

Introduction

Multilingualism

Language, Brain, and Cognition

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As is well known, the prefix *multi-* conveys the meaning of *many*. Perhaps not intuitively (pragmatically), yet logically, the smallest subset of *many* is at least more than one or *two*. In the world of *-lingualism*, then, it would technically be justified to claim that bilingualism is the smallest subset of multilingualism. Given the proliferation of societal bilingualism and/or high incidences of second language (L2) learning, such a liberal criterion for applying the term multilingualism would make it the default state of linguistic knowledge globally (e.g., Romaine, 1995; De Houwer, 2021). Yet, in typical parlance – in the real world as well as in language sciences – most people understand the term multilingual to refer to a step beyond bilingualism; that is, a context in which at least three languages are implicated. While it thus might not be the case that a majority of the world is multilingual, it is increasingly common to acquire a third (or more) language, be it by individuals who grow up bilingually or by individuals in monolingual contexts who had already learned an L2 in childhood or adulthood.

Until recently (and still at times), third or more language acquisition was not uniformly treated or investigated in its own right. Over the past two decades or so, there has been an upswing in third (or more) (L3/L_n) language acquisition studies and bespoke theories/models/hypotheses which acknowledge, and indeed demonstrate on empirical grounds, the need to study multilingual acquisition independently, yet complementarily, to the study of bilingualism. A critical mass of research now exists along a range of approaches to multilingualism, examining various domains of grammar and asking unique questions. The view that emerges from this work is that L3/L_n acquisition and processing are complex and display both similarities and differences to the acquisition and processing of an L2 on many planes (e.g., Rothman et al., 2013; Rothman et al., 2019). Understanding how, where, and why multilingualism is distinct not only contributes to better descriptions of multilingual acquisition and processing themselves, but

also contributes in nontrivial ways to more complete descriptions and interpretations of the same in general terms.

Of course, like in all cases of language acquisition and processing, L3/Ln acquisition/processing does not occur in vacuums devoid of sociological, educational, and neurocognitive considerations. This relationship is, of course, not unidirectional: Processes inherent to L3/Ln also have implications for educational practice, neurocognition, and sociolinguistic competencies. And so, any complete approach to multilingualism, regardless of the research question in focus, inevitably includes at least basic knowledge of the related research being done under the guise of distinct disciplines such as various sub-disciplines/approaches of linguistics, education, psychology, neuroscience, and more. It is with this in mind that the present handbook is compiled and meant to serve the community of scholars and students interested in multilingualism. Moreover, from this same perspective of interdisciplinarity, the study of L3/Ln constitutes both an opportunity for cross-fertilization and collaboration between disciplines that do not communicate as much as they should as well as a robust testing ground for hypothesized connections between language acquisition/processing and cognition, brain structure, and function, not to mention the unique implications these connections hold for education, linguistic theories, health science, social justice, and more.

In sum, the main goal of this handbook is to bring all of the aforementioned research areas and their relevant work together into one survey manual for scholars interested in the study of multilingual acquisition/processing and its multifarious implications across the lifespan. In doing so, the book comprises twenty-nine chapters across six unique subsections written by the world's leading experts in theory and empiricism. In the remainder of this Introduction, we provide a cursory review of the main content of each chapter, followed by a succinct discussion section that seeks to draw attention to overarching themes and connections between them.

Part 1: Theoretical Approaches to L3/Ln

Chapter 1: Generative Approaches (González Alonso)

The study of third or further language acquisition from a generative perspective can be considered a relatively recent endeavor when compared to other topics within the generative enterprise, as well as to multilingualism studies within other approaches. Even so, generative approaches to L3/Ln acquisition are well into their third decade and constitute an important contributor to the surge in popularity this topic has enjoyed in recent years. This chapter aims to provide an introduction and succinct overview of the themes, models, and theories that have dominated the field for most

of its existence, with some thoughts on what makes these, in fact, *generative* approaches to L3.

González Alonso's chapter starts by providing an overview of current generative approaches to L3/*L_n* acquisition. He provides the reader with some thoughts on why some of the work on L3/*L_n* acquisition is, indeed, framed within a generative context, highlighting some of the primary assumptions and tenets sustained in the field, as well as some of the inherited questions from the generative L2 acquisition literature. González Alonso makes a good case for why examining L3 acquisition can in fact serve as a disambiguating context for some of those key questions. The chapter continues with a succinct overview of the main models that have been formally put forward in the domain of morphosyntax. Finally, he concludes by discussing the field's current state and future directions, including a brief introduction to the topic of L3 development, which has gathered growing interest in recent years.

Chapter 2: Usage-Based Approaches (Morales-Front & Sanz)

Morales-Front and Sanz's chapter provides an overview of how usage-based approaches can be employed within the study of L3 acquisition. Their chapter starts with an introduction to usage-based approaches and outlines their cognitive and social underpinnings, with an emphasis on the role of categorizations, exemplars, constructions, adaptive systems, analogy, and entrenchment. They provide contextualization in relation to usage-based approaches and L1 and L2 acquisition, where they discuss issues including developmental stages, interlanguage, markedness, transfer, the role of input and types of input, individual differences, and attrition. The central section presents a panoramic review of the major findings in the existing literature on L3/*L_n* acquisition and processing, and discusses what usage-based approaches contribute to the general discussion in relation to some of the key questions in the field. The chapter concludes that usage-based approaches will see important developments in the near future as they bring an interesting perspective to our understanding of L3/*L_n* issues.

Chapter 3: Dynamic Systems Theory Approaches (Jessner)

Jessner focuses on the Dynamic Model of Multilingualism (DMM), which applies Dynamic Systems Theory to multilingual development and use, and argues that this model paves the ground for the development of a paradigm change in language acquisition research.

The chapter starts with a short introduction to the historical development and main principles of Dynamic Systems and Complexity Theory (CDST) in science with a particular focus on applied linguistics. Jessner further discusses fundamental features of the dynamics and complexity of

multilingual systems, with a focus on the qualitative differences between L2 and L3 development. The chapter continues by unfolding a holistic approach to multilingual development and use by increasing the complexity in the interaction of levels of inquiry in the study of L3/*L_n* and multilingualism. Jessner further argues that a holistic approach is a necessary prerequisite of a CDST approach and includes discussion both from a research and educational perspective on multilingual development and multilingual use. The chapter ends by suggesting some key directions for future research in the field.

Chapter 4: Sociolinguistic Approaches (Moyer)

Moyer adopts a critical sociolinguistics perspective on L3 acquisition, which can offer a lens to the acquisition of an L3 by providing qualitative information about the context in which acquisition takes place. It is an approach that places concerns of power, inequality, and social inclusion at the center of inquiry. It also provides a focus on ongoing social processes and the way those processes are connected to a political and economic order in which we live, revealing how they shape our research agenda and our thinking about what counts as valid knowledge.

Moyer starts the chapter situating the research in L3 acquisition in a set of ontological and epistemological positions. She argues that this contextual backdrop is critical for understanding the multiple motivations and outcomes of learning a third or an additional language. She then presents an overview of the ideological underpinnings leading to the policies regarding L3 acquisition and reviews some of the key studies that have led to such policies. The chapter continues with a discussion of the study of English as an L3, focusing on the predominance of English in research concerning multilingualism and the potential implications of this. The chapter finishes with some critical sociolinguistic considerations regarding the assumptions and methods employed in the field of L3 acquisition.

Part 2: L3/*L_n* across Linguistic Domains

Chapter 5: Exploring the Acquisition of L3 Phonology: Challenges, New Insights and Future Directions (Wrembel)

Wrembel discusses the state of affairs in L3/*L_n* phonological acquisition research, which has recently begun to stand out as a thriving subfield. As in other areas of L3/*L_n*, multilingual phonological acquisition inherited methodologies and theories from L2 acquisition research, but, as Wrembel highlights, the field must come up with its own ways of investigating and explaining the more complex multilingual scenarios.

The chapter presents an overview of the latest research on phonological acquisition in multilingual populations, primarily focusing on the

challenges L3/*L_n* learner populations pose for implementing effective research methodologies. On more theoretical grounds, the chapter addresses how existing L3 morphosyntactic models can be applied to phonological data, as well as the emergence of alternative theories. Finally, Wrembel discusses recent findings from a longitudinal project and new avenues for future research.

Chapter 6: Characteristics of the L3 Lexicon (Lindqvist & Falk)

While lexical acquisition has a relatively long tradition within L3/*L_n* research, the field seems to be separated from the closely related study of L2 vocabulary. In this sense, Lindqvist and Falk's chapter aims to bring together these two areas by discussing their similarities (i.e., factors governing vocabulary acquisition) and differences (i.e., more intricate learning scenarios).

The chapter outlines what constitutes vocabulary knowledge and the mechanisms considered to subserve the process of L2, L3, and *L_n* vocabulary acquisition. Notably, learners have access to already established lexical-semantic representations from the other language(s) when learning a(n additional) foreign language. Lindqvist and Falk focus on this major feature of L3 vocabulary learning, which, as the authors discuss, results in both benefits and disadvantages during the acquisition process.

Chapter 7: Processing Words in a Multilingual Lexicon (Lemhöfer)

How do people who speak more than one language comprehend and produce (and switch between) different languages without apparent difficulties? How are words for those languages organized in the lexicon? While intriguing when observed in bilingual speakers, such abilities are much more so when additional languages are involved – which, as noted by the author, may be the reality for a majority of people in countries such as the Netherlands or Denmark. Addressing these questions is the main focus of Lemhöfer's chapter, providing an overview of our current understanding of the structure and inner workings of the tri-/multilingual lexicon.

While the chapter begins by introducing traditional debates around word representation and processing in the bilingual lexicon, it quickly moves on to the case of trilingualism and its idiosyncrasies. It then focuses on how the more complex nature of the trilingual scenario (e.g., different typologies, ages of acquisition, overall proficiency) gives rise to asymmetries in representation/processing, discussing the inherent difficulties this complexity brings about for studying the trilingual lexicon systematically.

Chapters 8 and 9: Full Transfer in L3/*Ln* Acquisition: Evidence from Two Clusters of Studies (Puig-Mayenco)/Full Transfer Potential in L3/*Ln* Acquisition: Crosslinguistic Influence as a Property-by-Property Process (Westergaard, Mitrofanova, Rodina, & Slabakova)

In several ways, these two chapters are counterpoints to each other insofar as they each deal with, from distinct perspectives, a main debate/controversy within theoretical discussions of linguistic transfer in sequential multilingualism: the *extent* or *scope* of transfer. In short, the issue at hand is whether: (1) transfer representations are sourced individually from a previous grammar over development as needed (i.e., property-by-property) or (2) transfer takes place as a process of fully copying a previously acquired grammar, creating a first-pass interlanguage grammar over which L3 development takes places.

Puig-Mayenco offers an overview of the arguments and empirical evidence in favor of full/wholesale transfer taking place in L3 acquisition, as it has been proposed for L2 acquisition. This exposition takes the reader through a brief history of full transfer in L3/*Ln*, and discusses several data sets and language combinations that have come together throughout the years to maintain the idea of full transfer from one of the previously acquired grammars as a plausible account of the initial stages of L3 acquisition.

Alternatively, Westergaard, Mitrofanova, Rodina, and Slabakova offer a counterpoint position, presenting some of the most common arguments in favor of property-by-property transfer in L3/*Ln* acquisition, together with supporting empirical evidence. The chapter also provides a detailed methodology section where the authors work out the logic of experiments designed to test specifically for this type of transfer, which are better served by experimental designs not always in line with other standards in the field (e.g., mirror-image groups) that were originally devised to adjudicate between the predictions of other models.

Chapter 10: The Acquisition and Processing of Pragmatics in Multilinguals and Third Language Learners (Antoniou & Michaelides)

As this handbook spotlights, Antoniou and Michaelides reflect on the fact that the multilingual experience is different from the bilingual one in many respects (beyond simply involving additional languages), making its investigation necessary for the advancement of our understanding of human cognition. One of the areas that can benefit from investigating multilingual speakers is the study of pragmatic performance.

Thus, this chapter presents an overview of research on how multilinguals produce and interpret meaning in context. After establishing the

theoretical grounds regarding the constitution of what pragmatics entails, the chapter moves on to specific research investigating multilingual populations. The authors consider the more traditional approach of studying speech acts and research on other aspects like language acquisition in multilingual children and the comprehension of implicatures. The chapter ends with a look into the methodological challenges (and opportunities) that the field faces.

Part 3: Becoming and Staying Multilingual at Different Ages

Chapter 11: 3L1 Acquisition during Childhood (Kupisch)

Although there is growing interest in the study of simultaneous multilingualism, the vast majority of work to date has focused on contexts where two languages are being acquired. Kupisch discusses situations in which children are exposed to three languages during early childhood (i.e., before they start school), which are becoming increasingly common. Thus, the focus of the chapter is a review of the scarce literature on early trilingualism.

This chapter starts by providing a state of the art, first contextualizing the notion of early trilingualism and then reviewing some fundamental concepts explored in the literature. Kupisch then discusses a set of seminal studies in terms of their contribution to the field as a whole before shifting focus to specific domains of language (phonology, lexis, syntax, and pragmatics). She goes on to discuss factors that either support or jeopardize early trilingual language development and maintenance. The chapter concludes with some key remarks and directions for future research.

Chapter 12: Multilingualism and Education in Adulthood (Pérez Vidal & Roquet)

Multilingualism in education has been studied from three main fields: educational language planning (contingent on language ideologies); linguistics as it relates to instructed language acquisition/learning; and sociolinguistics, focusing on the often-problematic status of local minority languages and of new languages brought in by either elite mobility or economic and forced migration.

This chapter provides a critical look at research on language learning in multilingual educational policies in higher education, while framing it in prior compulsory education. Pérez-Vidal and Roquet begin by describing new multilingual policies and programs, which are then illustrated with case studies and the existing descriptive models that account for them. They continue by examining existing research findings concerning language acquisition, identity construction, and long-term individual,

personal, and professional development as a result of multilingual education. They conclude by analyzing arising problems and tensions and possible future avenues.

Chapter 13: Language Attrition and L3/Ln (Cabrelli)

Cabrelli's chapter focuses on the study of language attrition in the context of L3 acquisition. Following a growing body of research on L2 effects on an L1, it is accepted that an L1 is not a static linguistic system and that L2 influence can present at the lexical, morphosyntactic, and phonological levels from even the earliest stages of L2 acquisition at the levels of both processing and representation. From this body of work, it is then logical to predict that any system can affect a previously acquired system, just as it has been established that existing systems can affect subsequently acquired systems. In this case, the prediction is that an L3 can influence an L1 and an L2, and a small body of research reported on in this chapter supports this prediction.

Cabrelli begins the chapter with an overview of the relevant L1 attrition research and relates it to the predictions that this body of work makes for a context of L3 acquisition. She then highlights two of the questions that are central in the study of the effects of an L3 on previously acquired systems, reviewing the research that has established the groundwork for these lines of inquiry. The majority of this research has centered on linguistic factors among sequential L3 learners in a formal learning context. She continues by pointing toward some outstanding questions stemming from this research and discussion of how we might model attrition in multilingualism. Toward the end, Cabrelli raises some key considerations for the development of a methodological framework, highlighting the need to draw further from experimental approaches used in L1 attrition as a complement to L3-specific methods.

Chapter 14: Heritage Bilingualism and Mother Tongue Relearning: A Case for L3 Acquisition? (Lloyd-Smith & Kupisch)

A population of L3 learners that has received little attention to date is that of heritage speakers – individuals who grow up speaking two languages in early childhood and learn an L3 later on. The particular situation of these speakers is that they have two early-acquired languages that were primarily acquired in a naturalistic setting before starting to acquire additional languages later in life.

The chapter begins by contextualizing (some) heritage speakers as L3 acquirers and elaborating on the work that has been done with heritage speakers in the field of L3 acquisition; Lloyd-Smith and Kupisch highlight that most of the work has been done on morphosyntax and to a lesser extent on phonology. The chapter discusses the findings in relation to

existing theories of L3 morphosyntactic transfer, ending by raising pivotal points in the literature and suggesting areas for further research.

Chapter 15: The Effects of Environment Change on Third Languages: The Case of Returnees (Flores & Kubota)

Although the literature on returnees – a subset of heritage speaker bilinguals that go to/return to the heritage homeland, either in childhood or as adults – and L3 acquisition is scarce, Flores and Kubota review the limited research and resulting theoretical considerations and further propose research hypotheses that may be tested moving forward.

The chapter discusses three scenarios in which an environmental shift may affect the status of an L3 and raises theoretical questions that follow from these scenarios. The first involves L3 attrition, where they discuss what the trajectories of L3 attrition may look like and what variables may influence or offset the effects of L3 attrition in light of evidence from L2 attrition research. The second scenario includes theoretical discussions of whether the relearning of an attrited L2 can be considered L3 acquisition. Finally, the third scenario explores the source of crosslinguistic influence on the L3, and how studying the returnee population can provide the opportunity to tease apart internal and external factors that are otherwise confounded in more commonly studied bilingual populations. Flores and Kubota conclude by laying the groundwork for future considerations of the intersection between L3 acquisition and returnee research.

Part 4: L3/Ln in Action

Chapter 16: Theoretical Linguistic Approaches to Multilingual Code-Switching (Parafita Couto, Bellamy, & Ameka)

In this chapter, Parafita Couto, Bellamy, and Ameka discuss how existing theoretical approaches (null theory, generative, variationist approaches, usage-based approaches, and more) originating from different linguistic traditions may account for multilingual code-switched speech. They acknowledge the points where these models converge as well as diverge to understand bilingual code-switching. To date, the majority of the code-switching research has focused on bilingual populations, while little attention has been paid to communities where three (or more) languages are employed. Thus, one of the main objectives in the chapter is to understand whether these theoretical accounts are enough to understand multilingual code-switching, or if they need additions and updating. Through an analysis of various examples, they conclude that existing theoretical approaches do not require extra machinery to account for multilingual code-switching, but that their existing limitations also apply in multilingual settings. Existing research is largely grounded in sociolinguistic, educational, and acquisition

approaches, with little attention paid to the grammatical outcomes. Irrespective of the various traditions and whether they account (or not) for multilingual data in the same way as bilingual data, this chapter illustrates how the field is still collectively searching for the most effective way to explain the complex phenomenon that is code-switching.

Chapter 17: Psycholinguistics of Multilingual Code-Switching (Valdés Kroff, Kheder, Tomic, & Kaan)

Code-switching is the fluid alternation between languages in text or during speech. Despite its ubiquity within multilingual communities, the processing of code-switches is associated with processing costs. Recent attempts have been made to reconcile this apparent contradiction by investigating how linguistic, cognitive, social, and experiential factors attenuate or modify potential switch costs in comprehension. This complex interaction of factors is incorporated into recent experience-based models of bilingualism such as the Adaptive Control hypothesis.

In this chapter, Valdés Kroff, Kheder, Tomic, and Kaan review the extant literature and summarize three recent studies on Algerian multilinguals (speakers of Algerian Arabic, Standard Arabic, and French) that illustrate how these factors extend to multilingual scenario, both sociolinguistically through language contact and psycholinguistically through studies on lexical selection and switch costs. They conclude with a special emphasis on the social context of multilingual communities as a critical foundation for experimental studies on multilingual code-switching.

Chapter 18: Third Language Acquisition in the Classroom (Angelovska & Hahn)

The 2002 Barcelona European Council meeting yielded a recommendation from the European Commission to implement the goal of “mother tongue + 2” (i.e., that European citizens would learn two foreign languages in addition to their mother tongue). This implementation, combined with migration processes due to globalization, has resulted in quite heterogeneous classrooms. This heterogeneity has led to new questions for psycholinguists and teachers, especially concerning the effective acquisition and teaching of L3/*L_n* grammar. Despite the increasing interest in and quality of the research on the acquisition of L3/*L_n* morphosyntactic properties, we are faced with several challenges of how to practically apply the existing theoretical knowledge in a classroom setting. Boosting L3 acquisition in classrooms requires careful consideration of the type of learners, as well as the learners’ background languages, acquisitional paths, and current language usage patterns.

Angelovska and Hahn start with the factors that condition (non-) facilitative transfer and how teachers can draw on learners’ prior

languages when teaching a target language. They then illustrate the heterogeneity of today's multilingual classrooms, the role of bilingual upbringing, and influential factors associated with the acquisition of an L3. Next, they focus on the application of existing models of morphosyntactic transfer in L3 acquisition to the L3 classroom. They follow with a discussion of the role of contrastive analysis and review classroom-based and classroom-relevant implications for instructed L3 acquisition. They highlight the possibilities of integrating previously acquired languages through learner-individualized approaches. In the final section, they focus on teacher-related factors and discuss the complexity of what it means to foster L3 acquisition in diverse classrooms.

Chapter 19: Diversity in Multilingual Learners: How Variation in Learners and Contexts for Learning Shape the Acquisition and Processing of an L3/*L_n* (Kroll & Degani)

In this chapter, Kroll and Degani focus on the extent to which variation in bi- and multilingual experience impacts L3/*L_n* learning outcomes. They review extensive evidence that suggests that bi- and multilinguals speakers may be advantaged in some aspects of novel language learning. Furthermore, they consider some of the mechanisms that may be responsible for creating these outcomes. They also suggest that L3/*L_n* learning research requires a much more nuanced look at how variation manifests across learners, how individual language learning histories differ, and especially how learning outcomes and language processes are influenced by specific environments.

New findings highlight that brain activity may provide an important glimpse into language learning processes even before these processes are behaviorally perceptible. Crucially, they argue that, without particular attention to native speakers' variation, the meaning of native speaker is itself underspecified and might potentially obscure the L2 to L3/*L_n* distinction in learning processes. In other words, until the advent of more precise and adequate approaches to (fully) capture variation in language experience, research will fail to fully provide the information that the authors have sought to unveil in this chapter. Thus, there is a need for a research agenda dedicated to the importance of variation and dynamic change in language learning.

Part 5: L3/*L_n* and Cognition

Chapter 20: Multilingualism and Cognitive Control in the Brain (Chung-Fat-Yiim, Hayakawa, & Marian)

This chapter examines the impact of multilingual language experience on cognitive control. Converging evidence reveals that bilinguals' languages are constantly active, even when only a single language is required. The

need to control interference from co-activated languages places unique demands on cognitive systems, with consequences for performance as well as brain structure and function. Despite growing recognition within the scientific community of the variability among (multilingual) speakers, researchers often continue – erroneously – to designate individuals as monolingual or bilingual even though many speak more than two languages.

Chung-Fat-Yim, Hayakawa, and Marian begin with a brief overview of the neuroimaging literature on bilingualism and cognitive control, followed by a focus on three different groups who rely on varying degrees of language control to overcome competition from other languages: third-language learners, multilingual young adults, and simultaneous interpreters. Research on bilinguals who are in the process of acquiring an L3 reveals that early stages of language learning produce neural changes in regions underlying cognitive control, whereas studies on multilingual young adults reveal that the effects of language experience may reflect a qualitative difference between monolingual and multilingual processing rather than a cumulative effect of increased linguistic knowledge. Finally, among simultaneous interpreters, changes in gray matter volume and white matter integrity have been found in brain areas associated with language selection and cognitive control, which may reflect increased neural efficiency due to experience with rapid translation. These findings are discussed in light of their potential implications for our understanding of multilingualism and the value of moving beyond the monolingual–bilingual dichotomy.

Chapter 21: Multilingualism and Cognitive Reserve (Calvo & Bialystok)

During the last decades, different concepts of reserve have been postulated to account for the brain's capacity for resilience in the face of neurodegeneration. Whereas cognitive reserve refers to the behavioral exponents of neuroplasticity accrued to resist changes associated with normal or pathological aging, brain reserve describes a biological trait (e.g., having larger brains, more neurons) that allows people to cope with declining cognitive capacity. Bilingualism has been shown to enhance cognitive reserve in older age, correlating with postponed symptoms of dementia across large populations. Nonetheless, the evidence remains inconsistent, and the trajectory of these effects is not clear. A possible explanation for the discrepancies between findings is the fact that bilingualism has been treated as a categorical variable (bilingual/monolingual), whereas it is actually a broader concept that depends on sociolinguistic factors. In this respect, one aspect of the bilingual experience that has not been studied extensively is the case of people who speak more than two languages.

Calvo and Bialystok aim to examine the literature addressing the relationship between the bilingual experience and reserve to delineate the major trends in the field, starting with a discussion of the operationalization of cognitive reserve. They then review the bi-multilingual literature to evaluate the question of whether bi-multilingualism leads to higher cognitive reserve. For this purpose, they re-examine three areas: (1) results indicating a postponement of symptoms of dementia, (2) results showing differences in brain pathology, and (3) results describing the progression of pathology in bi-multilinguals. Such considerations may shed light not just on the relationship between bi-multilingualism and cognitive reserve but may also lead to a re-evaluation of the construct in the bilingual literature and its implication in clinical studies.

Chapter 22: The Effects of Multilingualism on Brain Structure, Language Control, and Language Processing: Insights from MRI (Yee, DeLuca, & Pliatsikas)

The use of more than one language has substantial implications for underlying neural mechanisms in terms of brain structure, function, and processing. Indeed, a growing body of research shows that the brain adapts in relation to the learning and acquisition of an L2. However, the literature is scarce when it comes to if and/or how these processes differ when we learn a third (or additional) language. Do we observe continuous brain adaptations to multilingualism in terms of its structural architecture, functional connectivity, and neural network processing? And, if so, how? Does the sheer number of spoken languages modulate these changes, or are other factors at play, such as proficiency and use of each language?

Yee, DeLuca, and Pliatsikas review the available evidence to date, addressing these questions to understand the extent to which bilingualism and multilingualism neural effects differ. They begin with a short introduction on the effects of bilingualism on brain structure and function before transitioning to how these effects might apply similarly or differentially to multilingualism. The studies reviewed reveal initial effects of multilingualism on (sub)cortical gray matter volume and white matter tracts' integrity. The authors also describe the various processes that occur during language processing and control and highlight variations in resting-state functional connectivity. Moreover, they discuss the effect of modulating factors on (multilingual) neuroplasticity such as age of acquisition, proficiency, and expertise level. The chapter then presents (non)conflicting evidence in the literature and consolidates the findings via suggestions based on contemporary theories, before posing future directions for the field.

Chapter 23: Mechanisms of Cognitive Aging in Multilingualism (Antolovic, Higby, & Obler)

The process of aging encompasses lifetime dynamic changes that occur in the body (and mind). A growing field investigates how lifetime language experiences (such as multilingualism) impact aging processes. Such experiences may impact the brain and potentially slow cognitive declines related to aging. Because language abilities are embedded in and interact with more general cognitive mechanisms, language and cognitive processes impact each other at many levels. Thus, the lifetime use and management of multiple languages might lead to the strengthening of cognitive mechanisms used for language processing and production. However, some researchers have challenged this proposition and argue that domain-specific (and not necessarily domain-general) mechanisms support language. Much of the literature to date on language control, aging, and cognition comes from bilingual studies, whereas this type of work in multilinguals is only recently emerging. Thus, novel important questions have arisen (e.g., is there an additive protection effect on cognition and cognitive decline in aging?) that link aging with the experience of being multilingual as a distinct case from bilingualism.

Antolovic, Higby, and Obler first review how aging and multilingualism impact cognitive and executive functioning. Next, they outline three mechanisms to describe how multilingualism may interact with and modulate aging: compensation, maintenance, and reserve. These three mechanisms highlight processes underlying cognitive changes at the interface between aging and multilingualism and provide initial frameworks for predicting if and particularly how multilingual aging impacts cognitive abilities.

Chapter 24: Multilingualism and Language Impairment (Goral & Fortunato-Tavares)

In this chapter, Goral and Fortunato-Tavares review studies of multilingual people with language impairments, specifically autism, dyslexia, and developmental language disorder in children, and aphasia and traumatic brain injury in adults. The authors address three topics that have emerged: the disadvantages and advantages of being multilingual, the manifestation of impairments across different languages, and cross-language effects following intervention. Whereas the field of language impairment and bilingualism has grown, few studies have focused specifically on multilingual people, and even fewer have compared multilingual to bilingual individuals. Further, methodological differences among the studies and the limited amount of data for each communication disorder impede the ability to draw consistent conclusions. Despite these limitations, the authors discuss common themes and point to future directions, proposing

that the study of more than two languages can add to the understanding of key aspects of language impairment, representation, and processing.

Part 6: Research Methods in L3/Ln

Chapter 25: Innovations and Challenges in Acquisition and Processing Methodologies for L3/Ln (Pereira Soares, Chaouch-Orozco, & González Alonso)

Methodological innovation is one of the driving forces of scientific progress within a field. Such innovation can yield new answers to old questions and stimulate theoretical development in light of different sources of data on phenomena we already believe to know well. These advancements, however, are always at risk of focusing on the mastery of complex experimental techniques at the expense of the necessary focus on the questions that truly drive the field.

In their chapter, Pereira Soares, Chaouch-Orozco, and González Alonso present an overview of the work targeting language processing in a third or additional language, moving beyond the more commonly studied area of bilingual language processing. In many cases, these studies follow from the tradition of the psycholinguistics of L2 acquisition research to answer questions relative to specific theories of L3/Ln acquisition. However, the authors show that the scope of psycholinguistics, neurolinguistics, and computational linguistics in multilingualism research extends beyond these L2-specific questions and requires L3-specific methodological advances.

Chapter 26: Corpus Research (Wulff)

The inherent complexities of the multilingual scenario that most, if not all, of the present chapters have commented on, are not alien to corpus research. However, there is a scarcity of resources for carrying out this type of investigation. In her chapter, Wulff points to this problem and offers a relevant tool and foundational attempts to build such corpora in the near future.

Wulff's chapter is devoted to discussing L3/Ln research involving the use of publicly available corpora from multilingual speakers, directing the reader toward these resources while acknowledging the need for additional corpora. The author then describes the results of a survey conducted with L3/Ln researchers on the essential features of future L3/Ln corpora, constituting a first step in this necessary enterprise. Finally, the chapter closes by discussing how L3/Ln corpus research can complement (and, on occasions, be preferable to) experimental research.

Chapter 27: Case Study Research in Multilingual Contexts (Hammarberg)

In contrast to other areas of research within the field of L3/Ln acquisition and processing, case studies are relatively well represented, with studies spanning a broad scope. Hammarberg's chapter offers a detailed summary of such investigations, while also aiming at differentiating multilingual studies from those involving only two languages, something that has not been much highlighted in a literature that has traditionally had a "second language acquisition" focus but has, on many occasions, dealt with more than two languages.

Thus, Hammarberg's contribution explores case study research applied to multilingual contexts. The chapter first briefly describes the methodology and the multilingual scope of this type of work. Then, it discusses case studies in multilingual contexts that have investigated language acquisition and production, intercomprehension processes, the case of polyglots, linguistic biographies, self-reports, and the subjective experience of multilingual speakers.

Chapter 28: Using Artificial Languages to Study Third Language Learning and Processing (Grey)

In comparison with the bilingual scenario, studying L3/Ln speakers constitutes a dramatic increase in the difficulties associated with finding and using experimental setups that are informative and logistically feasible. The many challenges faced by L3/Ln researchers must, on many occasions, be addressed by making use of innovative solutions. One such answer to these practical obstacles consists of employing artificial linguistic systems, which, as Grey's chapter effectively shows, provide numerous benefits in this endeavor.

In particular, Grey discusses the advantages and potential of employing three types of artificial (constructed) linguistic systems in the study of multilingual language acquisition and processing: Artificial languages, semi-artificial languages, and mini-languages. In addition, the chapter reviews previous research using these methodologies and discusses relevant topics where these methods have made an impact, such as the study of L1/L2 transfer and the potential advantages bilingual speakers have in subsequent language learning.

Chapter 29: Statistical Modeling in L3/Ln Acquisition (Duarte Garcia)

One of the most immediate consequences of conducting L3/Ln research, when myriad factors need to be accounted for and controlled, is that sample sizes tend to be quite small. This is a problem that broadly affects psychological research, but it is much more acute in the type of investigations that

this handbook is concerned with. We could not think of a better way to end this volume than by drawing attention to an increasingly popular statistical approach, Bayesian data analysis, which can effectively handle small sample sizes – one of the most urgent challenges in L3/ L_n research.

In a practical introductory chapter, Duarte Garcia discusses the utility and appropriateness of Bayesian statistical analyses to approach L3/ L_n data, focusing on the common problem of reduced sample sizes and on the much-needed harmony between statistical analyses and theoretical assumptions. Duarte Garcia makes a persuasive case for the use of Bayesian frameworks to analyze multilingual language acquisition data, and walks the reader through a re-analysis of a well-known data set, Rothman (2010), to showcase what these approaches have to offer for a more scientifically rigorous practice.

Conclusion

Despite the very specific, sometimes non-intersecting, foci of each individual chapter, there are key commonalities and recurrent themes throughout which highlight past, present, and future potential for cross-fertilization and collaboration between subfields. Without exception, each chapter, written by world-leading experts in their respective fields, treats/considers/ponders the unique nature and/or contributions of a linguistic state where at least three languages in a single individual are implicated for questions related to how multiple languages: (1) are acquired/learned and processed; (2) interact; (3) need to be controlled for efficient and effective communication; (4) are socially manifested and conditioned; and (5) are implicated in structural and functional changes to cognition and the physical brain, inclusive of effects for atypical language across the lifespan and healthy and neurodegenerative aging. Each chapter expertly summarizes what we know to-date in these areas of multilingualism while carving out some gaps in the literature as well as novel questions for the near future. This alone makes the sum total of this book worth even more than its constituent parts.

To be sure, more work is needed to understand the similarities and differences between acquiring, processing, mentally juggling and/or navigating the social landscapes of a life with at least three languages as compared to two (bilingualism) or one (monolingualism). As a wholistic reading of this book or, indeed, any given chapter shows, *multilingualism is not simply a subcase of bilingualism*. Indeed, it is not yet clear what, if any, additional contribution yet another language (beyond two) would bring for multifarious questions, for example:

Is it really “easier” to acquire additional languages if one already knows two, and, if so, what underlies this advantage?

Is acquiring simultaneously three or more languages distinct from acquiring two and, if so, how, and why?

Does having three or more languages yield differential patterns of crosslinguistic influence, and, if so, what additional factors (e.g., (dis) similarity in the triad) moderate this?

Does the mind/brain adapt differentially to accommodate the processing and controlling of three or more language, relative to just two?

What differences can we expect for any multilingual domain of inquiry dependent on the type and timing of previous – before additional languages are added – linguistic experience?

While we do not know the answer to these mere example questions – there are many more to be sure – researchers are confident of at least a few things. To start, the human linguistic and mental capacities are perfectly capable of acquiring, processing, and managing multiple languages. That is, multilingualism as compared to bilingualism or monolingualism imposes no insurmountable obstacles, confusion, or strain on our mental systems. Beyond potential benefits for domain general neurocognition, protection against age-related decline, the broadening of an individual's opportunities for meaningful cross-cultural communication, social mobility, and building diverse identities, increased multilingualism can have positive collective effects for societies not least in fostering greater cross-cultural awareness and acceptance, maintenance of (endangered) heritage languages, and broader economic prosperity. Nevertheless, we know that there are tradeoffs at the same time. To cite merely one example, acquiring additional languages can come at some costs to the ones we previously knew: crosslinguistic influence and attrition are not unidirectional.

There is much more that could be said by way of a summative conclusion to introduce this volume, but virtually no amount of space would do justice to the plethora of ideas, suggestions, queries, and more within the pages of these individual chapters. And so, we leave the rest of the discovery process to the reader of this anthology, confident in the fact that it will serve seasoned, fledging, and aspirational researchers alike working on or merely interested in the contemporary study of multilingualism in all its facets.

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