COMMENTS ON CHOMSKY (2007) AND CARROLL (2005) [IWO]

Chomsky refers in a somewhat vague sense to the "evo-devo revolution" (Chomsky 2007: 3). The context of this reference is that within the Principles and Parameters (P&P) approach principles of physical organization may be attributed significant prominence. The classic passage is to be found in Chomsky (1965: 59):

> "However, there is surely no reason today for taking seriously a position that attributes a complex human achievement entirely to months (or at most years) of experience, rather than to millions of years of evolution or to *principles of neural organization that may be even more deeply grounded in physical law* – a position that would, furthermore, yield the conclusion that man is, apparently, unique among animals in the way in which he acquires knowledge" (emphasis mine).

In later publications, those principles that are grounded in physical law can be said to become **third factors**, this means general principles of physical organization that influence the internal structure of FL. Third factors fall into two categories:

- (a) *principles of data analysis*[1]
- (b) *principles of structural architecture and developmental constraints*

This is taken from Chomsky's (2005b) "Three Factors in Language Design" (p. 6). The factors that enter into the growth of language in the individual can schematically be depicted as follows (Figure (1)).

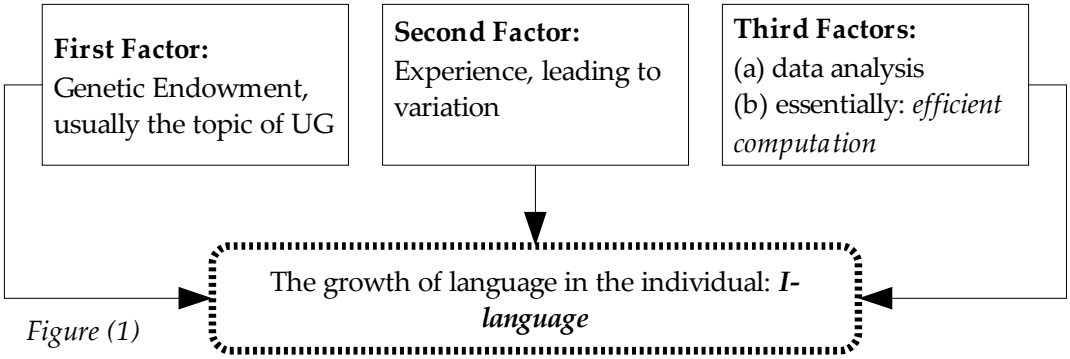


Figure (1)

Chomsky apparently focusses more and more on the *efficient computation* part of the third factors. At least this is the emerging picture – if one evaluates the more recent papers that we read. The rationale behind this is clear:

a) **Minimize experience** as language is more or less uniform throughout the species.
b) **Minimize genetic endowment** as this only complicates FL. If FL is to be explained in evolutionary terms it has to be the result of a minor even minute change of the mind/brain. The bigger that change, the more burden rests on a traditional evolutionary explanation in terms of genetic adaptation. Recall: **FL(N!) is hardly a classic genetic adaptation.**
c) It follows that the more you can attribute to third factors the better for UG and experience; remember that for UG and the experience part is is always good to be as slim and minimal as possible.

Now: We don't know all that much about third factors! Chomsky always invokes the "evo-devo revolution" (Chomsky 2007: 3), though let me see what is really in there.

---

1 It can always be asked: *What are those principles?* While this may be a though question, it can more easily be stated what they *do*. Put bluntly, they make the language learner recognize linguistic sounds as such. For example, the child will readily learn than coughing is not a linguistic signal (broader pragmatic usages left unconsidered here). To the best of my knowledge, coughing is non-linguistic in nature in any language, though I might turn out to be wrong.

Mind/Brain and Language

Let's assume that the brain has something to do with language and vice versa. Let us also suppose that brain growth somehow influences the capacity for language. The point is that nobody really knows why the brain grew the way it did. There are some competing hypothesis around. See figure (2).

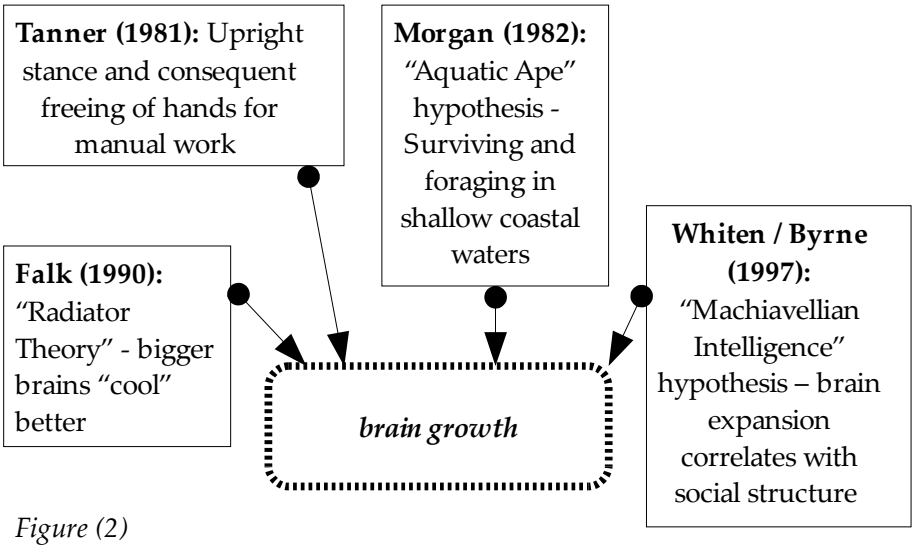


Figure (2)

This is just a sample of the possible hypothesis on brain growth, though it is very likely that brain size has something to do with social interaction and arguments along those lines: "Perhaps the most popular current view is that brain expansion is an effect of the social structure of hominid societies" (Sterelny/Griffith 1999: 235). Reading Carroll (2005), one gets the impression that multiple factors may account for the growth of the hominid brain. Bipedalism may have been of some importance here. Perhaps the brain had to adapt to constantly changing climatic conditions. Carroll writes:

> "The changing climate and its effects on food availability, water, hunting, and migration may have selected for hominins better adapted to such constantly changing conditions" (Carroll 2005: 260).

So an adaptive brain is a thinking brain is a bigger brain? This correlation is not that apparent, though it may be a nice folk theory. Another argument explaining brain size growth could be a change in jaw musculature and some related skull features. At any rate, it is an incremental process with some evolutionary speed-ups. This incremental process created new centres within the brain. Some designated to communicative purposes: Anatomical architecture for communication is said to be left-hemispheric. This communicative lateralization could have long pre-dated hominins,[2] which means that it is possibly older than six million years. The stuff of our (linguistic) evolution apparently has to be found in the "microanatomy" of our brain; the difference of hominins to apes is much more fine-grained than normally assumed. We need to get down to the nitty-gritty brain circuits and highly isolated, yet still interactive cortical regions. Note that it could possibly turn out that a minimal circuit corresponds to some minimal cognitive/linguistic operation, **endowing humans with infinite merge and apes (as matters stand today) not.**

2 As there have bee some questions to the difference between the terms *hominid* and *hominin*, here the answer: "[T]he term 'hominid' refers to both humans and the African apes; 'hominin' refers only to humans and our ancestors back to our separation from the apes" (Carroll 2005: 255). Hominid evolution is therefore much older. Hominin evolution amounts to roughly six million years.

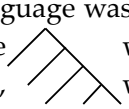
FOXP2

Some interesting points:

- FOXP2 is not unique to humans.
- During the past 200,000 years some mutation of that gene could have spread within the species of *Homo Sapiens*. Favouring *something.*
- WHAT IT DOES: NOBODY REALLY KNOWS!
  "It is known that *FOXP2* is expressed in many sites in the developing human brain. […] It is not clear yet precisely what FOXP2 does in development, but it is likely that it affects how *subregions of the brain form and connect with other parts*" (Carroll 2005: 276 – emphasis mine).

Nothing happened in one fell swoop. Everything took tens of thousands of generations.

> "Rather, the more likely picture is that hominin evolution was forged by selection for variants of many genes, responsible for small increments of differences in size, shape, and tissue composition, over sustained intervals of many thousands of generations" (Carroll 2005: 278).

It is very unfortunate that all these arguments on gene selection and slight gene mutation only very indirectly correlate with hard third factors. And here we face a problem: *What are core third factors? What are third factors at all?* To my mind, the ideal third factor should be a physical law or something. But what we have with Evo Devo is explicit talk of genes and how they are switched on and off. How "TOOL KIT" genes govern the development of organisms. But when it comes to microstructures it is still a long way to go till we understand how they are generated by "MASTER" genes. It remains to be shown that the expression of some micro circuit in the brain really follows from or is conditioned by some "MASTER" gene. So far, as I understand, far from obvious. Carroll talks about large-scale body structures. Analyses of Evo Devo at a more fine-grained level have yet to come. I don't know if it is sound to build an argument, as Chomsky frequently does, on something about which we nearly know nil – and "suppose this to be true". If it turned out to be wrong, then who from the scientific community would give up pursuing the *research programme*? You could always say that we have to temporarily endure some "anomaly", but I guess this counts for other approaches as well. It is perhaps healthy to see all this talk as a mere "analogy". In Chomsky (2005a), the term "analogy" appears exactly three times – always in connection to biolinguistics and the Evo Devo revolution. So even though language is a natural object, a biological object in particular, and the study of language is inspired by recent developments in Evo Devo style biologies, then all this is just analogy, and no real connection can yet be established. Say your study of language was inspired by the beauty of fractal structures and our syntax told you that it looked like  would you conclude that language is a fractal mathematical object? The bet is on, we could still be wrong and general intelligence gradualism could still win. Though this would not be minimal.

A BRIEF COMMENT ON IWANOV [Michael]

In his comments on Chomsky (2007) and Carroll (2005), Iwanov (2010) offers some interesting remarks on Noam Chomsky's theory of language and its proposed relationship to the movement of "evo-devo" (as presented, e.g., in Carroll (2005)). In his assessment, Iwanov especially focuses on brain evolution and the FOXP2 gene. Sampling the current state of knowledge on these topics, he emphasises the role of complex genetic interactions in the development of phenotypic traits as well as the possible importance of multiple factors in brain evolution. This assessment makes him sceptical of any real connection between scientific theories of the evolution of the brain language and Chomsky's proposal of "third-factor" principles at least at the present time. I concur with Iwanov's view on these matters but nevertheless I want to add some remarks of my own regarding our present state of knowledge about the relationship between human evolution,

genes, language and what bearing this knowledge has on the relationship of "third factor" principles and "evo-devo". First, I want to focus on Iwanov's (2010: 2-3) discussion of the FOXP2 gene.

The FOXP2 Gene

Iwanov (2010: 2) argues that "NOBODY REALLY KNOWS" what FOXP2 does, but quotes approvingly Carroll's (2005: 276) hypothesis that it may have something to do with the interconnections of neuronal subregions. I also think that the FOXP2-Story is not clear-cut, given the fact that it is a transcription factor that influences the expression of a network of other genes (See e.g. MacAndrew 2003), but some of the relevant knowledge we have about it is, in my view, very interesting and points into certain directions.

Firstly, as Iwanov (2010) has observed, FOXP2 is a highly conserved gene found in at least all mammalian species as well as birds. The versions of the gene differ only slightly between species. Interestingly, however, the difference between the FOXP2-version of humans and chimpanzees is more pronounced (in two amino acids, to be precise) than between chimpanzees and mice.

Among other things, FOXP2 seems to have something to do with vocalizations in these other species as well. If you "knock out" the FOXP2 gene in mice, baby mice don't vocalize to their mothers anymore (Shu et al. 2005). Also, FOXP2 is expressed to a significant amount in songbirds but not in other birds, especially at the time they have to learn their songs. (Haesler et al. 2004). In addition, it has been found that the FOXP2-gene of bats is implicated in their ability for echolocation (Li et al. 2007). These findings lend support to the hypothesis that at least one of the multiple functions of the FOXP2-transcription factor lie in the vocal-articulatory domain.

This doesn't seem to be the whole story, however, especially when it comes to humans, as the famous KE family, which lacking one copy of the FOXP2-gene, is not only deficient in regards to oro-facial/vocal articulation and some grammatical aspects, but also show very low scores on standardised IQ-Tests. Interestingly, the effect seems to remain even after taking their verbal deficiencies into account and it could be argued that FOXP2 primarily affects intelligence and linguistic/oro-facial difficulties were the results of abnormal cognitive development (MacAndrew 2003). Supporting evidence that FOXP2 is linked to intelligence as well as vocalization can be found in the already mentioned "knock out" mice, which not only didn't vocalize to their mothers any more, but also seemed to be cognitively deficient and had a very short-lifespan (See again MacAndrew 2003).

Clearly, as Iwanov (2010) pointed out FOXP2 is part of a very complicated network and it is far from clear how the specifically human version influences these complex networks. The latest finding in this ongoing research project however, points into a certain direction. Enard et al. (2009) inserted mice with the human version of the FOXP2 gene and found that it changed the development of a cortico-ganglial region known to play a role in articulation and language.

Another interesting approach comes from the observation that allelic variations in FOXP2 are related to language as well as to the capacity for sequential learning, which both involve ""the extraction and further processing of discrete elements occurring in complex temporal sequences" (Christiansen & Chater 2009: 502). In the view of some researchers, this suggests "that FOXP2 influences systems that are important to the development of both sequential learning and language, supporting the hypothesis that language may have been shaped through cultural evolution constrained by underlying mechanisms for sequential learning." (Christiansen et al. 2009, see also Tomblin et al. 2007).

FOXP2, Neanderthals, and the Evolution of Language

One further thing that makes FOXP2 quite valuable for people interested in the evolution of language is what it can tell us about the dating of the emergence of language. It seems quite reasonable to assume the following (or something close to it): FOXP2 is not the "language gene" that gave us language, but is probable that

a) FOXP2 was one of the genes implicated in language evolution and
b) it wasn't the first one but probably developed in the context of some already existing cognitive capacities for language-like forms of communication and rudiments of shared intentionality (e.g. Tomasello 2008).

Now we can make the following observation:

- Neanderthals have the same version of the same FOXP2 gene as we do. This means that we both inherited the current version of the FOXP2-gene from our last common ancestor. This would date the emergence of the human form of FOXP2, and, mutatis mutandis, some form of linguistic capacities, to 325,000 years ago (Krause et al. 2007).

- Converging evidence for this hypothesis comes from the fact that detailed analysis of the nerve channels in the spine of our last common ancestor with Neanderthals gave them the fine-grained control over their breathing necessary for extended speech. Homo erectus, in comparison, lacked this relevant enervation. (MacLarnon & Hewitt 2004).

- One further line of evidence supporting this view comes from the calculations of Robin Dunbar (1996, see also Dunbar & Shultz 2007). Dunbar found that in primates there is a positive correlation between group size and brain size. This means that you can estimate how big the social group of a given primate or hominid ancestor was just by looking at the size of its brain. But here's the tricky part: primate social groups are held together by grooming. Without enough of it there isn't enough cohesion and the group falls apart. This presents an upper limit for primate group size as you can only groom so many con-specifics and still have time to find food, etc. Humans however, live and lived in much larger groups than all other primates. Somehow a more efficient bonding mechanism had to develop, otherwise, our ancestors wouldn't have been able to live in groups with up to 150 individuals (which still is the average population of hunter-gatherer villages around the world). Dunbar suggests that this innovation was vocal grooming which then developed in piecemeal fashion "as more and more complex layers were added onto the existing primate communication system" (Dunbar 1996: 104). Dunbar's estimate for the time frame in which these vocal capacities must have developed more and more – based on the aforementioned calculations of neocortex size and group size in primate groups as well as analysis of fossil skulls – is 500,000-250,00.

What this means for "Evo-Devo" and "third factor" principles

Taken together with the little we know about other language-related genes, the data on the relationship between genes, evolution and language fit best into a gradualist account of language evolution, in which genes evolved for non-linguistic functions in large scale interactional networks bias and tweak our capacities for linguistic communication in slight ways. Language competency, then, can be seen as "*diverse and dynamic*" complex adaptive system, that is constantly changing on the timeline of both cultural transmission as well as individual development (Ladd et al. 2008: 121).

If we add a) the fascinating data on emergent grammatical properties that develop in computer simulations of interacting agents which do not have any innate grammatical pre-specifications built into them (see e.g. Kirby & Christiansen 2003,) as well as b) Kirby et al.'s (2009) real-life experiment in which an "Alien" language acquires grammatical structuring simply through repeated transmission with slight unconscious changes to it, it seems to me that Chomsky's (2007) view of the importance of "third factor" principles seems misguided.

Iwanov (2010) expressed irritation about the fact that Chomsky's (2007) proposed connection of "third factor" principles with "the evo-devo revelation" didn't square very well with what evolutionary-developmental biologists like Carroll (2005) actually talked about, namely *interactions* of genes and their behaviour in *networks*, and not about "physical laws." And here, in my opinion, lies the crux of the matter. Evo-devo doesn't talk about physical laws very

much, but instead sees interactions on multiple layers of organisation as the key explanatory device for the development of phenotypic traits.

In fact, I ask myself to what extent "evo-devo" and Chomsky's newest proposals are even compatible at all. This questions becomes apparent, for example, when we look at the criticism that Fodor & Piatelli-Palmarini (2010) had to face from proponents of evo-devo, the very science they tried to employ in their attack on orthodox evolutionary principles. Developmental Biologist PZ Myers takes Fodor & Piatelli-Palmarini for wanting to explain things with physical laws such as the Fibonacci sequence and then simply stopping there.

> "[T]he actual explanation for why it recurs in nature is because it's what happens when patches of cells recruit adjacent cells in a temporal sequence. Abstract math won't tell you the details of how it happens; for that, you need to ask what are the signaling molecules and what are the responding genes in the sunflower or the mollusc. "

In my view, this criticism can be extended to similar attempts in generative linguistics as well.

I would argue then, that the problems that Iwanov (2010) encountered when comparing Chomsky (2007) and Carroll (2005) are real but that in fact the situation is even graver. It is way too strong to call Chomsky the "Pied Piper of Cambridge" (Lieberman 2005) who once again leads linguists into the wrong direction. But I feel that instead of looking for abstract "physical laws" or genetic governing principles that explain a certain linguistic property of the mind/brain, linguists really interested in taking their cue from "evo-devo" should try to understand how the "interactional instinct" enables the emergence of language in a developing organism with slight language-related genetic biases when that organisms grows up while being embedded in a richly social and interactive environment (Lee et al. 2009, see also the articles in Hopkins 2005 (ed.)).

Some References [Iwo]

Carroll, Sean B. (2005): *Endless Forms Most Beautiful. The New Science of Evo Devo and the Making of the Animal Kingdom*. London: Phoenix.

Chomsky, Noam (1965): *Aspects of the Theory of Syntax*. Cambridge: The MIT Press.

Chomsky, Noam (2005a): *Some Simple Evo-Devo Theses: How True Might They Be For Language?* Stony Brook: SUNY. (=*Evolution of Human Language: The Morris Symposium*).

Chomsky, Noam (2005b): "Three Factors in Language Design". *Linguistic Inquiry* 1/36: 1–22.

Chomsky, Noam (2007): "Approaching UG from Below". In: Sauerland, Uli/Gärtner, Hans-Martin (eds.): *Interfaces + Recursion = Language?: Chomsky's Minimalism and the View from Syntax-Semantics.* New-York: Mouton de Gruyter: 1–29.

Falk, Dean (1990): "Brain Evolution in *Homo*: The 'radiator' theory". *Behavioral and Brain Sciences* 13: 331–381.

Hauser, Marc D./Chomsky, Noam/Fitch, Tecumseh W. (2002): "The Faculty of Language: What Is It, Who Has it, and How Did It Evolve?". *Science* 298: 1569–1579.

Morgan, Elaine (1982): *The Aquatic Ape*. London: Souvenir Press.

Sauerland, Uli/Gärtner, Hans-Martin (eds.) (2007): *Interfaces + Recursion = Language?: Chomsky's Minimalism and the View from Syntax-Semantics.* New-York: Mouton de Gruyter.

Sterelny, Kim/Griffith, Paul E. (1999): *Sex and Death: An Introduction to Philosophy of Biology*. Chicago: The University of Chicago Press.

Striedter, Georg F. (2006): "Précis of Principles of Brain Evolution". *Behavioral and Brain Sciences* 29: 1–36.

Tanner, Nancy M. (1981): *On Becoming Human*. Cambridge: Cambridge University Press.

Whiten, Andrew/Byrne, Richard W. (eds.) (1997): Machiavellian Intelligence II: Extensions and Evaluations. New York: Cambridge University Press.

Some References [Michael]

Carroll, Sean B. (2005): *Endless Forms Most Beautiful. The New Science of Evo Devo and the Making of the Animal Kingdom*. London: Phoenix.

Chomsky, Noam (2007): "Approaching UG from Below". In: Sauerland, Uli/Gärtner, Hans-Martin (eds.): *Interfaces + Recursion = Language?: Chomsky's Minimalism and the View from Syntax-Semantics.* New-York: Mouton de Gruyter: 1–29.

Christiansen, Morten H. and Nick Chater (2008): Language as Shaped by the Brain. *Behavioral and Brain Sciences* 31: 489-558.

Christiansen, Morten H. et al. (2009): Cultural Evolution of Language: Implications for Cognitive Science. *CogSci 2009 Conference*.
http://csjarchive.cogsci.rpi.edu/Proceedings/2009/papers/491/paper491.pdf

Dunbar, Robin (1998): "Theory of mind and the evolution of language." In Hurford, J. R. and Studdert-Kennedy, M. and Knight C. (eds.) *Approaches to the Evolution of Language: Social and Cognitive Bases*. Cambridge: Cambridge University Press.

Dunbar, R. I. M. and Susanne Shultz. (2007)"Evolution of the Social Brain" Science 317: 1344-1347

Enard et al (2009): "A Humanized Version of Foxp2 Affects Cortico-Basal Ganglia Circuits in Mice." *Cell* 137: 961-971.

Haesler, S. et al... (2004) "FoxP2 expression in avian vocal learners and non-learners" In: *Journal of Neuroscience*, 24 S. 3164–75

Hopkins, Brian (ed.) (2005): *The Cambridge Encyclopaedia of Child Development.* With Ronald G. Barr, George F. Michel, Phillipe Rochat. Cambridge: Cambridge University Press.

Krause et al. (2007): "The Derived *FOXP2* Variant of Modern Humans Was Shared with Neanderthals." *Current Biology 17*: 1908-1912

Kirby, S., Cornish, H., and Smith, K. (2008). "Cumulative Cultural Evolution in the Laboratory: an experimental approach to the origins of structure in human language." *Proceedings of the National Academy of Sciences*, 105(31):10681-10686.

Kirby, S. and Christiansen, M. H. (2003). "From language learning to language evolution." In Christiansen, M. and Kirby, S., editors, *Language Evolution*, pages Oxford: Oxford University Press. 272-294.

Ladd, D.Robert, Dan Dediu & Anna R. Kinsella (2008): "Languages and Genes: Reflections on Biolinguistics and the Nature–Nurture Question." In: Biolinguistics 2.1, 114–126

Lee, Namhee et al. (2009) *The Interactional Instinct: The Acquisition and Evolution of Language*. Oxford: Oxford University Press.

Li, G. et al. (2007): "Accelerated FoxP2 evolution in echolocating bats." In: *PLoS ONE* 2: e900

Lieberman, Phillip (2005): "The Pied Piper of Cambridge". *The Linguistic Review* 22: 289–302.

MacAndrew, Alec (2003): FOXP2 and the Evolution of Language. Evolution Pages http://www.evolutionpages.com/FOXP2_language.htm

Myers, PZ (2010): Fodor and Piatelli-Palmarini get it all wrong. *Pharyngula* http://scienceblogs.com/pharyngula/2010/02/fodor_and_piattelli-palmarini.php

Shu, Weiguo et al. (2005): "Altered Ultrasonic Vocalization in Mice with a Disruption in the Foxp2 Gene." PNAS 102: 9643-9648.

Steels, Luc (2009) "Modelling the Formation of Language in Embodied Agents: Methods and Open Challenges." In Nolfi, S. and Mirolli, M., editors, Evolution of Communication and Language in Embodied Agents. Berlin: Springer. 223-233

Tomasello, Michael (2008): The Origins of Human Communication. Cambridge, MA: MIT Press.

Tomblin, J.B., *et al.* (2007) Association of FOXP2 genetic markers with procedural learning and language. Poster presented at the 57th Annual Meeting of the American Society of Human Genetics, San Diego, CA. 2007.