

## **John W. Schwieter: The Handbook of the Neuroscience of Multilingualism**

(Hoboken, New Jersey: Wiley-Blackwell. 2019. 830 p.)

The Handbook of the Neuroscience of Multilingualism has been published recently by Wiley-Blackwell. The unique book provides an insight into the neurolinguistics of multilingualism paying special attention to cognitive science and the organisation of the brain. Since the book contains 36 chapters, in this book review I can only briefly introduce the content of each chapter.

In the first part of the handbook several approaches of multilingualism are presented, and the major theories and methods are listed. Chapter 1 focuses on how multilingualism should be defined and how it can be assessed. Definitions range from a minimal non-balanced level of proficiency to a high-level balanced mastery. In Chapter 2, outstanding theories and methods are listed paying special attention to the linguistic and neuroscientific aspects of multilingualism. The author also introduces new methodological applications of electrophysiological and hemodynamic imaging technologies (e.g. cortical stimulation mapping, functional magnetic resonance imaging, and longitudinal studies). Chapter 3 provides a splendid outline of the bilingual models and the neurocognition of multiple languages by listing the two main bilingual models, BIA, BIA+ and the Inhibitory Control Model. In Chapter 4 the psycholinguistic methods in multilingual research are compiled. One of the greatest findings of the recent years is that multilingual language users cannot switch off any of their languages intentionally. Chapter 5 and 6 specify the real-time measures of the multilingual brain and lists some neuroimaging studies. An EEG can detect changes in brain activity that might be useful in diagnosing brain disorders, especially epilepsy or some other seizure disorder, such as tumour, damage from head injury, dysfunction, inflammation of the brain, stroke, sleep disorders, etc. Chapter 7 describes language forgetting. Language attrition is the loss of the knowledge of a foreign or second language over the time of disuse, or the first language forgetting in the context of a second language environment. A language once learned but later forgotten leaves imprints in the person's brain that later facilitate relearning and identification of that language. Chapter 8 highlights the brain adaptations and neurological indices of processing in adult second language acquisition. EEG/ERP and (f)MRI data show that the majority of evidence for the critical period in second language acquisition comes from behavioural experimentation or spontaneous production and from populations of L2 learners who are not exposed to the target language in a way similar to children L1 acquirers.

The second part includes eight chapters belonging to the field of neural representations of multilingualism. Chapter 9 presents the language organization in the bilingual and multilingual brain. In this section the brain basis of L2

phonology, grammar, lexico-semantics and language control are listed. All languages and their features in the bilingual brain are localized in common language areas, but there are influencing factors that may change the localization, such as age and manner of acquisition. If a second language is learnt at school, it is represented in the cerebral cortex more widely than the first language, but if it is acquired informally, it is more likely to involve subcortical structures (basal ganglia and cerebellum) as in the case with the first language. Language is represented primarily in the left hemisphere, including Broca's area (which is responsible for the ability to speak), and Wernicke's area (which processes audio input). Language processing related to phonology, morphology and syntax takes place in the left hemisphere, and the right hemisphere is involved in nonverbal and visual activities, intonation and pragmatics. Chapter 10 discusses bilingual word production. Both cortical and subcortical structures are involved in language control and lexical selection. Chapter 11 explains the relationship between multilingualism and brain plasticity. In the brain, the cell bodies are concentrated mainly on the cortical and the cerebellar surface, with the exception of some subcortical clusters, such as the basal ganglia and the thalamus. Chapter 12 provides an insight into cortical representation and its affecting factors. In case of acquiring multiple languages at early stages of life language control is developed, while in case of low proficient languages there is a greater neural activity, and language networks become more efficient. Chapter 13 presents individual differences in non-native speech perception. Non-native language learning is influenced by the type and amount of input, learning environment, general language acquisition capability. Chapter 14 discusses the lexical organization in the multilingual mind. The mental lexicon contains all the information (phonological, morphological, semantic and syntactic) that speakers have about individual words. In Chapter 15, the authors focus on emotion and emotion concepts, the form of words and images, and Chapter 16 introduces representing, detecting and translating humour in the brain. As for the brain activities, humour and joy take place in the temporal lobes near the junctions of the parietal or occipital lobes, at the temporal and the prefrontal cortex. Playing with words and language contributes to the development of the individual's communicative skills, furthermore, it expands their endeavours to use the language more proficiently.

The third section of the book provides an insight into the functions and processes of multilingualism. Chapter 17 describes the metacognitive processing of multilingualism. Bilingualism delays the onset of dementia, and it also benefits the executive functions, which include planning, inhibiting, shifting, and updating. Chapter 18 introduces the main factors that affect multilingual processing. These factors include socioeconomic status, immigrant status, extent of sport or exercise, presence of musical training, experience with video games, education level, time spent in leisure activities, and personality variables. Chapter 19 provides an insight into the relationship between learning processes and the

memory of the bilingual mind. The findings of a bilingual advantage rather for concrete than for abstract novel words suggests that the effects of bilingualism on word learning are more likely to emerge when semantic information associated with the novel words is more accessible. Chapter 20 describes the brain-based challenges of second language learning in older adulthood. According to Penfield (1959), the optimal period for language acquisition ends when the brain starts to lose its plasticity. L2 learning fosters brain plasticity, and delays age-related cognitive decline, such as dementia, and it maintains memory skills. Chapter 21 depicts language control and attention during conversation. To test language control and the brain processes in conversation neural synchronization is the most ideal method. Chapter 22 explores the relationship between language and executive control. The authors claim that the overlap of mechanisms between bilingual language control and executive control is partial. Bilinguals who suffer from aphasia have limited inhibitory control and conflict resolution. Chapter 23 depicts the connection between language and cognition, moreover, it highlights the aspects of sentence processing. What can be taken for granted is that monolinguals and bilinguals converge when it comes to the variability of language processing, which means that they both have different linguistic experiences, and different factors that influence their processing. Chapter 24 outlines translation, interpreting, and the bilingual brain. The chapter correlates to the previous units in terms of executive control and neuroplasticity. The earlier a language is learned and the higher L2 proficiency is, the more grey matter intensity and white matter integrity can be detected. Chapter 25 provides an insight into event-related potentials in monolingual and bilingual language processing. N400 and P600, the most salient components of the ERPs are detailed.

The next section, Part IV includes impairments and disorders. Chapter 26, 27 and 28 address the relationship between aphasia and multilingualism. Aphasia is a clinical condition that affects language as a consequence of a lesion to the sensory, motor, or cognitive brain networks that support language. Clinical parameters (such as the extent and location of the lesion), age of acquisition, premorbid (language history) and postmorbid (language spoken during hospitalization) conditions are all manipulating factors. Chapter 29 is about reading disorders. Bilinguals having dyslexia showed less activation regarding certain parts of their left hemisphere (inferior frontal gyrus, inferior parietal lobe, temporal cortex) of the brain when reading. Chapter 30 describes the relationship between dementia and multilingualism. The onset of dementia can be determined by several factors, such as lifestyle, physical activity, stimulating leisure involvement, social engagement, education, high occupational status, intelligence, and mental activities. Chapter 31 describes schizophrenia. In case of bilinguals diagnosed with schizophrenia, Panntelis et al. (2007) noted grey matter volume loss in frontal lobes, and the patient's lateral ventricle volume increases, which ends in poor cognitive functioning.

The last section of the handbook, Part V discusses the cognitive and neurocognitive consequences of multilingualism. Chapter 32 provides an insight into the neurocognitive effects of multilingualism throughout the lifespan. Multilinguals who start acquiring their second language at an early age have more homogeneous brain activation in each of their languages compared to those who acquired their L2 later in life. Chapter 33 reports about the intense bilingual experience of interpreting and its neurocognitive consequences. The executive functions that are exercised during interpreting tend to produce an interpreter advantage, i.e. working memory updating and coordination, selective attention, and cognitive flexibility. Chapter 34 and 35 discuss the bilingual advantage. According to Bialystok (2017), bilinguals outperform monolinguals in several tasks related to selective attention and cognitive flexibility. The neural processing of bilinguals and monolinguals differs during the performance of executive function tasks. The last chapter (Chapter 36) of the section discusses speech-sign bilingualism. Neuroimaging research has indicated a common neural circuitry for sign and speech, similar to that of spoken-language bilinguals. In case of comprehension tasks, sign-print and bimodal bilinguals activated the superior temporal cortex bilaterally, both in speech-based and sign-based tasks.

To sum up, The Handbook of the Neuroscience of Multilingualism offers an excellent outline of the relationship between neuroscience and multilingualism. This book with all its 36 chapters is a splendid choice not just for researchers but for those who are interested in the multilingual brain.

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