

Bilingual Lexical Ambiguity Resolution

This book provides students and researchers of bilingualism with the most recent methodological and theoretical advances on how bilinguals resolve ambiguous information across languages. With reports on the latest findings from the behavioral and neuropsychological fields, the authors survey the latest research into bilingual language-system modeling and bilingual lexical ambiguity processing. Each chapter looks at bilingual ambiguity resolution both at the word and sentence levels, describing how bilinguals ultimately comprehend ambiguous information arising from languages they already know. This volume not only explores enduring theoretical questions in bilingual research, such as bilingual representation and language processing, but also evaluates the extent to which the existing bilingual models can satisfactorily account for the most recent research findings.

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Para nantsin, tataj, y siuapiltsin

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Preface

This book is intended as a cognitive map for students and researchers of bilingualism/multilingualism on how bilinguals resolve and ultimately understand information that could potentially pose retrieval issues due to competing activation between their two languages. It provides a state-of-the-art update to the broad field of *lexical ambiguity resolution* from a bilingual perspective. We would be remiss if we failed to acknowledge Small, Cottrell, and Tanenhaus's (1988) classic book on *Lexical Ambiguity Resolution* as the model and inspiration for the present volume.

From its original conception, one purpose of this book was to provide a critical overview of what is presently known about bilingual lexical access and ambiguity resolution at both the word and the sentential levels. A second purpose was to bring forth the various methodological approaches and arrive at a better understanding of whether the bilingual's lexical system is *language-selective* (i.e., involves the activation of a contextually relevant linguistic system only) or *nonselective* (i.e., involves the simultaneous activation of both linguistic systems regardless of contextually relevant language). A third aim was to be exhaustive in its coverage and provide an overall picture of the behavioral and neuropsychological correlates of bilingual lexical access and ambiguity resolution.

First, the book critically reviews research findings from the isolated word level, in the traditional word recognition and word production studies, as well as from sentence processing, at both the behavioral (e.g., eye-tracking and other reaction time-based reading tasks) and the neuropsychological (event-related potentials and neuroimaging) levels. Second, throughout the book, research findings are critically evaluated in relation to methodological considerations (e.g., experimental stimuli and tasks) and their usefulness in assessing the nature of bilingual lexical access.

Research on bilingual language nonselectivity is interesting and exciting in and of itself. Yet it would be much more interesting to pinpoint how

or where the particular effects reported in this research have originated. Are the resulting bilingual lexical access results due to the experimental task measuring automatic psycholinguistic processes occurring at early stages of lexical processing or problem-solving strategic processes taking place at late stages of language processing? Although this book hints at the possibility that bilingual language nonselectivity might be automatic, at least for cross-language cognates (i.e., words sharing overlapping orthographic configurations and meaning, such as *hospital* in Spanish and English), the research findings for interlingual homographs (i.e., cross-language words with overlapping orthographies and different meanings, as *red* = color in English and *red* = net in Spanish) point to a different conclusion. It is our hope that this book provides the bilingual student and researcher with the necessary tools to advance the field, both at the theoretical and empirical levels and, particularly, at the neuroimaging and electrophysiological levels. As will become apparent, the question of whether bilingual access is language-nonselective is an open question and its resolution is empirical, requiring highly sensitive experimental paradigms measuring *true online* language processing.

The book is divided into four main parts. Part I (Chapters 1–3) is devoted to theoretical and methodological considerations. In Chapter 1, Heredia and Cieřlicka focus on methodological issues crucial in the exploration of bilingual lexical ambiguity resolution, with a particular emphasis on the *cross-modal lexical priming* (CMLP) paradigm. The chapter starts with a discussion of the importance of task demands and task selection in assessing bilingual lexical access. Experimental tasks tapping tacit knowledge and measuring automatic cognitive processes are seen as more appropriate than tasks requiring awareness or conscious recollection that encourage participants to engage in strategic processing during experimentation. The chapter continues with a critical review of the functionality and reliability of the CMLP and studies that have been carried out with this paradigm to address the question of bilingual ambiguity resolution at the word and sentence level of processing. Specifically, at the word level, the authors review the few existing studies employing the CMLP into bilingual processing of translation prime-target associates and cross-language homophones that have helped shed light on the issue of whether bilingual lexical access is exhaustive and nonselective or selective. At the sentence level, studies into bilingual figurative language (idiom and metaphor processing) are reviewed, along with the implications they have for the cognitive mechanisms involved in bilingual ambiguity resolution. The chapter concludes with recommendations for future studies and identification of the criteria that an

ideal experimental paradigm designed to tap into bilingual lexical access should possess in order to accurately reflect bilingual processing as it happens in real time.

Chapter 2, by Falandays and Spivey, provides a thorough and fascinating account on how connectionist modeling, wherein the human language system is envisaged as a high-dimensional state space, can account for lexical ambiguity resolution both in monolingual and in bilingual language users. Unlike traditional accounts relying on the *box-and-arrow* computer metaphor of the human mind, where language systems and processes are considered submodules within a more general *language module*, connectionist models view these systems of speakers' linguistic representations as dimensions in a single massive state space. Such a dynamic account of language knowledge representation allows viewing lexical ambiguity resolution as movement through a multidimensional state space. Falandays and Spivey start with a discussion of different types of ambiguity involved in language processing, such as homophonous or polysemous words, and of individual differences likely to affect how language users resolve lexical ambiguity. The chapter then continues with a detailed account of the connectionist models of word processing, starting with the monolingual predecessors, such as the *interactive activation* and *TRACE* models, and the bilingual ones that followed, such as the *bilingual interactive activation models*. The authors conclude by suggesting how bilingual connectionist models account for such aspects of bilingual lexical ambiguity resolution as the processing of homographs, cognates, and interlingual cohorts (i.e., pairs of words across languages in which there is a partial overlap in spelling or phonology).

In Chapter 3, the final chapter of Part I, van Assche, Brysbaert, and Duyck review previous studies that point unequivocally to nonselectivity in bilingual lexical access. The chapter starts with the description of studies into the processing of cross-language homographs (i.e., words with identical spelling but different meanings), followed by research into the processing of cross-language homophones (i.e., words that sound the same but have different meanings) within the language. The remainder of the chapter is devoted to the discussion of some of the factors that might affect the degree of cross-language homophone and homograph activation. Some of those factors include the frequency of the ambiguous word in question, recency of use, the bilingual's level of language proficiency, the context in which word recognition takes place, and the task demands in a specific experiment.

Part II (Chapters 4–6) focuses on different aspects of bilingual lexical processing in the course of visual word recognition and spoken language

production at the word and sentence levels. Chapter 4, by Lijewska, looks at research into bilingual nonselective lexical access, with a focus on the processing of cross-language cognates. Lijewska starts with a review of studies into bilingual/multilingual language production and comprehension revealing the *cognate facilitation effect* (i.e., the faster processing of cognates as compared to noncognates). Results from different experimental paradigms (e.g., *picture-word interference task* and its variants) are discussed, along with their implications for the coactivation of nontarget language(s) in the course of bilingual lexical access. Moreover, Lijewska discusses research findings concerning the factors (e.g., word level, word class, task demands, context-level effects, participant characteristics) identified as critical in influencing the cognate facilitation effect. Lijewska concludes that the cognate facilitation effect is prevalent across different language modalities, such as visual language processing, speech comprehension, and speech perception, and in a variety of tasks combining word comprehension and production.

In turn, Chapter 5, by Schwieter and Prior, focuses on translation ambiguity, or the situations in which more than one possible translation is available for a given word in the bilingual's languages. The chapter starts by identifying sources of translation ambiguity arising from the source language (e.g., homography, homophony, homonymy, and polysyny), from the target language (e.g., synonymy and near synonymy), and from the differences in the meaning-to-form mapping across the two languages, such as morphological specification and semantic discrepancy. Existing estimates of translation ambiguity, such as the *first translation* method, are then reviewed, along with methodological factors likely to account for the variability across studies, such as stimuli selection, sample size, or the linguistic differences between the language pairs studied. Next, the chapter reviews offline and online studies that have been conducted to explore how bilinguals process ambiguous translations. Taken together, the studies suggest that translation ambiguity incurs greater processing costs than do words with unambiguous translations. The chapter concludes with a review of the models of bilingual lexical and conceptual representation that have been developed to specifically account for translation ambiguity resolution.

In Chapter 6, Santesteban and Schwieter present a discussion of bilingual lexical selection and competition, with a particular emphasis on spoken language production. Studies employing different experimental paradigms (e.g., *phoneme monitoring* or *picture-word interference*) are reviewed, clearly demonstrating simultaneous activation of lexical nodes in the bilingual's languages, with activation of the nontarget lexical representations spreading all the way down to sublexical phonological levels.

As Santesteban and Schwieter point out, while there seems to be a consensus on the question of language coactivation, it is debatable whether the activated languages compete for selection in the course of bilingual speech production. The *language switching paradigm*, widely used to investigate bilingual language control and inhibitory processes, is discussed, followed by a discussion focusing on whether the general executive control mechanism might be employed to perform specific language control functions in bilinguals or whether bilingual inhibitory control processes are largely independent of the domain-general executive control processes. Santesteban and Schwieter conclude with a brief discussion of the debate concerning the so-called *bilingual advantage*, under which a lifetime of managing the control of their two (or more) languages gives bilinguals a cognitive benefit, such that bilinguals outperform monolinguals on tasks involving executive control.

Part III (Chapters 7–8) considers bilingual ambiguity resolution at the level of the sentence. In Chapter 7, Palma and Titone look at bilingual lexical access through the lens of the multiple constraints that have been identified to affect top-down and bottom-up processing driving lexical ambiguity resolution in monolinguals. The chapter starts with a review of studies mostly carried out with interlingual homographs and cognates that have shown that bilingual lexical access is nonselective, just like ambiguous words are in the course of monolingual language processing. Palma and Titone then go on to discuss the eye-tracking paradigm, which relies on natural reading, thus capturing the real-time dynamics of the unfolding sentence comprehension process. While early, first-pass eye-tracking measures reflect initial lexical access, late or second-pass reading measures tap into higher-order semantic and syntactic integration and interpretative processes. As Palma and Titone argue, the eye-tracking paradigm is an ideal tool to test predictions of bilingual language-selective versus language-nonselective lexical access models. The picture emerging from research findings involving interlingual homographs and cognates is that a number of variables, such as the presence of a highly constraining sentential context, task demands, stimulus item characteristics, the bilingual's level of proficiency, dominance in a particular language, and age of acquisition of the second language, as well as individual differences in executive control, all converge to modulate the degree of cross-language activation in bilingual reading.

Chapter 8, by García, Cieślicka, and Heredia, discusses language-selective and language-nonselective activation, with a particular emphasis on the processing of interlingual homographs. The chapter starts with a review of the previous research, most of which provides evidence for exhaustive, nonselective access. A number of studies are described that

question the language-nonselective account and point to language-selectivity, depending on task demands and the linguistic context involved. For example, inducing a monolingual or bilingual language mode might modulate the degree to which the bilingual's languages are coactivated. In addition, the authors suggest that a more sensitive measurement of lexical access is needed to most accurately reflect bilingual language activation as it unfolds in real time. One such task is the CMLP paradigm, the tool employed in a series of experiments that are reported next. The experiments used Spanish-English homographs and homograph-translation primes, additionally manipulating context and the language mode. Results indicate the modulating role of language proficiency.

Part IV (Chapters 9–11) explores the neuroscience of bilingual lexical access. Chapter 9, by Whitford and Guedea, provides a critical review of studies conducted with the use of eye tracking and functional magnetic resonance imaging (fMRI) to investigate bilingual lexical access in the course of first (L1) and second language (L2) reading. The first part of the chapter provides a review of eye-tracking studies that have generally demonstrated facilitatory effects for cognates and cross-language neighborhood density and interference effects for interlingual homographs, for both L1 and L2 reading and for both early and late stages of the reading process. However, a number of factors have emerged as modulating those effects, such as, for example, the type of task involved, the amount of cross-language overlap, presence of a strong biasing context, as well as individual differences between participants in terms of their L2 background, L2-reading skills, and executive function. The second part of the chapter focuses on fMRI research that has explored neural correlates of the bilingual language control network in general and bilingual lexical ambiguity resolution in particular. While most fMRI studies into lexical ambiguity resolution looked at monolinguals, with only one study to date investigating bilingual participants, the studies seem to point to the possibility that the same left-hemisphere regions that are involved in executive functions (e.g., inferior frontal gyrus, dorsolateral prefrontal cortex, and basal ganglia) also subserve the processing and resolution of lexical ambiguity in bilinguals.

In Chapter 10, Rataj looks at the electrophysiology of semantic violations and ambiguity in bilingual sentence processing. Its major focus is on the processing of lexical ambiguities arising when bilinguals encounter semantic violations, at both the word and the sentence level, as well as cross-language homographs. The chapter starts with a discussion of the

electroencephalogram (EEG) correlates of processing semantic ambiguity and semantic violations, such as the N400 and late positive complex (LPC) event-related potential (ERP) components. It then proceeds to examine the neural correlates of the semantic aspects of L2 sentence processing, as well as the factors that have been shown to affect the degree of the N400 and LPC amplitude modulations, such as age of exposure, language dominance, and proficiency level. Next, the chapter reviews ERP research into lexical semantic anticipation in bilingual sentence processing, examining studies in literal and nonliteral language processing. Finally, it discusses the limited literature on EEG oscillations and the relationship between increased theta activity and L1/L2 semantic processing.

Chapter 11, by Hayakawa and Marian, examines shared and separate bilingual representations through the eye-tracking and brain-imaging paradigms. The chapter starts with a review of studies employing eye tracking to explore bilingual lexical access. Overall, the eye-tracking studies conducted so far provide strong evidence for the automatic, parallel activation of all the languages known to a bilingual in the course of language processing. However, the degree to which different levels (e.g., semantic, phonological) of the nontarget language are coactivated is influenced by a number of factors, such as the bilingual's proficiency in each of the languages spoken or the degree of similarity across the languages known by the bilingual. The second part of the chapter examines fMRI research into bilingual lexical representation, particularly focusing on the question of whether bilingual language users have common, shared representations for each of their languages in the brain or whether each language has its separate neural representation. Here, again, the answer seems to be modulated by a range of factors that have been shown to affect the way in which each of the bilingual's languages elicits a different pattern of neural activity. The age of acquisition of the second language, the level of proficiency, the typological distance between languages, and the stage of language processing (e.g., phonological, syntactic, semantic) have all been shown to crucially affect the outcome of fMRI bilingualism studies. The final part of the chapter focuses on the processes related to the issue of language control and its neural correlates. The authors conclude with a discussion of how the different methodological paradigms can converge to shed more light on the issue of bilingual language processing in general and bilingual ambiguity resolution in particular.

Finally, we hope that this book inspires students, teachers, and researchers of the bilingual mind to further investigate how the overwhelming majority of the world's population who speak more than one

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language seem to so aptly and effortlessly resolve the multiple ambiguities they encounter in their everyday communication.

References

Small, S. I., Cottrell, G. W., & Tanenhaus, M. K. (1988) *Lexical ambiguity resolution: Perspectives from psycholinguistics, neuropsychology, and artificial intelligence*. Palo Alto, CA: Morgan Kaufman Publishers.

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I, Anna, dedicate this volume to my parents, my dad, Jerzy, who I hope will live to be a 100, and my mama, Tamara, who keeps watching out for me and guiding me in my life journey from far above. I am grateful to my wonderful sister Iwcia and my dad's loving and caring wife Joanna for their unwavering support. Many thanks to my dear friends and colleagues, both those in Poland and those here in Laredo, and to my long-time best friend, colleague, and coauthor and best research collaborator Roberto. Last, but not least, my acknowledgment is due to my ever-growing cat rescue family (Daktyl, the only surviving Polish senior cat and his Laredoan buddies: Tofi, Grusia, Rudy, Nunia, Pusia, Duszek, Kicia, Łapka, and Jędrus). It is their delightful company that makes work in my home office such an enjoyable and productive experience.

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