1 Introduction and Overview

Research Scope, Themes and Issues

Language aptitude and working memory in SLA

Even casual observations in our daily lives tell us that some people are able to learn a foreign or second language (L2) easier, faster and/or better than others (Grigorenko *et al*., 2000; Segalowitz, 1997). This common phenomenon is best captured by the concept of language aptitude in applied linguistics. By definition, L2 aptitude presupposes that 'there is a specific talent for learning foreign languages which exhibits considerable variation between individual learners' (Dörnyei & Skehan, 2003; Skehan, 1998). This underlying assumption of an L2 aptitude was put to considerable test as early as the 1950s and 1960s, mostly with respect to the research done by John Carroll on US military personnel (see Spolsky, 1995; Stansfield, 1989).

From the 1970s, however, research on L2 aptitude languished, with 'relatively little empirical work and little theorizing' taking place during the next three decades (Skehan, 2002: 69). This lack of research interest stemmed partly from several major criticisms levelled against the very concept of language aptitude *per se* (for more detailed discussion see Dörnyei & Skehan, 2003; Skehan, 1998, 2002). The first accusation was related to the anti-egalitarian 'labelling effect' of a concept that assigns the label of 'loser' to anyone who gets a low aptitude score (e.g. from the Modern Language Aptitude Test, or MLAT; Carroll & Sapon, 1959). The second accusation targeted the 'indecent origin' of the outdated teaching methodology used during the heyday of early language aptitude research (i.e. the audiolingual method, which was dominant in the 1950s when Carroll conducted most of his aptitude research). As a result of these accusations and other criticisms, such as Krashen's (1980) verdict that aptitude predicts only explicit learning, not language acquisition, there was little research on L2 aptitude from the 1970s until the 1990s (Wen *et al*., 2017).

In recent years, however, research on L2 aptitude has managed to gain some renewed momentum (Granena & Long, 2013; Granena *et al.*, 2016; Li *et al.*, 2015; Robinson, 2002). Intriguingly, this new body of research has consistently contradicted the criticisms made of the concept of language aptitude (Skehan, 2015b). For example, instead of being 'outdated' and 'ineffective', the concept of L2 aptitude is now being viewed as being very relevant to L2 learning, even in today's prevailing communicative L2 classrooms (Granena, 2013; Gregersen & MacIntyre, 2014; Skehan, 2015b; Vatz *et al.*, 2013). More importantly, research on second language acquisition (SLA) has increasingly confirmed that L2 aptitude is not just confined to traditional instructional settings but is also relevant under different learning conditions (e.g. implicit versus explicit; Granena, 2016) and different learning contexts (Robinson, 2007). In a recent meta-analysis of the empirical research conducted over the past 50 years, Li (2015) provided compelling evidence of a positive link between L2 aptitude and L2 grammar learning.

Nonetheless, this renewed wave of research interest has been accompanied by concerted calls among researchers to *reconsider* and *reconceptualize* the construct of L2 aptitude (Ganschow & Sparks, 2001; Granena, 2013; Kormos, 2013; Parry & Child, 1990; Robinson, 2002b, 2005, 2012; Skehan, 1998, 2002, 2012, 2015b, 2016; Wen & Skehan, 2011). The current research on L2 aptitude is being actively pursued by scholars from multiple disciplines—educational psychology, applied linguistics, cognitive science and neuroscience (Wen, 2012b; Wen *et al.*, 2017). Through these research efforts, a multitude of L2 aptitude models have been proposed, such as the linguistic coding difficulties hypothesis (LCDH) by Sparks and colleagues, the cognitive ability for novelty in the acquisition of language (CANAL-F) model by Grigorenko, Sternberg and colleagues, Peter Skehan's macro-SLA aptitude model and the 'aptitude complexes' model by Peter Robinson. Recently, cognitive scientists and neuroscientists have made significant contributions to L2 aptitude research by proposing innovative models from their own theoretical perspectives, including the impressive high-level language aptitude battery (Hi-LAB) model and neurological and brain network-based aptitude models (Wen, 2012b; Wen *et al.*, 2017).

Most relevantly, a consistent theme that has emerged either directly or indirectly from this renewed research interest is the proposal to incorporate the cognitive construct of working memory (WM) as a central component of L2 aptitude (e.g. Aguado, 2012; Hummel, 2009; Kormos, 2013; Linck & Weiss, 2015; McLaughlin, 1995; Miyake & Friedman, 1998; Sawyer & Ranta, 2001;

Skehan, 1998, 2002, 2012; Wen, 2007, 2012b; Wen & Skehan, 2011; Williams, 2012, 2015; Yoshimura, 2001). This proposal has garnered increasing attention in recent years from SLA scholars interested in language aptitude research (e.g. Dekeyser & Koeth, 2011; Juffs & Harrington, 2011; Kormos, 2013; see also Ellis & Shintani, 2014; Mitchell *et al.*, 2013; Singleton, 2014). This innovative conception of 'WM as L2 aptitude' thus constitutes the overarching theme of this book, and is fully discussed in Chapter 9. In other words, the first and foremost motivation of this book is to review and evaluate the extent to which the cognitive construct of WM plays a central role in SLA as an aptitude component.

L2 task-based planning and performance research in SLA

Situated within the postulation of 'WM as L2 aptitude', this book is also partially motivated by the ongoing debate in current research on L2 task-based language learning and teaching (Robinson, 2011; Skehan, 2011, 2014, 2015a, 2015c). In the realm of L2 task-based planning research, for example, an early paper by Rod Ellis (1987) is generally regarded as seminal in that it triggered enormous enthusiasm among SLA scholars to examine the variegated effects of *planning* on L2 task-based performance (R. Ellis, 2005; Skehan & Foster, 2012). These SLA scholars include Rod Ellis, Michael Long, Graham Crookes, Peter Skehan, Peter Robinson and Martin Bygate, among many others (Bygate, 2015). These scholars have published a number of empirical studies on this topic, culminating in an edited volume (R. Ellis, 2005) and a special issue of the journal *Applied Linguistics*, led by a review article by Rod Ellis (2009). Overall, these studies have adopted various perspectives to investigate the different effects of planning, either independently or in combination with various task features/designs and implementation variables, and explore its effects on L2 task performance with respect to the three global dimensions of complexity, accuracy and fluency (i.e. the 'CAF' framework; Housen & Kuiken, 2009; Housen *et al.*, 2012; cf. Lambert & Kormos, 2014).

Indeed, most of the hypotheses regarding the effects of planning on L2 task performance have been borne out in empirical studies (R. Ellis, 2005; Skehan, 2014, 2015a). For example, giving L2 learners time to plan before executing a task normally results in the learners developing more fluent and complex speech (Foster & Skehan, 1996; Mehnert, 1998; Nielson, 2014). However, what is more intriguing and controversial is the inconsistent results observed with accuracy measures, which subsequently give way to two

competing theoretical views on the cognitive mechanisms underlying these discrepancies in L2 task performance (Révész, 2014). For instance, Skehan (1998, 2009, 2014, 2015a, 2015c) postulated a 'limited attention capacity' theory epitomized by a 'tradeoff hypothesis' that assumes competition for cognitive resources with respect to complexity, accuracy and fluency (especially between the first two). In contrast, Robinson's (2001, 2011, 2012, 2015) 'cognition hypothesis' advocates a 'multiple-resources' view of attention and processing, under which the learner is empowered with enhanced capacity to attend to more than one area of language performance (e.g. when prompted by manipulating the cognitive complexity of the task). In other words, if the task is complex enough, it is possible to expect improved performance in all three performance areas, that is, more complex, accurate and fluent speech.

When this debate is examined from the broader perspective of cognitive psychology, the controversy can be interpreted as reflecting two rather different epistemological stances on the function of the cognitive construct of 'attention' and its consequential effects (which sometimes interplay with planning) on L2 speech performance. Given this unresolved issue, it is conceivable that a clearer understanding of the relevant cognitive functions supporting L2 speech planning and performance is necessary before such disputes can be resolved and a consensus reached (Nielson, 2014; Révész, 2014).

Regarding the cognitive underpinnings of L2 task performance, Rod Ellis (2005) appeared to side with Skehan's stance on the 'limited attention capacity' hypothesis. In this respect, Ellis further highlighted three possible cognitive constructs that presumably influence L2 learners' speech performance under planning conditions, namely the noticing/attention mechanism (Schmidt, 1990), the focus on form mechanism (Doughty, 2001) and limited WM capacity (Baddeley, 2003). Among the three constructs, it can be argued that WM emerges as the most pivotal resource in regulating and modulating the effects of the other two mechanisms on speech planning and task performance.

Indeed, some preliminary studies following this line of inquiry have demonstrated that WM plays an important role in mediating various L2 task features/designs and thus ultimately affecting L2 speech performance (e.g. Ahmadian, 2012, 2013; Fortkamp, 1999, 2003; Kim *et al.*, 2015). Despite this initial evidence, the assumption that planning can compensate for WM limitations in L2 task performance remains largely inconclusive and merits further examination (Nielson, 2014).

In this sense, a second motivation of this book is to elucidate the cognitive underpinnings of L2 task planning and speech performance by specifying the possible effects of the WM functions independently or in combination with the task features or designs. Hopefully, this WM perspective on L2 task performance will help shed light on the current 'tradeoff–cognition' debate in research on task-based language learning and teaching (Robinson, 2015; Skehan, 2015c). This second theme figures prominently in Chapter 8, which demonstrates how the integrated WM–SLA perspective can shed light on more focused research on the intricate relationships between WM, tasks and L2 speech performance.

Summary of the motivations for this book

In recent years, an increasing number of SLA researchers have examined the role of WM in different areas of SLA (e.g. Juffs & Harrington, 2011; Sagarra, 2013; Wen, 2012a; Williams, 2012). An increasing number of empirical studies on SLA have also begun to converge on the pervasive effects of WM on L2 learning processes and outcomes—see for example Linck *et al.* (2014) for an updated comprehensive research synthesis and meta-analysis and Wen *et al.* (2013, 2015) for two collections of recent empirical studies. Nonetheless, given the myriad WM models (e.g. Miyake & Shah, 1999), complicated by the daunting number of currently available WM span tasks (e.g. the non-word repetition span, the reading span and the operation span task) from the feeder discipline of cognitive psychology, SLA researchers are likely to face and experience confusion in applying the WM construct in their research designs and methodologies.

Indeed, the lack of consensus on the WM construct among SLA researchers and the inconsistent WM measures implemented in the current WM–SLA empirical studies are already imposing a considerable challenge for those SLA researchers who are seeking to replicate this research (such as L2 interaction studies; Gass & Valmori, 2015) and make it even more difficult to systematically compare their results across studies (Gass & Lee, 2011; Juffs, 2006; Juffs & Harrington, 2011; Linck *et al.*, 2014). In the worst-case scenario, WM–SLA studies may suffer severe limitations and even pitfalls in their research designs and methodologies, which could result in potential fallacies and caveats in research practice (Linck *et al.*, 2014; Wen, 2012a, 2014, 2015).

To address some of these issues besetting current WM–SLA research and to further advance this interdisciplinary enterprise, in this book I aim to

introduce a more *principled* approach to conceptualizing and operationalizing WM in SLA research. In pursuit of this goal, I first survey, then synthesize and finally *integrate* research insights from the cognitive sciences (in particular, WM research in cognitive psychology) and applied linguistics (in particular cognitively oriented SLA research) to advocate an integrated perspective on WM and SLA research. Then, expanding on this conceptual framework, I propose a theoretical model of WM and SLA (the phonological/executive model) that not only integrates and accommodates empirical evidence in the current WM–SLA research, but also provides an overarching framework for orienting future WM–SLA explorations.

Outline of the Book

As mentioned above, the overall aim of this book is to offer a more *principled* approach to situating the cognitive construct of WM within SLA research. To that end, the book is organized as three parts. Following this introductory chapter, Part 1 comprises two chapters (Chapters 2 and 3) that lay the theoretical and methodological foundations of the book as a whole. More specifically, Chapter 2 first traces the evolution and development of the WM concept in multiple disciplines of the cognitive sciences that have provided sources for the WM theories used in most SLA research. The chapter provides a critical review of the current theoretical models and the controversies surrounding the multiple perspectives on the construct. The review culminates in consensual and nomothetic conceptions of the WM construct (as consisting of multiple components/functions) that *integrate* multidisciplinary perspectives from major fields of the cognitive sciences (e.g. psychology, biology, neuroscience, computer science, anthropology and philosophy). It is argued that such unifying characterizations of the WM construct are essential for providing a viable theoretical foundation for conceptualizing the WM construct for application in more practical areas (such as in general education and language learning).

Following the discussion of the WM theories in Chapter 2, Chapter 3 discusses the methodological issues related to the WM measures and their assessment procedures. After describing the prevailing versions of the WM span tasks in the two major research paradigms in cognitive psychology, which include the simple memory span tasks (e.g. the digit span task and the non-word repetition span task) and complex memory span tasks (e.g. the reading span task and the operation span task), the chapter also discusses some of the

controversial issues besetting the wide array of WM measures with regard to their construction and implementation procedures. The chapter concludes by aligning the two versions of the WM span tasks (simple versus complex) with the putative underlying cognitive functions that are associated with the two distinct WM components (the phonological and executive components).

After outlining the theoretical and methodological foundations of WM in Part 1, in Part 2 (comprising Chapters 4 and 5) I synthesize specific strands of research on the role of WM in first and second language learning. Chapter 4 reviews the more specific lines of cognitive psycholinguistic research on WM and first language acquisition (L1A). A review of this body of WM–L1 research reveals two distinct research traditions that have gradually emerged on the two sides of the Atlantic (the European and North American paradigms), with each adhering to its own research focus on a certain WM component or area (phonological versus executive) and distinct research methodologies for the WM assessment procedures. The analysis subsequently converges on the initial links between the two key language-relevant WM components, namely phonological working memory (PWM) and executive working memory (EWM). This dichotomy serves as the precursor for the integrated conceptual framework of WM and SLA proposed in this book.

In Chapter 5, I first outline the major theoretical assumptions held by some SLA researchers that depict the potential links between the effects of WM and L2 acquisition and processing. Then, I further synthesize the current WM and SLA research to provide a state-of-the-art review of this area. The review not only points to the positive theoretical links between WM and the essential components of SLA, but also reveals the inherent shortcomings and caveats in the theoretical conceptualizations and research methodologies in current research practice. It is argued that a major factor in these shortcomings stems from the current disputes and controversies over the nature of the WM construct and the lack of a standardized assessment procedure for its measurement. Therefore, it is argued that a more principled approach to conceptualizing and measuring WM is needed in SLA research.

To resolve the theoretical and methodological issues in the current WM–SLA research, in Part 3 of the book I present an integrated perspective on WM and SLA research. In Chapter 6, an integrated conceptual framework for WM and SLA research is presented. The chapter begins by redefining the WM construct in SLA research on the basis of the unified theories (reviewed in Chapter 2) and proceeds to provide a detailed account of the integrated

conceptual framework, including its structure and constitutive WM components. The chapter also highlights the theoretical and methodological implications of this integrated perspective for future WM–SLA research.

Having defined the integrated conceptual framework, Chapter 7 begins by demonstrating how this integrated approach can help to reconceptualize and reframe specific areas of WM–SLA research. Drawing on the basic tenets of the integrated framework and emerging patterns with respect to the distinct effects of the two major WM components (phonological and executive), the chapter formulates an integrated theoretical model that serves to align each component and its associated functions with their likely affected SLA domains and processes. The resulting phonological/executive (P/E) model encapsulates hypotheses that capture these juxtapositions.

Given that the research on L2 planning and L2 task-based performance now occupies a dominant position in SLA, Chapter 8 further explores how the proposed integrated WM perspective (i.e. the P/E model) can help illuminate the theoretical debate on the 'tradeoff–cognition' hypothesis postulated to underlie L2 task performance (e.g. as indexed by the three dimensions of complexity, accuracy and fluency; i.e. the CAF framework). Because most of the participants in L2 task studies are college students who have already obtained intermediate and post-intermediate L2 proficiency (to complete a task), it can be argued that effects of PWM are minimal, while EWM can be expected to exert more influence on the selective areas of L2 task performance that rely on attention-regulating and attention-monitoring mechanisms. Therefore, it can be claimed that most of the hypotheses regarding WM–L2 task performance can be restricted to the effects of EWM. In terms of L2 task performance, it is further postulated that EWM should be linked more closely to the *fluency* measures (that subsume lexical retrieval efficiency) and *accuracy* measures that are likely to draw on the monitoring and self-repair mechanisms. The chapter also calls for distinctions to be made between the main effects, interaction effects and threshold effects of WM in relation to the task characteristics and implementation procedures when designing future studies of WM–L2 task performance.

In Chapter 9, the focus shifts from L2 acquisition, processing and performance to the relationship between WM and the longer-term development of L2 within the broader context of language aptitude research. After critically reviewing the current L2 aptitude models, the chapter proposes a reconceptualization of L2 aptitude from a WM perspective by elaborating

the rationale, feasibility, perceived advantages and possible limitations of the concept of L2 aptitude. The chapter thus argues that WM should be incorporated as a central aptitude component and that the relationship between WM and language aptitude should be *reconfigured* within the SLA developmental stages.

Chapter 10 concludes the book by first recapitulating the theoretical and methodological ramifications of the integrated perspective of WM for nuanced SLA research. The nature and major characteristics of SLA, including its *acquisitional* and *developmental* domains and essential *processing* and *performance* components, are thus put into better order. These domains and components are then further aligned with the underlying and modulating cognitive mechanisms of the multiple WM components and functions, particularly those associated with PWM and EWM. Ultimately, the call is made for more concerted efforts from multiple disciplines, including the cognitive sciences and SLA, to explore the complexities and intricacies of WM and SLA. To facilitate these multidisciplinary efforts, an integrated research agenda is also proposed for the shared goals of arriving at a deeper understanding of human cognition and bilingualism. It is therefore my final hope that the integrated account of WM and SLA proposed in this book will shed light on the complex relationship between WM and SLA and ultimately inform L2 learning, training and classroom practice.