

Dayu Jiang

Cognitive Load Theory and Foreign Language Listening Comprehension

 Springer

Cognitive Load Theory and Foreign Language Listening Comprehension

Dayu Jiang

Cognitive Load Theory and Foreign Language Listening Comprehension

 Springer

Dayu Jiang
Wuhan University
Wuhan, China

ISBN 978-981-97-2316-4 ISBN 978-981-97-2317-1 (eBook)
<https://doi.org/10.1007/978-981-97-2317-1>

© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd. 2024

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd. The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

If disposing of this product, please recycle the paper.

Preface

Cognitive load theory, an instructional design theory developed on the basis of our ever-expanding knowledge of human cognitive architecture, deals with the design of teaching and learning approaches to facilitate the acquisition of meaningful knowledge (Sweller, 2010a, 2019; Sweller et al., 2011). When an instructional approach developed within the framework of cognitive load leads to better learning outcomes by using randomized, controlled experiments, a cognitive load effect is demonstrated. One of the cognitive load principles that have been generated since 1980s is the expertise reversal effect, which occurs when an instructional approach that is effective for novice learners is less effective or even counterproductive for more expert learners (Kalyuga et al, 2003; Sweller et al., 2011). Empirical evidence for the expertise reversal effect has come from research studies in domains of teaching technical and scientific knowledge (e.g., Homer & Plass, 2010; Kalyuga et al., 2003; Khacharem et al., 2014), and in the domain of first language acquisition, including reading and writing (e.g., Kalyuga et al., 2013; Oksa et al., 2010). However, limited research has been conducted to explore the expertise reversal effect in developing second language listening skills. This is an important area as there have existed data implying that foreign language listening skills can be developed more by reading rather than by listening (Jiang et al., 2018; Moussa-Inaty et al., 2012). These data are counter-intuitive but may be explained by the expertise reversal effect.

This book reports an empirical investigation through a series of four experiments to investigate the expertise reversal effect in the field of foreign language listening teaching and learning. Three instructional formats (read-only, listen-only, and read-and-listen) were designed to teach native Chinese students English (Experiments 1-3) or French (Experiment 4) listening skills. Experiment 1 (Chap. 8) found a significant interaction with no effect for learners with lower levels of listening expertise but a significant effect for learners with higher levels of listening expertise favouring the read-only approach. The results of Experiment 2 (Chap. 9) replicated the counterintuitive findings of Experiment 1. Experiment 3 (Chap. 10) testing less knowledgeable students than Experiments 1 and 2 indicated that the read-and-listen condition was more effective for novice learners. Experiment 4 (Chap. 11) testing beginner-level learners of French as a foreign language obtained results consistent with those of

Experiment 3 in that lower expertise learners gained greater benefits from the read-and-listen than the read-only or listen-only teaching approaches. It is concluded from the four experiments that the read-and-listen approach was advantageous for novice learners in learning foreign language listening skills but more expert learners could gain more benefits from the read-only approach.

Highlights of this book: it represents

- an interdisciplinary approach to understanding learning listening skills of a foreign language from the perspectives of cognitive load theory and second language acquisition theories;
- an exploration of when and how foreign language listening skills could be curiously improved more effectively by reading than by listening;
- a call to adjust instructional approaches to accommodate learners' expertise level with evidence from randomized controlled experiments;
- a development of the existing language comprehension frameworks by including working memory load as a crucial factor in written or verbal information processing;
- an application of cognitive load theory in a less well-structured subject area—foreign language learning.

Wuhan, China

Dayu Jiang

References

- Homer, B., & Plass, J. (2010). Expertise reversal for iconic representations in science visualizations. *Instructional Science*, *38*, 259–276.
- Jiang, D., Kalyuga, S., & Sweller, J. (2018). The Curious Case of Improving Foreign Language Listening Skills by Reading rather than Listening: An Expertise Reversal Effect. *Educational Psychology Review*, *30*, 1139–1165. <https://doi.org/10.1007/s10648-017-9427-1>
- Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). The Expertise Reversal Effect. *Educational Psychologist*, *38*, 23–31.
- Kalyuga, S., Law, Y., & Lee, C. (2013). Expertise reversal effect in reading Chinese texts with added causal words. *Instructional Science*, *41*, 481–497.
- Khacharem, A., Zoudji, B., Spanjers, I., & Kalyuga, S. (2014). Improving learning from animated soccer scenes: Evidence for the expertise reversal effect. *Computers in Human Behavior*, *35*, 339–349.
- Moussa-Inaty, J., Ayres, P., & Sweller, J. (2012). Improving Listening Skills in English as a Foreign Language by Reading Rather than Listening: A Cognitive Load Perspective. *Applied Cognitive Psychology*, *26*, 391–402. [10.1002/acp.1840](https://doi.org/10.1002/acp.1840)
- Oksa, A., Kalyuga, S., & Chandler, P. (2010). Expertise reversal effect in using explanatory notes for readers of shakespearean text. *Instructional Science*, *38*(3), 217–236.
- Sweller, J. (2010a). Cognitive Load Theory: Recent Theoretical Advances. In J. Plass, R. Moreno, & R. Brünken (Eds.), *Cognitive Load Theory* (pp. 29–47). Cambridge: Cambridge University Press.
- Sweller, J. (2019). Cognitive load theory and educational technology. *Educational Technology Research and Development*, *68*, 1–16. <https://doi.org/10.1007/s11423-019-09701-3>
- Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive Load Theory*. London: Springer. <https://doi.org/10.1007/978-1-4419-8126-4>

Acknowledgements

With regard to this book, I would like to express my greatest gratitude to my supervisors and mentors, Emeritus Professor Slava Kalyuga and Emeritus Professor John Sweller at the University of New South Wales, for their superb academic guidance, amazing support, insightful inspirations, and constant encouragements. This book is revised from my PhD thesis. Therefore, without their guidance and supervision, this book would never have come to be. In fact, my gratitude to them is beyond words.

I would also like to say thank you to the editors and anonymous reviewers from *Educational Psychology Review* and *The Quantitative Methods for Psychology*, the journals where some experiments included in this book have been published. Their intellectual input enhanced the quality of this book.

I am indebted to all the research participants, my colleagues and friends who helped me coordinate the experiments, without whom the research reported in this book could not be possible.

My appreciation goes to the editors at Springer Nature for their great support.

I am deeply grateful to my wonderful family. First, I would like to thank my parents, Liyan and Deyuan, and my mother-in-law Junfang Wang for always standing on my side. I also want to say thank you to my son Ruiqi and my daughter Yitong for being my continuous source of love, strength and momentum. Last but not least, I am very grateful to my wife, Xin, for supporting me in many ways and for allowing me concentrate on this book project as well as on my other academic pursuits.

***Confucian Analects* and the Expertise Reversal Effect**

An instance in Tsze-lû and Zan Yû of how Confucius dealt with his disciples according to their characters manifests the ideas of the expertise reversal effect.

子路問：“聞斯行諸？”

子曰：“有父兄在，如之何其聞斯行之！”

冉有問：“聞斯行諸？”

子曰：“聞斯行之！”

公西華曰：“由也問‘聞斯行諸’，子曰：‘有父兄在。’求也問‘聞斯行諸’，子曰：‘聞斯行之。’赤也惑，敢問。”

子曰：“求也退，故進之。由也兼人，故退之。”

—选自《論語•先進篇》

—Selected from Chap. 21, *Book XI: Hsien Tsin, Confucian Analects*

English Translations

Tsze-lû asked, “Should I immediately carry into practice what I heard?”

The Master said, “There are your father and elder brothers to be consulted; -- why should you act on that principle of immediately carrying into practice what you hear?”

Zan Yû asked the same, “Should I immediately carry into practice what I heard?”

The Master answered, “Immediately carry into practice what you hear.”

Kung-hsî Hwâ said, “Yû asked whether he should carry immediately into practice what he heard, and you said, ‘There are your father and elder brothers to be consulted.’ Ch’iû asked whether he should immediately carry into practice what he heard, and you said, ‘Carry it immediately into practice.’ I, Ch’ih, am perplexed, and venture to ask you for an explanation.”

The Master said, “Ch’iü is retiring and slow; therefore I urged him forward. Yü has more than his own share of energy; therefore I kept him back.”

—The English extract was adapted from Chapter XXI, *Confucian Analects* (Legge, 1966, pp. 147–148).

Contents

Part I Theoretical Background and Literature Review of Cognitive Load and Language Expertise	
1 Introduction	3
1.1 Listening Teaching Approaches	4
1.2 Cognitive Load Theory	5
1.3 Research Aims and Hypotheses	6
1.4 Scope of the Study	7
1.5 Significance of the Research	7
References	8
2 Human Cognitive Architecture	11
2.1 The Informational Dimension of the Architecture: Categories of Knowledge	12
2.2 The Structural Dimension of the Architecture: The Modal Model	13
2.3 The Operational Dimension of the Architecture: Five Principles	14
2.3.1 The Randomness as Genesis Principle	15
2.3.2 The Information Store Principle	15
2.3.3 The Borrowing and Reorganizing Principle	16
2.3.4 The Narrow Limits of Change Principle	16
2.3.5 The Environmental Organizing and Linking Principle	17
2.4 Chapter Summary	17
References	18
3 Sensory Memory, Working Memory, and Long-Term Memory	21
3.1 Sensory Memory	22
3.1.1 Iconic Memory	22
3.1.2 Echoic Memory	23
3.2 Working Memory	23

- 3.2.1 The Multi-Component Model of Working Memory 24
- 3.2.2 Characteristics of Working Memory 28
- 3.3 Long-Term Memory 30
 - 3.3.1 Declarative Knowledge Versus Procedural Knowledge 31
 - 3.3.2 Schema Theory: How Knowledge is Structured 32
- 3.4 Chapter Summary 34
- References 35
- 4 Cognitive Load: Categories and Measurements 39**
 - 4.1 Categories of Cognitive Load 39
 - 4.2 Measurements of Cognitive Load 40
 - 4.3 A Confirmatory Factor Analysis on Cognitive Load Model 43
 - 4.3.1 Method 44
 - 4.3.2 Results and Discussion 45
 - 4.3.3 Conclusion 46
 - 4.4 Calculation of Instructional Efficiency 47
 - 4.5 Chapter Summary 48
 - Appendix A: Subjective Rating Scale 49
 - References 49
- 5 Cognitive Load Effects 53**
 - 5.1 Redundancy Effect 53
 - 5.1.1 Evidence from Research in Technical and Scientific Teaching 54
 - 5.1.2 Evidence from Research on Developing Language Skills 55
 - 5.2 Transient Information Effect 56
 - 5.2.1 Evidence from Research in Technical and Scientific Teaching 56
 - 5.2.2 Evidence from Research on Developing Language Skills 58
 - 5.3 Imagination Effect (Mental Rehearsing) 60
 - 5.3.1 Evidence from Research in Technical and Scientific Teaching 61
 - 5.3.2 Evidence from Research on Developing Language Skills 62
 - 5.4 Expertise Reversal Effect 64
 - 5.4.1 Evidence from Research in Technical and Scientific Teaching 65
 - 5.4.2 Evidence from Research on Teaching (Second/ Foreign) Language Listening 66
 - 5.5 Chapter Summary 68
 - References 69

6	A Cognitive Perspective of Language Processing	75
6.1	Design Features of Language	76
6.1.1	Arbitrariness in Relations Between Form and Meaning	76
6.1.2	Duality of Patterning	76
6.1.3	Generative Capacity	77
6.2	Foreign Language Listening Expertise	77
6.2.1	Phonological Knowledge	78
6.2.2	Semantic Knowledge	79
6.2.3	Syntactic Knowledge	79
6.2.4	Pragmatic Knowledge	80
6.3	A Cognitive Perspective of Language Comprehension	80
6.3.1	A Cognitive Model of Listening Comprehension	81
6.3.2	A Cognitive Perspective of Reading Comprehension	84
6.4	Expert-Novice Differences in Listening Comprehension	86
6.4.1	Expert-Novice Differences in Terms of Memory	87
6.4.2	Expert-Novice Difference in Terms of Phonemic Coding Ability	88
6.4.3	Expert-Novice Difference in Terms of Grammatical Sensitivity	89
6.4.4	Expert-Novice Difference in Terms of Inductive Language Learning Ability	89
6.5	Factors of Element Interactivity in Listening Materials	90
6.6	Chapter Summary	91
	References	92

Part II Empirical Investigations

7	Research Hypotheses and Research Design	99
7.1	Conceptualization of Hypotheses	99
7.2	Research Design	102
7.3	Chapter Summary	104
	Appendix A: Ethical Approval	104
	References	105
8	Expertise Reversal Effect and Teaching EFL Listening Skills (Experiment 1)	107
8.1	Method	107
8.1.1	Participants	107
8.1.2	Materials	108
8.1.3	Procedures	109
8.1.4	Scoring	110
8.2	Results and Discussion	110
8.2.1	Results	110

8.2.2	Discussion	112
8.3	Chapter Summary	114
	Appendices: Instructional and Test Materials for Experiment 1	114
	References	119
9	Expertise Reversal Effect: When Years of Active Learning	
	Account for Language Expertise (Experiment 2)	121
9.1	Method	121
9.1.1	Participants	121
9.1.2	Materials	122
9.1.3	Procedures	122
9.1.4	Scoring	123
9.2	Results and Discussion	123
9.2.1	Results	123
9.2.2	Discussion	124
9.3	Chapter Summary	125
	Appendices: Instructional and Test Materials for Experiment 2	125
	References	130
10	Expertise Reversal Effect and Teaching EFL Listening Skills	
	to Lower Expertise Learners (Experiment 3)	131
10.1	Method	132
10.1.1	Participants	132
10.1.2	Materials	132
10.1.3	Procedures	133
10.1.4	Scoring	134
10.2	Results and Discussion	134
10.2.1	Results	134
10.2.2	Discussion	136
10.3	Chapter Summary	137
	Appendices: Instructional and Test Materials for Experiment 3	138
	References	141
11	Expertise Reversal Effect and Teaching French as a Foreign	
	Language Listening Skills (Experiment 4)	143
11.1	Method	143
11.1.1	Participants	143
11.1.2	Materials	144
11.1.3	Scoring	145
11.2	Results and Discussion	145
11.2.1	Results	145
11.2.2	Discussion	147
11.3	Chapter Summary	148
	Appendices: Instructional and Test Material for Experiment 4	149
	References	152

Part III General Discussion and Conclusion

12 General Discussion and Conclusion 155

12.1 Summary of Empirical Investigation 155

12.2 Transient Information Effect 157

12.2.1 Teaching Listening by Reading—Permanency
Counters Transiency 157

12.2.2 The Effectiveness of Teaching Listening
by Reading—Years of Language Learning
Experience Count 158

12.2.3 Teaching Listening by Listening—Transiency
Results in Incompetency 159

12.3 Imagination Effect 161

12.3.1 Imagination for Higher Expertise
Learner—the Sound of Words 161

12.3.2 Imagination for Lower Expertise
Learners—the Silence of Words 161

12.4 Redundancy Effect—When More is Less 162

12.5 Expertise Reversal Effect 163

12.6 Theoretical and Pedagogical Implications 165

12.7 Limitations of the Research and Suggestions for Future
Studies 165

12.8 Conclusion 167

References 167

List of Figures

- Fig. 2.1 The modal model of memory (adapted from Bruning et al. 2011) 14
- Fig. 3.1 Cognitive model of information processing (adapted from Mayer, 2009, 2024) 22
- Fig. 3.2 The original three-component model of working memory (Baddeley & Hitch, 1974) 24
- Fig. 3.3 A functional model of phonological short-term memory (Vallar & Papagno, 2002) 26
- Fig. 3.4 Current four-component model of working memory (adapted from Baddeley, 2010, 2015) 29
- Fig. 6.1 Schematic representation of the processing components involved in spoken language use (Levelt, 1993) 83
- Fig. 6.2 Schematic representation of the processing components involved in written language use (Perfetti, 1999, p.169) 85

List of Tables

Table 4.1	Means, standard deviations (SD), skewness, kurtosis, and correlations for the questionnaire items	45
Table 4.2	Factor loadings, standard errors (SE), <i>t</i> values, and <i>p</i> values for the questionnaire items	46
Table 8.1	Means and standard deviations for the listening performance scores, the subjective ratings of cognitive load, and the instructional efficiencies for different instructional groups and levels of learner listening expertise in Experiment 1	111
Table 9.1	Means and standard deviations for the listening performance scores, the subjective ratings of cognitive load, and the instructional efficiencies for different instructional groups in Experiment 2	124
Table 10.1	Means and standard deviations for the listening performance scores, the subjective ratings of cognitive load, and the instructional efficiencies for different instructional groups in Experiment 3	135
Table 11.1	Means and standard deviations for the listening performance scores, the subjective ratings of cognitive load, and the instructional efficiencies for different instructional groups in Experiment 4	146

Part I

Theoretical Background and Literature Review of Cognitive Load and Language Expertise

This part has six chapters, which aims to depict the research context, explain the theoretical frameworks, and present an extensive review of empirical studies on cognitive load effects and their connections to teaching foreign language listening skills.

Chapter 1 Introduction explains the rationale of the research, introduces cognitive load theory, and briefs the research hypotheses, research aims, research scope, and research significance.

Chapter 2 Human Cognitive Architecture discusses the preliminaries of cognitive load theory—the human cognitive architecture. This chapter elaborates the architecture from the informational, structural, and operational aspects.

Chapter 3 Sensory Memory, Working Memory, and Long-Term Memory is devoted to discussing the human memory systems and their significance to language learning.

Chapter 4 Cognitive Load: Categories and Measurements discusses the types of cognitive load and presents a confirmatory factor analysis on two-factor cognitive load model.

Chapter 5 Cognitive Load Effects presents a detailed review of four effects and their significance to developing foreign language skills, especially listening skills.

Chapter 6 A Cognitive Perspective of Language Processing presents cognitive models of listening comprehension and reading comprehension and discusses expert-novice differences in listening comprehension.