Should It Stay or Should It Go? A Critical Reflection on the Critical Period for Language

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This paper tries to shed light on traditional and current observations that give support to the idea that language is subject to critical period effects. It is suggested that this idea is not adequately grounded on a view on language as a developmental phenomenon which motivates the suggestion of moving from the now classic concept of language as a 'faculty' to a new concept of language as a 'gradient': i.e. an aggregate of cognitive abilities, the weight of which is variable from one to another developmental stage, and which exercise crucial scaffolding effects on each other. Once this well-supported view is assumed, the idea of 'critical period' becomes an avoidable one, for language can instantiate different forms of gradation, none of which is inherently normal or deviant relatively to each other. In any event, a notion of 'criticality' is retained within this view, yet simply to name the transitional effects of scaffolding influences within the gradient.

Keywords: critical period; faculty of language; behavioral gradients; cognitive hybridization; scaffolding

The end-state is not coded anywhere.
Thelen & Smith (1994: 49)

1. Introduction

When thinking about the suitability of the 'critical period' concept to the particular case of the acquisition of languages, there exist two preliminary questions that cannot be avoided: (i) What is (and what is not) a critical period for the development of any given organic capacity? (ii) Does language actually belong to the kind of phenomena to which the concept may be aptly applied? Surprisingly enough, an ample majority of the sources on the topic of the critical period for language seem to sidestep both questions. As for the second question, while language is customarily referred to as the target of critical period effects in the relevant literature, what one ultimately discovers is that what is suggested there to be subject to such effects are the putative organic bases underlying the acqui-

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sition, storing or use of languages; so on reflection, the corresponding approaches seem to implicitly adhere to the view that languages are not *qua languages* the locus of critical period effects. As for the first question, most views seem to conceptualize the critical period for language as a scheduling of sorts, which inadvertently introduces an unacceptable teleological bias into a developmental matter. In this paper, after reviewing the current consensus about why and how language is specifically thought to be a capacity subject to maturational control or critical period effects, we argue that by means of a clarification of the developmental character of languages and, in parallel, of critical period effects in developmental phenomena at large, one may avoid the cumulative odd implications of connecting these two issues.

In the second section of this paper we review the most important pieces of evidence that have in the last fifty years or so been collected in support of the idea that learning a language is subject to critical period effects. After that, we explain in section 3 that different contemporary views on language base their ideas about the individual process of internalizing a language on problematic assumptions about the boundaries between 'what acquires' and 'what is acquired' in this critical domain of human cognition. Such a critique is aimed at paving the way to a new conceptualization of language that, based upon invigorated versions of the ideas of 'behavioral gradient' and 'cognitive hybridization', we claim is better positioned than its traditional counterparts in order to test how language behaves regarding the nature of the maturational effects to which it is specifically subject. Our position on this particular concern is then unfolded in section 4, where we claim that avoiding some traditional preconceptions, language may unproblematically be incorporated into and treated within the parameters of an emergent theoretical trend that envisions development as the most basic manifestation of life and as a open-ended process in every single entity that manifests it. We thus conclude that despite the fact that certain developmental milestones typically punctuate the growth of language in the individual, it is not affected by any kind of critical period effect proper. We contend in section 5 that an important sample of neurobiological evidence supports such a view. Some other interesting conclusions follow regarding the existence of normal and deviant instantiations of language, with which we briefly close the paper.

2. The Received View: An Overview

It has been known for a long time that children are more apt than adults to learn non-native linguistic systems. To wit, Juan Huarte de San Juan, one of the founding figures of the field of Cognitive Psychology (see Chomsky 1966, 1968; Virués Ortega 2005), expressed with the following words in 1575 what for many continues to sound as a paradox (Newport 1990; Jackendoff 1991):

> The extent to which imagination and understanding seem to be improper skills in order to learn languages is clearly demonstrated by childhood, for while being the age at which men are the less gifted in them both, yet children, as already observed by Aristotle, learn any single language better than older men, in spite of the latter being more rational. And no one needs

> to remember us this, for common experience amply shows it, as when a thirty or forty years old native from Biscay [Basque Country] comes to Castile, and he never learns the Romance language, but if he is a child, within two or three years he looks as if born in Toledo.
>
> (Huarte de San Juan 1575/1991: 151; authors' translation)

> If one wants to learn Latin or any other language, she better does it while still a child, for if she waits until the body becomes rigid and gains its proper perfection, she will never succeed.
>
> (Huarte de San Juan 1575/1991: 60; authors' translation)

Efforts at scientifically clarifying this paradox had however to wait some four hundred years, after the focus was again put on the question by Wilder Penfield and Lamar Roberts (Penfield & Roberts 1959; see Lenneberg 1960), paving the way to the ground breaking work of Eric Lenneberg (Lenneberg 1967), to whom present conceptions and factual knowledge on the issue are profoundly in debt. As a matter of fact, Lenneberg's landmark postulation of a critical period for language acquisition, as an associated aspect to its maturationally controlled character, was a generalization based on his first-hand observations on the recovery patterns from traumatic aphasias at different age ranges, starting from very young children. Specifically, he discovered that children before 3 years (re)acquired their mother tongue almost as if they had not suffered any trauma, but that from that point on the following pattern was attested: From 4 to 10 years, gradual (re)acquisition without residual signs of impairment; around 15 years, gradual (re)acquisition with residual signs of impairment; and from 15 years on, unpredictable pattern of recovery, as it is typical of adult aphasias associated to strokes and so on. From these observations, Lenneberg concluded that a window of opportunity existed for first language acquisition that extended from age 2 until the onset of puberty, out of which normal levels of grammatical competence were not guaranteed at all. The indirectness of Lenneberg's method, far from problematic, was the perfect strategy to remedy the (fortunate) scarcity of related natural experiments—as children almost unexceptionally receive sufficient linguistic stimulation from the very onset of the relevant period, and the (obvious) ethical impediments to perform them in artificial conditions. Nevertheless, some new cases of feral children were known and studied with care after Lenneberg's untimely death, yet only to confirm his predictions (Curtiss 1977; see also Curtiss 1988 for a résumé). Moreover, a whole new field of linguistic research was concurrently being opened, namely the study of the signed languages used in deaf communities, which offered particularly valuable direct information on the impact of age on first language acquisition, for contrarily to non-hearing-impaired children, deaf children may start their contacts with signed languages at rather different ages due to their very different medical and sociological circumstances. Again, conclusions in this new field were in complete agreement with Lenneberg's hypothesis, at the same time that they served to refine the character of the decline along the age axis within the critical period (Newport 1984).

Incidentally mentioned by Lenneberg (1967: 176), but left unexplored in his book, was the question of how the hypothesis applied to the fact that not only the onset of first language acquisition may in certain exceptional situations vary from

one to another individual, but that this is actually the most common pattern when people learn second languages beyond their native ones. A logical expectation regarding this would be that an endowment to successfully acquire linguistic systems is unlocked permanently if exercised with a first system at the right time. But as we all know well, this is not what is actually attested. The *locus classicus* of the experimental study of the impact of age effects on second language acquisition is Johnson & Newport (1989), where the following findings are reported. In highly competent bilinguals whose contact with the second language started at different ages, competence is almost indistinguishable from that of native controls when contact started from 3 to 7 years. From that age to 15, a lineal decline is observed as we approximate to this upper age limit; moreover, a strong correlation seems to exist between competence level and onset of exposure in that most people show a similar level within each particular age. Finally, when the contact started from 15 years on, levels of competence are generally (but not necessarily) lower than when it did at previous ages and, more importantly, the strong correlation between competence level and onset of exposure vanishes: People show extremely variable levels of competence at each particular age.

While Johnson and Newport's findings offer a certainly detailed and well-motivated image of the impact of the age factor on the human capacity to acquire non-native linguistic systems, a limitation of this study, obviously enough dictated by practical reasons, was that it exclusively concentrated on the domains of morphology and syntax (or 'compositional domains' in Newport 1990), thus excluding ('non-compositional') aspects of linguistic competence like mastery of phonology or lexical knowledge. In any event, the question of the critical period in relation to phonology had previously been touched upon by Asher & García (1969) and Oyama (1976), with not completely identical but nevertheless rather convergent results. According to both sources in populations not very dissimilar to the one studied by Johnson and Newport, 'foreign accent effects' were increasingly observed in parallel with the increase of the onset of the contact with the non-native system. Besides, a strong contrast was observed between those whose contact started before or after 12 years, while differences intensify only gradually within the 6- to 12-years range. A divergent result of the two above-mentioned studies is that, while Oyama's informants whose contacts with the second language started around 6 years were judged within the range of native controls, Asher and García's counterparts were not. Whatever the reasons for this clash, more recent research concludes that the onset of the age of exposure to a second language may be critically reflected on foreign accent effects simply with a delay of one year relative to the first language (Hyltenstam & Abrahamsson 2003; Meisel 2013), with similar observations being applicable to the acquisition of a second dialect by in-migrant families with children (Labov 2010: 416–417). So it seems that the opportunity to attain native-like levels of competence that extends until ±7 years in the morpho-syntactic domain does not apply to the case of phonology, while the onset of puberty continues to be a critical frontier also in this domain. Complementing such observations, research conducted in the domain of lexical knowledge lead to the conclusion that competence levels are not significantly different between native speakers and those whose onset of expo-

sure to the same language started no later than at 11–13 years of age (Weber-Fox & Neville 1996). So the onset of puberty continues to be a Rubicon of sorts also in this domain, but a window of opportunity extends until that age stronger than in the case of phonology and morpho-syntax that allows attaining native-like levels of competence for a longer period.

Of course, many details and discussions could be added to this overview. For example, it has been argued that some aspects of morpho-syntax show a behavior closer to that of phonology than to other aspects of the same domain (Weber-Fox & Neville 1996). In any event, the picture thus far presented is a reliable synthesis of the consensus view, which may be enough to reflect on how data should be interpreted respecting the best criteria currently offered by different fields of expertise devoted to developmental matters. So before closing this section, let us briefly summarize the most basic points that readers should keep in mind in the remainder of this paper: (i) The onset of puberty seems to be a crucial landmark regarding the human capacity to acquire linguistic systems; (ii) before that point, languages can be acquired unproblematically and attaining high competence levels. (iii) In any event, aspects of language seem to be differentially affected along this temporal axis: Namely, (iv) phonology and certain aspects of morpho-syntax seem to be exposed to a decay prior to other aspects of the latter domain, while (v) lexical knowledge related abilities seem to remain stable until the end of this critical period.

3. What Is Language, that It May Develop…[1]

Describing children's speech with adult grammatical categories […] automatically sets the developmental problem in terms of goals rather than in terms of origins.
Michel & Moore (1995: 370)

A complicating factor when dealing with questions like the subject matter of this paper is the multifaceted meaning of the word 'language', which different traditions and authors use to refer to rather disparate things. The opening pages of Chomsky (1986) contain a comprehensive analysis of this state of affairs, a source of difficulties that undermine productive discussions that could eventually lead to more agreed-upon conclusions in critical areas of our understanding of this distinctive feature of the human species. According to Chomsky's examination, concepts of 'language' range from physicalist interpretations, according to which language exists in materialized utterances (meaningful noises, printed material, and so on) to which linguistic properties somehow inhere, to psychological ones, for which such properties are derivative from the mind that projects them into utterances. Correspondingly, 'language' is understood as something 'given out there', in the world external to speakers/hearers ('E-Language'), or as something deeply rooted in the human mind, thus internal to speakers/hearers ('I-Language'). Followers of the respective views thereby understand that the human mind is either a more or less passive receptacle of the regularities

[1] The headings of sections 3 and 4 are inspired by the title of Piattelli-Palamarini (2009).

underlying the organization of utterances, or its source, actively devoted to the acquisition and use of particular instantiations of language according to *a priori* patterns common to them all.

The aim of the following pages is not to decide which one of these competing views is on the right track. As readers will note as the paper moves forward, our position is somehow in a middle ground, as it emphasizes the hybrid character of language (in a sense to be presently made clear), yet believing that it is a mind-based capacity to create and take advantage of such hybrid products. The specific goal of the next sub-section is to show that despite differences, such divergent views as those sketched out above share common or related shortcomings that have hitherto prevented them from offering satisfactory answers to the question whether the critical period concept applies or not to language: Namely, they both rely on problematic assumptions regarding how boundaries should be defined between biological and non-biological aspects of language, or between more or less central biological aspects of language. A subsequent sub-section introduces a new concept of language that seems better qualified in order to overcome these problems.

3.1. Does Language Develop? The **Whats** *and* **Whys** *of a Negationist Consensus*

Children start experiencing the world as non-linguistic beings, who nevertheless attain the mastery of the intricate properties of human languages within a few years, traversing along the way a series of distinctive stages and milestones. This is a seemingly innocent and uncontroversial claim, with which most laypeople would unhesitatingly agree. It is for this reason that the fact comes as a surprise that many past and present approaches to the question of language acquisition are based on theoretical models that incorporate the entailment that language does not belong to the kind of phenomena that properly follow a developmental path of individual growth. This is particularly clear in the case of the Vygotskian and Piagetian approaches that paved the way to the whole field of expertise that we recognize today as Developmental Psychology (Piaget 1962; Vygotsky 1986). In both cases, a gap of sorts is created between cognitive ontogeny proper, on the one hand, and the mental implementation of psychological contents, such as language, on the other hand. Clearly enough, the gap is somehow softened by the promiscuity and mutually reactive dynamics that the corresponding layers ultimately attain; yet it is clear that they belong to different realms, so to speak, for the former (Vygotsky's 'lower functions') can be unproblematically assimilable to other 'natural functions' that undergo normal development (up to the 'formal operational stage', in the case of Piaget), while the latter (corresponding to Vygotsky's 'higher' or 'cultural' functions, or to Piaget's 'intellectual development') are rather the outcome of the cumulative accommodation to such natural architectures of externally given and independently existing contents (corresponding, in the case of language, to what Chomsky 1986 critically refers to as tokens of an 'E-language').

But maybe more striking is the fact that the theoretical perspective that has hitherto adopted the most radically naturalistic stance on language (Chomsky 2000a, 2002) has at the same time encouraged a view on acquisition that under-

scores the idea that languages, as a matter of fact, do not develop in the mind of children (Lorenzo 2013).[2] Based on logical arguments having to do with the poverty of the linguistic stimuli to guide *bona fide* processes of rule induction, which may be traced back as far as to Chomsky (1959), Chomskyan linguistics has traditionally embraced the thesis that children must therefore face their first contacts with the adults' linguistic utterances with a mental blueprint of sorts containing detailed information about the basic building blocks and structures of any possible human language; actually, so detailed and/or efficacious as to pave the way to full-fledged linguistic systems in a virtually instantaneous way (Chomsky 1975, 1980, 2000b). In parallel to this central tenet, it is also argued that the seemingly 'non-instantaneous' course that acquiring a language follows is just a deceiving appearance, due to 'difficulties' and 'delays' mostly explicable by the maturational path of the associated neuroanatomical systems that allow the individual to put into use her knowledge of language (Hyams 1986).[3] Attending to this 'consensus view' (Hornstein *et al*. 2005) within the nowadays mainstream 'biolinguistic' position (Boeckx & Grohmann 2013), it is not surprising that the most relevant among recent efforts to explain the maturational effects observed in relation to different modalities of language acquisition, actually point to some putatively language-associated systems as the locus of such effects, instead of suggesting more language-centered proposals. Let us briefly review two of them.

According to one such popular explanation, customarily referred to as the 'less is more' model (Newport 1990), the critical period effect on language is the direct consequence of the accomplishment of the mature version of the short-term (working) memory device on which analytical procedures are executed when trying to discover and fix rule systems from the incoming input in language acquisition processes. The more underdeveloped this device, according to Newport's argument, the better to the rule-extraction operations, for the device operates then on small chunks, which are much easier to analyze and make sense of than the chunks that the device retains in active memory when it attains maturity. Note that the hypothesis is in itself neutral regarding the question whether analyses are or are not based on a preexistent linguistic blueprint, but it nevertheless relies on the premise that the criteria on which analyses are based remain the same all along the process: In other words, what is subject to maturation and gives rise to the somehow deceiving appearance of decay in the capacity for acquiring languages, is actually a language-associated (but not language-specific) memory system, and not properly the language faculty. This

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[2] The most explicit statement of this position is by Fodor (1985: 35), who wrote: "Deep down, I'm inclined to doubt that there is such a thing as cognitive development in the sense developmental cognitive psychologists have had in mind".

[3] Two main proposals have been made within Chomskyan linguistics in order to make compatible the strong 'aprioristic' stance of the trend and the obvious fact that languages develop anyway. The first one is Borer & Wexler's (1987) 'maturational hypothesis', according to which languages unfold following a schedule that is an added component part of the preinstalled program also containing the general guidelines of every single language; the second one is Yang's (2002) 'variational hypothesis', which holds that particular parts of the inborn universal grammar unfold as a function of the relative frequency of the corresponding environmental triggers. Both frameworks thus remain strongly anchored in the extreme nativism of mainstream Chomskyan linguistics.

aspect of Newport's thesis makes it particularly suitable to work in association with the Chomskyan nativist stance regarding the specifically linguistic dimension of the language acquisition device. Note, however, that the idea is also compatible with a Vygotskyan–Pieagetian reading, according to which Newport's device serves to decipher entirely public or external rule systems.

According to another serious attempt to explain the effect of age on language acquisition (Ullman 2001), it is suggested that the critical period is actually a side effect of the maturational tension between two memory systems, differently committed to the task of acquiring a language: Namely, a 'procedural' memory in charge of learning, representing and using automatized compositional routines (and thus implied in morpho-syntax), and a 'declarative' memory in charge of factual knowledge and arbitrary associations (and thus implied in lexical knowledge). According to Ullman's hypothesis, there exists a maturational mismatch between these systems, for the former is subject to decay from prepubertal ages, while the latter's decay only begins after the onset of puberty. Due to this mismatch, from the age the critical period is customarily supposed to end onwards, the declarative system is forced to apply in the learning of rule systems governing the composition of words and phrases on the basis of generalizations from models, thus basically treating them as idiomatically frozen items. So again, it is not the language faculty *per se* what is supposed to be subject to an age-associated decay according to this hypothesis, but systems external to this faculty (Chomsky 1995; Hauser *et al*. 2002), which impact on how speakers give language-particular contents to it and how these contents (i.e., language-particular rule systems and associated lexicons) are put into use in real settings.

This is not the place to evaluate the merits of these hypotheses at large. The point of the previous comments is that recent serious efforts to offer *bona fide* explanations to the critical period for language acquisition point to causes that do not even touch the alternative of languages being the true *locus* of such maturational effect, opting instead for explicating it as a delusory side-effect of sorts of the maturational schedule of certain language-related external systems. Such a position actually has a reinforcing effect on the two influential views on language referred to above: Namely, one that privileges the idea that languages are externally or public givens, not properly subject to organic development (but rather to 'acculturation' or 'intellectual development'); and another one that privileges the alternative view that languages are so deeply rooted in the human organism that they do not need to properly develop, being instead subjected to an almost instantaneous 'triggering' process. We are obviously aware that these two stances do not exhaust present-day conceptualizations of language, but we think that other representative efforts of somehow naturalizing language fall some point in between them, without really correcting the main shortcomings of such an intent that we are criticizing here.[4]

[4] In a nutshell, current theoretical models of language describe a wide spectrum, ranging from cognitivist/functionalist oriented models that highlight the character of languages as socio-cultural achievements assimilable by general cognitive devices and principles (Croft & Cruse 2004), to Generativist oriented approaches that accentuate the biological character of language as a specific cognitive organ (Anderson & Lightfoot 2002). Middle-ground positions obviously exist (e.g., the rather convergent models of Construction Grammar and

For the time being, let us then concentrate on the Vygotskyan–Piagetian and the Chomskyan views thus far reviewed, which, despite their very obvious discrepancies, nevertheless share the rather shocking feature of protecting languages from being properly considered outputs of developmental processes. According to our diagnosis, this is so because both approaches embrace certain pervasive forms of dualism, each of a different pedigree, but both equally problematic: As for the first one, it has been criticized and referred to before in the literature as the 'culture-biology dualism' (Michel & Moore 1995; Oyama 2000a); as for the second one, not having to our knowledge received a specific denomination up till now, we will refer to it here as the 'underpinnings-capacity dualism'.[5]

The 'culture-biology' dualism, on the one hand, is the (usually 'implicit'; Michel & Moore 1995: 72) assumption that traditional forms of shared knowledge and/or behavior correspond to a distinct ontological realm and, correspondingly, that they are individually internalized by means also specific to the objects of that realm. Internalization, the story goes, obviously requires a biological machinery, which is also relevant in the long-term fixation, retrieving and practice of the related activities. In any event, the relation between such an organic ground and the superimposed cultural contents is one of accommodation of the latter to the former, even if more dynamic views have been also implemented where the cultural superstratum impacts on the biological layer, fine-tuning it as to pave the way to further cultural enhancements (Jablonka & Lamb 2005). In any event, the 'biological core' and the 'overlying cultural' stratum remain distinct despite such functional and developmental promiscuities. The most obvious present manifestation of this form of dualism is the common distinction between 'languages' as diversified cultural or traditional accomplishments, and '(the faculty of) language' as the uniform biological background that makes possible the acquisition and use of such cultural artifacts.[6]

The 'underpinnings-capacity' dualism, on the other hand, is the assumption (usually implicit as well) that a further distinction may also be made between 'language', as an organic faculty containing the bare essentials of any possible language-particular system, and the 'underpinnings', 'foundations', 'basis', 'equipment' or 'biological correlate' (see Lenneberg 1967; Lieberman 2006; Boeckx 2013; Piattelli-Palmarini 2013, among others) of such a cognitive organ (Anderson & Lightfoot 2002), notions that customarily, but rather vaguely, refer to aspects of the human anatomy and/or genotype. Actually, under the umbrella

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Simpler Syntax of Goldberg 2005 and Jackendoff & Culicover 2005), which nevertheless do not solve the tensions and dualisms (see below for details) on which modern linguistics is grounded. To wit, Tomasello's (2003) usage-based theory of acquisition, framed within the model of Construction Grammar, explicitly assumes a sharp distinction between the biological and the cultural aspects and processes of language acquisition (Tomasello 2003: Ch. 8) and not surprisingly, it locates the question whether a critical period for language actually exists within the former domain (Tomasello 2003: 286–287).

[5] Maybe Kuo (1976: 94) approximates the most to what we have in mind, when criticizing a 'physiology-behavior dualism' typical of the developmental study of behavior.

[6] For two recent sophisticated versions of this stance, see Balari & Lorenzo (2013) and Bickerton (2014). The former have however advanced towards a more biologically nuanced position in Balari & Lorenzo (2015b), based on the idea of 'scaffolding' (see below).

of this distinction the whole field of expertise customarily referred to as 'biolinguistics' has grown in the last years (Boeckx & Grohmann 2013), conceived of as "a branch of cognitive sciences that focuses on uncovering the biological underpinnings of the human capacity to acquire at least one natural language" (Boeckx 2013: 1). Such an approach, perhaps inadvertently to its practitioners, contains the problematic entailment that a 'capacity' (and an assumedly 'organic' one) can be dissociated from its 'biological underpinnings', and ultimately that language (an assumedly biological object) can be somehow taken apart from its biology (whatever that means, if it makes any sense at all).

3.2. An Alternative View: Setting the 'Gradient of Language' Concept

What follows is a batch of suggestions aimed at instigating an image of language as the outcome of normal developmental processes, the conceptualization of which does not require something along the lines of the two forms of dualism thus far reviewed. In association with the set of premises that will be put forward in the next section, these suggestions should help (or hopefully so) deciphering the observations introduced in the first section, avoiding the conceptual complications that accumulate around the idea of 'critical period' in developmental studies at large, and specifically in the case of language.

The first such suggestion implies recovering and applying Kuo's (1976) 'gradient' concept to the case of language. Kuo's main contention was that many and very different parts of an organism participate in any one of its various capacities, but obviously enough with "differences in intensity and extent of involvement for each of the different organs and different parts" (Kuo 1976: 92). Besides, the implication of parts as well as the intensity of single parts may vary in the temporal axis. To a certain degree this is due to the dynamics internal to the growing body (or 'maturation', in Schneirla's 1966 sense), but also crucially to the kind and amount of environmental inputs that it receives throughout the process (or 'experience', in Schneirla's 1966 also coincidental sense). Kuo's 'gradient' concept refers to the changing pattern of differently compromised pieces, both internal and external to the organism, which jointly compound the capacities that ultimately manifest in expected forms of behavioral displays. This idea is readily transferable to language.

There is enough consensus now around the idea that language, in a sense, is but a heterogeneous assembly of bodily resources, ranging from motor to intentional abilities, which takes advantage of the component parts of organic systems with rather disparate non-linguistic specializations (respiration, digestion, long term and short term memory, mindreading skills, and so on). This is, for example, the idea under the 'faculty of language in the broad sense' (FLB) concept put forward in Hauser *et al*. (2002). We however disagree with this FLB concept in that it was specifically suggested in a context aimed at preserving another sense in which 'language' names a subset of FLB that may be deemed a language specifically committed part of our brains—the 'faculty of language in the narrow sense' (FLN), which acts as a center of gravity of sorts that *a priori* guarantees the linguistic distinctiveness of the human brain. However, most recent research conducted in order to locate brain activity when executing

linguistic tasks points to the direction that every single identified location is also routinely assembled for the execution of other non-linguistic tasks (see Stowe *et al.* 2005; Friederici 2011, for an overview), including the cortico-basal computational core that most reasonably corresponds to or contains Hauser *et al.*'s FLN (Balari & Lorenzo 2013, 2015a). So a more realistic picture than the one privileged by Hauser *et al.* seems to be one according to which no 'faculty of language' exists in the classical sense—not even a 'narrow' one, for such an idea problematically purports that human brains incorporate a language-specifically dedicated main component. Note that what is being questioned here is not a matter of localization, but of functional commitment, and that the more reasonable conclusion is one that supports the idea that language is, from root to branch, a collection of multipurpose components contingently recruited and developmentally stabilized into a coherent functional unit. Also relevant to our point is Hauser *et al.*'s complementary observation that not every organic system that is active when exercising language should automatically be included into FLB, even if it is a necessary condition for conducting such an activity (say, the circulatory system). We think that taking all these observations together, the 'gradient' concept is the one that less problematically can accommodate them, giving grounds to a concept of 'language' according to which the surrogate of the old 'faculty' is an array of interconnected capacities, each one differently involved ("in intensity and extent"; Kuo 1976: 92) in its linguistic specialization. According to this idea, the most involved a capacity in activities other than language, the less central its position in the linguistic functional system (Lieberman 2006), and the other way around. So the idea does not exclude the possibility that a core of highly specialized brain activity exists of a linguistic nature (misleadingly inviting to pinpoint it as the ultimate site of language proper), while at the same time predicting its enacting in other non-linguistic activities as well. The main point of the idea is, however, that language ramifies according to a complex pattern of bodily activities, even if each branch may be described as showing a different extension and a different thickness in the overall pattern.

Two relevant ideas still need to be added to this implementation of the 'gradient' concept to the case of language. The first one has to do with a shortcoming of Hauser *et al.*'s model, which entails a static and adultocentric view on language where each component belongs to the whole at every possible point in time in which observations could be possibly made. Obviously enough, we are not naively reading the model as if it purported that the parts that compound FLB do not undergo processes of growing, maturation, decay, and so on. What we actually mean is that a model is preferable in which, as it happens with the 'gradient' concept, parts are developmentally recruited, so not every one is present at every developmental stage, or not with the same intensity and extent. Thus in our opinion, an accurate image to render the process of the growth of language is one of different developmental paths more or less concurrently occurring, normally leading to increasingly interactive developmental dynamics, progressively bringing about more and more integrated and robust units of function. According to this view, language is not 'more or less' language at any given point of this constructive process. If anything, it is a different form of language, in which components that become very strong at a particular point

are weaker or even absent at prior or later points.

The second point to be added has to do with the relevance of aspects external to the organism in Kuo's original formulation of the 'gradient' concept. It is our suggestion that respecting this aspect of Kuo's proposal contains the clue to overcome the two forms of dualisms that run, as argued above, against an integral developmental treatment of language. It is now perfectly known that the impact of verbal stimulation on children starts at an extremely early age, as a matter of fact prenatally (see Gervain & Mehler 2010 for a synthesis). Thus responses to particular aspects of such stimulation are precociously and rapidly being embodied by the growing organisms, in all likelihood starting with aspects of prosodic and categorical perception pertaining to the phonological domain, in such a way that prevents considering from the start that a distinction can be made between a biological agent that acquires and a cultural kit of contents that are acquired. In other words, a 'hybridization' of sorts materializes from the very beginnings of language development, considering which the 'E-language' against 'I-language' dualism vanishes, given the mutually scaffolding effects coming about throughout the process (Griesemer 2014; Balari & Lorenzo 2015b).

Within this new framework, moreover, the distinction between linguistic contents *a priori* belonging to human nature, on the one side, and linguistic contents resulting from historical processes and subject to social transmission, on the other side, lacks most of its original motivation. The growing organic capacity that successively becomes suitable to new scaffolding interactions, until attaining the overall domains of linguistic competence, appears to be a constraining enough force to limit the logical space of possible linguistic outcomes in the absence of *a priori* expectations about how the languages of the world are and differ (see Kajita 1997 and Lorenzo & Longa 2009 for two congenial approaches).[7] For the sake of clarity, let us elaborate this a little bit with some relevant illustrations.

Within the framework thus far presented motivation is lacking for positing a language-specific bias towards, for example, structure-dependent rules (*versus* linear-dependent ones that children never seem to consider; see Chomsky 1975, among other places),[8] which according to the Chomskyan view is literally coded in the brain of children prior to any linguistic experience. Alternatively, one may confidently conceptualize the robust observations gathered in this specific area of research by just considering what children know about language as they are particularly developing it at each developmental stage. In a nutshell, we suggest that from a very early age on they most probably scan different sequentially organized incoming stimuli on the grounds of a computational device with a working memory resolution that makes 'structural constraints' to be naturally

[7] We are grateful to an anonymous reviewer for suggesting us the connection between Kajita's framework and our developmental ideas.

[8] The *locus classicus* in the study of this bias is question formation in 'subject-cum relative sentences', as in *Is the man who is tall happy?*, with a fronting operation of the *main* verb. In constructing these sentences, children never make errors that could be interpreted as if they were considering a linear alternative (e.g. 'front the *first* verb'), like **Is the man who tall is happy?* Children do commit errors when first producing this kind of sentences, but curiously enough they again have a structure dependent character: For example, sometimes they repeat the main (*Can the man who is tall can see Mickey?*), but never the first verb (* *Is the man who is tall can see Mickey?* or similar alternatives; see Crain & Nakayama 1987).

expected (Gervain *et al.* 2012). We specifically mean that from a certain degree of resolution on, such a device will be able to detect and to retain in working memory sequences of items (say, *x x x x … x x x*) for the time and/or with the intensity required in order to capture long distance dependencies (say, $x\ x_1\ x\ x\ \ldots\ x\ x_1$), of the sort instantiated in linguistic strings like *John claimed*$_1$ *that she was wrong emphatically*$_1$—where subscripts serve to annotate the points at which a *main* sentence is interrupted by an *embedded* one and restarted again. Such a degree of memory resolution is thus a computational requirement for the kind of nested relations through which structure dependent relations hold, obviating other putative linear/numerical constrictions. So, contrary to Chomsky's (2007: 7) suggestion, there seems to be a good reason for children to adopt the 'structural stance' even in the absence of a genetically coded UG instruction, for this is how they optimize a system of computation already in place for the scanning of incoming sequential stimuli—which if anything, might be conceptualized as a 'third factor' effect of sorts (Chomsky 2005).[9] Children consequently behave as if they were (so to speak) 'linear blind' (Longa & Lorenzo 2012). Our position is thus that as soon as children apply such a computational device to the flow of speech they are being exposed to, a linguistic hybrid of sorts is automatically created in their minds, the regularities underlying which are unavoidably interpreted as structure-dependent. Note that no piece of propositional knowledge establishing in advance a universal property of languages seems to be required for such a constraining effect to follow. Children may be capable of deriving it from the unique perspective of the language particular gradient that they are constructing.

A next logical expectation from this idea is that as development goes by, it successively creates the grounds for constraining further aspects of the hybridization process. For example, a language-particular case system (either following an accusative pattern or an ergative one) may within this framework be conceptualized as a hybrid outcome of the structure-dependent asymmetry detected among the verb's most prominent arguments, on the one hand, and a system of formal marks (case morphology proper, agreement, and so on), on the other hand, regarding which the incoming stimulation contains rich positive evidence (see, for example, Uriagereka 2007). Again, no particular expectation about how languages actually differ in this area of grammar seems to be required in order to constrain how the corresponding patterns are fixed. Thus the resulting image is one where over-arching or high-level principles of organization (like 'structure-dependence') pave the way to more nuanced or idiosyncratic ones (like the formal patterns chosen for marking specific structure-dependent relations), which in their turn probably reinforce the supporting operative principles (Balari & Lorenzo 2015b). For example, according to Crain & Nakayama's (1987) classic experiments, the bias towards 'structure-dependence' is fully operative in

[9] Chomsky actually incorporates into his list of third factor effects "principles of data analysis that might be used in language acquisition and other domains" and "principles of structural architecture and developmental constraints," but he emphatically adds that they correspond to "principles not specific to the faculty of language" (Chomsky 2005: 6). So ours is a welcome conclusion from a minimalist perspective, but one that clearly goes counter the classical view of language 'as a faculty'.

question formation tasks at 3;2 (years;months), but according to Lidz et al. (2003) it can already be attested at 1;6 in relation to other structure-dependent phenomena, like *one*-substitution. As for case marking patterns, a study by Elosegui Aduriz (1997) shows that full mastery of both the ergative (Basque) and the accusative (Spanish) patterns of case marking is attested on bilinguals at 3;3, with the respective key case distinctions ('ergative/absolutive' and 'nominative/accusative') emerging almost concurrently at 2;2–2;5. Such a partially overlapping chronogram between the precocious sensitivity to structure dependency and the subsequent fixation of a case system pattern, seems particularly fit to support Balari & Lorenzo's (2015b) reinforcing loops hypothesis.

Note that the reading according to which children's first language acquisition occurs as if they were respecting a 'logical flowchart' (Baker 2001) that they know in advance (see also Yang 2002), thus may be thought of as somehow motivated, yet it is simply the effect of viewing the process from the misleading perspective of the ultimately attained outcomes. We alternatively contend that only by inverting such a logic may one gain a true developmental perspective, for it is obvious that constraining influences on development must work the other way around: i.e. they must be derivative from the ongoing constructive process of the hybrid gradient, on which internal and external forces conspire with the hybrid-in-the-way itself to channel its own fate.

Turning to the main concern of this paper, we believe that the resulting 'gradient of language' concept fits particularly well with the basic maturational observations introduced in the first section of this paper and other, more recent findings to be reviewed in section 5. We note above that evidence has accumulated after years of intensive research that language is not monolithically affected by a single critical period effect. Effects seem to operate in a more selective way, with the ones touching the phonological domain affecting individuals earlier and being more noticeable afterwards, the ones touching lexical knowledge having a later chart of appearance and being less intrusive, and the ones touching morpho-syntax being in a middle ground both in timing and affectation of the acquired competence. Current research (Meisel 2013) even points to a more nuanced view, in which domains may eventually be parceled out in sub-domains motivated on maturational grounds. Such a state of affairs seems in perfect agreement with the ideas put forward in this section, which predict a complex pattern of maturational milestones as the gradient of language unfolds in time.

Moreover, development shows that the 'faculty-to-be' is not like a miniaturized version of the adult steady counterpart at every different stage that we may arbitrarily choose to study. So a more accurate approximation to these findings is one that envisions them as the chronological unfolding of an ever-changing gradient, in which a mostly phonologically biased capacity paves the way to increasingly complex units of function where the non-compositional lexical component and the compositional morpho-syntactic one take successively the lead in the complex. Correspondingly, the 'behavioral potential' (Kuo 1976) of the evolving capacity advances from its original link to social cognition (e.g. social attachment and maternal bond by means of acoustic cues; Locke 1993) to the open-ended functionality of adult versions of language (Chomsky 1975, 1980).

3.3. The 'Gradient of Language' and the 'Modularity of Mind'

A relevant question raised by an anonymous reviewer has to do with how the 'gradient of language' concept that we are entertaining here relates to the 'modular' view on the organization of mind, a framework within which the 'faculty of language' has traditionally been perceived as a welcome component. Two points of clarification are in order before trying to settle our particular take on this issue. The first is that the 'gradient of language' is a category that primarily belongs to the developmental analysis of language, while 'modularity' is a category that primarily pertains to the study of mind as a collection of full-fledged or steady cognitive components. So in a way, one is incurring in a category mistake of sorts when trying to evaluate them as competing hypothesis. Notwithstanding, and this is our second point of clarification, one may legitimately be interested in deciding whether they are or they are not coherent hypotheses from their respective (diachronic and synchronic) points of view. The more so attending to the fact that there is not a single or monolithic concept of 'modularity' (Robins 2015), so the door is clearly open to the possibility that one or another 'modularity' concept is the most congenial with the developmental view on language advanced in this paper. Let us briefly dwell on this.

Obviously enough, links between 'modularity' and 'development' have previously been suggested. To begin with, the ninth and last of Fodor's (1983) diagnostic features of modularity is a developmental one, according to which each module exhibits "a characteristic pace and sequencing": "[T]he neural mechanisms subserving input analysis [a.k.a. modules; SB&GL] develop according to specific, endogenously determined patterns under the impact of environmental releasers" (Fodor 1983: 100). Another well-known connection between 'modularity' and 'development' is the one suggested in Karmiloff-Smith (1992), according to which "the mind becomes modularized *as development proceeds*" (Karmiloff-Smith 1992: 4). But for different reasons, none of these seminal approaches appears to be congenial with the 'gradient' view advanced here. As for Fodorian modules, developmental determination obtains *via* a rich, pre-specified base of innate information at their disposal (Fodor 1983: 100–101), which contradicts the dynamic and contingent process of module construction that the 'gradient of language' concept should in any event require.[10] This is alternatively very much in the spirit of Karmiloff-Smith's model. However, Karmiloff-Smith's developmental perspective mainly boils down to the idea that module construction is a pace along a series of distinctive representational formats of increasing explicitness within particular mental specializations. The kinds of horizontal negotiations and dynamic accommodations between different bodily capacities that define the 'gradient' concept seem however alien to Karmiloff-Smith's idea.

Should we consequently quit trying to unite the 'gradient' and the 'modularity' concepts? Not necessarily, for versions of the latter exist that seem congenial with the former, particularly Carruthers' (2006) 'weak modularity', which envisions 'modules' as emergent and highly interactive functional units, maybe

[10] For the same reason, 'massive modularity' (Pinker 1997) is not an approach congenial with a 'gradient' concept of language either.

implemented with an enhanced version of Segal's (1996) 'diachronic modularity', namely one that privileges inter-domain penetrability as a developmental strategy to build functional modules proper as architectural units at relatively more stabilized stages. Along similar lines, Lieberman's (2006) 'functional systems' model also shows a desirable degree of compatibility with the 'gradient' developmental concept, for functional systems are modular in the sense of being well-defined specialized architectural components, without precluding their sharing specific sub-components. We don't see any in principle inconvenient in adding to Lieberman's 'weak modularity' the idea that by sharing components and activity, functional systems may help each other in their respective constructive processes.

But in the end, the substantial aspect of this issue revolves around the empirical consequences of bounding the fate of the 'gradient of language' concept with a particular vision of the architectural organization of mind—namely, a weak version of the modularity thesis. In this respect, two promissory areas in which predictions may be advanced and confronted with known facts are neurobiological findings regarding neural circuitry underlying putatively modular abilities and the study of breakdown patterns affecting them (Fodor 1983: 98–100). We devote sections 5 and 6 to each of these sides of the matter.

4. … and What Is Development, that It May Apply to Language

> *Development is a serially ordered process that is identifiable across time, but it is not defined by time.*
>
> Michel & Tyler (2005: 156)

This section inevitably requires a metaphysical opening. There exists a long-standing persuasion that the workings of nature are alien to the human system of categorization and explanation based on teleological categories: i.e. aims, goals, stages towards, expected paths and achievements, intermediary points, and so on, all of which entail the endeavors of rational/intentional agents (Dennett 1987). But as a matter of fact, the presence of such a system is pervasive in many domains of the natural sciences (for a critique in relation to current functionalist-oriented biological thinking, see Fodor & Piattelli-Palmarini 2010). Kant was particularly aware of this shortcoming of the life sciences and devoted to the topic most of the second part of his *Kritik der Urteilskraft* (1790). Kant's position was, however, somehow compliant with the teleological perspective, in that he understood that in as much as conscience is not lost that the rational/intentional categories are inevitably linked to the means by which natural causation becomes understandable from a human frame of mind, and not constitutive parts of the biological *explananda*, it may be maintained with no serious harm to the scientific enterprise. In any event, that the propensity of transferring the intentional stance from the explanatory strategy to the object being explained is a strong one is clearly attested by the fact that many functionalist-oriented approaches, particularly in the field of evolutionary biology, continue to take for granted that "teleological notions are a distinctive and ineliminable feature of biological explan-

ations" (Allen 2009). The general position underlying the following pages is that approaches that cut off the 'look ahead' signature of teleology from interpretations of natural facts are better positioned to offer *bona fide* explanations in the corresponding domains than competing frames containing residues of the rational/intentional stance.[11]

We thus subscribe here a metaphysical framing for development along the lines put forward by developmental systems theoreticians (Oyama 2000a, 2000b; Oyama *et al*. 2001) or probabilistic epigeneticists (Gottlieb 1997, 2007), according to which nothing is contained (not even required) within organisms (plans, programs, blueprints, pre-installed structure, an so on) in order for development to unfold following highly predictable paths leading to highly predictable outcomes: It suffices to recruit resources anew and to repeat processes afresh in order to expected (yet not completely guaranteed) outcomes to obtain, given the chances that history offers to such contingent cycles to gain robustness and long term stability. Variability inevitably becomes a *sequitur* of such a take on development, ranging from the minor signatures of individuality to deleterious forms of teratology, through the generation of innovative morphotypes with a prospect of evolutionary stabilization. This general view also adheres to the idea, explicitly held for example by Minelli (2003, 2011), that development is to be taken as the most distinguishing feature of life, if not completely identical to it, and consequently that it may also be taken as an open-ended process, where no clear points of termination are to be searched and assigned. This is not in contradiction with observations inspiring the contrary conclusion that processes of maturation exist that lead to more or less durable steady states; but the default position within this general framework is that they do not, and that organic matter is an always evolving (i.e. developing) kind of stuff. It is also a consequence of this overall view on the organic realm that organisms do not evolve the means to plan, program, preview or prefigure their developmental fates; rather, organic resources at all levels of organization become liable to persist that directly benefit the reiteration of advantageous developmental cycles. According to Minelli's (2003) motto, development exists (primarily at least) just for its own sake.

4.1. The Position of the Gradient of Language within the Theory of Development

Modern linguistics has proven particularly refractory to the kind of non-teleological approach just reviewed when confronting the problems of language acquisition. Traditionally, the image of acquiring a language within the learning paradigm was one of 'successive approximations' (Skinner 1957) to the adult external models. But once the conclusion was settled that the primary linguistic data offered to children lack models and are very opaque in relation to crucial aspects of the grammatical competence already attested at very early ages (e.g. the structure-dependent character of most rules of grammar; see above), the consequence was not to abandon an adultocentric stance regarding language

[11] The position does not entail an eliminative stance concerning the status of 'intentionality' as a putative biological category in the domain of the mental, in the sense, for example, of Searle (1992). The position rather points to a stance according to which 'intentionality' is a putative biological *explanandum*, but is not a legitimate biological *explanans*.

acquisition. Contrarily to this, the common move was rather a generalized acceptance of the idea that the adult model is almost completely given from the start (see Chomsky 1981, Baker 2001, and Yang 2002, for some instantiations of the thesis), thus radicalizing adultocentrism with the extra assumption of a performationist stance, which adds to the 'aimed at' character of the process a strict 'determination' and 'tutelage' from the inside of the individual that acquires the surrounding linguistic conventions.

But things may become very different once the idea of a 'faculty of language', virtually preformed and fated from its very onset, is replaced with the alternative 'gradient of language' concept along the lines suggested in the previous section, as the view is particularly fitted to accommodate what may be seen as one of the central axioms of a theory of development (in the sense of Minelli & Pradeu 2014): "Development emerges *from* earlier conditions; it is not directed toward later conditions" (Michel & Moore 1995: 21). Earlier conditions are of course completely ignorant of their intermediary or ultimate fate (if at all), which may change radically, both in structure and functionality, as component parts appear, grow, associate with or dissociate from each other, gain or lose centrality within the whole, and so on. To wit, as pointed out above the gradient of language seems to have its starting point in an effective detector of the quasi-musical properties of adults' utterances (pitch contour, rhythm types, and so on). The fact that trials aimed at unveiling this ability customarily test them in experimental settings in which newborns are defied to tell apart stimuli belonging to different languages (Gervain & Mehler 2010), may help to create the image that it is a specifically language-devoted skill. But, as a matter of fact, it probably serves in most real situations to create and consolidate the newborn's affective and social bonds with her caretakers (Locke 1993). It is now a well-attested fact that later on this ability serves to the children as part of a phonological and statistical 'self-aid' kit with which they start breaking the continuous speech flow into component parts corresponding to 'word candidates', which they rapidly associate with presumptive meanings (or definitely discard as true words) (see Guasti 2002: 74–80, for a presentation and relevant bibliography). According to the point of view that we are adhering to here, it is a wrong conceptualization of such a developmental sequence that newborns' musical skills are there from the start 'in order to' facilitate segmenting the speech flow into word-like units, as a part of a 'program' of sorts in which language-specific categories (like 'word') are moreover anticipated. For the sake of the developmental explanation, it suffices to say that the corresponding perceptive abilities transform the incoming stimuli into one compounded of segments that children match very fast with meaningful associations (Carey & Bartlett 1978; Markson & Bloom 1997). Thus *from* abilities related to the musicality of sequences, a lexicon of arbitrary associations starts growing as an aspect of the child's declarative memory (Ullman 2001); a very different claim that saying that the former are *directed toward* the latter. The advantages that follow from having a catalogue of arbitrary pairings of sensory-motor and conceptual percepts may act, obviously enough, in the sense of entrenching the original underlying capacities, but they do not transform the latter into an anticipation of the lexicon to come in any meaningful sense. Similarly, it is a reasonable assumption that as soon as the child breaks the continuity of speech

flow into component pieces, the stimulus now perceived as sequentially organized starts to instigate and strengthen procedural activity (Ullman 2001) capable of detecting and memorizing combinatorial patterns,[12] paving the way to productively using them in due time. The number of lexical items known by children at a given developmental stage serves as a good predictor of the moment at which syntactic abilities emerge (a schematic or telegraphic syntax appears when they are entering the hundreds, and around the four hundreds a more productive 'adult-like' one; see Guasti 2002, for a synthesis), which may actually be used for diagnostic concerns (Locke 1997; Bates & Goodman 1999). But again, the only sensible way of conceptualizing these facts is that *from* abilities related with the identification of discrete units in the stimulus and the increase of items within declarative memory, children obtain the opportunity of feeding the development of syntactic procedures or routines.

A final point of clarification is in order before closing this sub-section. As important as clarifying that there is no 'directed toward' development is the complementary task of explaining that when enumerating cognitive skills involved in the acquisition of languages by children, one is not really contemplating a number of instrumental means to acquire languages: What one is contemplating is just language, period. Language has no other reality and cannot be taken apart from the skills of concern, contingently recruited as development progresses and thus becoming part of a complex pattern of dynamics, where the position and the weight of each relatively to the others varies along the way. So similarly to how we previously saw that the distinction between 'languages as given out there' and 'language as a internal faculty' (as in the 'biology-culture' dualism) blurs within our developmental frame, we believe that it may complementarily also help blur the distinction between 'the faculty of language' and its putative 'underpinnings', for the resulting image of language as a developing phenomenon is one of a complexly evolving system that metamorphoses from (for example) an English acoustic and statistical detector successively into an English fragment of declarative memory, and into an English set of memorized compositional procedures, and so on (and the same with whatever other language one might be interested in observing from such a longitudinal perspective).

4.2. The Critical Period in Critical Condition

We are now in the position of answering the main question that motivates this paper, and in a way that does not differ too much from the answer given by Zing-Yang Kuo decades ago regarding the suitability of the critical period concept to developmental processes at large: "[…] the concept of critical period […] is of dubious scientific value" (Kuo 1976: 115). Sure enough, Kuo's is the most reasonable conclusion when one accepts the dynamic and ever evolving character of every single aspect of the cognitive/behavioral make-up of a species. So once the premises are settled (i) that language is a complexly growing system in which rather disparate skills are contingently recruited along the way (instead

[12] Gervain *et al*. (2012) have experimentally shown that newborns already display similar pattern-identification skills in relation to meaningless syllabic stimuli.

of a well-delimited faculty from the start), and (ii) that the development of language entails the 'negotiation' of predominance relations among the successively assembled abilities, corresponding to the upsurge of new emergent functionalities (instead of a monolithically given kind of functionality within the reach of children from the outset), then a very different idea of 'criticality' in the realm of cognition/behavior is due.

We also agree with Kuo that a 'criticality' concept may be nevertheless saved if conceived of in the physicist's sense in which it names 'points' at which certain states of matter undergo characteristic modifications (e.g. "the temperature above which a substance in gaseous form cannot be liquefied no matter how much pressure is applied"; Kuo 1976: 115). A congenial notion has also been implemented within the dynamic systems approach to the development of cognition and action advocated by Thelen & Smith (1994) under the interchangeable labels of 'critical' or 'transition' points and in their turn taking inspiration from the behavior of chemical reactions. In any event, the term boils down to the same idea of points at which continuously evolving complexes acquire the potential to engage in qualitatively new kinds of processes and/or exhibit qualitatively new patterns of activity. Irrespective of the label one prefers to choose, the distinguishing feature of this new concept of 'criticality' is that it puts the stress on the new kinds of events or states to come (given antecedent developmental events and present conditions), instead of focusing (as it is the case of the classical 'critical period' concept) on the potentialities left behind (as windows of opportunity close following more o less rigid schedules).

In the realm of language, similar 'critical (or transition) points' may be posited, for example, regarding the critical amount of lexical units that may already pave the way to a 'more procedural' than 'declarative' style of language, as observed in most children from their second year of life. It is our suggestion that this is the model of 'criticality' that ought to be generalized to the experimental evidence reviewed in the first section of this paper. Thus 'foreign accent' effects observed after minimal delays in the exposure to a second language, for example, should simply be seen as the ('normal' or 'characteristic') kind of reflex in production of a phonological system acquired *from* a certain maturational stage of the ongoing language gradient (and/or a certain degree of exposure), instead of as a 'deviant' outcome of an ill-timed exposure—the reading that one would be more prone to follow with the lenses of an orthodox 'critical period' concept. This interpretation fits in nicely with the observation that a complex of nervous fibers exists connecting posterior auditory and more anterior pre-motor left hemispheric areas, which is involved in phonological processing tasks and attains full maturity rapidly after birth (Friederici 2011). Thus, two partially different patterns of phonological assimilation naturally follow, due to the more or less earlier exposure to the relevant stimulation. Similarly, the 'decay' in the capacity of assimilating the morpho-syntax of a second language, customarily dated as concurrent with the onset of puberty, should rather be conceptualized as the point *from* which, as if mirroring developmental effects previously observed in prepubertal acquisition, the language gradient becomes more 'declarative' than 'procedural' in the relevant domain, so rules are now instantiated following a less automatized and more conscious style, maybe closer to the style with

which words and idiomatic phrases are instantiated at previous stages of the gradient.

It has been suggested that similar corrective effects may be obtained by completely giving the 'critical period' concept up, and adopting instead an alternative notion of 'sensitive period' (Schneirla & Rosenblatt 1963; Bornstein 1989; see Locke 1993: 296ff., for the particular case of language). While we agree that the concept of 'sensitive period(s)' is a well-motivated and relevant one in every single developmental realm, yet we have an objection to rise concerning whether it truly is the right alternate to its purportedly classical antecedent. As explained in Michel & Tyler (2005: 160), the idea of 'sensitive period' offers an escape hatch to the "clock-like, built-in or predetermined periods in development",[13] replacing such teleologically connoted notions with a view according to which development itself produces distinctive stages, with an intrinsic 'variability in onset/offset (timing)', each being constructed *from* their (causally active) predecessors. We have not, as previously said, any conceptual objection to an idea of 'sensitive periodicity' thus defined; but we think that, if any, it may serve as a conceptual surrogate not of the 'critical period' concept, but of the idea of 'development' in itself, in case one decides to waive the old word with all its odd connotations and to introduce a brand new one to name what, in the end, is just development as usual. Conversely, it is our opinion that a concept of 'criticality' along the lines of this sub-section adds something substantive within such a renewed view of 'sensitive' development, so they are complements instead of competitors of each other.[14]

5. Some Neurobiological Evidence

It is important to see that there is not a cultural level above the *psychological above* the *biological, but many interpenetrating ones.*
William Wimsatt (2007: 136)

Throughout this paper we have been developing an alternative conception of language acquisition, based on the notion of 'language gradient' as a natural replacement of such theoretical constructs as 'the faculty of language' on which classical models of language acquisition are based. It has been our contention that with the notion of gradient a much more integrative view of cognitive development in general and language acquisition in particular is made possible, with the net effect of making these processes virtually indistinguishable from the onto-

[13] But maybe not always: For example, Bornstein's (1989) is an exhaustive, but rather conventional framework for disentangling 'sensitive period' effects, where 'sensitive' is perfectly interchangeably for 'critical' in the most traditional sense.

[14] Actually, Schneirla & Rosenblatt (1963) insisted on clarifying that their own concept of 'sensitivity' as applied to development simply boiled down to the idea (maybe the platitude) that developmental events are fuelled, *at every developmental stage*, by the conspiracy of the state already attained from previous events and the environmental inputs that the organism becomes reactive to given that particular state. Therefore, their 'sensitive period(s)' concept does not entail (but also does not exclude) the identification of characteristically 'critical' landmarks.

geny of the organism. In other words, our proposal promotes cognitive and linguistic development to the status of *bona fide* ontogenetic processes rather than ascribing them to the class of processes traditionally tagged as 'psychological development' taking place through the interaction with a properly articulated biological substrate. By blurring the biology/psychology-culture divide, we submitted that a novel interpretation is possible—from a non-teleological and non-adultocentric perspective—of an ample body of acquisition data concerning in particular the long-debated issue of critical periods. The pertinent question at this point is whether our view finds some independent support. This is the main purpose of this section.

In the last decade, a number of interesting works have been published on the matter of critical periods, with special reference to their molecular basis. It should be pointed out from the outset, however, that, as we suggested in the last paragraph of the previous section, critical/sensitive periods are the hallmark of development, in the sense that the emergence of virtually any developmental product is restricted to a more or less flexible time window (Hensch 2004). Thus, the question eventually reduces to what is meant by 'criticality': Either (i) a pre-specified or innately determined point in developmental time where the opportunity window is closed, or (ii) a stage in development in which, for whatever reason, the appropriate scaffolds are not present with the consequence of precluding the emergence of some expected developmental products and driving the process through a different, perhaps novel pathway.

Neurobiologist Eric Knudsen has contributed a number of important works to the understanding of critical periods. In a review article published in 2004, he proposed the following definition:

> The term 'sensitive period' is a broad term that applies whenever the effects of experience on the brain are unusually strong during a limited period in development. Sensitive periods are of interest to scientists and educators because they represent periods in development during which *certain capacities are readily shaped or altered by experience*. Critical periods are a special class of sensitive periods that result in irreversible changes in brain function. (Knudsen 2004: 1412; our emphasis)

Two points are of particular importance here: (i) the decisive role played by experience in defining the boundaries of the sensitive period, and (ii) inclusion of critical periods as a subclass of sensitive periods. A third factor also mentioned by Knudsen is that "although sensitive periods are reflected in behavior, they are actually a property of neural circuits". In this latter connection, Knudsen establishes a typology of neural circuitry on the basis of its inherent stability or plasticity. Thus, at one extreme of the continuum defined by this typology, we find those circuits that, for obvious reasons, possess an initial pattern of connectivity that is extremely resistant to change, due to the strengths of their connections. These circuits are built up essentially through endogenous processes, i.e. independently of experience, and are often those on whose functioning depends the activity of other, more plastic circuits, as it is the case of those "circuits located near the sensory or motor periphery, such as in the retina or the

spinal cord" (Knudsen 2004: 1413). At the other extreme of the continuum are those circuits with an ample range of potential more or less stable patterns, attainable as development proceeds and experiential input through the sensory systems is supplied as a function of the availability of the appropriate stimuli in the environment. In between these two extremes, a variety of neural circuits exists with different degrees of stability and sensitivity to change.

To be sure, Knudsen's preferred metaphor to represent the development of neural circuits is that of the well of attraction or stability landscape, already familiar from dynamical systems theory or the developmental landscapes Conrad Waddington used to illustrate his notion of canalization. In this sense, less plastic circuits will be those with deeper wells of attraction and, consequently, only capable of changing if high amounts of energy are spent to perturb their strongly canalized pathways. Less stable circuits, on the other hand, will be reactive to weaker doses of perturbation, but will nevertheless be able to reach one or more stable patterns through the action of repeated experience (p. 1417) or, in the absence thereof, through the operation of "homeostatic mechanisms, intrinsic to neurons and circuits, which attempt to maintain a minimal level of impulse activity in developing neural circuits" (p. 1420).[15] Note already how close this idea of criticality is to the one Kuo urged us to adopt in the 1970s.

A number of conclusions can already be drawn from this. First and foremost, sensitive/critical periods are not series of windows of opportunity that open and close following a predetermined developmental schedule but rather stages characterized by variable degrees of plasticity in a global process tending to maximize stability.[16] Stability is not guaranteed, however, as it is highly dependent on the degree of plasticity of the system, on the one hand, but also on the intensity of the experience, on the other hand. Accordingly, even the most stable circuits are liable to change if perturbations are strong enough to make them revert to earlier stages or to follow alternative pathways, although, logically enough, the more deeply entrenched (Wimsatt 1986, 2001, 2007) the circuit the more difficult will be to perturb it, as highly entrenched systems often act as scaffolds to later-developing systems, and alterations of their functionality may have negative effects on the global stability of the whole system to the point of being deleterious.[17] Thus, the boundaries defining the onset and termination of sensitive/critical periods are not pre-established by some developmental clock, but are nevertheless more or less predictable given the very same dynamics of developmental processes seen as continuous chains of stabilization and scaffold-

[15] We will not offer here a detailed account of the neuroanatomical and molecular events associated to sensitive periods, but the reader may refer to Knudsen's paper for a general exposition. For a more detailed review, with special emphasis on visual and auditory circuits, the work of Takao Hensch and his team is particularly relevant; see Hensch (2004, 2005), Morishita & Hensch (2008), and Barkat *et al*. (2011).

[16] This is therefore perhaps the only sense in which one can say that developmental processes are goal-directed. This is nonetheless an interpretation of goal-directedness that is much closer to the physical notion of thermodynamic equilibrium than to the traditional teleological definition based, for example, on ideal adult models.

[17] In Balari & Lorenzo (2015b) irreversibility was highlighted as one of the hallmarks of developmental products. In light of the discussion in the text, this is clearly too strong, but the idea may be easily reformulated in terms of generative entrenchment and the degree of stability of the said developmental products.

ing effects.

This hierarchical organization of neural circuitry, with downstream systems dependent on other, more entrenched ones prompts, Knudsen's recommendation that researchers should be wary at the time of positing critical periods at the behavioral level (Knudsen 2004: 1421). The reason is that downstream systems tend to remain plastic, retaining the ability to compensate for potential abnormalities stabilized in the most entrenched ones. This situation may have the effect that irreversibility at the circuit level need not necessarily mean irreversibility at the behavioral level. In our opinion, this observation reinforces our gradient view of development, since behavioral/psychological categories like 'language', based on idealized adult models, tend to be much too coarse-grained to be applicable at all stages of the developmental process. As we pointed out in a previous section, if anything, 'language' is 'language' from the very beginning, but with the specific properties characteristic of each stage of the process attained through the participation of the different elements of the gradient.

We are ready to accept, however, that this does not really solve the question of 'language' in one direction or another. To be sure, despite Knudsen's advice, all the experimental data reviewed earlier could still be interpreted in the sense that some language specific system is susceptible to show criticality effects. For one reason: That sensory systems undergo maturational processes is well-known since, at least, the 1960s with David Hubel and Torsten Wiesel's experiments on the visual cortex of kittens (see Wiesel 1982 for an overview). Thus, one could argue, language is just another example of this, but one that does not contradict the idea that there are language-ready systems that require linguistic input to unfold or the idea that language, as a cultural phenomenon, requires a properly developed biological substrate to be acquired. For example, a celebrated experiment performed by Mayberry & Lock (2003) could receive any of these two interpretations. In a nutshell, Mayberry and Lock analyzed language performance of early *vs*. late acquirers of both spoken and signed languages in order to test "whether the onset of language acquisition in early life is related to the subsequent ability to learn any other language for the remainder of life, independent of the sensory and motor modalities of the first or second languages" (Mayberry & Lock 2003: 370). All tests assessed syntactic abilities through a variety of tasks comprising, for example, grammaticality judgments, sentence to picture matchings, etc. Perhaps not surprisingly, the final results suggested "that language experience during human development dramatically alters the capacity to learn throughout life" (p. 380). Mayberry and Lock's conclusions are somewhat puzzling. Thus, while they dismiss an interpretation in terms of a genetically specified ability and favor the idea of an epigenetic process "whereby environmental experience during early life drives and organizes the growth of this complex behavioral and neurocortical system" (p. 382), they characterize the critical period for language as "a time-delimited window in early life where the degree and complexity of neurocortical development underlying the language system is governed" (p. 382). The conclusion is puzzling, in our opinion, because, while the authors are ready to accept that cortical structures develop, nothing of the sort applies to language, which is 'out there' waiting to be learned by the appropriate structure. It certainly does not escape the teleological, adultocentric

model we are arguing against in this paper.

So, the question is: Are there any acquisition data unequivocally or at least strongly supporting the gradient view? We believe there are, and we would like to close this section by briefly reviewing them.

In the early 1970s, Peter Eimas demonstrated experimentally that 1-month-old human infants are capable of perceiving speech sounds categorically (Eimas *et al*. 1970, Eimas 1974). Moreover, it was also shown that the ability to categorically discriminate certain distinctions at a very early age was lost as acquisition proceeded of a language in which such contrasts are not functional (Eimas 1975). These results were interpreted as evidence for the existence of a universal and innately specified human- and language-specific phonetic detector system operating in a selectionist mode as acquisition proceeded, stabilizing on a system of phonetic categories on the basis of phonetic evidence provided by the environment. Such interpretation was soon called into question when categorical perception of speech sounds was also experimentally observed in a non-human species (Kuhl & Miller 1975, 1978). This is an old story, and a well known one. Clearly, categorical perception of speech was not an ability based on some language-specific processing device, but rather the human system of phonetic categories was constructed on the basis of oppositions to which the mammalian or even the vertebrate ear is highly sensitive.[18] This story also signals the beginning of a fruitful research program on the acquisition of linguistic capacities that strongly supports the developmental view we have been defending in this paper.

In 1991, Kuhl (1991) described the 'perceptual magnet effect' in the processing of speech sounds by human adults. In essence, Kuhl's finding was based on the earlier discovery that speech categories have an internal structure and are organized around a prototypical center (Grieser & Kuhl 1989). The prototype then acts as a 'magnet' during perceptual tasks in such a way that all stimuli assigned to the category are interpreted in terms of the prototype. According to Kuhl (1991), this effect would explain the gradual loss of the ability to perceive categorically non-native sounds already observed by Eimas (1975) and later confirmed by Janet Werker and collaborators (Werker *et al*. 1981, Werker & Tees 1984). Another interesting finding of Kuhl's experiments was that the perceptual reorganization observed by Werker & Tees (1984) is a strictly human phenomenon—not observed in monkeys, for example—and partially completed around 6 months of age.

Summarizing so far, speech perception is driven by a deeply entrenched ability to perceive categorically which, in humans, acts as a scaffold to later construct a richly structured system of phonetic categories on the basis of the stimuli supplied by the environment. This system drives subsequent speech perception, acting as a filter where prototypes function as 'magnets' attracting those stimuli that are similar but not identical to the prototype and thus producing the typical effect observed in the processing of non-native sounds. The question now is what role does this early form of language plays in later stages of

[18] Later experiments showed that the ability to perceive categorically is also found in many other nonhuman species, like apes, monkeys, and birds; see Balari *et al*. (2013: 497–499) for a brief discussion of these results and references.

the acquisition process.

New evidence supporting this view was reported in Kuhl (2000, 2004), where a number of experiments using neural imaging techniques are presented suggesting that perceptual reorganization is caused by what Kuhl calls 'native language neural commitment' (NLNC). In essence, NLNC would be an example of neural circuitry that has reached a relatively stable state for the processing of auditory inputs and thus showing a certain degree of criticality in the sense that non-native sounds are processed according to the stabilized patterns to which the system is sensitive. In Kuhl's (2000, 2004) words, early language experience literally "warps perception" of further linguistic input and thus "interferes with the processing of information that does not conform to the learned pattern" (Kuhl 2000: 11855). As later research demonstrated (Kuhl *et al*. 2005, Kuhl *et al*. 2008), NLNC, a form of entrenchment, positively acts as a scaffold for further language development, boosting the development of grammatical skills. Interestingly, this is a form of a critical period effect, in the sense that NLNC hinders the development of a second language once the neural network has reached a high degree of stabilization, a point previously raised in Marchman (1993). Concomitantly, however, variable degrees of neural commitment have been observed (Kuhl *et al*. 2008) such that lower levels of stabilization give rise to slower acquisition of further skills, but favor, should the environment include foreign language input, the eventual development of a second language, as it is the case with bilingual infants; see Kuhl *et al*. (2008: §5) for details.

Everything considered, we believe that the evidence reviewed clearly supports the gradient view of language development proposed here. One in which different components participate in different degree and intensity at different stages, in which a gradual hybridization is effected, starting with the development of prototypical phonetic categories, and proceeding through the development of later skills in a continuous chain of entrenchment and scaffolding effects (Dove 2012).

6. Final Remarks: Broadening Our Understanding and Appreciation of Linguistic Varieties through the 'Gradient of Language' Concept

In closing this reflection, we want to briefly stress two advantages of adopting a renewed view of 'criticality' along the lines put forward in the previous sections, each of a different character, but both ultimately related. The first has to do with the suitability of the idea of 'gradient of language', which replaces here the concept of 'faculty of language', as well as the associated 'critical point(s)' concept, to accommodate certain intriguing findings recently exposed in Hankock & Bever (2013). After following up an intensive research on groups with a relatively high incidence of familial sinistrality, the authors present the conclusion there that individuals belonging to such groups (not necessarily left-handed) show a certain advantage relatively to the outgroup in some linguistic skills, like the quickness with which they access and retrieve lexical (declarative) information. From this observation, Hancock and Bever raise some unorthodox, yet reasonable claims concerning the character of language: Namely, that it may display more than one

'normal' form of neurological/computational architecture, and correspondingly more than one 'normal' system of associated behavioral reflexes. Such a conclusion, anchored as shown in well-attested observations, agrees with the expectations of the view on language defended in this paper as a convoluted system of neurological/computational resources, contingently assembled as the corresponding gradient evolves and consequently open to a range of variation within which several architectural/computational styles may fit comfortably (for example, more or less 'declarative' *vs*. 'procedural' styles). As, according to Hancock and Bever, such an expectation seems to be fulfilled within the limits of what are considered 'normal' patterns of linguistic development and behavior, we suggest referring to such variants as 'computational styles', or 'computational dialects', respecting the traditional term in linguistics ('dialect') to refer to all classes of 'normal' variability.

Note that once such a move is made, nothing prevents us form extending the range of expected variability to slightly but increasingly deviant styles: For example, variants in which characteristic physiognomies and/or intellectual disabilities selectively impact on the language capacity, but with mild to moderate effects—as it is the case of Down syndrome, particularly in the expressive side (Martin *et al*. 2009); or variants in which other non-radically disruptive effects are observed—for example, a differential ability to deal with names as compared with verbs, in the context of certain developmental conditions, like Potocki-Lupski syndrome (Vares 2015).[19] Generalizing this, what obtains is a gradient of linguistic conditions, in clear agreement with the gradient character of language in the developmental sense that we have defended in this paper. Likewise, nothing prevents us from extending the gradient as to also cover the transition from monolingualism to different forms of multilingualism—actually conforming a complex spectrum with many transitional forms of multidialectalism in between, the cognitive/linguistic reflexes of which (differences in executive control tasks, visual and speech perception, etc.) are now becoming to be understood (Sebastián-Gallés & Díaz 2012; Sebastián-Gallés *et al*. 2012, Hernández *et al*. 2013). Developmentally speaking, the resulting gradient view purports that language is not circumscribed to a particular compartment of our mind/brain, but spreads on a complexly interactive system of bodily capacities subject to the impact of a correspondingly complex array of developmental influences, both endogenous and exogenous. Such a picture makes very unlikely the idea of a faculty of language as an epitome of sorts, from the point of view of which impaired, lessened or even enhanced variants must be deemed exceptionally deviant.[20]

Our second and final remark points to the added suitability of the developmental framework unfolded here to overcome the inconveniences of a vocabulary too much loaded with normative connotations, as the one displayed in prior passages (with all its occurrences of 'normal' within quotation marks). Forms of language are routinely referred to as 'abnormal', 'deviant', 'impaired', and so on, which obviously entails a 'normal' point of reference, as well as 'second', which

[19] Verb–noun dissociations are also a well-known effect in the context of different forms of acquired aphasia. See Kambanaros & Grohmann (forthcoming), and references therein.

[20] We are grateful to Kleanthes Grohmann for sharing his thoughts on these ideas.

purports a question of priority, or 'foreign', an administrative condition completely alien to the way languages are acquired. We are not suggesting that labels like these are not necessary at least in some of the fields where they are applied. Our message rather is that they must be handled with extreme care and ideally even replaced when the aims of research have to do with purely developmental matters. Some of them (for example, 'impaired language') name exceptional courses of development (as when 'specific language impairment' is said to affect to 7% of people), which sometimes leave the individual in a more or less handicapped position; but some other times differences are negligible, revealed only after close technical scrutiny. Some other forms are however as common as so-called 'normal' language, like modalities of languages acquired and used in adulthood. In all these cases the developmental perspective, which must be ignorant of normative considerations, should see, again, just cognitive or computational dialects in such varieties (see Corder 1981, for some pioneering suggestions along similar lines; see also Boeckx & Benítez-Burraco 2014, for some recent observations). The move may perhaps prove also useful to remove many language-related stigmas and to promote more proactive attitudes in rehabilitation or reconstructive endeavors (Michel & Tyler 2005).

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