

50 Years Later: A Tribute to Eric Lenneberg's *Biological Foundations of Language*

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Introduction

"The study of language is pertinent to many fields of inquiry," reads the first sentence of the preface to *Biological Foundations of Language*. The serious scientific study of the biological foundations of the human capacity for language as one of the youngest branches of linguistic inquiry, nowadays frequently referred to using the label "biolinguistics," began roughly half a century ago and was, in part, fuelled by the so-called "cognitive revolution" (Miller 2003) of the 1950s. Eric Lenneberg's book *Biological Foundations of Language*, one of the field's founding documents, was first published in 1967, that is exactly 50 years ago. Today, though not as universally known as it should be, Lenneberg's book is regarded as a classic by most people in the field. Consequently, this year's anniversary provides an excellent occasion for revisiting Lenneberg's by now classic work and reassessing the scope, validity, and foresight of the evidence presented and arguments put forward.

The purpose of this special issue thus is to reconsider and reflect on Eric Lenneberg's ideas and how they influenced (or actually didn't influence, because they were quickly forgotten) today's field of biology of language. In his *Biological Foundations of Language*, amongst other things, Lenneberg already outlined the possibility of a genetics of language and wrote about language and the brain long before any of the multitude and major technological advancement in both, genetics and neuroimaging, that we have seen in the past decades were even looming on the horizon. A whole lot has been learned since *Biological Foundations of Language* was first published and there can be little doubt that Lenneberg would be amazed by

I would like to seize this opportunity to thank all those who contributed to this special issue of *Biolinguistics* in one way or another, be it by submitting papers, reviewing manuscripts, or assisting with various steps of the editorial process. A special thank-you is due to Kleantes K. Grohmann, editor of *Biolinguistics*, for providing me with the opportunity to organise and guest-edit this special issue, as well as for his enduring support, advice, and assistance throughout the editorial process. Similarly, I would like to thank Katie Gough, Lisa Miklauschitsch, Valeriia Perepelytsia, Corina M. Sturm, and Michael C. Trettenbrein for volunteering their time as editorial assistants. I am grateful to Koji Fujita for bringing the Japanese translation of *Biological Foundations of Language* to my attention as well as for generously providing pictures and scans. On a related note, thanks is due to Maximilian Gorfer for translating the preface of the Japanese edition. The production and publication of this special issue was subsidised by the Referat für Wissenschaft & Forschung der Steiermärkischen Landesregierung.



the technological and methodological progress in neuroimaging, neuroscience at large, and genetics. The contributions collected in this special issue discuss various aspects of these developments insofar as they revisit and/or update Lenneberg's interpretation of the data and especially their theoretical implications from a contemporary point of view.

About Eric Lenneberg

Eric Heinz Lenneberg (* 19th September 1921 – † 31st May 1975) was born in Germany in 1921 and attended grammar school in Düsseldorf before his family, being Jewish, had to flee from the Nazis to Brazil. He lived in Brazil until 1945, at which point he left for the United States in order to study at the University of Chicago. After obtaining his bachelor's degree, Lenneberg continued his university education by studying linguistics and, in 1956, received his Ph.D. in linguistics and psychology from Harvard. However, Lenneberg was not done yet and went on to study neuroscience at Harvard Medical School. He was interested and tried to keep up with the literature and latest developments in embryology, neuroanatomy, motor control, and evolution, to name just a few of his spheres of interest. Throughout his life Lenneberg held appointments at a number of major universities in the United States and lectured all over the world. He organised workshops in cooperation with the Neuroscience Research Program (Arbib, this issue), UNESCO (Lenneberg & Lenneberg 1975), and the Max Planck Society in Germany and published a number of volumes on a variety of issues in the study of mind, brain, and language.

This brief sketch of Lenneberg's life and education already reveals why he was probably uniquely suited to co-found what would later become biolinguistics together with two other young students who were at Harvard at the same time, the graduate student Morris Halle and the then even younger Harvard junior fellow Noam Chomsky. Their shared scepticism about the radical behaviourism that dominated psychology in Cambridge at the time led them to read a lot of the now classical ethological literature coming from Europe (e.g., Konrad Lorenz, Nikolaas Tinbergen, Otto Koehler, etc.). Lenneberg and Halle could speak German and would frequently read ethological publications in their original language. This reading matter provided a basis for considering the human language capacity as being rooted in the biological nature of the species, rather than a cultural or technological achievement (for a brief recap of these early days see the interview with Noam Chomsky in this issue). Together, Lenneberg, Halle, and Chomsky spearhead the cognitive revolution in linguistics and psychology by adopting a biological approach to the study of the human language capacity. While Chomsky's own work focused on the formal analysis of natural language (also reflected in the ap-



Figure 1: The late Eric H. Lenneberg as portrayed in Lenneberg & Lenneberg (1975). © Elsevier Inc.

pendix he contributed to *Biological Foundations of Language*), Lenneberg was interested in the biological facts about language and its development—ontogenetically as well as phylogenetically—his ultimate goal being to develop a biological theory of language (Lenneberg 1964a). These efforts culminated in *Biological Foundations of Language*.

About the Book

Biological Foundations of Language was first published in 1967 and, somewhat surprisingly, has never been reissued, neither in its original nor as an updated version. However, a German translation was published as *Biologische Grundlagen der Sprache* only in 1972 and, as Koji Fujita brought to my attention, a Japanese translation of the book also exists (see figure 2). Interestingly, Lenneberg used the foreword for the Japanese translation of the book to clarify what he meant by discontinuity in the evolution of language, emphasising the qualitative difference between human language and animal communication systems and pointing out that such a discontinuous take on language evolution does not imply that natural history itself is discontinuous—a topic that is also taken up in two contributions to this special issue by Callum Hackett as well as Sergio Balari and Guillermo Lorenzo.

The scope and depth of Lenneberg's book is intimidating, even upon rereading 50 years after it was first published: Chapter after chapter, the contemporary reader will find ideas that they might think of as particularly “modern” or “new” already discussed in varying depth but always with persuasive clarity. For example, Lenneberg already noted that “speech and language are not confined to the cerebral cortex” and warned us that there is no single brain region to which the language capacity is confined, while there clearly are specific regions and networks that are crucially involved in language processing. Despite this, *Biological Foundations of Language* was by no means intended to serve as a textbook or survey of the literature at the time; instead Lenneberg's vision had been to write what he himself called a “theoretical treatise.”

The body of issues in which Lenneberg was interested and on which he would elaborate in his 1967 book is foreshadowed in a vast number of publications preceding *Biological Foundations of Language*. For example, in Lenneberg (1964) we read that

[...] all these considerations serve to establish an hypothesis and to stimulate new directions for research on the nature of man. However, the facts presented [in this paper] do not constitute a theory. Let us hope they will lead to one in the future.
(Lenneberg 1964: 85)

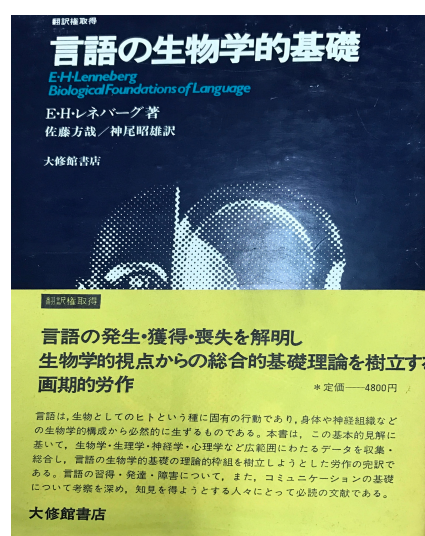


Figure 2: The cover of the Japanese translation of *Biological Foundations of Language*.

Biological Foundations of Language then was Eric Lenneberg's attempt to get at least a step closer to such a theory, as is evident from the concluding chapter, in which he provides his attempt at such a biological theory of language. This explains why, in many respects, Lenneberg's book was kind of a latecomer to the party: Skinner's take on language had famously been debunked by Chomsky (1959) and many a behavioural psychologist had been "converted" and was already advocating for a more nativist take on the study of language solely on the basis of arguments and analyses stemming from theoretical linguistics.

Therefore, Lenneberg's *Biological Foundations of Language* was, at least in part, also supposed

[...] to provide a palpable biological plausibility for conclusions to which a number of uncomfortable Empiricists [...] [had] committed themselves on the basis of formal argument alone.

(Bem & Bem 1968: 498–499)

Interestingly, as Bem & Bem also say in their review, Lenneberg's line of argument and the evidence on which he relies, more often than not, is indirect or negative. Thus, it is not so clear as to whether Lenneberg succeeded in identifying the biological basis of linguistic competence in his book because this, of course, is still an ongoing endeavour. The connection between theoretical linguistics and biology remains indirect, even in neurolinguistics as the currently most promising point of contact with recent interesting results (e.g., Ding et al. 2016, Nelson et al. 2017; for a brief review see Zaccarella & Friederici, 2016).

In the famous debate on "bio-linguistics" in 1974, organised by Massimo Piattelli-Palmarini, in which Lenneberg unfortunately did not participate, the psychologist Hans-Lukas Teuber already pointed out that there are two different ways of looking for a possible physiology of language: A crude and a fine one. Back then Teuber was optimistic about both, whereas it now seems appropriate to say that only the crude one has seen significant progress in the past decades (reviewed in detail in Friederici 2017; with a focus on syntax in this issue), especially due to advent of neuroimaging. Yet, some very interesting results have also come from the "fine" approach (e.g., Zilles et al. 2015), while (many) long-standing problems remain (see the contributions to this issue by Sussman and Piattelli-Palmarini; also, more generally, see Gallistel & King 2009). In this context, it is interesting to see that Lenneberg's thinking was so modern in many respects as to indirectly anticipate this development: In what basically amounts to a side note in the book's chapter on "Neurological aspects of speech and language," Lenneberg reaches a conclusion similar to the one reached by Gallistel & King (2009) on computational grounds:

[...] we may conceive of molecular changes taking place within cells that are located over wide areas in the brain and causing changes in the interaction between cells. [...] We are now merely postulating that the restructuring may take place within cells instead of between them.

(Lenneberg 1967: 215)

This point of view has now received some tentative empirical support (e.g., Jirenhed et al. 2017; see Trettenbrein 2016 for a review), with far-reaching implications.

Keeping with Lenneberg's developmentalist spirit, a vast number of contributions discuss various aspects of language development in health and disease. Insofar as necessary the contributions expand upon or (slightly) modify and revise Lenneberg's original theoretical considerations on the basis of the contemporary abundance of developmental data that just was not available when Lenneberg was writing. Famously, Lenneberg already recognised that

[e]ven if the maturational scale as a whole is distorted through retarding disease, the order of developmental milestones, including onset of speech, remains invariable. Onset and accomplishment of language learning do not seem to be affected by cultural or linguistic variations.

(Lenneberg 1964b: 66–67)

Accordingly, Koji Hoshi evaluates Lenneberg's legacy to the field of (child) aphasiology, with a special focus on Landau-Kleffner syndrome, a child aphasia of epileptic origin. Karin Stromsworld and Aliza Lichtenstein contrast the relationship between phoneme production and perception in speech-impaired and typically-developing children, and their conclusion offers support for Lenneberg's observation that children's ability to perceive speech does not depend on their ability to produce speech.

Keeping with Lenneberg's focus on case studies that have the potential to shed light on the biological basis of the human language capacity, Maria Kambanaros and Kleanthes K. Grohmann present a case study of a child with 22q11 deletion syndrome and argue for a language profile associated with the syndrome that is distinct from specific language impairment, thereby relying on pathologies in order to advance a comparative biolinguistic approach to uncovering the genetic basis of language (i.e. Universal Grammar). Keeping with the genetic theme, Ken Wexler reviews his and others' work on language development and the genetic basis of human grammatical abilities, culminating in an outline of what he refers to as "a program for the genetics of grammar".

Very much in Lenneberg's spirit of attempting to construct a biological theory of language, a number of contributions seek to make theoretical advances in many respects: Evelina Leivada takes Lenneberg's conjecture that categories such as noun phrase, noun, and verb are not absolute constructs but flexible and contextually defined (Lenneberg 1967, 1975) as a point of departure for her interdisciplinary approach towards labels, Label, and the study of categories more generally. Also on a theoretical note, Veno Volenec and Charles Reiss draw upon some of Lenneberg's ideas to outline their theory of how phonology and phonetics interface which they have termed 'Cognitive Phonetics'. From the perspective of theoretical syntax, Misha Becker reviews the question of how human children figure out that a string of words was generated by displacement operations due to the transformational nature of natural language syntax. Maria Garraffa reconsiders Lenneberg's notion of language as a maturational controlled behaviour, using the emergence of non-local syntactic dependencies and their impairment as an example.

Coming from the perspective of the cognitive neuroscience of language, Barbara Lust and colleagues revisit the regression hypothesis of language development, attempting to link language acquisition to language deterioration against the background of a lot of independent work in neuroimaging and the cognitive neu-

rosience of language more generally by linking behavioural findings to data from structural Magnetic Resonance Imaging (MRI). Amongst ample other things, Eric Lenneberg already recognised that a “general ‘grammatizing’ ability” is a constitutional propensity that is “conspicuously absent in the parrot, and only develops in crude rudiments in several retarded children” (Lenneberg 1960: 882). Against this background, Angela Friederici presents an succinct overview of recent neuroimaging studies on the neural syntactic network and discusses these against the background of non-human primates’ syntactic capabilities.

Any volume honouring Eric Lenneberg and his pioneering work would seem incomplete if it did not mention his idea of a critical period for first language acquisition in one way or another. Harvey Sussman approaches this question from the micro-perspective of neural morphology (Teuber’s above-mentioned “fine” look), discussing whether an anatomical feature of a neuron’s dendritic arborisation could be a potential neural correlate for this time-sensitive development. Taking a more macro or “cruder” look (in Teuber’s sense), Elissa Newport and colleagues revisit Lenneberg’s ideas about early developmental plasticity by discussing data from children after left-hemisphere perinatal stroke. Their data and review of the literature suggest “that there are very limited and patterned ways in which language develops in the human brain.” Then, taking a lifespan-perspective, Ellen Bialystok and Judith Kroll revisit the concept of a critical period for first language acquisition against the background of studies with bi- and multilingual subjects, showing that “there is variation in how constrained or plastic different aspects of language acquisition may be.”

As already mentioned above, Lenneberg was interested in many different biological subfields and tried to keep track of all of them. Needless to say, this is a next to impossible undertaking (even 50 years ago), which is why he ended up sending off graduate students to work on problems and in subfields that he found interesting. One example is the study of motor control that repeatedly resurfaces in workshops he organised and his edited volumes. The graduate student sent off by Lenneberg to focus on the study of motor control was Avis Cohen, who generously contributed a short personal piece in which she revisits her career and interaction with her advisor. The connection of motor control to writing and language is also discussed in the contribution of Maria Teresa Guasti, Elena Pagliarini, and Natale Stucchi who draw upon Lenneberg’s biological notion of language and related ideas like rhythmicity and temporal structural regularities to argue that individuals with developmental dyslexia are less efficient than control individuals in using structural regularities during handwriting and some language activities.

Given that Lenneberg was amongst the first who saw language as a biological object, he was of course also profoundly interested in how the human language faculty had evolved. Callum Hackett reviews justifications for a discontinuity theory of language evolution—now a somewhat prominent position in biolinguistics (Berwick & Chomsky 2016) that was first formulated by Lenneberg. Interestingly, as mentioned above, Lenneberg sought it necessary to clarify the sense in which he considered the evolution of language to be discontinuous in the foreword to the Japanese translation of *Biological Foundations of Language*. Similarly, also building upon Lenneberg’s ideas about the evolution of the language faculty, Sergio Balari

and Guillermo Lorenzo propose a homological program for the study of language phylogeny that rest upon a non-functional homology concept.

In the Forum section, Tecumseh Fitch invites us to ask the question “What would Lenneberg think?” and, luckily, also attempts to provide an answer to said question by discussing the advances in comparative study of cognition, neuroimaging, and genetics in the past 50 years since *Biological Foundations of Language* was first published, and especially in recent years. In a very similar spirit, Massimo Piattelli-Palmarini also revisits *Biological Foundations of Language* from a contemporary point of view, thereby reevaluating Lenneberg’s thought and original insights, while updating and/or building on Lenneberg’s original ideas.

Lastly, it should be recalled that Lenneberg was an avid organiser of (international) workshops all over the world. Unfortunately, the reports of these workshops have frequently been forgotten by now because they are hardly (or not at all) accessible online. Luckily, Michael Arbib has managed to rescue from oblivion one of these reports, more precisely, a report entitled “Language and Brain: Developmental Aspects” from a Neurosciences Research Program work session organised by Lenneberg in 1972. Arbib’s reappraisal of the report as well as scans of the original report are now available online as part of this special issue. Finally, in conversation with myself, Noam Chomsky as one of Eric Lenneberg’s contemporaries back in Harvard and one of the co-founders of the field has answered a number of questions about the early days, the importance of Lenneberg’s work, and the current state of the field.

I end by thanking everyone who has made this special issue of *Biolinguistics* possible, be it by submitting papers, reviewing manuscripts, or assisting with various steps of the editorial process and hope that you will enjoy reading it as much as we have enjoyed putting it together. It seems to me that Tecumseh Fitch in his contribution to this issue is on the right track when he concludes that, were he alive today, Eric Lenneberg would be pleased to see the progress the field has made since *Biological Foundations of Language* was published. The biolinguistic approach to the study of language has aged well and Lenneberg would certainly be eager to find out what the future may hold.

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