Stemmer, B., & Whitaker, H.A. (Eds.). (2008). *Handbook of the Neuroscience of Language.* **USA: Academic Press Elsevier, 512p.**

by Cyntia Bailer
Universidade Federal de Santa Catarina

Students, clinicians, and scholars in Applied Linguistics, Neuroscience, Medicine, Psychiatry, Psychology, Speech Therapy, in short, everybody with an interest in the neuroscience of language have at their disposal the *Handbook of the Neuroscience of Language*. This standard reference book edited by Brigitte Stemmer - Canada Research Chair in Neuroscience and Neuropragmatics, Université de Montréal, Canada -, and Harry A. Whitaker - Department of Psychology, Northern Michigan University Marquette, USA - covers a broad range of topics, and is as comprehensive as possible within a single volume. It is the continuity of the *Handbook of Neurolinguistics* (1998), a state-of-the-art reference and resource book of the field of Neurolinguistics and its development at the time. The *Handbook of the Neuroscience of Language* comes a decade after since during that 10-year-period, the field

has matured, new theories advanced and old ones were supported, retracted or refuted. As the title indicates, the volume is useful to the newcomer to the field, as well as the expert searching for the latest developments in such a highly interdisciplinary field.

The *Handbook of the Neuroscience of Language* clearly demonstrates that the developments in linguistic and psychological theories are equally important. Neuroscience of Language has evolved as a field from descriptions of language and communication disorders and their correlations with lesion sites. Pioneers such as Broca, Wernicke, and Déjerine discovered the cortical localization of language and other cognitive functions and proposed theoretical models that sought to explain the meaning of their discoveries. Since then, well-known researchers have developed the investigation of the neuroscience of language and cognition by extending and deepening the investigation of the anatomical correlates of disorders and by offering a personal account of the body of clinical and experimental data.

Contemporary protagonists of the neuroscience of language introduced and developed new models, methods and lines of research, as well as tackling

some basic educational problems. Gainotti, in the prologue, states that we are facing a methodological challenge. Before, a creative individual considered a critical problem of the existing literature and proposed a personal solution. At present, this problem is collectively tackled by an interdisciplinary team that seeks to preserve the autonomy and the originality of the approach of the different components of the team. As the reader acquainted with the field can note, we are still fascinated by localizing brain areas responsible for specific functions. Nevertheless, Stemmer and Whitaker pose that the challenge now is to study "the neural systems associated with language and communication within the framework of interacting brain systems that mediate affective, cognitive and monitoring systems" (2008, p.xix).

The *Handbook* honors three scholars who greatly influenced and advanced the neuroscience of language, Harold Goodglass, André Roch Lecours and Klaus Poeck. These researchers devoted their work to the training of graduate students, postgraduate research and clinical fellows; to the foundation of neuropsychological or aphasiological journals and societies; to the preparation of textbooks of Neuropsychology or Neurolinguistics; and to the construction and validation of important aphasia batteries.

Stemmer and Whitaker could count on contributions of researchers and professors from several laboratories, such as the USA, the UK, Germany, Canada, Italy, Finland, and Australia. These authors had to adhere to strict space limitations, limit their bibliography to a maximum of 30-40 references, refer the reader to review work whenever possible, and focus on the advancements that were achieved in their field during the last 10 years. They were encouraged to present their chapters in such a way that the information could serve the broad audience. As a result, all chapters provide an abstract; an introduction to the topic; the development with illustrations, tables, and boxes that particularly aim at offering the reader additional information on specific topics; a section named challenges and future directions; references; and finally, in further readings, the author(s) present extra references with a brief summary of each, so that readers can deepen their knowledge about that specific subject, if they are interested in it.

The *Handbook of the Neuroscience of Language* is divided into five

parts, forty-three chapters and a glossary of items and concepts that serve as a reference guide to help the novice become acquainted with the field, and even to the expert, who needs to understand terms from neighboring fields. Moreover, at the end, the editors present an index of the topics covered in the book. This review aims at offering the reader an appraisal of the book through the lenses of a graduate student from the area of Applied Linguistics, interested more specifically in reading.

Part I: Methods and Techniques' introduces the reader to classical, clinical assessment approaches to aphasia and acquired disorders of language (Ch.1 by Turgeon & Macoir; Ch.2 by Nickels; Ch.3 by Tröster & Mohn); methods of mapping the human brain, as the cytoarchitectonic mapping (Ch.4 by Amunts); and a theoretical framework for interpreting the multiple levels of neural organization that contribute to language comprehension, the microgenetic theory (Ch.5 by Tucker, Frishkoff & Luu). Chapter 6 provides a brief introduction to the second part of the book: neuroimaging of language (Ch.6 by Rodden & Stemmer) by bringing common neuroimaging techniques as EEG (electroencephalogram), ERPs (event-related potentials), MEG (magnetoencephalography), fMRI (functional magnetic resonance), PET (positron emission tomography), DTI (diffusion tensor imaging), rTMS (repetitive transcranial magnetic stimulation), and NIRS (near-infrared spectroscopy).

In 'Part II: Neuroimaging of Language', the authors discuss the impact that imaging techniques have made to language research, as PET (Ch.7 by Horwitz & Wise), fMRI (Ch.8 by Hasson & Small), ERPs (Ch.9 by Steinhauer & Connolly), direct electrical stimulation of language cortex (Ch.10 by Gordon & Ledoux), and TMS (Ch.11 by Watkins & Devlin). These methods have much contributed to the field and there is a lot more to be discovered. The challenge, according to Hasson and Small (2008, p.81), lies in finding out "how different levels of processing are neurally instantiated and the interface between these levels". Steinhauer and Connolly (2008, p.91) present the three major goals of using neuroimaging: (1) to understand where language is processed in the brain, and (2) when and (3) how the different levels of linguistic processing unfold in time.

'Part III: Experimental Neuroscience of Language and Communication' discusses experimental approaches to the field (neuroscience of

language and communication), including disorders at different language levels, as disorders of Phonetics and Phonology (Ch.12 by Buckingham & Christman), impaired morphological processing (Ch.13 by Jarema), disorders of Lexis (Ch.14 by Libben) and Syntax (Ch.15 by Beretta). The part includes chapters about the neural basis of text and discourse processing (Ch.16 by Perfetti & Frishkoff), Neuropragmatics (Ch.17 by Stemmer), the role of memory systems (Ch.18 by Ullman), the relation of human language to human emotion (Ch.19 by Sidtis), acquired reading and writing disorders (Ch.20 by Luzzatti) and number processing (Ch.21 by Semenza). Additionally, neurolinguistic computational models (Ch.22 by MacWhinney & Li) are addressed, the role of mirror systems for language (Ch.23 by Arbib) is discussed, the lateralization of language across the life span (Ch.24 by Hiscock & Kinsbourne) and the interhemispheric interaction in the lateralized brain (Ch.25 by Hellige) are covered. The chapters present the specific issues from the point of view of language disorders. At first sight, chapters 16, 18 and 20 seem to be of major interest to the audience of this issue, reading enthusiasts.

In Chapter 16: 'The Neural Bases of Text and Discourse Processing', Perfetti and Frishkoff outline the cognitive and linguistic processes that support discourse comprehension as well as explore the functional neuroanatomy of text and discourse processing. It is taken for granted that we must comprehend individual words and sentences while integrating representations across sentences, to form a coherent understanding of the discourse as a whole. Psycholinguistic models postulate that comprehenders struggle to build coherent mental models that, in turn, are built from propositions, idea units of language. The authors cite briefly the textbase model (Kintsch & van Dijk, 1978) and the situation model (van Dijk & Kintsch, 1983) without clear reference to the originals. They call for a neural theory of discourse comprehension which would identify the neurocognitive and neurolinguistic mechanisms that link propositions together. For them, it is crucial to understand "the nature of these representations, how they are formed, and how they are maintained and integrated during online comprehension" (Perfetti & Frishkoff, 2008, p.166). While reading, comprehenders establish links within and across sentences by making use of grammatical cues and by drawing inferences

that require additional processes dependent on the comprehender's standard for coherence, cognitive capacity and language skills. In this process, a dynamic interplay between mental representations of the current sentence, the prior sentences and the comprehender's background knowledge happens so that coherence may be achieved.

Perfetti and Frishkoff suggest that a broad extended language network supports text comprehension, including left dorsal and ventral frontal regions, left temporal cortex, medial frontal cortex, and posterior cingulate. Evidence supports the importance of left frontal and temporal networks in discourse processing, but the role of the right hemisphere networks is less precise. It seems that the right temporal activation reflects support for more difficult processing. Their review points out to the fact that the areas of the brain active during sentence comprehension also support the comprehension of connected text. While reading the chapter, the reader might reflect on the definition of discourse, the definition of text in these studies, and the operationalization of the construct comprehension. Although being relevant, these issues were not tackled in this chapter. As challenges

and future directions, the authors recommend studying the role of the right hemisphere in establishing coherence, the nature of syntactic processes and individual differences through neuroimaging.

In Chapter 18: 'The Role of Memory Systems in Disorders of Language', Ullman refutes the assumption that language may rely on domain-specific neurocognitive substrates by presenting his Declarative/ Procedural model that relies on general-purpose brain memory systems. The model hypothesizes that "the two memory systems play critical roles in the learning, representation, and processing of language, and that these roles are analogous to the roles they play in non-language functions" (2008, p.191). The relations between declarative memory, procedural memory and language have been investigated with various methods in developmental, psycholinguistic, neurological, electrophysiological, and neuroimaging studies. Evidence suggests that declarative memory is responsible for the lexical memory; it is specialized for arbitrary associations; and it is rooted in temporal lobe structures. Procedural memory, in turn, is the mental grammar; it is specialized for rules and sequences; and it is rooted in frontal/basal ganglia structures.

These two memory systems are predicted to interact both cooperatively and competitively. The author focuses the chapter on the application of the model to language disorders. He presents Specific Language Impairment (SLI), autism, Tourette syndrome, Parkinson's disease, Huntington's disease, and non-fluent aphasia as disorders of grammar and procedural memory; and Alzheimer's, semantic dementia, fluent aphasia, and anterograde amnesia as disorders of lexicon and declarative memory. Evidence suggests that disorders of these systems similarly affect language and non-language functions.

In Chapter 20: 'Acquired Reading and Writing Disorders', Luzzatti outlines the mental and neural foundations of written language and describes the main aspects of acquired reading and spelling disorders. The invention of written language is considered the landmark of the shift from prehistory to history. For the author (2008, p.210), it is very unlikely that the acquisition of written language is "genetically determined and that the brain contains built-in mechanisms specifically devised for reading and writing", as for oral language. Dual-route models of reading and spelling can account for the ability normal literate subjects have to process regular words, irregular words and nonwords. Though, it is the reading and spelling performance of brain damaged patients that provide stronger evidence of a dual-route mental organization of written language. For instance, these models of reading hypothesize two routes, a sub-word-level (SWL) routine and a lexical route. The SWL procedure involves the application of *orthographic-to-phonological* conversion rules, which allow individuals to convert letter strings into corresponding strings of phonemes. The lexical route presupposes that the processing of lexical strings of letters depends on the retrieval of stored knowledge from the orthographic input lexicon, the cognitive system and the phonological output lexicon. This last procedure entails quicker processing than the SWL route, since it consumes fewer cognitive resources and activates conceptual knowledge automatically. However, it can only be applied to words whose orthography has already been learned, and as a result, it cannot process nonwords. The author describes different types of acquired reading and writing disorders and concludes that "the performance of dyslexic and dysgraphic patients points toward the universality of dual-route models both in alphabetic and in nonalphabetic

scripts" (2008, p.217). As challenges, research should concentrate on clarifying the cerebral correlates of the two functional routes.

Part IV: Clinical Neuroscience of Language' is divided into three subparts. The first one focuses on language in special populations and in various disease processes, as acute aphasias (Ch.26 by Wallesch & Bartels), in dementia (Ch.27 by Grossman), damage to the frontal lobes (Ch.28 by McDonald), schizophrenia (Ch.29 by Crow), stuttering and dysfluency (Ch.30 by Rosenfield), mesial temporal lobe epilepsy (Ch.31 by Tracy & Boswell), subcortical aphasia (Ch.32 by Nadeau), communication disorders in multilinguals (Ch.33 by Paradis), and in aging (Ch.34 by Obler & Pekkala). The second subpart describes language and communication in developmental disorders, as Landau-Kleffner Syndrome (Ch.35 by Denes), Williams Syndrome (Ch.36 by Elsabbagh), and Autism and Asperger Syndrome (Ch.37 by Surian & Siegal). The third subpart deals with recovery, treatment and rehabilitation of language and communication disorders, as the spontaneous recovery of aphasia (Ch.38 by Cappa), therapeutic approaches in aphasia rehabilitation (Ch.39

by Springer), pharmacological treatment of aphasia (Ch.40 by Lee & Hillis), recovery and treatment of acquired reading and spelling disorders (Ch.41 by Basso), and the role of electronic devices in the rehabilitation of language disorders (Ch.42 by Petheram & Enderby).

Those chapters deepen our knowledge on the relationship between clinical aspects of disorders and language. An aspect to be highlighted refers to the fact that autistic children have the tacit knowledge of subtle rules but they seem not to achieve a correct understanding of what they have read. According to Surian and Siegal (2008, p.381), few studies demonstrate that "performance is poor when individuals with autism have to read homographs that need to be disambiguated on the basis of contextual information, and that their ability to form bridging inferences appears less developed than mental age matched controls". In addition, Springer (2008) provides a table illustrating the standard techniques of impairment-specific therapy across language domains. Furthermore, Basso (2008) considers the importance of the linguist in the recovery and treatment of acquired reading and spelling disorders, since the team of professionals must know what components are

damaged to initiate a well-motivated treatment. Surian and Siegal (2008) also acknowledge the importance of pursuing an integrative approach that includes investigations targeted at genetic, neurobiological, and cognitive levels of explanations if the aim is to gain a comprehensive understanding of the wide range of language and communication difficulties displayed by patients. Not less relevant, Cappa (2008) reminds us that the neuroimaging methods allow the investigation of the brain and its plasticity *in vivo* in ways that could not have been predicted before, and recommends that "we should never forget that the quality of the information that can be derived from technology depends crucially on the quality of the questions that are formulated by the researcher" (p.394).

'Part V: Resources' offers the reader a listing of resources in the neuroscience of language (Ch.43 by Stemmer). The chapter lists journals, books, source books, associations and societies. The attentive reader will perceive that only international journals written in the English language are pointed out. Books and source books are presented with a brief description and just the ones published since 1999 are indicated.

The emerging picture is that the brain does not store precise information at specific locations; instead, it reaches decisions through the dynamic interaction of several areas that operate in functional neural circuits. Specific areas in these functional circuits seem to play highly flexible and dynamic roles. Our brain systems seem to function in a so automatic, effective, and seamless fashion so that we are able to accomplish our daily goals. Unfortunately, we only perceive the importance of each step each connection when errors occur and when an individual is affected by a disorder or a disease.

In chapter 15, Beretta (2008, p.156) warns us that "much neurolinguistic experiment is descriptive and atheoretical, preoccupied with describing the locations of everyday aspects of language". According to him, lots of articles avoid clear reference to any aspect of linguistic theory and do not make contact with any aspect of brain theory. The Neuroscience of Language, as a field, should make an effort to unify theories, to ask theoretically coherent questions. As Beretta (2008, p.162) clearly claims, "we know how not to proceed: ignore theory of language, ignore theories of brain, and posit atheoretical mechanisms in their place". Stemmer (2008) also

recommends that understanding the processing mechanisms of language requires a cross-disciplinary endeavor, as well as a combination of methods. Moreover, researchers should struggle to ensure ecological validity of findings, to verify whether what is tested in the experimental conditions in the labs also applies to 'real life'.

While reading the *Handbook of the Neuroscience of Language*, the reader may feel overwhelmed by the amount of information, especially because some authors use shifting models in their explanations. This is not a problem if the reader continues reading the chapter and accepts the authors' invitation to deepen the knowledge of the subject by reading the suggestions in the section 'further readings'. And despite the editors' and authors' efforts, there has to be an understanding that not every topic related to the Neuroscience of Language was covered and that the approach to each of the topics was limited in scope. As the editors themselves explained, the main limitation and challenge of the book was "to squeeze a field that keeps growing into a one volume book" (2008, p.xix). All in all, Stemmer and Whitaker's handbook provides lay readers and experts a thorough review of the achievements in the Neuroscience of Language, as well

as offering different perspectives and discussing the future of the field.

References:

Kintsch, W., & van Dijk, T.A. (1978). Toward a model of text comprehension and production. *Psychological Review*, 85, 363-394.

Stemmer, B., & Whitaker, H.A. (Eds.). (2008). Handbook of the Neuroscience of Language. USA: Academic Press Elsevier, 512p.

van Dijk, T. A., & Kintsch, W. (1983). Strategies of discourse comprehension. New York: Academic Press.