS/evolution? F&PP argue that NS does not contain within itself such laws and that, given the main lines of the theory, it is very unlikely that any could be developed.
9. Interestingly, this gap(/flaw) in NS is now often remarked in the biology literature. F&PP sample some work of this sort in the book. The research they review tends to have a common form in that it explores a variety of structural constraints that, were they operative, would circumscribe the possible choices NS faces. However, importantly, the mechanisms proposed are adventitious to NS; they can be added to it but do not follow from it.
10. If these kinds of proposals succeed, then they could be combined with NS to provide a causal theory of evolution. However, this would require giving up the claim that NS explains evolution. Rather, at most, *NS + structural theories* together explain evolutionary change.⁴
11. But, were such accounts to develop, the explanatory weight of the combined 'NS + structural theory' account would be carried by the added structural constraints — not NS. In other words, all that is missing from NS is that part that can give it causal heft and, though this could be added to NS, NS itself does not contain the resources to develop such a theory on its own. Critics might then conclude as follows: This means that NS can give causal accounts when supplemented in the ways indicated. However, this is quite tendentious. It is like saying Newton's theory suffices to account for electro-magnetic effects for, after all, Newton's laws can be added to Maxwell's to give an account of electro-magnetic phenomena!
12. F&PP make one additional point of interest to linguists. Their review and conclusions concerning NS are not really surprising, for NS replays the history of empiricist psychology — though strictly speaking, the latter was

⁴ Observe that the supposition that selection is simply a function of 'external' environmental factors lies behind the standard claim that NS (and NS alone) explains why evolutionary changes are generally adaptive. Adding structural 'internal' constraints to the selective mix weakens the force of this explanation. To the degree that the internal structural factors constrain the domain of selection — to that degree, the classical explanation for the adaptive fit between organism and environment fails.

less nutty than NS, for empiricists had a way of distinguishing intensional from non-intensional as minds are just the sorts of things that are inherently intensional. In other words, though attributing mental intensional powers to NS (i.e. Mother Nature) is silly, attributing such powers to humans is not.

This is the argument. To be honest, it strikes me as pretty powerful if correct, and it does indeed look very similar to early debates between rationalist and empiricist approaches to cognition. However, my present intention has not been to defend the argument, but to lay it out given that much of the criticism against F&PP's book seems to have misconstrued what they were saying.

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Review of the Summer Institute in Cognitive Sciences 2010: The Origins of Language

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1. Overview

During the last two weeks of June, the Faculty of Social Science and Humanities at the Université du Québec à Montréal (UQÀM) organized the [Summer Institute in Cognitive Sciences 2010](#) (UQÀM 2010, 21–30 June 2010). This year's topic was “the hardest problem in science” (Christiansen & Kirby 2003a) — the origins of language. Language origin refers to the phylogenetic process whereby *Homo sapiens* made the transition from a pre-linguistic communication system to a communication system with languages of the sort we use today (Wang 1978, Gong 2009). Questions concerning when, where, and how human language (henceforth, simply ‘language’) originated and evolved belong to the realm of evolutionary linguistics (Ke & Holland 2006, Hauser *et al.* 2007). This field has now become resurgent as a scientific and collaborative beacon for research (Oud-eyer 2006), as shown by many anthologies and reviews; see, among others, Harnad *et al.* (1976), Wang (1991), Hurford *et al.* (1998), Briscoe (2002), Wray (2002b), Christiansen & Kirby (2003a, 2003b), Cangelosi *et al.* (2006), Smith *et al.* (2008), Bickerton & Szathmáry (2009), Larson *et al.* (2009), and Smith *et al.* (2010).

More than 100 scholars and students from the Americas, Europe, and Asia gathered in Montreal for UQÀM 2010 to study and discuss the outline and recent research of evolutionary linguistics. On each day of the institute, there were five lectures plus one hosted discussion in English. In addition to these lectures and discussions, there were two poster sessions for participants to present their work. The 8 days of lectures collectively introduced a variety of theoretical topics, research methods, and latest findings pertinent to the study of language origins from a range of different fields which included anthropology, archaeology, paleontology, neuroscience, genetics, philosophy, psychology, zoology, computer science and linguistics. The lectures covered a wide range of fields, including the history of evolutionary linguistics, animal behaviors, embodiment of language, theories of language origin, computational simulations of language, and perspectives about language and its evolution from a number of disciplines.

In section 2, we briefly review the opening presentation of this institute, and then follow this with a description of the plenary lectures in section 3.

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Presentations of the poster sessions are not covered by this report, but interested readers may contact the UQÀM 2010 organizers for more information.

2. Opening Presentation: What Is Language?

On 21 June 2010, the summer institute commenced with an opening address by Ray Jackendoff from Tufts University, who was also awarded an honorary doctorate by UQÀM. In this presentation, Jackendoff reanalyzed the view on the Faculty of Language (FL) articulated by generative linguists (Hauser *et al.* 2002). According to this view, FL consists of FLB (FL in the broad sense) and FLN (FL in the narrow sense): FLB contains sensorimotor and conceptual-intentional capacities, such as auditory channels, working memory, general intelligence, and shared attention, most of which, shared by humans and other species in different levels, are not specific to language; however, FLN involves capacities that are specific to language, and recursion is proposed to be the only component of FLN in Hauser *et al.* (2002). Based on the evidence from visual processing, music recursion, and narrative structure of comics, Jackendoff claimed that recursion was ubiquitous in cognition and, instead of being considered a defining characteristic of language, it should belong to FLB.

Jackendoff further evaluated the Minimalist Program within generative grammar (Chomsky 1993), pointing out that Merge (the operation combining lexical items, according to their intrinsic lexical constraints, into phrases and of combining phrases with each other), as formulated, was not rich enough to handle recursion. Unlike the, what Jackendoff calls, syntacto-centric architecture of language (Chomsky 1993) claiming that the generative capacity of language is localized in the syntactic component where combinatorial properties of sound and meaning are all derived from syntactic derivations, Jackendoff presented his parallel architecture of language (Jackendoff 2002). This structural perspective holds that there are independent combinatorial principles in syntax, semantics, and phonology. Structures from these three components are connected via interface rules and perceptual systems; and instead of being passively manipulated by syntactic derivations, associations between phonological, syntactic, and semantic features are an active part of the interfaces among these components. This view re-positions syntax in language, re-evaluates the relations among linguistic components and general intelligence, and is consistent with the new evidence of human language processing capacities (Jackendoff 2009).

3. Lectures

3.1. *History and Outline of Evolutionary Linguistics*

Explorations on language origin date back to the debates of early philosophers and the language deprivation experiments conducted in early dynasties.

Henri Cohen (UQÀM) reviewed some early theories on language, such as Plato's etymological account of words, Fauchet's discussion on individual linguistic knowledge, Alighieri's historical treatment of languages, and Condillac's emphasis on sign languages, most of which were influential to Darwinian and even today's theories on language. He also evaluated some early language deprivation

vation experiments conducted in Egypt, India, and Scotland, and showed their contradictory results. The lack of scientific ways of thinking and conducting experiments led to the famous ban on the discussion of language origin from the *Société de Linguistique de Paris* in 1866 (the SLP ban).

Sylvain Auroux (CNRS) examined the philosophical views on language in the 18th century and analyzed two theoretical models proposed during this period. The 'speculative' model focused on individuals and aimed to establish a scenario from minimum hypotheses. Based on this model, Condillac claimed that thoughts were the essential force driving language evolution; language would complete its development if men ceased to generate new needs or ideas. The 'historical' model focused on empirical data and aimed to establish historical relations among languages. Based on this model, Jones believed that many Indo-European languages evolved from a common ancestor. The approach based on the 'historical' model, not rejected by the SLP ban, led to the emergence of historical linguistics, which is one of the most important components of modern linguistics.

Based on these reviews, Cohen listed some outlines of evolutionary linguistics: (i) This field studies FL instead of specific languages, (ii) it focuses on biological capacities and their precursors that enable humans or early hominins to acquire and use languages, and (iii) instead of recovering each step of evolution, it aims to identify selective pressures on language origin and evolution. These outlines provide instructions for evolutionary linguistics research in linguistics and other relevant disciplines.

3.2. *Animal Behaviors and Language*

Comparative studies on other species' culturally varied behaviors could provide us with a sense of the likeliest range of behavioral or cognitive options that early hominins could have taken (Stanford 2006).

Klaus Zuberbühler (University of St. Andrews) provided an update of research on primate vocal communications in natural environments. In order to make comparisons with the physical and behavioral adaptations underlying language, their likely origins in the primate lineage, and their functional roles in communications, this branch of animal studies is usually conducted in the wild using observational sampling techniques or based on non-invasive field playback experiments, covering a wide range of monkeys and ape species (e.g., Cheney & Seyfarth 1990, 2007). At a broader functional level, compared with human communication, many pre-adaptations, such as call combination, social awareness and shared intentionality (Arnold & Zuberbühler 2006 and Pika & Zuberbühler 2007), have been observed in nearly all these species, indicating that during the recent evolutionary history of primates only minor adjustments were necessary to endow humans with FL.

Sue Savage-Rumbaugh & William Fields (Georgia State University) reviewed studies on animal communications based on captive chimpanzees and bonobos, and focused on the signs and lexigrams used by these animals during interactions with human raisers (Savage-Rumbaugh *et al.* 1998). Though limited in vocal communications, these animals can use signs and lexigrams fluently to reflect their minds. Other social skills, such as pointing, joint attention, turn-

taking, and sensitivity to others' minds, were also observed in captive animals during experiments using controlled stimuli.

James R. Hurford (University of Edinburgh) examined the cognitive precursors of linguistic capacities in a variety of animals including birds, dogs, and primates. He reviewed the rich evidence showing that these species can solve the object permanence task, possess the episodic memory for a series of events, represent some abstract properties or relations, do transitive inference, form simple concepts of sameness and difference, have the simple predicate–argument semantic structure, and so on (Hurford 2007). This collection of apparently similar cognitive mechanisms between humans and other species could inspire us to reconsider the singularity of language and relevant learning capacities.

Stephanie A. White (University of California at Los Angeles) focused on songbirds, rather than primates, and used them as behaviorally relevant and physiologically accessible models to determine whether the FoxP2 gene in songbirds functions additionally in their vocal learning and adulthood. She and colleagues found that FoxP2 mRNA in male zebra finches declined rapidly and specifically within the striatal song control region (Area X) when these birds sang, but was stable in non-singing birds. This decline also occurred when males practiced alone, but not when they performed for females (Teramitsu & White 2006). This real-time regulation of FoxP2 during vocalization, dependent on the social context, indicates that FoxP2 functions beyond development and pure motor control (White *et al.* 2006).

3.3. *Embodiment of Language*

This line of research examines questions of how human capacities make language, especially speech, possible and how these capacities affect each other during language processing and communications.

Examining factors involved in the emergence of speech could help to search for answers to language origin. Based on the favored phonetic forms in the babbling and early words of present day infants, Peter F. MacNeilage (University of Texas at Austin) claimed that three forms of CV-like syllables — coronal stop consonants with front vowels (e.g., “dada”), dorsal stop consonants with back vowels (e.g., “gogo”), and bilabial nasal consonants with central or low vowels (e.g., “mama”) — constitute the fundamental property of speech (MacNeilage & Davis 2000). Following the ‘putting the baby down’ scenario (Falk 2004), he suggested that parental terms, possessing present day equivalents to the phonetic forms of the first words, are modern copies of language fossils, and that the second words resulted from the requirement of linguistic distinctiveness applied to the parental forms (MacNeilage 2008).

Lucie Ménard (UQÀM) found that universal tendencies in sound representations observed in languages could be explained in light of individuals' sensorimotor constraints. By listing favored vowels and consonants in some language inventories extracted from the UCLA Phonological Segment Inventory Database, she suggested that these recurrent sound patterns were deeply rooted in physical constraints related to the speaker's vocal tract shape and motor control, and to the listener's perceptual mechanisms. Similar constraints derived from open-close jaw cycle and perceptual saliency also found ways to cause the preferred

syllable structures such as CV and CVC in languages. These universal sound patterns and syllable structures were also attested in babies' babbling and first word inventories (MacNeilage & Davis 2000).

Based on paleoanthropological fossils, a solid understanding of the shape of the vocal tract of human ancestors can shed light on the emergence of speech. In light of head morphology and genetics, Louis-Jean Boë (CNRS) introduced a method of reconstructing vocal tract geometry from skulls with mandible and cervical vertebrae. Arguing against Lieberman's claim that the unlowered larynx with respect to the high position of hyoid bone in newborns and Neanderthals makes it impossible for them to produce the full range of phonetic contrasts, such as /i/, /u/, and /a/ (Lieberman & Crelin 1971, Lieberman 1972), Boë combined phylogenetic reconstruction and ontogenetic data to show that there is no obvious descent of larynx in phylogeny and that it is not necessary to have a low larynx to produce the cardinal vowels /i/, /u/, and /a/ in infants; instead, it is the cognitive capacity for motor control (e.g., feeding gestures as an exaptation for the control of speech production) that should be considered for the emergence of speech.

Nathalie Tzourio-Mazoyer (CNRS) studied multiple factors besides handedness that could affect the hemispheric asymmetry of language areas. She found that the brain volume and asymmetry of left planum temporale (LPT, an auditory area more developed on the left side in the general population; Geschwind & Levitsky 1968) could best explain the variability measured in speech comprehension. She also presented evidence that subjects who had left-handers in their family exhibited a reduction in the surface area of the LPT. This evidence indicates the existence of a genetic influence on hemispheric specialization of language, and supports the hypothesis that perceptive constraints on speech processing can affect the development of hemispheric language organization, which is compatible with the motor and gestural theories of language origin.

David Poeppel (New York University) introduced a method to construct explicit 'linking hypotheses' between brain mechanisms and linguistic computation. After explaining the cortical organization of speech processing, he proposed a dual-stream model in which constituent elementary computations were mediated by an array of cortical areas (Hickok & Poeppel 2007). The MEG studies on cortical rhythms showed that the phase of low frequency responses recorded from human cortex (e.g., theta range) could be a sensitive neuro-physiological index of online speech processing. Other studies combining EEG/fMRI recordings (Giraud *et al.* 2007) further showed that the spontaneous power fluctuations of human brain intrinsic oscillations were paralleled by specific modulations of neural activity in auditory/temporal cortices and correlated with the mouth premotor area. This evidence implies common cortical oscillatory frequency bands for speech production and perception, and provides a supportive brain-based account for the frame/content theory of evolution of speech (MacNeilage 1998).

3.4. *Anthropological Perspectives on Language*

Anthropologists and archaeologists were among the first group of scholars trying to construe language origin. Paleoanthropological records of extinct hominins

can reveal evidence of presence or absence of bony conformations associated with speech, and archaeological records can provide information of every approximate levels of cognitive and social complexity of extinct hominins.

Based on the tooth fossils of Neanderthals, Jean-Jacques Hublin (Max Planck Institute for Evolutionary Anthropology) examined the life history of Neanderthals. This study can facilitate assessment of growth and development in hominins with greater precision than skeletal analyses, since during tooth formation, biological rhythms manifested in enamel and dentine, creating permanent records of growth rate and duration. Hublin and colleagues found that the period of tooth formation of Neanderthals was shorter than that of Modern humans, implying that a prolonged childhood and slow life history could be unique to *Homo sapiens*, as other biological adaptations and aspects of social organization (Smith *et al.* 2007).

Based on the archaeological evidence of stone tool-making, Ian Tattersall (American Museum of Natural History) claimed that, because the appearance of modern symbolic cognition (ca. 70,000 years ago) considerably post-dated that of anatomically modern humans (ca. 160–200,000 years ago), the peripheral structures permitting speech must have been acquired in an exaptive context, unrelated to language use, and that besides an internal conduit to thought, language must have been a candidate for the role of cultural releaser (Tattersall 2009).

Based on the analysis of the ornament materials excavated from the Middle Stone Age caves in southern Africa, Christopher Henshilwood (University of Bergen) and Benoît Dubreuil (UQÀM) argued that the creation of such symbolic artifacts relied upon a higher level of theory of mind, which is impossible for non-human primates or young human children due to their simple social categorization abilities. And since such a high level of theory of mind is an important prerequisite for language (Tomasello 2008), they further argued that the appearance of symbolic artifacts implied the origin of some form of language.

Following the assumption that nonlinguistic phenotypes are usually associated with the origin of language, Francesco D'Errico (CNRS) analyzed the knapping techniques shown in stone tool-making of early hominins. These techniques could reveal the ability of hierarchical thinking and syntax of actions, and the recurrent appearance of such techniques in Africa could be the evidence rejecting the hypothesis of the abrupt origin of language in Africa. In addition, the analysis of the symbolic use of marine shells and mineral pigments by Iberian Neanderthals showed that European Neanderthals were no different from coeval Africans (Zilhão *et al.* 2010), which questions the hypotheses of the exclusive origin of language in Africa.

Jean-Marie Hombert (CNRS) focused on populations of early hominins. The number of *Homo sapiens* was extremely small during the early development of human communication system. The early increase in human population was influenced especially by natural events, whereas the more recent increase in population correlated with the impact of agriculture and the spread of linguistic groups. Besides population size and density, he suggested that the heterogeneous make-up of the population was also a relevant factor in the current development of linguistic diversity.

From the anthropological perspective, Alan Barnard (University of Edin-

burgh) suggested that language development proceeded in several revolutionary phases, including (i) the 'signifying revolution', during which early Homo sapiens started to use words to classify things, (ii) the 'syntactic revolution', during which rudimentary syntax emerged to formulate complex kinship descriptions, and (iii) the 'symbolic revolution', during which fully-developed syntax, music, art, religion, and fully-developed kinship structures all became available. He pointed out that the evolution of story-telling, legends and myths, as culturally important means of expression, played significant roles in creating the linguistic complexities we see today.

3.5. *Philosophical and Psychological Perspectives on Language*

Denis Bouchard (UQÀM) proposed a philosophical perspective on the origin of structural properties in language. He suggested that language developed as a part of a complex human adaptive suite, all traits of which came from the micro-anatomical brain structures with offline potentials. Such an offline brain system allowed meanings and forms to meet through their representations, thus forming the elementary element of language, uni-signs (meta-representation linking an acoustic image with a concept). Then combi-signs (combinations of uni-signs) and uni-signs collectively triggered the structural properties in phonology and syntax.

Dan Sperber (Institute Jean Nicod) proposed a pragmatic account of language origin. He suggested that language communication is not a 'coding model' in which the communicator encodes meanings into utterances, but an 'inferential model' in which the communicator helps the addressee by giving evidence of her meaning, and the addressee infers the meaning from this evidence and the context. The success of inferential communication is mainly due to the mind reading ability in humans, and does not require identical semantic representations in utterances. Therefore, it is common that the linguistic utterances we use today are full of semantic ambiguities and referential indeterminacies. Being disposed to treating uncoded communicative behavior as a coded signal facilitates the inferential comprehension of the communicator's intention, thus leading to the stabilization of this kind of behavior as a signal. The relatively rapid evolution of language and the relatively high heterogeneity of linguistic knowledge within a community are possible only if the function of language communication is to provide evidence of the speaker's meaning and not to encode it directly (Sperber & Origgi 2009).

Pierre Jacob (Institute Jean Nicod) further argued that communicative intentions were a special sort of social intentions, requiring a high level of meta-representation ability, which challenged the view that the mirror neuron activity alone could enable the addressee to represent the speaker's communicative intention.

Michael Tomasello (Max Planck Institute for Evolutionary Anthropology) studied language origin from a psychological perspective. He claimed that collaborative activities acted as the pre-existing social context for human communication. Within this cooperative context, natural gestures helped to form pragmatic infrastructure, and later, conventional symbols and constructions, as much more powerful means of communication, became possible in larger communities.

To support this cooperation-first hypothesis (Tomasello 2008), he provided evidence that human infants could use natural gestures, especially pointing, to convey their intentions and make use of common ground (shared experience) to read social intentions of the experimenter and to cooperate in realization of shared goals, whereas the pragmatic complexity reflected in referential choices was absent in communications of apes (Tomasello 2009). Based on this evidence, he concluded that linguistic conventions are possible only if the shared intentionality infrastructure is in place.

Stevan Harnad (UQÀM) emphasized the role of human categorization mechanism in language origin. He proposed that language came into existence when purposive miming became conventionalized into arbitrary sequences of shared names used for describing and defining new categories via propositions. Most categorical knowledge in humans is not inborn but learnt via two ways: through direct experience (induction) shared by most species or through word of mouth (instruction) only possessed by humans. He demonstrated this theory in three ways: Artificial-life simulations illustrated the evolutionary advantages of instruction over induction, human electrophysiology experiments revealed the shared features in the two ways of acquiring categories, and graph-theoretic analyses showed that our lexical dictionaries consist of a core set of concrete words learned more early from direct experience and a peripheral set of words learned later by combining core words into subject.

3.6. *Social and Genetic Perspectives on Language*

Following a social perspective, David Sloan Wilson (Binghamton University) introduced the 'multi-level selection theory' for language, which states that the evolution of socio-cultural behaviors like language must involve multi-level selections within an individual and within or between groups of individuals, and culturally evolved meaning systems could guide adaptations at the individual and group levels, as well as cultural transmission of language.

From a genetic perspective, Karin Stromswold (Rutgers University) reported how genetic findings informed theories of language evolution through family aggregation, adoption, and twin studies. She found that genetic factors affected articulation and syntax more than vocabulary, indicating that syntax and phonology might evolve with similar selective pressures separate from that of lexicon, and that there was genetic overlap between linguistic and non-linguistic skills, indicating that language could have shared an evolutionary history with non-linguistic abilities such as motor or social skills (Stromswold 2009). She suggested that the current genetic research should focus on whether it was a natural selection or exaptation process by which the genetic factors subserving language came into being, and whether there were language-specific genetic factors or whether they all 'piggy-backed' (Tomasello 2008) on other abilities.

Wolfgang Enard (Max Planck Institute for Evolutionary Anthropology) presented a molecular genetic study which introduced two amino acid replacements into the endogenous FoxP2 gene of mice and compared these partially 'humanized' mice with the wild-type ones, and showed that, although the mice with substitutions were generally healthy, they had qualitatively different ultrasonic vocalizations and decreased exploratory behaviors and dopamine con-

centrations in their brains. These results indicated that the humanized FoxP2 allele could affect basal ganglia (Enard *et al.* 2010). Considering that the wild-type FoxP2 protein can be viewed as an ancestral version of the human FOXP2 (to distinct FoxP2 in other species) protein, this study indicated that alterations in cortico-basal ganglia circuits could be crucial for the evolution of speech and language in humans.

Terrence Deacon (University of California at Berkeley) analyzed the role of relaxation of natural selection on language. He hypothesized that functional redundancy could relax selection on other structures or functions, in which accumulated mutations could produce some variants. These variants tend to dedifferentiate but may also complement the functions of others, thus initiating their synergistic effect. Using finches as an example, he found that domestication of finches could remove the stabilizing effect of sexual selection and degrade constraints on song generation. Following the relaxed sexual selection pressure, other neural influences could cause the song structures to be increasingly subject to social influence. He claimed that such a genetic dedifferentiation effect might contribute to the functional complexity in language. The similar relaxation role could allow cross-talks among cerebral cortical systems in human brains, and the unmasked selection for new functional synergies could cause anatomical reorganization, thus leading to a coevolution of human brains and language (Deacon 1997). Such coevolution proceeded in a context of niche construction (Laland *et al.* 1999 and Day *et al.* 2003): Once a language-like behavior became critical to a hominin's life, it would effectively become an artificial niche to which hominin brains had to adapt.

3.7. Theories of Language Origin

Compared with early philosophical theories, modern theories of language origin are internally coherent, drawn from empirical and comparative evidence in humans and other species, and many parts of them can be systematically evaluated based on methods from different disciplines besides linguistics.

Modern theories of language origin are usually based on the concept of *proto-language*. Proto-language refers to the hypothesized early form of language used by our last common ancestor in the hominin family, which does not exhibit the full range of structural properties as modern languages. For example, in light of the 'ontogeny recapitulating phylogeny' analogy from biology and studies on language acquisition, pidgins and creoles, Bickerton proposed the 'lexical proto-language hypothesis' (Bickerton 1990), which states that modern languages with hierarchical structures originated from a lexical proto-language consisting of a few words and without syntactic structures, and that this origin process was achieved via exaptation and a series of niche construction processes. Jackendoff (2002) further extended this theory by listing several developmental stages from one-word utterances, to a proto-language without hierarchy, and finally to a modern language with sophisticated syntax and phonology.

At UQAM 2010, Maggie Tallerman (Newcastle University) evaluated the lexical protolanguage hypothesis, listing some arguments for it based on examples of languages from non-industrialized communities. In addition, Luigi Rizzi (University of Siena) proposed four successive steps in the origin of

syntactic computations, from simple access to the lexicon, to *primary merge* resulting two-word utterances, to *recursive merge* leading to head-phrase utterances, and finally to *phrasal merge* allowing infinity of phrases with complex specifiers. These steps are consistent with the lexical protolanguage hypothesis. Based on the rapidity of acquisition and early appearance of abstract syntactic knowledge in human young children, he pointed out that there must be an 'instinctive tendency to speak' in humans that calls for an evolutionary explanation.

Apart from oral languages, much recent research focuses on gestures and its roles in language origin. This interest arose partially due to the flexible and context-independent gestures used by chimpanzees in the wild (Pollick & de Waal 2007) and the relative success in teaching signed, instead of spoken, languages to captive chimpanzees and bonobos (Gardner & Gardner 1969 and Savage-Rumbaugh *et al.* 1998).

Based on the evidence from gestures of great apes, development of signed languages, and studies on handedness and cerebral asymmetry, Michael C. Corballis (University of Auckland) proposed the 'gestural proto-language hypothesis' (Corballis 2002), which states that proto-language was in the form of gestures and gradually shifted to speech. The recently-found mirror neuron system in monkeys served as the key component in linking action and speech, and the essential overlap between the mirror neurons in monkeys and the homologous areas for language in humans indicated that language could be incorporated in the human mirror neuron system (Rizzolatti *et al.* 1991, Rizzolatti & Craighero 2004). Corballis proposed several causes for the shift from manual gestures to vocal gestures, such as pedagogy and energy demand, and pointed out that, despite the present dominance of speech, manual gestures could accompany speech in various ways.

Aiming to bridge praxis and communication, Michael A. Arbib (University of Southern California) further examined the neural bases for the gestural origin of language. He modeled the mirror system for execution and observation of actions, and used it as an analogy to the human mirror neuron system for production and perception of words and constructions in language (Arbib 2005).

W. Tecumseh Fitch (University of Vienna) reconsidered the 'musical protolanguage hypothesis' proposed by Darwin (Darwin 1871), which states that proto-language was musical, full of phonological and syntactic regularities but lacking rich meanings, and that our ancestors produced musical phrases with holistic meanings before the advent of words and syntax as in modern languages (Fitch 2010). The second part of this theory is in line with the 'holistic protolanguage hypothesis' (Wray 2002a, Mithen 2005, Arbib 2008).

In addition to evaluating this theory, Fitch incisively advocated testing this and other theories of language origin empirically. He emphasized the comparative approach, and constructed a comparative database covering many non-human species to identify *homology* and *analogy/convergence* of linguistic mechanisms in humans (Fitch 2010). Homology could help to pinpoint the origin of broadly shared traits in the hominin family, and analogy/convergence could help to locate cases in which similar traits evolved independently in separate lineages such as primates and birds. Both of homology and analogy/convergence

would provide new insights on the evolution of language and linguistic capacities. He also noticed that molecular genetics based on comparative data could help to test models of language evolution and eventually discover the appearance order of different linguistic modules.

According to Tallerman, there is an ongoing discussion on the nature of proto-language (Tallerman 2007, Smith 2008). And as pointed out by Fitch, the comparative evidence and new methods from relevant disciplines besides linguistics could certainly contribute to this discussion.

3.8. *Computational Modeling of Language*

In evolutionary linguistics, computational modeling can be viewed as the 'operational' hypotheses expressed in computer programs (Parisi & Mirolli 2007), and the results of these programs become the empirical predictions derived from the incorporated hypotheses. It can evaluate existing theories, explore theoretical constructs, exemplify how a theory works, and predict new experimental research (Christiansen & Kirby 2003a), all of which help to transform developmental theories from a descriptive science into an explanatory science (Jäger *et al.* 2009). Together with empirical experiments, computational modeling has become a new means to explore language evolution.

Simon Kirby (University of Edinburgh) argued that language resulted from biological evolution, individual learning and cultural transmission (Brighton *et al.* 2005). He proposed an 'iterated learning framework' (learning by observation of behavior in another that itself was learned in the same way) and simulated it in computational models to examine the roles of cultural transmission on language. The results of these models showed that the 'transmission bottleneck' (a learner is given incomplete information) makes cultural transmission become an adaptive system and language has to adapt itself (by showing certain design features such as compositionality) to 'fit' such bottleneck (Brighton *et al.* 2005). Besides simulations, he and colleagues also designed human subject experiments and showed similar results that after several rounds of iterated learning, an initially random language gradually become structured and easier to learn (Kirby *et al.* 2008). All these support a 'design without a designer' view on language evolution.

Morten H. Christiansen (Cornell University) examined the relations between cultural and biological evolutions. Based on the simple recurrent network model (Elman 1991), he examined whether word order in language could derive from sequential learning constraints. The simulation results showed that cultural evolution could overpower biological adaptation, that sequential learning constraints could lead to structural features in language, and that linguistic forms fitting these constraints could become more readily learned and spread among individuals, all of which reflect the 'language is shaped by the brain' view (Christiansen & Chater 2008). Further experiments on human subjects revealed that there are similar neural and genetic bases for sequential learning and language, and that sequential learning provides important constraints on cultural evolution of language.

Based on the recruitment theory that language originates and evolves by recruiting cognitive operations for the purpose of symbolic communication (Steels 2009), Luc Steels (Free University Brussels) presented a series of compu-

tational and robotic experiments on language evolution. Each experiment adopted a particular language game (Loreto & Steels 2007) to specify some challenge, which eventually led to the emergence of certain features in language, such as color lexicon, tense, aspect, or expressions of roles of participants in events. These experiments showed that FL could be formed by the epigenetic recruitment and configuration of distributed networks supporting the language strategies culturally emerging in a population, and that both the recruitment mechanism and the adopted neuro-computational functions were not necessarily unique for language.

Using robotic experiments, Stefano Nolfi (Institute of Cognitive Sciences and Technologies) examined how simple communicative forms originated and changed in a population of initially non-communicating robots, what conditions were the prerequisite for such emergence, and how signals and meanings got grounded in individuals' sensorimotor states. In these experiments, a pair of robots, equipped with motors, signalers for sending light signals, and sensors for detecting others' signals and environmental information, were placed in an environment with marked patches, and gradually evolved, based on their ability to travel, to occupy the same or different patches to each other. A primitive communication system emerged in which the robots used simple forms of light signals to indicate position information. Although such forms were naive compared with language, these studies were useful for exploring the fundamental conditions and strategies for language origin.

3.9. *Linguistic Perspectives*

Unlike other disciplines that examine the ancient remains of language-like behaviors, general cognitive capacities in humans or other species, or processing of artificial languages by automatic agents or human subjects, linguistic studies on language evolution largely follow the 'historical' model and rely firmly on various forms of historical or ontogenetic language data.

Bernard Comrie (Max Planck Institute for Evolutionary Anthropology) illustrated how linguists, using the comparative method based on the typological data from languages in different historical periods, such as Latin, Sanskrit, Ancient Greek, Old High German, or Modern German, and those from the *WALS* database (Haspelmath *et al.* 2008), reconstructed the consonant system of Proto-Indo-European, regular sound change patterns, and evolving structural complexity in phonetics and morphology. This comparative method not only helps linguists to reconstruct the origins of particular languages, but also sheds light on the universal typological features across languages.

Claire Lefebvre (UQÀM) reanalyzed Bickerton's (1990) approach that uses pidgins and creoles as an analogy to protolanguage and language origin. Based on the analysis of the recent data on pidgins and creoles around the world, Lefebvre pointed out that pidgins are not reduced codes, different from creoles only in lexicon size and fluency. Moreover, according to Lefebvre, pidgins do have syntax, and arise by means of relabeling. In contrast to Bickerton's opinion, she concluded that pidgins and creoles do not provide a window of protolanguage or language origin, since they usually emerged gradually in a multilingual society in need of a *lingua franca*.

Bernd Heine (University of Cologne) introduced grammaticalization theory as a window on language origins (Heine & Kuteva 2007). This theory makes use of diachronic data to reflect on historical changes in phonology and syntax, following the assumption that grammatical change taking place in contemporary languages is driven by similar forces that exert their influences on languages in history. Heine exemplified how to apply the grammaticalization theory to reconstruct the origins of grammar in language, and showed that this theory allows us to speculate and reconstruct possible forms in early languages outside the scope of historical linguistics.

4. Conclusions

UQÀM 2010 offered a great opportunity for scholars and students from various disciplines to share ideas, methods, and latest findings on language origin and evolution. The lectures at this institute provide several important guidelines for future work on language evolution. First, language can be realized in aspects other than speech, such as signs or writings; linguistic research on these aspects can reveal both the general features of language and specific ones to speech. Second, language is created, acquired, and used by its users; comparative evidence on language processing or general cognitive capacities (e.g., episodic memory, shared intentionality, theory of mind, sequential learning, recursive thinking, etc.), neural and genetic bases for these capacities (e.g., the mirror neuron systems and FoxP2 gene), and archaeological remains of language-like behaviors (e.g., tool-making and symbolic ornaments) can collectively examine the foundations of language in humans. Third, language is inseparable from its socio-cultural environment; social or simulation studies on the emergence and evolution of communication system can reveal the nature of linguistic functions and the roles of cultural transmission in shaping linguistic features. As concluded by Bernard Comrie in the closing presentation of UQÀM 2010, studies on language origin and evolution have to be multi-disciplinary; no single discipline can come close to the answer to this hardest question in science, and knowledge, approaches and findings from many relevant disciplines together can contribute significantly to our understanding on language and its evolution.

What also clearly emerged from the institute is that the field of linguistics as we know it today plays a minor role in such a multi-disciplinary enterprise. There was a shared sense that phylogeny does not recapitulate ontogeny, and that therefore the study of fully developed modern human languages cannot offer a window on the origins of language in early humans. Within modern linguistics, it seems, the only promising domains of enquiry appear to be the following three: Speech sciences, psycholinguistics, and, most likely, grammaticalization as conceived of by Heine. This is a good wake-up call for a field that has progressively cut itself off from other scientific domains due to increased specialization of theory-internal discourses that function as firewalls against not only multi-disciplinary collaboration but also exchange between linguists of different persuasions. It also alerts us to the fact that, after years of assuming that there might be a cognitive dimension to language, it is time to go and look for it where it is actually supposed to reside, rather than speculate on its nature through abstract

representations, be they trees, logical formulas or anything else. Despite Jackendoff's valiant attempt to save syntax from the demise that Chomsky's recent notion of 'merge' condemns it to, approaches such as Tomasello's have convincingly shown us that there are more interesting lessons to be learnt elsewhere (Ansaldo 2009). The study of language origins paradoxically may have little use for much of linguistics, unless linguists are prepared to move away from the questions that have preoccupied them for the past half century, and turn to questions of real social, historical, and scientific significance in order to seek a biologically plausible, computationally feasible, and behaviorally adequate understanding of language and language evolution.

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