

Notes

Introduction

1. One has to be aware that the genetic basis will not be represented by a single gene as there are complex routes by which genomes contribute to brain development and behavior (Fisher and Vernes, 2015).
2. This theory does not go unchallenged. Jackendoff and Pinker (2005) provide an alternative conception in which combinatoriality is not restricted to narrow syntax, but expands to larger constructions.
3. Note that this is a hypothesis which momentarily awaits systematic empirical evaluation.
4. A thorough description of the history of psycholinguistics can be found in Levelt (2013).
5. The model in its initial version was published by Friederici (2002) and further developed in a further version published by Friederici (2011). These versions were based on reviewing the data available at that time. Here it serves as the backbone and reference for the data discussed in the book.

Chapter 1

1. Note, however, that there are other psycholinguistic models. Basically, two main classes of models have been proposed to account for the behavioral data on language comprehension: (1) serial, syntax-first and (2) interactive, constraint-satisfaction models. For alternative models see Mitchell (1994) and Marslen-Wilson and Tyler (1980).
2. Section 1.1 is partly based on a paper by Friederici (2011). This model will serve as the backbone for the empirical data discussed in sections 1.1 through 1.9.
3. Cytoarchitectonic studies have indicated that the primary auditory cortex usually covers the medial two-thirds of the anterior Heschl's gyrus (Morosan et al., 2001), and the identification of a subregion in the lateral convexity of the superior temporal gyrus has been confirmed by a receptorarchitectonic analysis (Morosan, Rademacher, Palomero-Gallagher, and Zilles, 2005).
4. Note other neuroimaging studies, however, that reported how the planum temporale or the supramarginal gyrus responded to speech compared with non-speech sounds (Dehaene-Lambertz et al., 2005; Jacquemot, Pallier, LeBihan, Dehaene, and Dupoux, 2003; Meyer et al., 2005). These studies, however, used attention-demanding tasks, which stand in contrast to passive listening paradigms used by others (Obleser, Zimmermann, et al., 2007). From these data, it appears that under specific task demands and under the influence of top-down processes, the differentiation between speech and non-speech sounds may occur at an earlier processing level, in this case to the planum temporale.
5. The following paragraphs are partly cited from Friederici and Singer (2015).
6. Examples of phrasal types. DP or NP: *the car, car*; VP: *drive, drive the car*; PP: *in the car*; AP: *big car*; AdvP: *drive slowly*.
7. There has been a discussion of the functional significance of the ELAN effect reported in response to word category violations in a critical review (Steinhauer and Drury, 2012). They suggest that context-driven top-down processing may play a larger role than assumed in syntax-first models, such as the one by Friederici (2002).

8. It should be noted at this point that the specific role of Broca's area in language processing is still under debate (Grodzinsky and Santi, 2008; Hagoort, 2005, 2008; Rogalsky and Hickok, 2011). This discussion takes place on multiple levels. At the most general level, the claim is made that Broca's region supports action observation and execution and that its part in language is related to motor-based speech production and comprehension processes (Rizzolatti and Arbib, 1998; Pulvermüller and Fadiga, 2010). At the next level, the claim is that Broca's region supports verbal working memory (Smith and Jonides, 1999) and that this is why this region shows activation when processing syntactically complex sentences (Caplan and Waters, 1999; Rogalsky, Matchin, and Hickok, 2008). At a linguistic level, subregions of Broca's area have been allocated to different aspects of language processing, either seeing BA 44 as supporting syntactic structure building, BA 44/45 as supporting thematic role assignment and BA 45/47 supporting semantic processes (Friederici, 2002); or specifying Broca's area (BA 44/45) as the region supporting the computation of syntactic movement (Grodzinsky, 2000); or defining Broca's region (BA 44/45/47) as the space for the unification of different aspects in language (Hagoort, 2005). Here I will not reiterate each of these studies, but will discuss recent studies that have contributed possible solutions to the open issues at the linguistic level and the related verbal working-memory processes.

9. The following paragraphs are based on Zaccarella and Friederici (2015b).

10. Note, however, that others suggest the inferior frontal gyrus as the candidate region of integration, since both semantic and syntactic information are processed in Broca's regions (Hagoort, 2005).

11. Here I only discuss the relation of speech and music with respect to prosodic processes, but not with respect to other aspects such as syntax and semantics. For a systematic comparison of language and music and their neural basis, see Patel (2008).

Chapter 2

1. This large and distributed activation pattern is possibly due to the fact that the difference between active sentences (*The woman strangles the man*) and a passive sentence (*The man is strangled by the woman*) implies more than just syntax. The different sentence structure (active/passive) also signals a different thematic focus on the first noun phrase as the actor or the undergoer. This may explain the involvement of temporo-parietal areas known to process aspects of the thematic aspects of argument structure.

Chapter 3

1. This section is partly based on Friederici (2015) and Friederici (2016).

2. This section is partly based on Friederici (2015).

3. A study that used intraoperative external stimulation to reveal the respective function of the two ventral fiber tracts suggests that the ECFS is more relevant for language than the uncinate fasciculus because verbal fluency (naming as many words as possible in a particular category) and performance on matching an article to the noun were found to be interrupted when externally stimulating the ECFS, but not when stimulating the uncinate fasciculus (Duffau, Gatignol, Moritz-Gasser, and Mandonnet, 2009). These tasks may have challenged the lexical-semantic system more than the combinatorial system and, thus, do not rule out the possibility that the uncinate fasciculus is involved in combinatorial processes.

4. This section is partly based on pp. 352–354 in Friederici (2016). The neuroanatomical pathway model of language: Syntactic and semantic networks. In *Neurobiology of Language*, ed. Steven L. Small and Gregory Hickok, 349–356. Elsevier Press.

Chapter 4

1. This section is largely based on Friederici (2012, pp. 262–266).

Part III Introduction

1. In the present context the term *native-like* means that the brain structures involved are similar to those observed under typical language learning conditions.

Chapter 5

1. This section is partly based on Friederici and Wartenburger (2010).
2. The term *native signer* refers to a person who has learned sign language as the first language early in life.

Chapter 6

1. This section is based on Friederici and Skeide (2015) and on Friederici and Männel (2014).
2. Note, however, that Dehaene-Lambertz and colleagues (2000, 2002) interpret their data to show that the system for processing speech is already in place shortly after birth.
3. This section is partly based on Friederici and Männel (2015).
4. Dubois et al. (2016), however, report a structural similarity of the white matter including the arcuate fasciculus between infants postnatally and young adults. The authors admit that there is variability in the white matter bundles with respect to their frontal terminating points, partly due to crossing fiber bundles. The infant data they present reveal arcuate fasciculus terminating in the precentral gyrus, similar to infant data presented by Perani et al. (2011).
5. Activation in the inferior frontal gyrus is also reported during speech perception (Dehaene-Lambertz et al., 2006; Perani et al., 2011), but its functional role remains elusive.

Chapter 8

1. Note that in this book I did not discuss reading and writing, which comprise a secondary system to the auditory language system. Reading and writing only developed late during evolution, with pictographic systems and ideographic systems emerging about 6000 BC, and with today's alphabetic systems in which one grapheme represents an elementary sound and which only developed around 3,000 years ago. This phylogenetically late emergence of reading and writing makes the evolution of a specific brain system unlikely—as such a development would require probably more than a couple of thousand years. It has, therefore, been argued that the brain might have “neuronally recycled” a brain region or circuit that originally evolved for another process (Dehaene and Cohen, 2007). In the case of reading, this would be an area that originally was involved in object recognition and became tuned late to recognize letters and words, such as the visual word form area in the left inferior temporal cortex (Dehaene, Cohen, Sigman, and Vinckier, 2005).

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By: Angela D. Friederici

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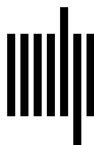
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