International Journal of Language Learning and Applied Linguistics World
(IJLLALW)
Volume 19 (3), November 2018; 1-13 Yusuke Sawaya
EISSN: 2289-2737 & ISSN: 2289-3245 www.ijllalw.org

THE INFLUENCE OF WOKING MEMORY CAPACITY AND BACKGROUND KNOWLEDGE ON COGNITIVE LOAD AND L2 LECTURE COMPREHENSION

Yusuke Sawaya
National Institute of Technology, Asahikawa College, Japan

ABSTRACT
This paper examines the effects of English as a foreign language (EFL) learners' working memory capacity (WMC) and background knowledge of lectures on their perceived cognitive load and lecture comprehension while attending lectures delivered in English. Forty-four EFL learners took listening span tests and performed two L2 lecture comprehension tasks. In the analyses, the relationships among the four variables were assessed through correlation analysis. In addition, a comparison was also made between the two tasks to examine the effects of differences in lectures on the relationships among the variables. The findings revealed that rather than WMC, background knowledge played a more important role in L2 lecture comprehension as it reduced their perceived intrinsic load during lectures and enhanced their lecture comprehension. However, in the more demanding task, although their background knowledge lessened perceived intrinsic load, the relationship between perceived intrinsic load and lecture comprehension could not be detected, which implied too heavy a load prevented them from making use of their background knowledge effectively to perform the task.

KEYWORDS: Working memory, Background knowledge, Cognitive load, L2 lecture comprehension

INTRODUCTION
In higher education, lectures are still considered the principal form of instruction around the world (Crawford Camiciottoli & Querol-Julián, 2016 ; Flowerdew, 1994; Lee, 2009). Various recent surveys show the number of international students studying in English-speaking countries such as the US, the UK and Australia has been steadily increasing (Crawford Camiciottoli & Querol-Julián, 2016). Furthermore, English-medium instruction (EMI) is becoming mainstream in higher education all over the world as English has been adopted as an instruction language (Brown, 2014; Dearden, 2014). Even in Japan, EMI in tertiary education has been growing over the past 15 years (Brown, 2014), and many institutions have adopted it for content courses usually delivered in Japanese (Fujimoto-Adamson & Adamson, 2018). As such, it is supposed that more non-native students of English will attend lectures delivered in English. It follows that the skills to understand academic lectures in English can be considered an important component of higher education.

Becker (2016) stated there exist substantial differences between listening for ordinary conversational purposes and academic lecture comprehension. One of the differences is that academic lectures require learners to engage in a number of relevant tasks simultaneously such as taking notes and reading slides while listening to input, which is supposed to impose a heavier load on L2 learners (Becker, 2016). Flowerdew (1994) also mentioned another important difference between academic lectures and ordinary conversation. In academic lectures, learners have a greater need to distinguish relevant information and background knowledge of special subject matter in a lecture compared with English in a conversation. Due to this, the academic lecture comprehension process is more complex. Yet researchers (Becker, 2016; Lynch, 2011) have pointed out that, of the four skills, listening has undergone the least amount of research. It can be assumed that academic listening, especially lecture comprehension, has undergone even less investigation. In order to understand what factors are related to lecture comprehension delivered in learners' L2, the current study attempted to figure out how working memory capacity and background knowledge affect EFL learners' perceived cognitive load and their comprehension.

LITERATURE REVIEW

Working memory capacity and listening comprehension

Working memory capacity (hereafter, WMC) refers to "the mental processes responsible for the temporary storage and manipulation of information in the course of on-going processing." (Juffs & Harrington, 2011, p.138). The concept of WMC, which has a short duration and limited capacity, implies that it potentially has a significant effect on complex tasks such as listening and reading comprehension (Miyake & Friedman, 1998; Wen, 2016). Among the research on L2 listening comprehension, Gu and Wang (2007) indicated that learners with larger WMC are more likely to have better listening comprehension abilities. In addition, Satori (2012) showed that learners' WMC influenced both literal comprehension (i.e., the one which is textually explicit) and inferential comprehension (i.e., the one which is textually implicit) in L2 listening comprehension. On the other hand, not all the studies showed a direct relationship between learners' WMC and listening comprehension. For example, Andringa, Olsthoorn, van Beuningen, Schoonen, & Hulstijn (2012) indicated that language knowledge (such as vocabulary and grammatical processing accuracy) was found to be a stronger predictor for second language listening than WMC. Furthermore, Pusey and Lenz (2014) hypothesized that visual input during listening could aid the academic listening comprehension of learners with lower WMC. However, their results showed that the presence of visual input had a significant negative effect on learners' listening comprehension and their WMC had no effect on their understanding. Previous research on the effects of learners' WMC on their listening comprehension have reached different conclusions. Moreover, it can be supposed that WMC gaps can be compensated by learners' linguistic knowledge. Also, there has not been much research in terms of the effects of WMC on listening in academic listening settings such as listening to academic lectures.

Learners' background knowledge in L2 listening comprehension

As mentioned in the introduction section, in academic lectures, background knowledge of special subject matter in a lecture is required compared with listening in a conversation (Flowerdew, 1994). The important role learners' background knowledge plays in language comprehension has been mentioned in schema theory (Brown & Yule, 1983; Chiang & Dunkel, 1992; Jensen & Hansen, 1995; Long, 1989; 1990; Sadighi & Zare, 2002). Brown and Yule (1983) referred to schemata as "the organized background knowledge which leads us to expect or predict aspects in our interpretation of discourse" (p.248). There are two types of schemata: content schemata and formal schemata (Carrel, 1987). Carrel (1987) defined each type of schemata as follows: content schemata refer to "knowledge relative to the content domain of the text, while formal schemata refer to "knowledge relative to the formal, rhetorical organizational structures of different types of texts" (p.461). Previous studies on background knowledge in L2 listening have focused on the effects of content schemata. For example, Sadighi and Zare (2002) demonstrated that by familiarizing the learners with materials and activating their background knowledge, they performed better in listening tests (TOEFL Listening section). On the other hand, Chiang and Dunkel (1992) showed that learners' background knowledge (familiar topic lecture) enhanced their lecture comprehension performance on only passage-independent items. No differences in the passage-dependent items were seen. In addition, Jensen and Hansen (1995) indicated that the effects of background knowledge on lecture comprehension were inconsistent. The results suggest that the effects of background knowledge were more likely to be present in technical lectures than in non-technical lectures. To summarize the results of previous studies, consistent conclusions have not been observed in terms of the direct relationship between learners' background knowledge and academic-related listening comprehension including lecture comprehension.

Relationship between working memory capacity and background knowledge

Although learners' WMC and background knowledge can be considered to be important factors which contribute to lecture comprehension, direct relationships between these two factors and listening (lecture) comprehension have not always been detected. In the research on L2 reading, some researchers have attempted to investigate the interplay between learners' WMC and their background knowledge (Alptekin & Erçetin, 2011; Joh & Plakans, 2017; Leeser, 2007) in their reading comprehension. As to the relationship between the two factors, Hambrick and Engle (2002) described three possible models. The first one is the *compensation model*. It proposes that high levels of background knowledge can compensate for low levels of WMC. The second one is the *independent-influences model*. This model predicts both WMC and background knowledge have additive effects on learners' performance, and they do not have interdependent effects. The final model is the *rich-get-richer model*. This model predicts learners with higher WMC tend to benefit from background knowledge more than those with lower WMC. In research on reading, the results are not consistant, as Alptekin and Erçetin (2011) supported the independent-influences model, yet two other studies (Leeser, 2007; Joh & Plakans, 2017) supported the rich-get-richer model. With regards to L2 listening, there is an even greater need for more research. In order to consider the influences of WMC and background knowledge on lecture comprehension, the interplay between those two factors also needs to be taken into account.

Cognitive load during L2 listening comprehension

In listening comprehension, listeners must comprehend the text as they listen to it, retain the information in their working memory, integrate it with what follows, and continually adjust their understanding of what they hear in the light of prior knowledge and incoming information. (Chen and Chang, 2009; Osada, 2004). It was supposed that this complex process imposed a heavy cognitive load on their working memory (Chen & Chang, 2009). Cognitive load refers to the total amount of mental effort imposed on working memory by a task (Sweller, 1988; Tanaka, 2015). "Cognitive load theory" was developed by Sweller and his colleagues and they identified three types of cognitive load: intrinsic, extraneous and germane load (Sweller, Ayres, & Kalyuga, 2011). Intrinsic load is imposed due to the nature and complexity of the content to be learned (Andrade, Huang & Bohn, 2014). Extraneous load is produced by the way the information is presented or organized, which means inadequate instructional design imposes this kind of cognitive load (Sweller, Ayres, and Kalyuga, 2011). The third type of cognitive load, germane load, is different from both intrinsic load and extraneous load. It refers to the working memory resources that the learner devotes to the intrinsic load associated with the information, which is considered to enhance learning (Sweller, Van Merriënboer, & Paas, 1998).

However, Leppink and van den Heuvel, (2015) suggest the total cognitive load consists of only intrinsic and extraneous loads and germane load was reconceptualized as a subtype of intrinsic cognitive load from the results of previous research (e.g., Leppink, Paas, Van Gog, Van der Vleuten, & Van Merriënboer, 2014). According to Sweller, Van Merriënboer, & Paas (1998), schemata or background knowledge, which were mentioned in the previous section, functions to reduce cognitive load. Tyler (2001) maintained this idea in terms of L2 listening comprehension. The results indicated that working memory consumption (i.e. working memory load) of L2 learners was not different from that of native speakers when the topic of the passage was given. On the other hand, L2 learners' working memory consumption was greater than that of native speakers when the information on the topic was not available. Previous studies (Sweller, Van Merriënboer, & Paas, 1998; Tyler, 2001) have implied that reducing cognitive loads would make more WMC available to perform better in tasks. However, the relationships between the learners' background knowledge (schemata), their perceived cognitive load and listening (lecture) comprehension has not been investigated. Moreover, although cognitive load is defined as the load imposed on working memory by a task, the relationship between WMC and cognitive load has not been thoroughly examined.

RESEARCH OBJECTIVES

According to previous research, it can be predicted that both WMC and background knowledge on lectures would have some relationships with learners' perceived cognitive load and lecture comprehension delivered in L2. It is supposed that their background knowledge reduces working memory load (i.e. cognitive load) during the lectures, which improves their lecture comprehension performance. Moreover, since cognitive load is the load imposed on working memory by a task, a relationship between WMC and cognitive load could be expected. Nevertheless, in previous research, both WMC and background knowledge were not always related to listening/ lecture comprehension. That is why when considering the effects of WMC and background knowledge, it is also important to consider the interaction between those two factors as carried out in previous research on L2 reading. As such the first research question is:

RQ1. How do EFL learners' working memory capacity and background knowledge affect their perceived cognitive load and lecture comprehension?

Furthermore, a previous study on background knowledge (Jensen & Hansen, 1995) showed lecture differences might cause a difference in the relationships among the four factors. As such the second research question is:

RQ2. Do differences in the lectures cause differences in the effects of EFL learners' working memory capacity and background knowledge on cognitive load and lecture comprehension?

METHODOLOGY

Participants

The participants were 44 first-year undergraduate university students taking a freshman general English course at a national university in Hokkaido. They were all native speakers of Japanese and all had at least six years of formal English instruction. Before the experiments were carried out, they were asked to answer a background questionnaire to collect demographic data. As to their proficiency level, the participants were supposed to self-report their own L2 proficiency test score on the questionnaire. However, almost none of them had taken any commercial proficiency tests after they graduated from high school, so their updated L2 proficiency information could not be obtained. Since the purpose of this study did not include the learners' L2 proficiency, the data collected at this time was excluded from the analysis.

Instruments and procedure

After the participants completed the background questionnaire, they moved on to the listening span test and their WMC was investigated. The listening span test used in the study was developed by Tsuchihira (2007). The test consisted of two question types: Yes-No questions and questions asking for the last word of the first sentence (recalling). The test was made up of five levels from a one sentence set (Level 1) to a five-sentence set (Level 5). In the scoring procedure, a point was given only when they provided the correct answers to both the Yes-No question and the recalling question for each set. After the listening span test, they performed two mini-video lecture tasks. The materials in the tasks were part of authentic lectures excerpted from MIT OpenCourseWare. The topics of the lectures were the Fundamentals of Biology (Lander et al., 2011, hereafter the biology lecture) and the Engineering Dynamics lecture (Vandiver & Gossard, 2011, hereafter the engineering lecture). These lectures were chosen because the contents of the lectures were understandable with high school level knowledge even though they were undergraduate level lectures. In addition, "chalk and talk" lectures were utilized as they were the most suitable in simulating classroom settings in video-recorded lectures with regards to the use of technology[1]. The characteristics of the script of each lecture are shown in Table 1. It shows that the script of the biology lecture is more difficult than that of engineering task from the text difficulty of the script judged by Flesch-Kincaid Grade level. In addition, five multiple-choice comprehension questions were created by the author for each lecture.

Table 1: The Characteristics of the Tasks used in the Study.

Index	Task 1 (Biology)	Task 2 (Engineering)
Words per minute	106.90	101.49
Flesch-Kincaid grade level	9.54	6.00

The procedure was as follows. First, one minute was given to all the participants to prepare to watch the video, while looking at the comprehension questions. Next, they watched the video lecture[2]. After the lecture finished, they were given two minutes to complete all the questions. This procedure closely followed previous studies (e.g. Wagner, 2007; 2013). After answering the questions for each lecture, the participants were asked to complete a Japanese version of a questionnaire on the cognitive load they perceived (See Appendix A). The questionnaire included five-point Likert-type items based on a scale ranging from 1 (not at all) to 5 (completely). Six question items on cognitive load were prepared following previous studies such as Yang (2014) and Leppink, Paas, Van Gog, Van der Vleuten, and Van Merriënboer (2014), including three items for intrinsic load and three for extraneous load. Originally, Leppink, Paas, Van Gog, Van der Vleuten, and Van Merriënboer (2014) utilized "complex" and "complexity" for the questions in their questionnaire which imply intrinsic load. However, since some collocational problems were present when the Japanese version of the questionnaire was created, the wording was changed from "complex" and "complexity" into "difficult" and "difficulty" following previous studies such as Yang (2014). The internal consistency was .829 for the biology lecture and .859 for the engineering lecture (Cronbach's alpha). Finally, one question was created to assess the participants' background knowledge on each lecture based on Kelson (2016).

Table 2: Correlations between Working Memory Capacity, Background Knowledge, Cognitive Load and Lecture Comprehension

	WMC	BK	IL	EL	LC
Working memory capacity (WMC)	1	-.15	-.17	.13	.09
Background knowledge (BK)		1	-.56**	-.14	.35*
Intrinsic load (IL)			1	.47**	-.44**
Extraneous load (EL)				1	.10
Lecture comprehension (LC)					1

Note. $^{**}p<.01$ $^{*}p<.05$

RESULTS AND DISCUSSION

Research question 1

To investigate the effects of WMC and background knowledge on cognitive load and lecture comprehension, Pearson product moment correlation coefficients were employed. The value utilized in the analysis except for WMC was the average of the two lectures. The findings could not detect any correlations between learners' WMC and cognitive load and lecture comprehension in this study as Table 2 shows. On the other hand, the results demonstrate a negative moderate correlation between background knowledge and intrinsic load (r (42) = -.56, *p*=.01). In addition, a statistically significant weak correlation was found between background knowledge and lecture comprehension scores (r (42) = .35, p=.05). The results also show there was a positive moderate correlation between intrinsic load and extraneous load (r (42) = .47, p=.01). Moreover, a negative moderate correlation between intrinsic load and lecture comprehension was found (r (42) = -.44, p=.01). The results of correlation analyses suggest that although both intrinsic load and extraneous load were correlated to each other in terms of cognitive load, intrinsic load was the only cognitive load which was negatively related to lecture comprehension. From the results, the more background knowledge the participants had, the less they perceived intrinsic loads. Furthermore, since the relationships between WMC and any other variables (i.e. cognitive load and lecture comprehension) could not be observed, there is a possibility that their background knowledge of lectures compensates the lack of their WMC to understand the lectures.

Table 3: Statistical Summary of the Results According to L2 Lecture Tasks

	Biology		Engineering		*t*
	Mean	SD	Mean	SD	
Lecture comprehension	3.96	0.91	2.70	0.90	7.38**
Background knowledge	2.68	1.47	2.36	1.14	0.17
Cognitive load					
Intrinsic load	2.86	1.00	3.58	1.00	-6.17**
Extraneous load	2.58	0.98	2.83	0.95	-1.76

Note. ***p*<.01

Research question 2

Table 4: Correlations between Lecture Comprehension, Working Memory Capacity, Cognitive Load and Lecture Comprehension (the Biology Task)

	WMC	BN	IL	EL	LC
Working memory capacity (WMC)	1	-.06	-.16	-.01	.15
Background knowledge (BN)		1	-.47**	-.05	.35*
Intrinsic load (IL)			1	.39**	-.54**
Extraneous load (EL)				1	-.08
Lecture comprehension (LC)					1

Note. ***p*<.01 **p*<.05

Firstly, a paired *t*-test was carried out to compare the results of the participants' lecture comprehension scores, background knowledge and cognitive load according to the lecture comprehension tasks. The results show that a significant difference between lecture comprehension scores (t (43) = 7.38, p<.01) and intrinsic load (t (43) = -6.17, p<.01) was found as shown in Table 3. The results suggest that the participants obtained lower comprehension scores and perceived more intrinsic loads in the engineering lecture. It is supposed that that the engineering task was a more difficult and demanding task for the participants.

Volume 19 (3), November 2018; 1-13
EISSN: 2289-2737 & ISSN: 2289-3245

Next, to examine whether there is a difference in the relationships among the variables between the two lectures, Pearson product moment correlation coefficients were employed for each task. As Table 4 shows, the results indicate the same results as research question 1 were obtained in the biology task, which is the less demanding task. There was a negative moderate correlation between background knowledge and intrinsic load (*r* (42) = -.47, *p*=.01).

Table 5: Correlations between Lecture Comprehension, Working Memory Capacity, Cognitive Load and Lecture Comprehension (the Engineering Task)

	WMC	BN	IL	EL	LC
Working memory capacity (WMC)	1	-.20	-.15	.25	-.02
Background knowledge (BN)		1	-.49**	-.29	.24
Intrinsic load (IL)			1	.44**	-.23
Extraneous load (EL)				1	-.08
Lecture comprehension (LC)					1

Note. ***p*<.01

In addition, a statistically significant weak correlation was found between background knowledge and lecture comprehension scores (*r* (42) = .35, *p*=.05). There was also a positive weak correlation between intrinsic load and extraneous load (*r* (42) = .39, *p*=.01) and a negative moderate correlation between intrinsic load and lecture comprehension (*r* (42) = -.54, *p*=.01). The analysis could not find any correlations between learners' WMC and their perceived cognitive load and lecture comprehension.

On the other hand, different phenomena could be observed in the engineering task, which is considered the more demanding task. As Table 5 shows, the analysis detected only a negative moderate correlation between background knowledge and intrinsic load (*r* (42) = -.49, *p*=.01) and a positive moderate correlation between intrinsic load and extraneous load (*r* (42) = .44, *p*=.01). In the engineering task, the results suggest that the participants' background knowledge possibly only reduced intrinsic load, although both intrinsic load and extraneous load were correlated. However, no variables were related to the lecture comprehension scores, although intrinsic load was negatively related to lecture comprehension in the biology task. From the results, the participants' background knowledge can be considered as an important factor in reducing perceived intrinsic load. Nevertheless, heavy intrinsic load during the lecture prevented the participants from making use of their background knowledge to understand the engineering task.

Discussion

The results of this study indicated that learners' WMC was not related to their perceived cognitive load and did not contribute to L2 lecture comprehension. On the other hand, learners' background knowledge was the most important factor to explain their lecture comprehension ability. That is why this study supports the compensation model suggested by Hambrick and Engle (2002) when considering the interplay between their WMC and background knowledge during lectures. The findings show that the more background knowledge the learners had on the lectures, the less the learners perceived intrinsic loads while attending the lectures. Furthermore, background knowledge also positively contributed to L2 lecture comprehension. From the results, it can be assumed that possessing background knowledge reduces the amount of perceived cognitive loads from the content of a lecture; as a result, learners will comprehend the lecture more accurately. On the other hand, although their background knowledge on the lecture lessened their perceived intrinsic load, it did not contribute to accurate lecture comprehension in the more demanding task, the engineering lecture. That is likely because they perceived too heavy a cognitive load to make use of their background knowledge appropriately in order to understand the lecture.

The results demonstrated that learners' background knowledge might compensate for low levels of WMC. However, although consistent conclusions have not yet been obtained, some previous studies (Gu & Wang, 2007; Satori, 2012) indicated larger WMC would lead to better listening comprehension. In addition, cognitive load is defined as the load imposed on working memory by a task. It implies that learners' WMC is supposed to be related to both perceived cognitive load and lecture comprehension. Some other possible interpretations why the effects of WMC could not be observed will be given as follows.

Firstly, learners' WMC might not always be directly related to their perceived cognitive load and lecture comprehension. Further insight has been gained from reading comprehension research. Tanaka (2015) was not able to find the interaction between learners' WMC and cognitive load among the three different reading modes while she could find the relationship between WMC and their reading comprehension. Tanaka suggested from the results that learners with large WMC do not always perceive lighter cognitive loads. Rather, they could process larger cognitive loads and allot cognitive resources effectively at the same time although they perceived almost the same cognitive loads as learners with lower WMC. In order to confirm if her suggestion relates to this study, all the participants were divided into two groups by the median score of a listening span test i.e., the upper WMC group and the lower WMC group. Then, an independent-samples *t*-test was carried out to confirm the differences between the two WMC groups. However, no statistical differences were found in both types of cognitive loads, which suggests that the cognitive loads the participants in both WMC groups perceived were not different. In addition, there was no statistical difference between both WMC groups in terms of lecture comprehension, which was different from the results of Tanaka (2015). It indicates that the analysis could not prove the learners with large WMC could process larger cognitive loads. Sawaya (2017) demonstrated that both intrinsic and extraneous load were correlated with L2 listening proficiency (TOEIC IP score, listening section). In addition, Andringa et al. (2012) showed that language knowledge (such as vocabulary and grammatical processing accuracy) is a stronger predictor for second language listening compared with learners' WMC. Combining the results of the previous studies with the results of this study, there is a possibility that not only background knowledge but also language knowledge are more related to perceived cognitive load and lecture comprehension rather than WMC itself.

Secondly, previewing the questions and answer options in advance lessened the influences of WMC differences. Kim (2015) showed learners with low WMC perform listening tests much better when questions and answer options are given in a written form compared with situations in which they cannot preview. In this study, the participants could also see the question items before and while watching the videos. It is supposed that the questions and answer options could provide the participants with contextual cues, and they could prepare for the upcoming content and listen selectively. Then, the written cues could compensate for the gap in individual differences in working memory. However, in real lecture settings, it can be considered that the students can rarely preview what questions the professors would ask in a written form. That is why further assessment will be necessary to confirm whether WMC differs for the learners' lecture comprehension when the questions are given after the entire lecture has finished.

CONCLUSION

Summary of the findings

This study found that background knowledge played an important role in L2 lecture comprehension in that it reduced their perceived intrinsic load during lectures and contributed to enhancing their understanding. However, in the more demanding task, although their background knowledge lessened perceived intrinsic load, too heavy a load prevented learners from making use of their background knowledge effectively to perform the tasks. On the other hand, this study failed to find a relationship between WMC on cognitive loads or L2 lecture comprehension, which means it is likely that their background knowledge on lectures compensated for low levels of WMC.

Limitations

There are at least three limitations of this study. Firstly, previous studies have demonstrated that learners' language knowledge such as vocabulary and grammatical knowledge might also be related to perceived intrinsic load and L2 lecture comprehension. Since it was not included in the analysis of this study, further studies will need to be carried out including language knowledge as a factor which might be related to L2 lecture comprehension. Secondly, there is a possibility that the way the comprehension questions are given compensated for the gaps in WMC differences. As stated in the discussion section, it will be necessary to investigate the WMC effects when the comprehension question items are provided after the lectures finish, which is supposed to be similar to real classroom settings. Finally, the current study was conducted with a limited number of the participants. In order to establish the relationship among the factors, a larger sample size will be required to obtain data with higher validity.

NOTE.

1. Even though PowerPoint was used, we could not see the PowerPoint slides and the instructors' behaviors at the same time in the video-recorded lectures. As such, it was not an ideal classroom simulation. Ideally, we would be able to monitor both the PowerPoint slides and the instructor at the same time.
2. While they were watching the video lectures, they were able to refer to the comprehension questions.

REFERENCES

Alptekin, C., & Erçetin, G. (2011). Effects of working memory capacity and content familiarity

Volume 19 (3), November 2018; 1-13 Yusuke Sawaya
EISSN: 2289-2737 & ISSN: 2289-3245 www.ijllalw.org
on literal and inferential comprehension in L2 reading. *TESOL Quarterly, 45*, 235–266.

Andrade, J., Huang, W.D., & Bohn, D. (2014). Multimedia's effect on college students' quantitative mental effort scores and qualitative extraneous cognitive load responses in a food science and human nutrition course. *Journal of Food Science Education, 13(3),* 40-46.

Andringa, S., Olsthoorn, N., van Beuningen, C., Schoonen, R., & Hulstijn, J. (2012). Determinants of success in native and non-native listening comprehension: An individual differences approach. *Language Learning, 62*, 49– 78.

Becker, A. (2016). L2 students' performance on listening comprehension items targeting local and global information. *Journal of English for Academic Purposes,24*, 1–13.

Brown, G., & Yule, G. (1983). *Discourse analysis.* Cambridge: Cambridge University Press.

Brown, H. (2014). Contextual factors driving the growth of undergraduate English-medium instruction programmes at universities in Japan. *The Asian Journal of Applied Linguistics*, *1*(2), 50-63.

Carrell, P. L. (1987). Content and formal schemata in ESL reading. *TESOL Quarterly, 21* (3), 461-481.

Crawford Camiciottoli, B & Querol-Julián, M. (2016). Lectures. In K. Hyland & P. Shaw (Eds.). *The Routledge Handbook of English for Academic Purposes*. London: Routledge, 311-324.

Chen, I. & Chang, C. (2009). Cognitive load theory: an empirical study of anxiety and lecture performance in language learning. *Electronic Journal of Research in Educational Psychology, 7 (2)*, 729-746.

Chiang, C. & Dunkel, P. (1992). The effect of speech modification, prior knowledge and listening proficiency on EFL lecture training. *TESOL Quarterly, 26*, 345-374

Dearden, J. (2014). *English as a medium of instruction–a growing global phenomenon: Phase 1*. London: British Council.

Dunkel, P.A. & Davis, J.N. (1994). The effects of rhetorical signaling cues on the recall of English lecture information by speakers of English as a native or second language. In Flowerdew, J. (ed). *Academic listening. Research perspectives*, 55-74. New York: Cambridge University Press.

Flowerdew, J. (1994). Research of relevance to second language lecture comprehension: An overview. In Flowerdew, J. (ed). *Academic listening. Research perspectives*, 7-29. New York: Cambridge University Press.

Fujimoto-Adamson N.& Adamson J. (2018). From EFL to EMI: hydrid practices in English as a medium of instruction in Japanese tertiary contexts. In: Kırkgöz Y., Dikilitaş K. (eds) *Key Issues in English for Specific Purposes in Higher Education.* 201-221. English Language Education, vol 11. Springer, Cham.

Gu., S. & Wang, T. (2007). Study on the relationship between working memory and EFL listening comprehension. *CELEA Journal, 30*, 46-56.

Hambrick, D. Z., & Engle, R. W. (2002). Effects of domain knowledge, working memory capacity, and age on cognitive performance: An investigation of the knowledge-is-power hypothesis. *Cognitive Psychology, 44*, 339–387.

Jensen,C.,&Hansen,C.(1995).The effect of prior knowledge on EAP listening-test performance. *Language Testing.12*(1),99-119.

Joh, J., & Plakans, L. (2017). Working memory in L2 reading comprehension: The influence of prior knowledge. *System, 70*, 107–120.

Juffs, A., & Harrington, M. (2011). Aspects of working memory in L2 learning *Language Teaching*, 44, 137-166.

Kelsen, B.(2016). The influence of interest and background knowledge on EFL students' current new article / podcast reading and listening. *CALL-EJ, 17*(1), 80-96.

Kim, B. (2015). The Effects of Working Memory Span on Listening Tests without Preview Questions. *Language Research*, 51(2), 403-420.

Lander,E., Weinberg, R., Jacks, T. Sive, H., Walker, G., Chisholm, S., & Mischke, M. (2011).*7.01SC Fundamentals of Biology.* Fall 2011. Massachusetts Institute of Technology: MIT OpenCourseWare, https://ocWMCit.edu. License: Creative Commons BY-NC-SA.

Lee, J. J. (2009). Size matters: an exploratory comparison of small- and large-class university lecture introductions. *English for Specific Purpose, 28* (1), 42 57.

Leeser, M. J. (2007). Learner-based factors in L2 reading comprehension and processing grammatical form: Topic familiarity and working memory. *Language Learning, 57*, 229–270.

Leppink, J., Paas, F., Van Gog, T., Van der Vleuten, C.P.M. & Van Merriënboer, J.J.G. (2014). Effects of pairs of problems and examples on lecture performance and different types of cognitive load. *Learning and Instruction*, *30,* 32–42.

Leppink J & van den Heuvel A. (2015). *The evolution of cognitive load theory and its application to medical education*. *Perspectives on Medical Education*, *4* (3), 119-127.

Lynch, T. (2011). Academic listening in the 21st century: Reviewing a decade of research. *Journal of English for Academic Purposes, 10*(2), 79-88.

Miyake, A. & Friedman N.P. (1998). Individual differences in second language proficiency: working memory as language aptitude. In Healey A.F. and L. J. Bourne (Eds.). *Foreign language learning: Psycholinguistic studies on training and retention*. Mahwah, N.J.: Lawrence Erlbaum.

Osada, N. (2004). Listening comprehension research: A brief review of the past thirty years. *Dialogue, 3,* 53-66.

Pusey, K., & Lenz, K. (2014) Investigating the interaction of visual input, working memory, and listening comprehension. *Language Education in Asia, 5* (1), 66-80.

Sadighi, F. and Zare, S. (2002). Is listening comprehension influenced by the background knowledge of the learners? A case study of Iranian EFL learners. *The Linguistics Journal, 1*(3), 110-126.

Satori, M. (2012). The Role of L1 and L2 Working Memory in Literal and Inferential Comprehension in L2 Listening. *Language Education & Technology,49,*173-195.

Sawaya, Y. (2017). EFL 学習者による英語講義動画視聴時の L2 リスニング能力、認知負荷、リスニング方略使用の関係性 (EFL learners' L2 listening ability, cognitive load and listening strategy use in L2 lecture comprehension.) Paper presented at the 43rd JASELE Conference, Shimane.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*, 257-285.

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive load theory*. New York: Springer.

Sweller, J., Van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. *Educational Psychology Review, 10 (3),* 251-296.

Tanaka, N. (2015). Effects of working memory capacity of EFL learners on text comprehension and perceptual cognitive loads: using three reading modes. Annual Review of English Language Education in Japan, 26, 269-284.
Tsuchihira, T. (2007). L2 working memory capacity and L2 listening test scores of Japanese junior college students. *Journal of Bunkyo Gakuin University Department of Foreign Languages and Bunkyo Gakuin College,7*, 159-175.
Tyler, M. D. (2001). Resource consumption as a function of topic knowledge in nonnative and native comprehension. *Language Learning, 51*(2), 257–280.
Vandiver & Gossard, (2011). *2.003SC Engineering Dynamics.* Fall 2011. Massachusetts Institute of Technology: MIT OpenCourseWare, https://ocWMCit.edu. License: Creative Commons BY-NC-SA.
Wagner, E. (2007). Are they watching? Test-taker viewing behavior during an L2 video listening test. *Language Learning & Technology, 11*(1), 67–86.
Wagner, E. (2013). An investigation of how the channel of input and access to test questions affect L2 listening test performance. *Language Assessment Quarterly, 10*, 178-195.
Wen, Z. (2016). *Working memory and second language learning: Towards an integrated approach.* Bristol: U. K: Multilingual Matters.
Yang, H-Y. (2014). Does multimedia support individual differences? - EFL learners' listening comprehension and cognitive load. *Australasian Journal of Educational Technology, 30*(6), 699-713.

Appendix A

English Translation of the Questionnaire on Cognitive Load and Background Knowledge

To what extent do you agree with each of the following statements?

1. The content of this lecture was very difficult.
2. In this lecture, very difficult terms were mentioned.
3. I invested a very high mental effort in the difficulty of the content of this lecture.
4. The explanations and instructions in this lecture were very unclear.
5. The explanations and instructions in this lecture were full of unclear language.
6. I invested a very high mental effort in unclear explanations and instructions in this lecture.
7. I know a lot about the content of this lecture.