

Introduction

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Language evolved as the species-specific communication system of *homo sapiens*. Although its evolutionary history will always remain intractable, it is reasonable to suppose that a major selective pressure derived from the need to maintain coherence in ever-growing cooperative clans. Our closest relatives in nature, the old world primates, achieve this bonding largely by grooming and, as Dunbar (1996) has shown, the amount of time spent on grooming indeed increases rapidly with group size across primate species. Bonding-by-grooming, however, becomes impractical for the much larger clan size that is typical of a human hunter-gatherer society. Clearly, language can serve this function of social bonding and much more. It is particularly well designed for communication in a society of individuals that have a “theory of mind” (Premack and Woodruff, 1978). When interactants mutually interpret their behaviors as proceeding from beliefs, wishes, hopes, and the like, as is the case in human societies only (Tomasello and Call, 1997), it is certainly useful to have a communicative system that can express such recursive attributions as “A believes that B knows X.” But it is a vain hope to *predict* the design of natural languages from the evolutionary pressures that must have shaped it. More is known about which areas of the primate brain were engaged to serve these new communicative functions. This is, first of all, the old call system, which is one of phonation. It involves the caudal midbrain structures and is expressive of the animal’s emotions (Müller-Preuss and Ploog, 1983). Neocortical control is restricted to input from the (limbic) anterior cingulate gyrus. This evolutionary old system is still involved in the modulation of vocal fold activity during speech, in particular intonation, which remains highly expressive of emotion. However, in our species phonation is clearly under

neocortical control: We can sing and we can feign emotion in speech. The same is true for the new supralaryngeal system. It modulates phonation in the time-frequency domain, i.e., it controls articulation. MacNeilage (1998) outlines the evolutionary precursors of this syllabic, articulatory system. Its evolution corresponds to further specialization of the face area in the primary motor cortex and to a vast expansion of supplementary and premotor cortices. At the same time, left temporal lobe areas adjacent to the primary auditory cortex became more specialized for the storage of phonological codes. Various left-hemisphere perisylvian areas (temporal, parietal, insular, frontal) became involved with the complexities of linguistic processing, ranging from semantic to syntactic, morphological, phonological, and phonetic analysis and synthesis. But evolution did not prepare us for reading. It is, in fact, an unexplained accident that most of us can learn to read. The skill is obviously parasitical on the reader's pre-existing linguistic and visual competence, but the specifics of grapheme-to-phoneme mapping (in alphabetic systems) requires the engagement of cortical structures that did not evolve for that purpose and that may vary from learner to learner. Given this biologically secondary status of reading, it is at least remarkable that the large majority of language-related brain-imaging studies involve printed, not spoken language as input.

The aim of this Language section is to review major relations between the functional and the neural architecture of language. The functional architecture of language use, i.e., its organization as a behavioral system, is the domain of psycholinguistics. Traditionally, the field is partitioned as the study of language production (speaking, signing), language comprehension, the development of these skills (language acquisition), and the study of their disorders. This schema is also followed in the present section. In their chapter on language production, Indefrey and Levelt relate the functional architecture of the process of speaking, in particular the generation of spoken words, to a wide range of recent imaging results. Language comprehension, always the more active field of research, is covered by two chapters. The first one, by Norris and Wise, deals with accessing words from auditory or visual input and relates the functional organization of word recognition to the neural architecture involved. The second one, by Brown, Hagoort, and Kutas, reviews the neurophysiology and hemodynamics of postlexical processing, i.e., the integration of words in their larger syntactic and se-

mantic context during sentence processing. Two further chapters are dedicated to the acquisition of linguistic skills. Mehler and Christophe discuss the initial stage, the infant's discovery of the sound structure of the single or multiple languages with which it is confronted. Stromswold reviews the further maturation of linguistic skills, both normal and disordered, from the perspective of the human brain's predisposition for language. Both chapters consider in some detail the neural architecture that supports this rapid buildup of linguistic competence. The final pair of chapters is dedicated to language disorders. Saffran, Dell, and Schwartz review recent computational accounts of the major aphasic disorders: Can aphasic syndromes be modeled by "damaging" the normal computational architecture? In their chapter, Dronkers, Redfern, and Knight discuss language disorders from the perspective of the damaged cortical structures involved. Their "triangulation" approach requires a detailed analysis of functional components combined with a substantial database of brain and behavioral patient data.

Together, these seven chapters provide optimal coverage of the cognitive neuroscience of language. But the coverage is, by no means, intended to be comprehensive. Not only is the literature, including such a classical source as Caplan's (1992) book, already vast, but the recent volcanic eruption of imaging studies of language use is transforming the field in ways that will become fully apparent only after the first dust has settled. Meanwhile, the best coverage of the field can be found in Stemmer and Whitacker (1998) and Brown and Hagoort (1999).

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