Book review

Neurolinguistics. An Introduction to Spoken Language Processing and its Disorders, John Ingram. Cambridge University Press, Cambridge (Cambridge Textbooks in Linguistics) (2007). xxi + 420 pp., ISBN 978-0-521-79640-8 (pb)

The present textbook is one of the few recent textbooks in the area of neurolinguistics and will be welcomed by teachers of neurolinguistic courses as well as researchers interested in the topic. Neurolinguistics is a huge area, and the boundaries between psycho- and neurolinguistics are not sharp. Often the term neurolinguistics is used to refer to research involving neuropsychological patients suffering from some sort of language disorder or impairment. Also, the term neuro- rather than psycholinguistics is used when referring to research that makes use of some sort of brain imaging technique, ranging from event-related brain potentials (ERP) to functional magnetic resonance imaging (fMRI). This book mainly reviews the state-of-the-art in research on language disorders, in particular aphasia, sometimes involving neuroimaging methodologies, but neuroimaging of language processing in healthy subjects is not the main focus.

The present textbook does not cover the whole area of neurolinguistics. As the subtitle suggests, the book focuses on *spoken* rather than *written* language processing disorders. That is, this textbook does not deal with the large field of visual word recognition, reading and its related neurolinguistic disorders such as all the different types of dyslexia. However, for reading disorders very good overview books are already available (e.g. Coltheart et al., 1980; Patterson et al., 1985). A further restriction not necessarily implied by the title is that the book mainly covers work in the area of language comprehension, not production. However, this is explicitly admitted by the author at the beginning of his book: ''Our concern is primarily with language comprehension and its disorders'' (p. 4). Speech and language production is covered relatively little in this book. Even language disorders, such as Broca's aphasia, which are widely associated with impairments in language production, are mostly discussed from the language comprehension perspective, i.e. what exactly are the comprehension deficits of aphasic patients with left inferior frontal damage labeled as Broca's aphasics? It is important to clearly delimit the boundaries of this textbook: It is about the neurolinguistics of spoken language comprehension. As such, this book may be conceived of as an excellent update of David Caplan's (1987) seminal introduction *Neurolinguistics and linguistic aphasiology* in the area of spoken language comprehension impairments.

The book is organized in five main parts called ''Foundational concepts and issues'', ''Speech perception and auditory processing'', ''Lexical semantics'', ''Sentence comprehension'', and ''Discourse: language comprehension in context''. I will briefly discuss each part below before I conclude my review with a general evaluation. Besides, this book contains a handy glossary of terms printed bold in the text, an extensive reference list as well as a subject and author index. The first part is set up as a broad introduction into cognitive neurolinguistics, i.e. the basic concepts of linguistic description of language, brain anatomy, and cognitive (neuro)psychology. Ingram starts by stating what his book is about and by drawing a line between psycho- and neurolinguistics: psycholinguistics, he writes (p. 12), ''bears on the relationship between language and mind (or language and cognition)'' while neurolinguistics, the topic of his textbook, ''bears upon the relationship between the brain and language functions'' (compare the differentiation between psycho- and neurolinguistics I gave in the first paragraph above). Of course, and John Ingram is aware of this, this may be an oversimplification for one may argue that cognition originates in the brain as well. However, this distinction may nevertheless be useful because it distinguishes psychological from neurological aspects. In that sense, whenever the neurological substrate and its relation to language processing comes into play, as with

neuropsychological patients with structural brain damage or imaging methods measuring the function (or activity) of brain tissue, we deal with neurolinguistics.

As Ingram also states in the very first chapter of his book, "classical studies of aphasia were conducted by neurologists and neuropsychologists who had no specialized linguistic training" (p. 4). One of the many strengths of the present textbook is that it relates neuropsychological impairments of language processing to linguistic theory. As a linguist, John Ingram is very knowledgeable regarding linguistic theories, especially generative grammar. I consider it as extremely helpful that chapter 2 of this textbook provides readers without any linguistic background with a basic description of the most important concepts in phonology (including prosody), morphology, syntax and semantics. Readers with a background in linguistics may skip this chapter, although it is well-written. Chapter 3, introducing the neuroanatomy of language, should not be skipped because in this chapter Ingram describes what is called the Broca–Wernicke–Lichtheim (BWL) model, a classical framework of cognitive neurolinguistics developed in the second half of the 19th century, but still valuable as a model. As we will see, Ingram refers to this model throughout his book to demonstrate that this model can still account for many neurolinguistic findings. From a brief historical perspective, the author also describes how the functional language areas were discovered, starting with Paul Broca's seminal work 150 years ago describing the French patient Leborgne (which is, unfortunately, consequently misspelled in Ingram's book as "Lebourge", p. 49) and finishing the chapter with a brief overview of modern brain imaging techniques, including ERPs, magnetoencephalography (MEG), as well as positron emission tomography (PET) and fMRI. With the linguistic and neuroscientific tool box at hand, Ingram continues his introductory part by a chapter on current views in cognitive science, including the concepts of modularity (Fodor, 1983) and its relation to neuropsychology (Coltheart, 2002) as well as connectionism (McClelland and Elman, 1986; McClelland and Rumelhart, 1981).

The second part of the present textbook covers speech perception and auditory processing, focusing on phonetic-phonological aspects of spoken word recognition, as well as models and disorders thereof. Chapter 5 introduces the basic problems of spoken word recognition, namely the segmentation problem (how does the listener determine word boundaries given the continuous nature of the speech signal and that word boundaries are not explicitly marked in the acoustic signal?) and the variability problem (how does the listener deal with the fact that a given word is never pronounced in exactly the same way?). A solution to these problems was considered to be essential to understand the way lexical retrieval works. Lexical retrieval is conceived of as the process of selecting word forms from the mental lexicon that match the acoustic input. This process is considered to be the first step in successful comprehension of the speech signal.

Ingram also reviews classic experimental findings regarding speech perception such as categorical perception of speech sounds, i.e. the fact that listeners perceive phonemes, especially consonants, in a categorical rather than in a continuous manner (Liberman et al., 1967), and cross-linguistic evidence for sublexical processing units such as phonemes, syllables, and morae in speech perception (referring especially to the work of Cutler and her colleagues; Cutler et al., 1986). The findings he discusses lead Ingram to a characterization of the speech recognition lexicon in chapter 7. The author exemplifies the process of lexical access and lexical retrieval by two models of spoken language processing namely Cohort (Marslen-Wilson, 1987; Marslen-Wilson and Welsh, 1978) and the computer-implemented TRACE model (McClelland and Elman, 1986). Unfortunately, Ingram does not discuss more recent competing models of spoken language processing such as Norris' models Shortlist (Norris, 1994) and MERGE (Norris et al., 2000). These latter models emphasize that there is no need for higher-order feedback (as in interactive models such as TRACE) to achieve successful speech recognition.

Chapter 8 is the first chapter in this textbook completely devoted to patient data. In this chapter, Ingram describes a number of aphasic deficits that genuinely belong to the area of auditory processing impairments, such as *pure word deafness*. Pure word deafness is a disorder in which the perception of speech sounds and spoken word recognition is impaired while the perception of other auditory signals as well as central language processing functions are largely intact, as evidenced by unimpaired reading and writing behavior. The precise neuropsychological cause of the deficit, i.e. the nature of pure word deafness, remains somewhat vague. This is a general property of this textbook: Ingram tends to stay away from drawing strong conclusions favoring one or the other hypothesis or theory discussed in his book. He rather keeps everything open and leaves it up to the readers to draw their own conclusions.

Part 3 of this textbook is concerned with lexical semantic representations. The internal structure of this part is similar to the previous: First, Ingram introduces the reader to linguistic aspects of the topic and provides behavioral, experimental evidence. Then, models of semantic representations are introduced, and in the final chapter of the third part of his book, disorders of lexical semantic representations are discussed. The main topic of chapter 9 is lexical

morphology and to what extent words are stored in a decomposed way in the mental lexicon. To illustrate this, is there evidence that the word *cats*, for instance, is represented as *cat + s* in the listener's mind? Important experimental evidence comes from so-called *cross-modal priming* studies in which a prime stimulus (e.g. a word) is presented auditorily and subjects are required to react to a visually presented target stimulus (e.g. a letter string) by making, for instance, a lexical decision response. Ingram refers extensively to the work by Marslen-Wilson and colleagues (Marslen-Wilson et al., 1994) showing that there is a large amount of evidence that listeners decompose words into morphemes and that morphemes have functional significance in word processing. This has recently been supported by evidence from neuroimaging data. Only very recently, though, it has been shown that speakers also show morphological priming effects in language production tasks (e.g. Zwitserlood et al., 2000), and even more recently neurocognitive evidence of morphological decomposition during language production has been acquired (e.g. Koester and Schiller, 2008, in preparation).

In the next chapter, chapter 10, Ingram discusses ways of representing meaning in the mind. Words are stored in the mental lexicon, presumably a virtual dictionary forming part of human long-term memory where word meaning is stored, together with its corresponding phonological and morpho-syntactic features. Computational models of lexical semantics were constructed in terms of semantic networks (e.g. Quillian, 1968), i.e. connectionist networks of nodes representing concepts or words connected by arcs. Semantic networks are used to account for priming effects such as semantic-categorical priming effects (e.g. prime: *pig*, target: *horse*) and have proven useful to explain category-specific semantic deficits in aphasia, e.g. patients who cannot name certain categories of objects (e.g. fruits and vegetables) while being significantly less impaired with all other object categories. A number of case studies have been reported including patients presenting with double dissociations of category-specific deficits. Furthermore, some neuroimaging studies have reported different brain activations for functional-grammatical categories such as nouns vs. verbs. Disorders of lexical semantics are reflected, for instance, by severe word-finding difficulties in certain forms of aphasia. As Ingram shows, evidence for automatic semantic priming is mixed in patients with Broca's or Wernicke's aphasia. Some researchers assume that the locus of comprehension deficits in Broca's aphasics is at the level of lexical integration, rather than lexical semantic representations per se.

The focus of part 4 is sentence comprehension and tries to answer in particular the question what the consequences for sentence comprehension are if one loses one's syntax, as in agrammatism. The first two chapters of this part, chapters 12 and 13, start with an overview of syntactic parsing in the framework of generative grammar followed by psycho- and neurolinguistic insights about syntactic processing in the mind, for instance, *minimal attachment* (Frazier and Fodor, 1978) and the *trace reactivation effect*. The role of working memory and its role in sentence processing are also discussed extensively as working memory seems to be extremely important in parsing when some parts of a sentence have to be buffered in memory while analyzing others. In chapter 13, Ingram introduces ERPs as the method of choice to investigate on-line sentence processing in the brain. The reader is introduced to well-known ERP markers of syntactic processing such as the N400 and P600 components as well as the Early Left Anterior Negativity (ELAN). In chapter 14, called ''Agrammatism revisited'' the author critically evaluates theories about receptive agrammatism, a comprehension impairment reflected by the inability to correctly assign thematic roles. Receptive agrammatism often co-occurs with expressive agrammatism as known from Broca's aphasia. It has been known for a long time (Zurif et al., 1972) that agrammatic patients with Broca's aphasia not only have language production difficulties but present also with impairments in language comprehension, and specifically when thematic role assignment becomes essential such as in active-passive constructions.

Recently, three competing theoretical approaches to agrammatism have been proposed in the literature. Although Ingram does not decide between those theories, he is able to conclude that receptive agrammatism is not a categorical, but rather a graded deficit. Concerning the brain region responsible for the deficit, little more than the left perisylvian field can be pointed at – however, this may already be considered overly specified by some researchers.

The final part of this book covers language comprehension in context, in other words: discourse. Chapter 15 introduces this topic and familiarizes the reader with some of the basic concepts such as the *Gricean maxims*, reference and implicature. Discourse processing is exemplified using the case of anaphora resolution. The next chapter mentions a number of examples of discourse breakdown, especially thought disorders. Chapter 17 concludes this textbook with a prospectus from the perspective of embodied cognition, which – according to Ingram – may ''point towards a better synthesis of a biologically grounded account of perceptual and cognitive processes, with the structure and function of the human language faculty'' (p. 379). For my taste, part 5 of the present textbook about discourse processing seems to be a bit disconnected from the preceding parts and chapters of the book, maybe because it focuses on thought disorders

rather than aphasia. Furthermore, I believe the prospectus from the perspective of embodied cognition is a rather personal one and controversial, and – this is now my own personal perspective – the book would not have lost much of its value without it.

My final evaluation of this textbook is that once the reader has realized that this book does not cover the whole area of neurolinguistics (as the main title may suggest) but rather spoken language comprehension and its disorders, it is extremely valuable due to its fine review of the available literature and its mostly unbiased way of presenting the available data. Therefore, it is of high value for interested scholars, including linguists, psychologists and cognitive scientists at all levels and may also be used as a textbook for a – advanced – course on neurolinguistics. Last, but not least, this book is very well-written and fun to read.

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