SLA Second Language Acquisition

Working Memory in Second Language Acquisition and Processing

Edited by Zhisheng (Edward) Wen, Mailce Borges Mota and Arthur McNeill

SECOND LANGUAGE ACQUISITION: 87

Working Memory in Second Language Acquisition and Processing

Edited by
Zhisheng (Edward) Wen, Mailce Borges Mota and Arthur McNeill

MULTILINGUAL MATTERS
Bristol • Buffalo • Toronto

Library of Congress Cataloging in Publication Data
A catalog record for this book is available from the Library of Congress.
Working Memory in Second Language Acquisition and Processing/Edited By Zhisheng (Edward) Wen, Mailce Borges Mota and Arthur McNeill.
Second Language Acquisition: 87.
1. Second language acquisition–Psychological aspects. 2. Memory. 3. Psycholinguistics. I. Wen, Zhisheng, editor. II. Mota, Mailce Borges, editor. III. McNeill, Arthur, editor.
P118.2.W667 2015
418.0071–dc23 2014047896

British Library Cataloguing in Publication Data
A catalogue entry for this book is available from the British Library.

ISBN-13: 978-1-78309-358-8 (hbk)
ISBN-13: 978-1-78309-357-1 (pbk)

Multilingual Matters
UK: St Nicholas House, 31-34 High Street, Bristol BS1 2AW, UK.
USA: UTP, 2250 Military Road, Tonawanda, NY 14150, USA.
Canada: UTP, 5201 Dufferin Street, North York, Ontario M3H 5T8, Canada.

Website: www.multilingual-matters.com
Twitter: Multi_Ling_Mat
Facebook: https://www.facebook.com/multilingualmatters
Blog: www.channelviewpublications.wordpress.com

The policy of Multilingual Matters/Channel View Publications is to use papers that are natural, renewable and recyclable products, made from wood grown in sustainable forests. In the manufacturing process of our books, and to further support our policy, preference is given to printers that have FSC and PEFC Chain of Custody certification. The FSC and/or PEFC logos will appear on those books where full certification has been granted to the printer concerned.

Typeset by Deanta Global Publishing Services Limited.
Printed and bound in Great Britain by Short Run Press Ltd.

Working Memory in Second Language Acquisition and Processing

SECOND LANGUAGE ACQUISITION

***Series Editor*: Professor David Singleton**, *University of Pannonia, Hungary* and Fellow Emeritus, *Trinity College, Dublin, Ireland*

This series brings together titles dealing with a variety of aspects of language acquisition and processing in situations where a language or languages other than the native language is involved. Second language is thus interpreted in its broadest possible sense. The volumes included in the series all offer in their different ways, on the one hand, exposition and discussion of empirical findings and, on the other, some degree of theoretical reflection. In this latter connection, no particular theoretical stance is privileged in the series; nor is any relevant perspective – sociolinguistic, psycholinguistic, neurolinguistic, etc. – deemed out of place. The intended readership of the series includes final-year undergraduates working on second language acquisition projects, postgraduate students involved in second language acquisition research, and researchers and teachers in general whose interests include a second language acquisition component.

Full details of all the books in this series and of all our other publications can be found on http://www.multilingual-matters.com, or by writing to Multilingual Matters, St Nicholas House, 31-34 High Street, Bristol BS1 2AW, UK.

Acknowledgements

The editors wish to thank all the contributors for making the effort to submit their chapters to the volume. In particular, we are grateful to Alan Juffs, Clare Wright and Peter Skehan for help in reviewing some chapters as well as contributing their own commentary chapters for each theme-based section. We also wish to express our special thanks to Michael Bunting, Randall Engle, Alan Baddeley, Nelson Cowan and John Williams for accepting our invitation to contribute their innovative insights into working memory second language acquisition (WM-SLA) issues at the latter stage of this volume. Their support to the WM-SLA enterprise is much welcomed and highly appreciated. Our thanks also go to the general editor of the SLA series, David Singleton, the anonymous reviewers and Laura Longworth of Multilingual Matters for their encouragement, assistance and patience at different stages of the book.

Finally, the editors gratefully acknowledge the initial support coming from the journal *Language Learning* (with its grant programme), The Center for Language Education of the Hong Kong University of Science and Technology, the Universidade Federal de Santa Catarina (UFSC) and the *Asian Journal of English Language Teaching* (AJELT) of The Chinese University of Hong Kong. Without their support, the current volume would not be possible.

Contributors

Mohammad Javad Ahmadian (PhD, University of Isfahan) is currently an assistant professor of second language acquisition at the University of Isfahan, Iran. His major research efforts and output have been in the area of task-based planning. Dr Ahmadian is interested in cognitive approaches to SLA, task-based language teaching and learning, and L2 speech production processes.

Alan Baddeley (PhD, Cambridge University) is a professor of psychology at the University of York. He graduated in psychology from University College London and after a master's from Princeton, completed a PhD at the Medical Research Council Applied Psychology Unit (APU) in Cambridge where he spent the next few years. He moved on to Sussex and then Stirling universities before returning to the APU where he followed Donald Broadbent as director. After 20 years, Alan retired from the directorship, moving first to Bristol and then to York University. Professor Baddeley is best known for his pioneering work on working memory, in particular for his multiple components model.

Melissa Baralt (PhD, Georgetown University) currently works as an assistant professor of Spanish applied linguistics at Florida International University in Miami, Florida. Her areas of research include task-based language teaching and learning, the perception and use of feedback during conversational interaction, cognitive and task design factors that affect language learning, and the ways in which teachers use tasks in the classroom – in both traditional and online settings.

Michael F. Bunting (PhD, University of Illinois at Chicago) is an associate research scientist and area director of cognitive psychology at the University of Maryland Center for Advanced Study of Language (CASL). He is a faculty affiliate of the University of Maryland's Neuroscience and Cognitive Science (NACS) Programme and the Department of Psychology. His research interests are the nature, organisation and trainability of working memory and selective attention; the structure of the inductive reasoning domain and the relationship between reasoning ability (general fluid intelligence) and working memory capacity; and the cognitive and non-cognitive determinants of human aptitude and acquired abilities, including complex skill acquisition and aptitude for foreign language learning.

Rendong Cai (PhD, Guangdong University of Foreign Studies) is currently a lecturer at the School of English and Education of Guangdong University of Foreign Studies. Dr Cai has research interests and publications in interpreting, psycholinguistics and applied linguistics.

Kiel Christianson (PhD, Michigan State University) is an associate professor at the Department of Educational Psychology and Beckman Institute for Advanced Science and Technology, University of Illinois, Urbana-Champaign. Dr Christianson's research is heavily influenced and informed by linguistic theory. Overarching themes in his present work are (mis)interpretation in sentence processing, morphological processing during reading and cross-linguistic research.

Nelson Cowan (PhD, University of Wisconsin) holds a distinguished Curators' Professor title at the University of Missouri, where he has taught since 1985. He authored *Attention and Memory: An Integrated Framework* (1995, Oxford University Press), *Working Memory Capacity* (2005, Psychology Press) and numerous journal articles on working memory and attention. He relates these interests to a curiosity about consciousness. He has broad interests in science, philosophy and current events and likes reading and film, but the non-work interests that receive a respectable amount of his time are those that involve his wife, three grown children, a grandchild, other relatives, a few close friends and a little exercise and amateur sport.

Yuncai Dai (PhD, Shanghai International Studies University) is currently a Professor and the Dean of the School of Foreign Languages at Chongqing Technology and Business University, China. Dr Dai's research interests include individual differences in second language acquisition, second language sentence processing and aptitude–treatment interaction.

Yanping Dong (PhD, Guangdong University of Foreign Studies) is a professor of psycholinguistics at the National Key Research Center for Linguistics and Applied Linguistics of Guangdong University of Foreign Studies. She has research interests and extensive publications in psycholinguistics, applied linguistics, bilingualism and interpreting. Professor Dong is also the founding president of the Chinese Association of Psycholinguistics.

Randall Engle (Randy) (PhD, Ohio State University) received his BS in psychology at West Virginia State University and his PhD in experimental psychology from Ohio State University. After positions at King College and the University of South Carolina, he served as chair of the School of Psychology at Georgia Institute of Technology (Georgia Tech) from 1995 to 2008. He was founding director of the Center for Advanced Brain Imaging from 2008 to 2009. His publications have been cited over 20,000 times and can be downloaded from http://psychology.gatech.edu/renglelab/index.htm. Dr Engle is a fellow of the American Psychological Association, the Association of Psychological Science, the American Association for the Advancement of Science, the Society of Experimental Psychology and the Memory Disorders Research Society. He has served as chair of the governing board of the Psychonomic Society, chair of the board of the Council of Graduate Departments of Psychology (COGDOP) and president of Division 3 of APA.

Sun-A Kim (PhD, University of Illinois at Urbana-Champaign) is currently an assistant professor at the Department of Chinese and Bilingual Studies, The Hong Kong Polytechnic University. Dr Kim's research interests include second language acquisition, the psycholinguistics of Chinese and of Korean and teaching Chinese and Korean as second languages.

Irina Konstantinova (MA, Ohio University) is currently involved in a major research project that investigates the relationship between cross-linguistic influence and working memory at Ohio University. Irina coordinates and leads weekly meetings, oversees the work of all students involved in this project and participates in data collection and analysis. Her interests include research in second language acquisition, working memory and transfer.

Scott Jarvis (PhD, Indiana University) holds the title of professor in the Department of Linguistics at Ohio University, where his main research interests include cross-linguistic influence, cognitive linguistics and research methods related to the investigation of language proficiency and the measurement of lexical diversity. His work in these areas has appeared in several authored and edited books, numerous book chapters and journal papers in the fields of second language acquisition and multilingualism. Professor Jarvis is also associate executive director for the journal *Language Learning*.

Alan Juffs (PhD, McGill University) is a professor of linguistics in the Department of Linguistics, University of Pittsburgh. He is the director of the English Language Institute at the University of Pittsburgh and co-editor of the Pitt Series in ESL textbooks published by the University of Michigan

Press. He is a former president of the University and College Intensive English Programs Consortium (UCIEP). Dr Juffs' research interests include the semantics–syntax interface and second language sentence processing. In addition to the more theoretical aspects of SLA, he conducts classroom research in ESL vocabulary teaching and materials development.

Shaofeng Li (PhD, Michigan State University) is currently a senior lecturer in applied language studies at the University of Auckland, New Zealand. Dr Li's research interests include form-focused instruction, the cognitive constraints of SLA (especially language aptitude and working memory) and language assessment. He has published widely in key international journals of applied linguistics and recently co-edited (with Rod Ellis) a special issue of *Applied Linguistics* (2015).

Yanbin Lu (PhD, Georgia State University) is currently an associate professor at the Department of Foreign Languages and Literatures, Tsinghua University, Beijing, China. Dr Lu's research interests include academic L2 writing assessment, working memory and L2 writing, and the teaching and learning of English for academic purposes (EAP) in EFL contexts.

Arthur McNeill (PhD, University of Wales, Swansea) is director of the Center for Language Education and associate dean of the School of Humanities and Social Science at the Hong Kong University of Science and Technology. Dr McNeill has research expertise and publications in key areas of applied linguistics, SLA, teacher education and vocabulary teaching and learning.

Anne Mitchell (MA, Ohio University) is a member of a research project at Ohio University examining the relationship between working memory, cross-linguistic influence and the language learning process. Her interests include research in working memory, second language acquisition and language transfer.

Mailce Borges Mota (PhD, Federal University of Santa Catarina) is currently a professor in the Department of Foreign Languages and Literatures at the Federal University of Santa Catarina, Brazil, and a research fellow of the prestigious Brazilian National Council for Scientific and Technological Development (CNPq). Dr Mota's research and publications have focused on the relationship between language processing and memory systems.

Michelle O'Malley (PhD, Ohio University) is currently an assistant professor in the Linguistics Department at Ohio University. Her areas of concentration are working memory and language acquisition, phonetics/phonology and dialect study. Michelle's dissertation research focused on the relative contributions of phonological and visual components of working memory to children's auditory language processing.

Jerome Packard (PhD, Cornell University) is a professor at the Department of East Asian Languages and Cultures and Beckman Institute for Advanced Science and Technology, University of Illinois, Urbana-Champaign. Professor Packard specialises in Chinese linguistics, Chinese word structure, Chinese psycholinguistics and Chinese language acquisition and pedagogy. His current research interests include sentence processing in native Mandarin speakers and learners of Mandarin as a second language, and the acquisition of reading by Chinese children in China.

Patrick Rebuschat (PhD, Cambridge University) is currently a lecturer in second language acquisition and bilingualism at the Department of Linguistics and English Language at Lancaster University. Prior to moving to Lancaster, he spent two years at Bangor University, Wales, and three years as a visiting assistant professor at Georgetown University in Washington, DC. Dr Rebuschat's research interests and extensive publications have focused on bilingual cognition, particularly the implicit and explicit learning of languages.

Kindra Santamaría (PhD, Florida State University) is now teaching French at Haltom High School in Texas. Prior to this, she worked as an assistant professor of French at Texas Christian University in Fort Worth, Texas. Dr Santamaria's research interests include working memory and classroom language acquisition.

Peter Skehan (PhD, Birkbeck College, University of London) is a professorial research fellow at St. Mary's University College, Twickenham, London, having previously worked at Auckland University, The Chinese University of Hong Kong, King's College London and Thames Valley University. Professor Skehan's research interests and extensive publications are in major areas of applied linguistics, second language acquisition, L2 task-based language teaching, learning and testing and individual differences (especially language aptitude).

Gretchen Sunderman (PhD, Penn State University) is an associate professor of Spanish linguistics at Florida State University in Tallahassee, Florida. Dr Sunderman's research interests include lexical processing and individual differences in second language acquisition.

Kaitlyn M. Tagarelli (PhD, Georgetown University) recently completed her PhD in applied linguistics and is currently a postdoctoral fellow in the Department of Psychology and Neuroscience at Dalhousie University in

Halifax, Nova Scotia. Dr Tagarelli's research focuses on the neural and cognitive mechanisms involved in second language learning, particularly which brain structures and memory systems underlie language learning, and how individual differences and learning conditions interact in ways that influence the language learning process and outcomes.

Zhisheng (Edward) Wen (PhD, The Chinese University of Hong Kong) is currently an associate professor at the School of Languages and Translation at Macao Polytechnic Institute (MPI). Dr Wen has lectured, researched and published extensively in second language acquisition, psycholinguistics and other areas of applied linguistics. His current research foci are theoretical, methodological and pedagogical issues surrounding cognitive aptitudes (e.g. working memory) in first and second language acquisition and processing. Dr Wen is a recipient of the 2012 Language Learning Roundtable Conference Grant and successfully convened the International Language Learning Roundtable on 'Memory and Second Language Acquisition' in Hong Kong (June, 2012).

John Williams (PhD, Cambridge University) is currently a reader in applied psycholinguistics at the Department of Theoretical and Applied Linguistics at the University of Cambridge. Dr Williams specialises in the cognitive mechanisms of second language learning and second language lexical and syntactic processing. His current research focuses on implicit learning of form-meaning connections and incidental learning of word order regularities. He has published numerous articles on these topics in journals such as *Language Learning*, *Studies in Second Language Acquisition* and *Applied Psycholinguistics*.

Clare Wright (PhD, Newcastle University) is currently a lecturer at the Department of English Language and Applied Linguistics at the University of Reading. Her main research focuses in the area of SLA with a particular emphasis on the development of grammatical accuracy and fluency in L2 English, L2 Mandarin and L2 French. Her research investigates linguistic, cognitive and contextual factors underpinning how language knowledge is acquired and processed, with special interest in how working memory can aid L2 development in and out of the classroom, as featured in her recent *TESOL Quarterly* paper and other publications.

Foreword

On a foreign language student's first trip abroad, an assignment might be asking a hotel concierge for directions to a popular café, navigating the streets and public transportation system and, at dinner, translating the waiter's dining recommendations for those companions who do not speak the language. These activities – formulating and following a plan, following directions and simultaneous translation – would be virtually impossible without the attentional and immediate memory system known as *working memory*. A convenient analogy for working memory is to think of it as the mental workspace of the mind: the small amount of memory that holds information and the capacity for attention control to manipulate that information for ongoing use. This dynamic working memory and attention system guides behaviour and permits conscious awareness of goal-relevant information. Another important function of the working memory system is to prevent potentially irrelevant or distracting information from gaining access to our consciousness. By deliberately focusing or dividing attention, that foreign language student can pay attention, make and maintain plans and engage in goal-directed behaviour.

It is for good reason that working memory processes are among the most important and widely studied components of human cognition. Working memory processes have been implicated in a variety of native language linguistic processes, such as paying attention to conversation, auditory and reading comprehension, speech planning, verbal problem solving and language use. Many aspects of first and second language comprehension rely heavily on working memory capacity: Working memory is positively correlated with first and second language vocabulary learning, reading and listening comprehension and writing proficiency (Atkins & Baddeley, 1998; Baddeley, 2000; Daneman & Hannon, 2007; Engle, 2001). Working memory is used when taking notes (Piolat *et al.*, 2005), while following directions (Engle *et al.*, 1991) or when ignoring visual and auditory distractions as well as internal distractions from one's own intruding thoughts and daydreams (Engle, 2001).

These same working memory processes are equally important outside of the verbal domain to learning, skills and abilities, including general fluid intelligence (Engle *et al.*, 1999), reasoning ability (Kyllonen & Christal, 1990), mathematical ability (Ashcraft & Krause, 2007) and spatial ability (Kane *et al.*, 2004). Because working memory plays an important role in these broader cognitive processes and abilities, it comes as no surprise that working memory is considered to be one of the most critical components of cognitive and linguistic achievement. The importance of working memory for everyday activities has been widely studied by cognitive psychologists interested in how memory works, by developmental psychologists interested in lifespan changes, by clinicians and psychiatrists interested in deficits due to illness or injury, and by educators interested in individual differences. While considerable progress has been made, the scientific study of the role of working memory in second language acquisition, by comparison to some of these other disciplines, has only just begun.

As almost anyone who has tried to learn another language can attest, second language learning can be a frustrating and time-consuming experience. This is true for adults and children alike. Despite serious effort and dedication, not all learners will achieve anything like native language proficiency. Even fewer still will learn to speak a second language without an 'accent'. For only the rarest of individuals, second language learning is easy and fast. For the vast majority of learners who want results, adult, post-critical period foreign language learning is not a casual enterprise. These observations of individual differences in ultimate attainment, as well as individual differences in the ease and rate of second language learning, suggest that there are abilities and talents that make some people better able than others to learn a second language. Hence, for these people, there is a *second language aptitude*.

Many factors complicate the scientific study of second language acquisition. For starters, the rate of learning is not a direct function of time on task, and it, as well as the way in which learners learn, varies by individual (McLaughlin, 1992). Furthermore, the greater the degree of dissimilarity between the second language a person wants to learn and his/her native language, the greater the difficulty of language learning. Some are fairly similar to the person's native language. English, for example, is one of 48 different living Germanic languages, which include Swedish, Dutch and German, and the majority of the English vocabulary is derived from Latin and French, which are members of another Indo-European language family, the Romance languages. As a result of these similarities, Swedish and French are easier for native English speakers to acquire than are languages from other more distally related language families. Learning Korean, which is a language isolate, or Arabic, a Semitic language of the Afro-Asiatic language family, represents a more significant challenge to native English speakers than learning more similar languages. Importantly, while the degree of similarity between a learner's native and target language is a determiner of the degree of difficulty of learning the language, research suggests that all languages require more or less the same aptitudes to learn (Carroll, 1985).

A fundamental tenet of cognition is that complex, high-level processes are dependent on lower-level, more elementary processes. For example, reading requires a complex interaction of lexical activation, syntactic parsing and meaning integration. If there is a deficiency in any one of these steps, the larger process fails. Some elementary processes are not specialised to any particular domain or broader skill, but are believed to be fundamental parts of all cognition.

It follows that people who possess processing advantages for these lower-level skills should also demonstrate processing advantages for more complex tasks. Variations between people for these skills are called individual differences, and there are four individual differences that are most clearly implicated as being important for understanding how well people perform high-level cognition (Kyllonen & Christal, 1990).

- *Working memory capacity*, the ability to temporarily retain information for short periods of time.
- *Declarative knowledge*, overall knowledge about the world or the domain at hand.
- *Procedural memory*, memory for automatised (non-conscious) procedures.
- *Processing speed*, how fast someone processes information.

These factors have been proposed as the primary sources of individual differences on cognitive tasks. They stem from a general outline of a standard cognitive architecture which charts the structures and processes that characterise human information processing, or the process of acquiring, retaining and using information.

This architecture is by no means comprehensive, but models used to explain performance on various cognitive and learning tasks have been developed from this framework (e.g. Anderson & Lebiere, 1998; Cowan, 1995). Individual differences may arise from any of the memory structures (procedural, working and declarative) or processing cycles (cognitive, motor and perceptual) in this framework, the key components being the type and extent of knowledge in declarative and procedural memory, working memory capacity and the speed with which one can execute the processing cycles (Kyllonen & Crystal, 1990). These are the four components of the four-sources model. Working memory capacity is thought to be the central factor in this model and is therefore considered to have the greatest influence on an individual's performance on cognitive and learning tasks.

Working memory is capacity and time limited, as is easy to see from one's own experience of memory limitations and forgetting. Who has not had the experience of meeting someone new and almost immediately forgetting his/her name, sometimes even before the conversation is over? There could be any number of reasons why this happens (inattentiveness, distractibility, information overload), but the point is that there are constraints on how much information can be managed, processed and integrated effectively all at once. Perhaps not surprisingly, people vary in their working memory capacity and in how susceptible they are to short-term forgetting.

Attention control is important to the function of the working memory system. Research indicates that attention control is one of those ubiquitous cognitive processes which operates across domains. Our view is that it is a central, limited-capacity, domain-general resource that can be voluntarily applied to holding and manipulating information in memory. The *central* aspect of attention indicates that the resource is shared among all modalities (vision, hearing, etc.) and types of information coding (phonological, orthographic, spatial, etc.). The *limited-capacity* aspect indicates that one type of manipulation or storage can be increased only at the expense of other types.

Science distinguishes between two fundamentally different forms of attention: exogenous and endogenous attention. From the amoeba that orients and moves away from bright illumination to the tourist entranced by the neon lights of Radio City Music Hall, organisms from the lowest form to the most advanced involuntarily orient towards (or sometimes away from) a stimulus that captures their attention. In contrast to exogenous attention, endogenous attention is paying attention to stimuli or locations of one's own choosing. Only the most evolved animals can voluntarily select objects to attend to. With intention and effort, the endogenous allocation of attention is under voluntary control, as when people allocate their attention according to variable instructions or pay-offs. However, attention is not completely voluntary: flashing lights, loud noises and sudden movements can involuntarily grab attention away from where it is intended, thus triggering an exogenous orienting response. Such a distraction can cause a lapse in attention to the task and, by extension, a failure to remember critical components of the task that was being completed (e.g. remembering the name of your new acquaintance or the context of the newspaper article you were just reading).

There are many diverse theoretical descriptions of the working memory system (cf. the 12 unique perspectives in Miyake and Shah [1999]). Baddeley and Hitch (1974) first described working memory as having two different subsystems or components: visuospatial working memory for manipulating and briefly maintaining information from the spatial domain; and phonological working memory for handling verbally mediated representations and processing (see also Baddeley, 1986, 2007; Baddeley & Logie, 1999). Research on structural models of working memory has addressed the further subdivision of these two primary components into subcomponents. Of relevance to the language community, Caplan and Waters (1999) suggested that verbal working memory should be differentiated for verbal (but not syntactic) processes for cognitive tasks generally versus syntactic/grammatical processes that support linguistically mediated tasks such as sentence processing and comprehension. Contrary to the approach that describes working memory in multiple task-specific processes, Kane *et al.* (2004) demonstrated that linguistic and non-linguistic (but still verbally mediated) tasks rely on a single pool of working memory resources and that working memory processes are by and large domain general.

More recent theories of working memory, such as Cowan's (1995, 2001, 2005) embedded processes model, are process oriented rather than structural. Cowan's model distinguishes a zone of privileged and immediate access – *the focus of attention* – from activated but not immediately accessible long-term memory. Information in the focus of attention is readily accessible and resistant to forgetting, but because the capacity of focus of attention is quite limited, very few items or fixed groups of items (*chunks*) can reside there. According to Cowan, that capacity may be as little as four items for the average individual. In contrast, the activated portion of long-term memory is not capacity limited, but memory in this state is prone to forgetting due to decay and/or interference (i.e. confusion with other similar information in memory). Attentional control processes are responsible for manipulating the contents of working memory. They activate, focus, update, switch and inhibit memory during information processing.

Because learning one's native language and learning a second one are both cases of language learning, the usual assumption is that information about one illuminates the other. Support for the idea that working memory plays an important role in second language acquisition comes from the Developmental Interdependence Hypothesis, which states that a learner's competence in the second language is at least partially dependent on competence in the first language (Cummins, 1979). This would be expected if working memory plays a role in ability for both first and second language processing. There is evidence showing that working memory is correlated with second language vocabulary acquisition time (Ellis, 1996), English as a second language vocabulary ability (Miyake & Friedman, 1998), second language explicit grammar learning (Tagarelli *et al.*, 2011) and second language reading and writing ability (Bergsleithner, 2010).

Linck *et al.* (2014) conducted the first comprehensive formal meta-analysis on the relationship between working memory and the products of second language acquisition: the development of second language