The Effect of Productive Vocabulary Knowledge on Second Language Comprehension: Behavioral and Neurocognitive Studies

by

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Abstract

Enhancing efficient listening comprehension skills, particularly quick processing abilities is essential. Since listening demands rapid and smooth understanding to match the constant flow of spoken information, it may seem extremely challenging for foreign language learners. While comprehending the meaning of vocabulary is undeniably crucial for listening comprehension, this alone may not suffice in maintaining pace with the speed of spoken input or guaranteeing thorough understanding. While second language learners often concentrate more on understanding the meanings of words rather than using them effectively in speech and writing, productive vocabulary knowledge (the ability to use words actively in communication) might also positively influence sentence comprehension. Most previous studies in this field typically compared production and comprehension abilities between participants or evaluated unrelated criteria between tasks, which may not adequately assess the direct impact of productive vocabulary knowledge on sentence listening comprehension. This study addresses this gap by investigating how much productive vocabulary knowledge influences sentence comprehension speed during listening, using a within-subjects comparison and controlling for other possible influential factors such as confidence, word frequency, stimulus duration, and individual differences. Results indicated that sentences containing productive phrases were processed faster compared to those with only comprehensive knowledge or uncomprehensive.

To further explore how the presence or absence of productive vocabulary knowledge affects brain function during sentence listening comprehension, the current study measured human scalp electroencephalography (EEG) and conducted a Time-Frequency Representation (TFR) of EEG power analysis and multivariate pattern analysis (MVPA). MVPA was complemented by a decoding model to ascertain the predictability of vocabulary knowledge levels through neural activities. The findings revealed that EEG activity could distinguish sentences containing phrases with productive knowledge from those without. This demonstrates that the positive impact of productive vocabulary knowledge on sentence comprehension is not only behaviorally evident but also correlates with distinct neural processing patterns.

Conclusively, this study emphasizes the significant role of productive vocabulary knowledge in enhancing the speed and efficiency of sentence comprehension in second language listening, as evidenced by both behavioral outcomes and neural activity changes.

Acknowledgments

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Contents

Chapter 1

General Introduction

1.1 Listening comprehension in second language

In terms of language four skills such as listening, speaking, reading, and writing, adults spend 40–50% of their communication time for listening, in contrast to reading, which is estimated to occupy only 11–16% of their time (Gilman & Moody, 1984). Developing efficient listening comprehension including rapid comprehension processing is important. Unlike reading, where people can control the pace of input, in listening, they need rapid and effortless comprehension to keep up with the continuous flow of information, which seems to be extremely difficult for foreign language learners. While the importance of language processing speed has often been emphasized as one of the crucial reading skills such as speed-reading, fast comprehension processing during the online processing that occurs in listening and speaking may have been overlooked. Then how can language learners improve listening comprehension speed? There seem to be several methods for the development of the overall listening comprehension processing. In educational settings, repeated input practice has been largely applied to foster learners' listening abilities. Vocabulary comprehension is also emphasized to support listening comprehension as a bottom-up factor. Although there is no doubt that understanding the meaning of vocabulary is a fundamental requirement for listening comprehension, this may not fully support keeping up with the speed of input and ensuring complete comprehension.

1.2 Development of vocabulary acquisition in second language

As Wilkins (1972, p.111) stated without grammar very little can be conveyed, without vocabulary nothing can be conveyed, vocabulary acquisition is absolutely essential for language acquisition. The quintessence of vocabulary mastery is to be able to use it fluently in communication (Schmitt, 2010). Fluency in vocabulary use refers to the ability to comprehend vocabulary automatically and use it effortlessly. For second language learners, one of their primary objectives might be to achieve automatic comprehension and production in their second language.

As for comprehension proficiency, a wide range of proficiency levels exist before reaching the level of fluent language users. For instance, some second language learners might understand a sentence by translating each word into their first language, while others may understand a sentence automatically without needing translation, similar to how native speakers do (Upton & Lee-Thompson, 2001). According to Segalowiz and Hulstijn (2005), as the learners' proficiency develops, automatic vocabulary processing occurs as a result of various processing changes including rapid processing, absence of attentional control, unconscious processing, effortless processing, ballistic processing, gain efficiency, and memory-based processing. While processing speed appears to be one of the indirect indicators of language proficiency, what degree of vocabulary mastery would be necessary for rapid comprehension processing is uncertain.

According to Webb (2012), comprehensive vocabulary knowledge refers to the ability to understand the meaning of a word in listening and reading. Productive vocabulary knowledge is the knowledge required to use a word in speaking and writing. The term vocabulary can include both single words and phrases (Schmitt, 2000). In terms of acquisition order, it is widely approved that productive vocabulary knowledge is acquired subsequently to comprehensive knowledge (Read, 2000). Assuming the acquisition order is a measurement of vocabulary development, acquiring only comprehensive vocabulary knowledge may not satisfy vocabulary mastery. In other words, rapid comprehension processing may be triggered by the presence of productive vocabulary knowledge. Language learners usually start learning the meaning of vocabulary and expand the size of comprehensive vocabulary, but they do not pay as much attention as to be able to use it in speaking and writing. As a result, many language learners seem to encounter words that they can understand the meaning of but cannot use in speaking and writing. Several studies have investigated differences between the size of comprehensive and productive vocabulary (Melka, 1997; Laufer, 1998; Fan, 2000), and approximately 53-81% of vocabulary was productive vocabulary compared to comprehensive vocabulary. These words are high-frequency words (2000, 3000, 5000-word level) and as for low-frequency words, only 16% of words could be retrieved in a translation task (Laufer, 2005). It is pointed out that students in Japan do not have enough opportunities to speak English (Humphries et al., 2023), and this situation was also mentioned in the High School National Curriculum Standard by the Ministry of Education, Culture, Sports, Science and Technology Japan (2018). This situation tells us the lack and the need for productive vocabulary knowledge acquisition.

1.3 Neural activity research on second language processing

In addition to the examination of behavioral change by vocabulary knowledge, neural function during listening comprehension processing should also be investigated. Examining neural activities alongside behavioral changes can help understand how changes in vocabulary knowledge are reflected in the brain and can lead to the development of more effective teaching and learning strategies. Segalowitz and Hulstijn (2005) pointed out that it is important to differentiate between rapid comprehension processing due to the simple acceleration of underlying processes and the development of processing change leading to fast processing. The concept of simple acceleration refers to an increased speed in basic cognitive operations without altering the method of information processing. This is akin to enhancing the speed of existing cognitive functions. On the other hand, the notion of the development of processing changes that facilitate rapid processing implies a qualitative evolution in cognitive strategies, such as the brain adopting more efficient methods for processing information. Distinguishing between these mechanisms is essential as they entail different educational and learning implications.

The brain has a remarkable capacity to functionally and structurally change or reconfigure its structure in reaction to the experience of second language learning (Osterhout et al., 2008; Li et al., 2014). A large number of neurocognitive research utilizes neuroimaging techniques such as functional magnetic resonance imaging (fMRI), and electroencephalography (EEG), which are both most commonly used, have investigated distinct brain function patterns in second language acquisition (Sabourin, 2009; Li et al., 2014). Changes in brain function are reflected in EEG pattern changes of the human scalp (Rossi et al., 2023). Numerous studies have examined neural activity change associated with language development by EEG (Newman et al., 2012; Yum et al., 2014; Soskey et al., 2016; Pérez et al., 2015; Shinozuka et al., 2021), and most of them have been conducted by observing event-related potential (ERP), while ERP can retrieve some kind of difference of neural activity for a particular action, it cannot suggest what information can be included in that particular neural activity. On the other hand, a Time-Frequency Representation (TFR) of EEG power, which decomposes the EEG signal into different frequencies and investigates the local synchrony, can detect linguistic and cognitive components (Cohen, 2014; Luk et al., 2020). Wang et al. (2012) stated that different aspects of language comprehension lead to synchrony in different frequency ranges. In second language sentence comprehension, a power change may be observed according to vocabulary knowledge.

1.4 Main purpose and structure of this dissertation

This dissertation aims to emphasize the importance of productive vocabulary knowledge acquisition for second language listening comprehension by examining behavioral and neural changes. Chapter 2 introduces the concept of vocabulary knowledge and the structure of listening comprehension processing from previous studies, and establishes a specific academic question. Chapter 3 elaborates on the positive effect of productive vocabulary knowledge on listening comprehension by observing comprehension speed. Chapter 4 shows an EEG study on the neural process during sentence listening comprehension regarding the vocabulary knowledge effect. Chapter 5 discusses the contributions of this study and provides insights in response to the specific academic question that was previously established. Finally, Chapter 6 presents the general conclusion derived from the studies in the previous chapters.

Chapter 2

The Relationship between Vocabulary Knowledge and Listening Comprehension

2.1 Vocabulary knowledge

In general, vocabulary knowledge can be defined by the recognition of its form (sound and spell), knowing its meaning, and the pattern of occurrence with other words (Cameron, 2001). Vocabulary knowledge has also been discussed based on two approaches; size and depth (Schmitt, 2010). The learners' size of vocabulary refers to the number of words that learners can recognize its meaning. There is a correlation between learners' vocabulary size and language proficiency. On the other hand, vocabulary depth is conceptualized in several ways. Vocabulary depth can refer to the concept of comprehensive and productive vocabulary knowledge (Schmitt, 2014). A second interpretation of vocabulary depth focuses on its components such as pronunciation, spelling, meaning, register, frequency, and so on (Read, 2004), and in this context, learners who have high proficiency in vocabulary depth possess linguistic knowledge about words. Vocabulary depth also refers to the ability to associate a word with other preexisting words in learners' mental lexicon (Meara, 2002), such as synonyms, collocations, and hypernyms.

In terms of the relationship between vocabulary knowledge and listening comprehension, the lexical quality hypothesis posits that vocabulary forms the foundation of language, and for learners to understand input, it is essential for them to know the meanings of the words in that context (Perfetti, 2007). Several studies show a significant correlation between comprehensive vocabulary knowledge and listening comprehension (Bonk, 2000; Mecatty, 2000; Stæhr, 2009; Ataş, 2018). For example, Bonk's study (2000) examined the relationship between lexical knowledge and listening comprehension in second-language learners. Fifty-nine Japanese university students were tested on listening comprehension and lexical familiarity as an index of word recognition using first-language recall and dictation methods, respectively, across texts with different frequencies of low-frequency words. The findings show a significant correlation between comprehension and familiarity with vocabulary. Good comprehension was rarely achieved with less than 75% vocabulary familiarity but was common at 90% or higher. The study concludes that while efficient listening strategies can aid in understanding lexically complex texts, high lexical familiarity is generally necessary for good comprehension. Ataş (2018) also conducts an empirical study on 33 advanced Turkish English learners to explore the impact of comprehensive vocabulary knowledge on listening comprehension. Findings reveal a significant correlation between comprehensive vocabulary knowledge and listening comprehension. Mecartty (2000) also discovered that vocabulary knowledge significantly influences and predicts the ability to comprehend spoken language. The greater the number of words learners are acquainted with, the more proficient they are likely to be in comprehension. Since the purpose of listening is understanding a conveyed message, language learners seem to think that knowing the word's meaning is enough to understand sentences. This may be one of the reasons that most of the studies investigating the contribution of comprehensive vocabulary size and the effect of productive vocabulary knowledge have been overlooked. According to Zeeland and Schmitt (2013), although a listener may grasp the message being communicated, the degree of comprehension can range from full understanding to satisfactory comprehension, and this variation is influenced by the listener's vocabulary knowledge level. Thus, influential factors other than comprehensive vocabulary knowledge that may facilitate listeners' comprehension should also be investigated.

Currently, there is an increasing focus on understanding how not only vocabulary size but also vocabulary depth contribute to second language listening comprehension (Luo et al., 2021). The extent to which vocabulary size and vocabulary depth influence second language listening comprehension varies among different research studies, and the precise degree of their contribution remains somewhat ambiguous (Stæhr, 2009; Wang, 2015; Teng, 2016; Luo et al., 2021). Stæhr (2009) investigated how vocabulary size and depth affect listening comprehension. One hundred fifteen advanced Danish learners of English as a foreign language participated in the research. Although the finding shows significant correlations between both vocabulary size and depth and listening comprehension, vocabulary size showed a higher correlation with listening comprehension. Additionally, the study suggested that a lexical coverage of 98% is necessary to understand spoken texts in the listening test. The study claimed that vocabulary size is a major contributing factor to listening comprehension. On the other hand, Teng (2016) investigated the impact of vocabulary knowledge size and depth on second language academic listening comprehension. The findings revealed that both vocabulary knowledge size and depth positively correlated with listening comprehension, with depth showing a higher correlation. Wang's study (2015) also indicated that both vocabulary size and depth significantly impact listening scores, with depth having a notably greater overall effect. This may be due to an inconsistency in the measurements of vocabulary knowledge. Since the definitions of vocabulary depth vary, such as obtaining linguistic knowledge of the words, ability to associate words, and ability to use words, each ability plays differently during listening processing. In order to investigate the relationship between productive vocabulary knowledge and listening comprehension, it is important to estimate the role of productive vocabulary knowledge and how significant it is during listening processing.

2.2 Listening comprehension processing

It is believed that effective listening comprehension arises from a sophisticated interplay of both bottom-up and top-down processing (Luo et al., 2021). Bottom-up processing involves decoding, such as breaking down the stream of sounds into meaningful segments and building understanding incrementally by progressively assembling larger meaningful units, starting from the phoneme level and advancing to the features of discourse. While top-down processing includes utilizing context and pre-existing knowledge to construct a conceptual structure aimed at interpretation (Vandergrift, 2011). In the listening modality, both bottom-up and top-down processing are involved in parallel and interact and integrate information (Bonk, 2000; Hulstijn, 2003). The extent to which listeners rely more on one process over the other is influenced by the purpose of listening, the circumstances surrounding the listening situation, and individual learner traits, such as language proficiency (Vandergrift; 2011). Guessing the meaning from the context, which is top-down processing, is an essential skill, especially for second language learners whose vocabulary knowledge is not enough to comprehend an input. However, it has limitations since, to achieve adequate comprehension and to effectively guess meanings from context, learners should understand at least 95% of the words they encounter (Nation, 2018).

According to Anderson's (1995) framework of cognitive processing in second language listening comprehension, the process can be divided into three interconnected phases: perception, parsing, and utilization. In the perception phase, listeners identify the sound categories of the language, temporarily storing these in their working memory. This phase mainly involves the bottom-up aspect of listening. During this process, listeners focus on the speech while ignoring other sounds around them. Subsequently, they organize these sounds into groups based on the recognized language categories.

In the parsing phase, which is primarily bottom-up processing but can be influenced by top-down processes, listeners break down what they have retained in their working memory and start to consider possible word choices (Rost, 2005). They retrieve these word options from long-term memory using cues such as the beginning of the word, often influenced by the prosodic information linked with the word (Field, 2004). They then form propositions to maintain a meaning-based representation of these words in working memory while new information is being processed. Meaning is usually the key factor in segmenting these elements (Sanders, Neville & Woldorff, 2002). As language proficiency increases, listeners are able to more rapidly identify appropriate word choices for the context and retain meaning in progressively larger segments of propositional content (Field, 2008a). Regarding the recognition and processing of function and content words, second language listeners tend to be more adept at identifying content words (Field, 2008b). This makes sense because content words are meaningful, and due to working memory limitations, second language listeners must focus selectively on the input.

In the final utilization phase, listeners connect the meaningful units they have deciphered with information stored in their long-term memory to grasp the intended or suggested meanings and form a memory representation of their understanding.

The phases have a bidirectional relationship with one another and there is often significant back-and-forth processing as new information is interpreted in the context of existing world knowledge and integrated with what has already been understood. These processes, which unfold in just milliseconds, involve cognitive fluency (Segalowitz, 2007). Successful listening clearly relies on how well listeners can efficiently synchronize these processes. Native listeners do this almost instinctively, paying little conscious attention to individual words.

In contrast, second language learners, often having limited language knowledge, might not process everything they hear automatically. Depending on the second language proficiency level, listeners may need to engage in controlled processing. This controlled processing may require more time and given the constraints of working memory, that may hinder comprehension (Vandergrift, 2011).

2.3 The relationship between productive vocabulary knowledge and listening comprehension processing

This research addresses a novel aspect in the field of language comprehension: while numerous studies have examined the impact of comprehensive vocabulary knowledge on listening comprehension, the specific role of productive vocabulary knowledge in the process of listening comprehension has not been thoroughly investigated. This gap in research is particularly significant considering the intricate nature of listening comprehension, which integrates various cognitive processes including both bottom-up and top-down processing. The research question focuses on exploring the unique contribution of productive vocabulary knowledge, which goes beyond simple word recognition to include active usage and application of vocabulary, in the context of listening comprehension. This study aims to shed light on how productive vocabulary affects the ability to understand spoken language. The findings of this research are expected to provide groundbreaking insights into the theory of second language comprehension and offer practical implications for language teaching and learning methodologies.

Chapter 3

The Effect of Productive Vocabulary Knowledge on Second Language Comprehension

3.1 Introduction

Several previous research has revealed cross-sectional effects, specifically regarding the interplay between language comprehension and production skills. Test scores for vocabulary production have shown positive correlations with reading and listening comprehension skills (Golkar & Yamini, 2007; Li & Zhang, 2019). While these findings are important for understanding the relationships between these skills across different subjects, they do not conclusively show the direct impact of productive vocabulary knowledge on sentence comprehension. This limitation stems from the fact that these studies did not use identical target vocabularies to assess proficiency in vocabulary production, vocabulary comprehension, and sentence comprehension. For instance, Golkar and Yamini (2007) utilized the Vocabulary Level Test (Schmitt et al., 2001) for comprehensive vocabulary knowledge, the Productive Version of the Vocabulary Levels Test (Laufer & Nation, 1995) for productive vocabulary knowledge, and the Test of English as a Foreign Language (TOEFL) for reading proficiency. Hence, the vocabulary in their study varied from measurement to measurement. Regarding the level of vocabulary knowledge, using the same target words in both productive and comprehensive vocabulary assessments is a practical method to evaluate a learner's proficiency with each word. This approach determines if a learner possesses both productive and comprehensive knowledge of a target word, only comprehensive knowledge, or lacks understanding of it entirely. Based on this concept, the comprehension task in this study included sentences with target words from various vocabulary levels, and their impacts were assessed through within-subject comparisons. Exploring how much different levels of vocabulary knowledge influence sentence listening comprehension could yield valuable educational recommendations and highlight the importance of acquiring productive vocabulary knowledge.

This study aimed to highlight the significance of productive vocabulary learning by exploring how productive vocabulary knowledge influences the speed of sentence listening comprehension. To examine this effect, a formulaic sequence, defined as "a phenomenon that encompasses various types of word string which appear to be stored and retrieved whole from memory" (Wray & Perkins, 2000, p. 1) was utilized. This approach suggests that comprehension speed could increase if learners acquire formulaic sequences in chunks, processing them as a single unit instead of individual words. Moreover, although processing these fixed phrases might initially be slower and lexical connections weaker in a second language compared to a first language, processing speed could improve as second language proficiency increases (Ito & Pickering, 2021). Therefore, the hypothesis of this study was that the speed of sentence listening comprehension would vary based on the learner's productive vocabulary knowledge, as this reflects the extent of vocabulary knowledge development (Read, 2000; González-Fernández & Schmitt, 2020).

There could be other contributing elements to the speed of sentence listening comprehension in a second language, including learners' confidence, the frequency of target words, and the length of the stimulus. Shen and Jiang (2013) suggested that a learner's confidence can expedite language comprehension. Thus, to investigate whether there are other influential factors other than vocabulary knowledge, the relationship between vocabulary knowledge and each of the other influential factors was examined for reference to decide which factors should be included in the following analysis. In addition to conventional comparisons, the current study tested the contribution of vocabulary knowledge on sentence comprehension by using the generalized linear mixed model

(GLMM) to partial out the effects of other influential factors.

Differences among second language learners might also stem from a variety of unmeasured factors, such as the age at which they began learning the second language, their learning methods, personality traits, and cognitive styles (Fan, 2000; González-Fernández & Schmitt, 2015; Yang et al., 2015). These individual differences could influence the variables of present interest in this study (vocabulary knowledge, confidence, frequency of target words, and stimulus duration). Given the diverse nature of these individual differences, they were incorporated as random intercepts and slopes in the GLMM analysis. This approach aimed to bolster the reliability of the first within-subject comparison analysis in this study. Through this methodology, the current study was able to establish a connection between productive vocabulary knowledge and sentence listening comprehension and ascertain the degree to which productive vocabulary knowledge enhances comprehension speed.

3.2 Materials and methods

3.2.1 Participants

The main analysis for this research involved 37 students, both undergraduate and graduate, from Kyoto University (17 males and 20 females). The determined number of participants needed for the statistical analysis was 28. This number was determined prior to the experiment through a power analysis in GPower (Version 3.1.9.6) for a one-way repeated measure ANOVA with the following criteria: $\alpha = 0.05$, $1\text{-}\beta = 0.8$, effect size $f = 0.25$, corr among rep measures = 0.5, and the number of measurements = 3 (productive knowledge, comprehensive knowledge only, and uncomprehensive). Since this study employed a unique within-subject comparison approach, there were no existing studies to estimate the expected effect size. Consequently, for a pragmatic reason, a medium effect size was chosen to calculate for the one-way repeated measure ANOVA, specifically for knowledge, which was the main focus of this research and applied to two analyses which are a one-way repeated measure ANOVA and the GLMM. Other parameters adhered to the default configurations in GPower.

The average age of the participants was 22.5 ± 1.57 (range: 20–26 years). All participants were native Japanese speakers and had achieved one of the following English proficiency test scores within the last two years: a score above 600 on the Test of English for International Communication (TOEIC), above 503 on the TOEFL Institutional Testing Program (ITP), over 61 on the TOEFL Internet-Based Testing (iBT), or over 5.0 on the International English Language Testing System (IELTS). They were all right-handed, as determined by the Edinburgh Handedness Inventory. Each participant received an honorarium for their involvement. The study received ethical approval from the ethics committee of the Kyoto University Psychological Science Unit (approval number: 1-P-2). A preliminary analysis was carried out with 11 participants who were not part of the 37 participants for the main analysis.

3.2.2 Stimuli

For the tasks, formulaic sequences were applied as the target. These were adverb and adjective phrases which consisted of three or four words long and can be placed at the end of sentences. Certain phrases were excluded to manage comprehension and retrieval difficulty, such as those with repeated words (e.g., “again and again”), phrases formed with antonyms (e.g., “sooner or later”), and phrases containing possessive pronouns contingent on a sentence (e.g., “above one’s head”). Two corpora were referenced to select phrases with a broad frequency range (appearing 7–36,475 times in the Corpus of Contemporary American English and 2–6,875 times in the British National Corpus), resulting in a selection of 200 phrases.

The experiment was divided into two experiments: 1) a screening experiment including both a production and a comprehension task, and 2) the behavioral experiment which was a comprehension task (Fig. 3.1).

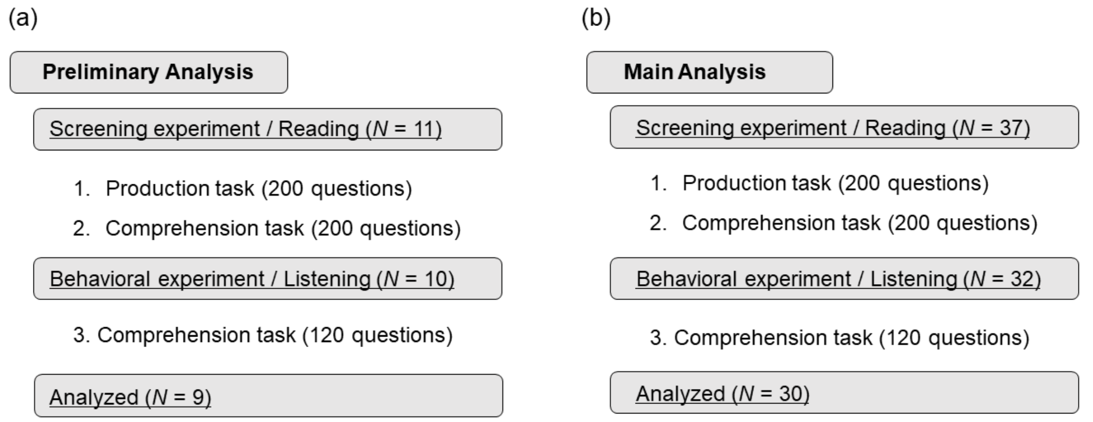

Fig. 3.1 The structure of the full experiment. (a) The preliminary analysis and (b) The main analysis. The screening experiment involved an assignment of translating phrases to measure the productive and comprehensive knowledge of various phrases. All the stimuli in the screening experiment were presented visually. The behavioral experiment included a listening comprehension task. All the stimuli in the behavioral experiment were presented in an auditory format.

The screening experiment was conducted for the following purposes: to assess the participants' knowledge of each phrase and to select suitable participants for the behavioral experiment who responded with at least 30 phrases applicable to each knowledge category. To provide varied sentences for each task in the screening experiment, three distinct sentences for each of the 200 chosen phrases (totaling 600 sentences) were picked from examples in dictionaries aimed at intermediate to upper-intermediate learners, including the Cambridge Learner's Dictionary, the Oxford Learner's Dictionary, and the Collins Online Dictionary. These sources offer sentences with simpler words and grammar compared to standard dictionaries (The sentences can be seen in Appendix 1 &

2). To ensure a consistent level of sentence comprehension difficulty, some sentences were modified to contain between eight to ten words. In the task of the behavioral experiment, all questions were presented in an auditory format, with English sentences produced using Google's text-to-speech function at a rate of 150 words per minute, mirroring the average speaking speed of native speakers (Wang, 2021).

3.2.3 Procedure

The screening experiment was carried out using Google Forms and consisted of two sets of 100 questions each for production and comprehension tasks, totaling 400 questions for each participant. In the production task, to test the participants' ability to generate the target phrases, a pair of sentences: one complete sentence in Japanese and another in English with the last word missing was displayed. The participants had to type in this missing word on the Google form. Spelling accuracy was not strictly enforced, accepting nearly correct spellings as valid. For the comprehension task, a complete English sentence was shown with the target phrase underlined. Participants had to translate only the underlined phrase into Japanese, assessing their comprehensive knowledge. Participants also rated their confidence in understanding these phrases on a Likert scale (5: strong confidence, 4: confidence to some extent, 3.: neutral, 2: less confidence, and 1: no confidence at all; Fig. 3.2). While there was no strict time limit, participants were advised to complete 100 questions within 30 minutes.

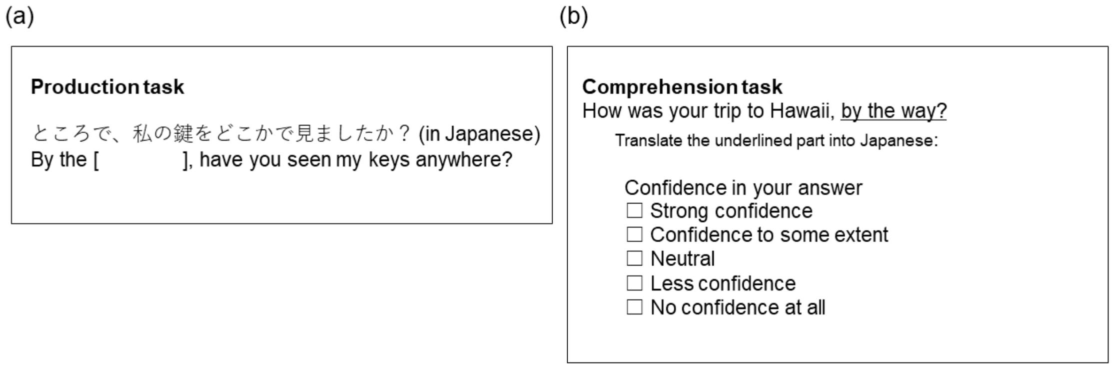

Fig 3.2 An example question from the screening experiment. (a) An example question from the production task. The Japanese sentence corresponds to the English sentence. (b) An example question from the comprehension task. The underlined word is the target phrase.

Based on the outcomes of the screening experiment, the phrases were categorized into three groups based on the participants' knowledge: phrases that could be both productive and comprehensive, phrases only comprehensive but not productive, and phrases neither comprehensive nor productive. Phrases that participants could produce but not understand were excluded, considering this an accidental rather than a significant indicator of vocabulary development. Derived from the screening experiment results, only the participants with at least 30 target phrases from each of the three vocabulary knowledge categories identified in the screening experiment were selected for the behavioral experiment. According to the central limit theorem, a sample size of at least 30 is often recommended for an approximately normal distribution of the sample mean (Smith & Wells, 2006). Furthermore, an additional 10% to 30% sample size is suggested to account for potential missing data (Shuai et al., 2012).

The behavioral experiment was conducted at least a week after the screening to reduce the influence of recent memory. The behavioral experiment included two sets of 60 trials, totaling 120 questions, with a minimum of 30 from each vocabulary knowledge category, supplemented by additional questions. The stimuli were tailored individually for each participant according to their performance in the screening experiment, and the participants were kept unaware of their knowledge levels for each specific phrase. The behavioral experiment was conducted online using Psytoolkit (Stoet, 2010, 2017). Except for the procedure explanation, all stimuli were presented in auditory format. Participants first adjusted the sound volume and completed five practice questions. In the comprehension task, each trial began with a 300 ms beep, followed by a randomly assigned silent period of 1000 ms, 1500 ms, or 2000 ms (see Fig. 3.3). An English sentence was then played in which the last three or four words was always the target phrase. Participants were instructed to press the space key as soon as they comprehended the sentence. Response time was measured from the start of the last word to the space key press. They were informed that they could press the space key even while the audio was playing, which led to the recording of response time as a negative value in some cases. All recorded times were converted to positive values by adding 2620 ms, as the shortest recorded response time was -2618 ms. Trials without a response ($M \pm SE$ = 19.17 ± 2.00%) were excluded from the analysis. Response times were sorted according to the screening experiment's vocabulary knowledge groupings for sentence comprehension speed comparison. Data from 30 participants, with over 10 phrases from each three vocabulary knowledge categories, were analyzed for statistical significance.

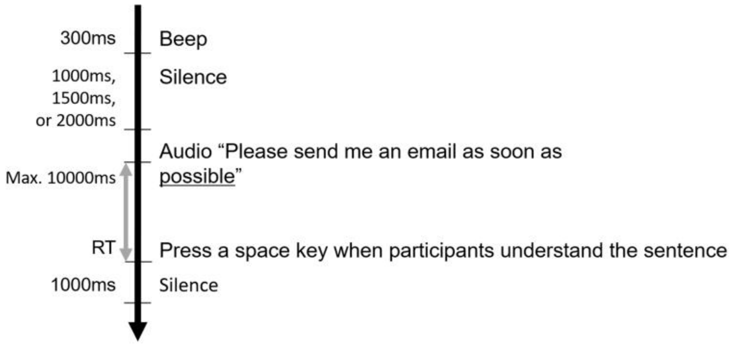

Fig. 3.3 The flow of comprehension tasks in the behavioral experiment. The black arrow indicates the flow of one trial. The times on the left side indicate the duration of the activities. Each trial began with a beep sound and finished with silence that lasted for 1,000 ms. RT (represented by the gray arrow) indicates the response time for sentence comprehension. Each sentence was played once. The underlined word is the last word of the target phrase.

3.2.4 Statistical Analysis

The findings from the preliminary study were used to finalize the analysis procedure for the main analysis. In the main analysis, 5 participants were excluded from the behavioral experiment based on their screening results. Exceptionally, 2 participants who had only 29 phrases of the uncomprehensive category were included in the behavioral experiment to achieve sufficient statistical power. The data from 2 participants in the behavioral experiment were excluded from the statistical analysis due to insufficient data points according to the criteria. Consequently, the analysis was conducted on data from 30 participants.

A one-way repeated measure ANOVA was carried out using IBM SPSS Statistics version 27 (IBM Corp., Armonk, NY). Prior to assessing the relationship between sentence comprehension speed and vocabulary knowledge through conventional ANOVA, all the response time data were logarithmically converted, and the logarithm of the response time was averaged for each participant's vocabulary knowledge. This study chose not to conduct outlier exclusion; according to Ratcliff (1993) and Nicklin and Plonsky (2020), transforming all data, including extreme values, is recommended to reduce the influence of outliers (e.g., log transformation, inverse transformation). To adopt the null hypothesis that response time remains unchanged according to vocabulary knowledge, a one-way repeated measures ANOVA was performed with the different types of knowledge (i.e., productive knowledge, comprehensive knowledge only, and uncomprehensive) as the independent variable and the log-transformed response time as the dependent variable. A Bonferroni correction was applied for multiple comparisons in case a significant main effect existed.

Given the possible concerns about a spurious correlation between vocabulary knowledge and the speed of sentence comprehension if vocabulary knowledge is correlated with confidence, the average confidence level for each type of vocabulary knowledge was categorized. A one-way repeated measures ANOVA was used for the three different levels of knowledge as the independent variable and confidence as the dependent variable. In addition, a one-way repeated measures ANOVA was performed to investigate the confounding effects on the speed of sentence comprehension caused by the other influential variables. The independent variable included the three different levels of knowledge, and the dependent variables were phrase frequency and stimulus duration.

After the analysis with a one-way repeated measures ANOVA, a Generalized Linear Mixed Model (GLMM) was employed using the lme4 package (Bates et al., 2022) and multcomp (Hothorn et al., 2008) in R (R Core Team, 2021) to assess if response times were consistent across different levels of vocabulary knowledge (i.e., productive knowledge, comprehensive knowledge only, and uncomprehensive) and other variables (confidence, phrase frequency, and stimulus duration). These factors were treated as fixed effects on sentence comprehension speed, with a random intercept and random slopes for the four variables across participants. Eight different models were established, as detailed in (Table 3.1)

Table 3.1 Models used for the generalized linear mixed model (GLMM) analyse.

Model
Model 1: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + \varepsilon$
Model 2: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_2 + S_{2j})X_2 + \varepsilon$
Model 3: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_3 + S_{3j})X_3 + \varepsilon$
Model 4: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_4 + S_{4j})X_4 + \varepsilon$
Model 5: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_2 + S_{2j})X_2 + (\beta_3 + S_{3j})X_3 + \varepsilon$
Model 6: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_2 + S_{2j})X_2 + (\beta_4 + S_{4j})X_4 + \varepsilon$
Model 7: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_3 + S_{3j})X_3 + (\beta_4 + S_{4j})X_4 + \varepsilon$
Model 8: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_2 + S_{2j})X_2 + (\beta_3 + S_{3j})X_3 + (\beta_4 + S_{4j})X_4 + \varepsilon$

RT: response time, X_i: independent variable (X_1: Knowledge, X_2: Confidence, X_3: Stimulus duration, X_4: Phrase frequency), α_0: fixed intercept, S_{0j}: random intercept for jth participant, β_i: fixed slope for ith independent variable, S_{ij}: random slope for ith independent variable for jth participant, ε: residual error

Model 1 included knowledge as a fixed effect, along with a random slope and intercept for each participant based on knowledge. Subsequent models incorporated a larger variety of variables. Model 8 was a full model with all four variables (knowledge, confidence, phrase frequency, and stimulation duration) as fixed effects, along with participant-wise random slopes for these variables and a participant-wise random intercept. In the GLMM analysis, the outcome variable (adjusted response time data) was assumed to follow a gamma distribution. For better model convergence, the adjusted response time, phrase frequency, and stimulus duration data were scaled down by 1:1000. If the main effects on the speed of sentence comprehension were found using Type III Wald chi-squared tests, Tukey tests for multiple comparisons were conducted.

3.3 Results

3.3.1 Association between knowledge levels and the speed of sentence listening comprehension

A one-way repeated measures ANOVA with a Greenhouse–Geisser correction was conducted. Mauchly's test indicated that the assumption of sphericity had been violated, $\chi 2(2) = 6.26$, $p < .05$; therefore, the degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity, $\varepsilon = .83$. The results showed a statistically significant effect of knowledge on the speed of sentence comprehension, $F(1.666, 48.320) = 47.268$, $\eta 2 = 0.62$, $p < .001$. A paired t-test with Bonferroni correction between each estimated marginal mean was conducted for multiple comparisons. The results indicated that the sentences with productive phrases were processed faster than those with only comprehensive phrases, $t(29) = 7.316$, $p < .001$, Cohen's $d = 1.336$, and those uncomprehensive phrases, $t(29) = 8.185$, $p < .001$, Cohen's $d = 1.494$. The sentences with only comprehensive phrases were processed faster than the sentences with uncomprehensive phrases, $t(29) = 3.934$, $p = .001$, Cohen's $d = .718$ (Fig. 3.4).

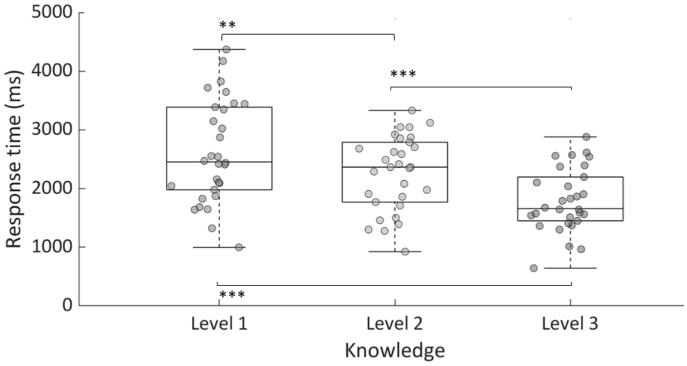

Fig. 3.4 The relationship between knowledge and the speed of sentence comprehension. The numbers at the bottom indicate the level of knowledge: 1. Uncomprehensive, 2. Only comprehensive, and 3. Productive. In the box plots, the line in the middle represents the average response time for sentence comprehension among participants for each knowledge level, and the box encloses the middle of 50% of the data. The top and bottom whiskers extend to the minimum and maximum. The points show the average comprehension speed of each participant (N = 30). The asterisks show the significance of the comprehension speed difference between each knowledge level calculated by ANOVA and multiple comparisons with Bonferroni correction with log-transformed response times (***p < .001, **p < .01, *p < .05).

3.3.2 Association between knowledge levels and the other influential variables: confidence, phrase frequency, and stimulus duration

One-way repeated measure ANOVAs with Greenhouse–Geisser corrections were performed to investigate the associations between knowledge levels and the other influential variables: confidence, phrase frequency, and stimulus duration. For confidence, a significant association existed between knowledge levels and confidence, $F(1.449, 42.027) = 367.297$, $\eta 2 = 0.93$, $p < .001$ (Fig. 3.5a). Significant associations were also found between knowledge levels and phrase frequency, $F(1.249, 36.223) = 576.381$, $\eta 2 = 0.95$, $p < .001$ (Fig. 3.5b), and knowledge levels and stimulus duration, $F(1.656, 48.033) = 43.587$, $\eta 2 = 0.60$, $p < .001$ (Fig. 3.5c). The results of the statistical analysis indicated possible confounding effects of these variables on the speed of sentence comprehension.

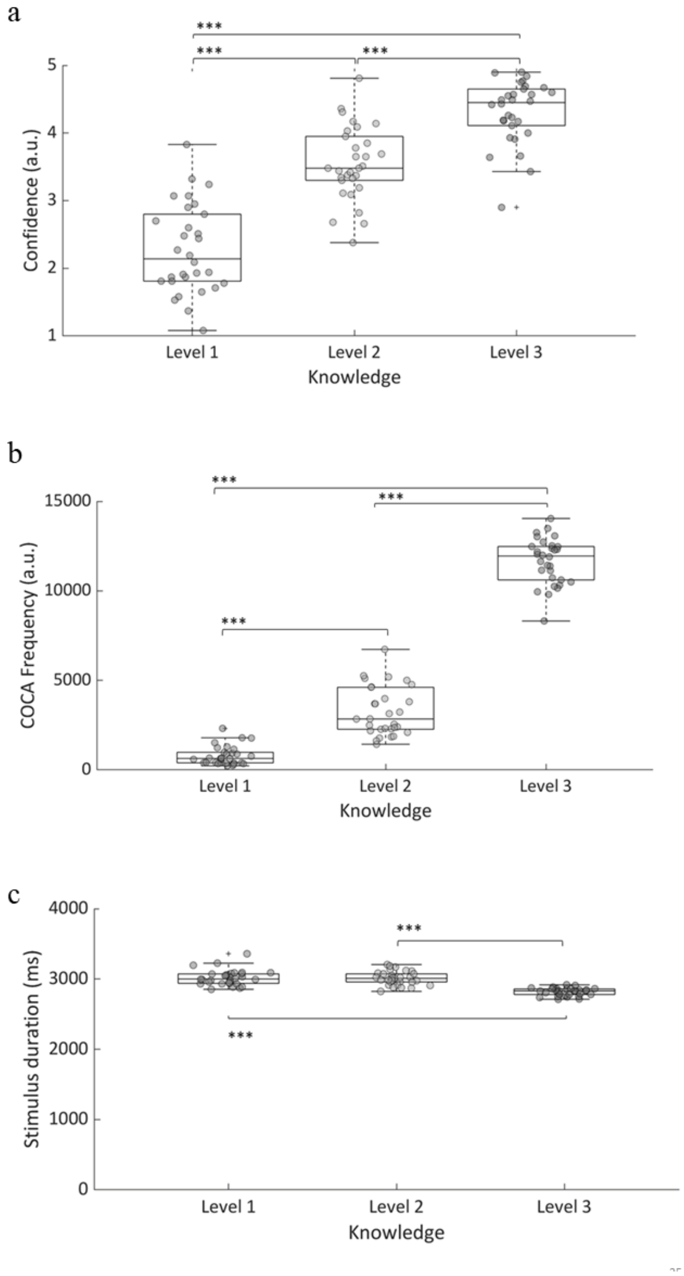
a
***
***
***
Confidence (a.u.)
5
4
3
2
1
Level 1
Level 2
Level 3
Knowledge
b
***
***
***
COCA Frequency (a.u.)
15000
10000
5000
0
Level 1
Level 2
Level 3
Knowledge
c
***
***
Stimulus duration (ms)
4000
3000
2000
1000
0
Level 1
Level 2
Level 3
Knowledge

Fig. 3.5 The relationships between knowledge and confidence **(a)**, phrase frequency **(b)**, and stimulus duration **(c)**. In the box plots, the line in the middle represents the average phrase comprehension confidence rate (on a scale of 1 to 5), phrase frequency in the Corpus of Contemporary American English (out of 1,001,610,938 words), and analyzed audio stimulus duration (sentence length excluding the final word) among participants at each knowledge level, respectively. The numbers at the bottom indicate the level of knowledge: 1. Uncomprehensive, 2. Only comprehensive, and 3. Productive. The boxes encloses the middle 50% of the data, and the top and bottom whiskers extend to the minimum and maximum. The points show each participant's average confidence rate, phrase frequency in COCA, and audio stimulus duration, respectively (N = 30). The asterisks indicate the significance of each confidence rate, phrase frequency, and stimulus duration difference between each knowledge level calculated by ANOVA and multiple comparisons with Bonferroni correction with confidence rate (***$p < .001$, **$p < .01$, *$p < .05$).

3.3.3 Association between knowledge levels and the speed of sentence listening comprehension based on generalized linear mixed models

A GLMM analysis was conducted to investigate the contributions of each variable—knowledge, confidence, phrase frequency, and stimulus duration—on the speed of sentence listening comprehension. This study particularly focused on the contribution of knowledge on comprehension speed by partialing out the effects of the other variables (Table 3.2).

Table 3.2 Models used for the generalized linear mixed model (GLMM) analyses and the model selection by the Akaike information criterion (AIC) and the Bayesian information criterion (BIC).

Model	AIC	BIC
Model 1: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + \varepsilon$	9621.947	9681.703
Model 2: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_2 + S_{2j})X_2 + \varepsilon$	9576.485	9666.119
Model 3: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_3 + S_{3j})X_3 + \varepsilon$	9597.005	9686.639
Model 4: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_4 + S_{4j})X_4 + \varepsilon$	9616.650	9706.283
Model 5: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_2 + S_{2j})X_2 + (\beta_3 + S_{3j})X_3 + \varepsilon$	9559.900	9685.387
Model 6: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_2 + S_{2j})X_2 + (\beta_4 + S_{4j})X_4 + \varepsilon$	9574.070	9699.557
Model 7: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_3 + S_{3j})X_3 + (\beta_4 + S_{4j})X_4 + \varepsilon$	9640.229	9765.715
Model 8: $RT=\alpha_0 + S_{0j} + (\beta_1 + S_{1j})X_1 + (\beta_2 + S_{2j})X_2 + (\beta_3 + S_{3j})X_3 + (\beta_4 + S_{4j})X_4 + \varepsilon$	9555.767	9723.083

RT: response time, X_i: independent variable (X_1: Knowledge, X_2: Confidence, X_3: Stimulus duration, X_4: Phrase frequency), α_0: fixed intercept, S_{0j}: random intercept for jth participant, β_i: fixed slope for ith independent variable, S_{ij}: random slope for ith independent variable for jth participant, ε: residual error

First, following the methodology of Barr et al. (2013), statistical analyses using the full model (Model 8) were performed (Fig. 3.6).

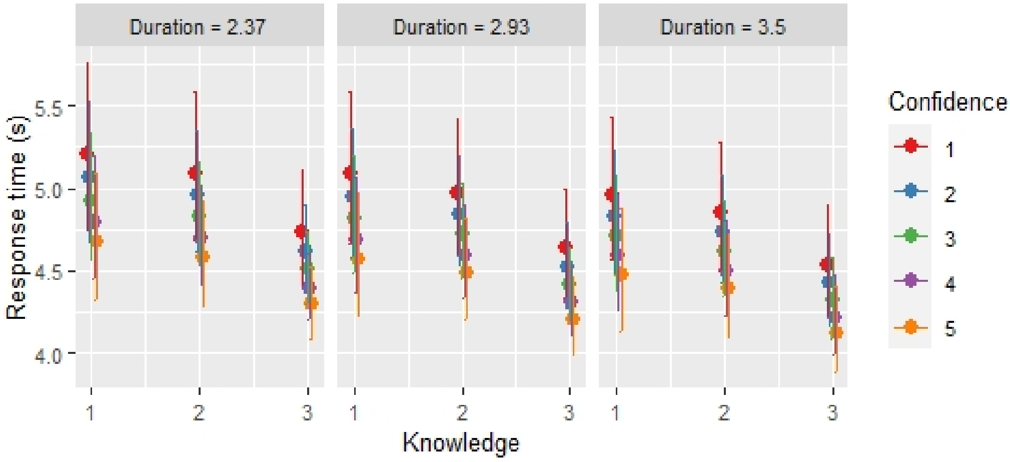

Fig 3.6 The relationship between sentence comprehension speed, knowledge, confidence and stimulus duration based on GLMM Model 8. In each plot, the point in the middle represents the predicted value of the response time for sentence comprehension at each knowledge level derived from Model 8. The lines indicate the 95% confidence intervals for the predicted values. The numbers at the bottom indicate the level of knowledge: 1. Uncomprehensive, 2. Only comprehensive, and 3. Productive. The points with different colors show each confidence level from 1 to 5. The graph in the middle shows the result with the mean of stimulus duration. The left and rights graphs are based on the mean of stimulus duration with −1 and + 1 standard deviations. Frequency is not included in the graphs, as it did not significantly affect sentence comprehension speed.

The result of the ANOVA Type III Wald chi-squared test indicated a significant main effect of knowledge ($\chi2$ (2) = 14.81, p < .001), confidence ($\chi2$ (1) = 5.76, p = .002), and stimulus duration ($\chi2$ (1) = 6.84, p < .001) on sentence comprehension speed. However, phrase frequency did not show a significant effect ($\chi2$ (1) = 3.07, p = .080). Further analysis using Tukey tests for multiple comparisons showed that sentences containing a productive phrase were comprehended more quickly than the sentences that included phrases with only comprehensive knowledge or uncomprehensive (productive knowledge – only comprehensive knowledge: z = 3.137, p < .001; productive knowledge – uncomprehensive: z = 3.616, p < .005; only comprehensive knowledge – uncomprehensive: z = 0.923, p = .625).

Regarding the comparison of models, the Akaike information criterion (AIC) favored Model 8. This model encompassed knowledge, confidence, phrase frequency, and stimulation duration as fixed effects, along with all potential random slopes and intercepts for participants. The Bayesian information criterion (BIC) preferred Model 2, which included knowledge and confidence as fixed effects with random slopes for these variables and a random intercept across participants (Table 3.2). It is typical for AIC and BIC to choose different models due to their distinct selection criteria. The foremost consideration is that in all analyses, knowledge consistently showed a significant contribution to the speed of sentence listening comprehension. Consequently, these findings collectively underscore the importance of knowledge as a key factor in determining the speed of sentence comprehension.

3.4 Discussion

3.4.1 Effects of productive vocabulary knowledge on sentence comprehension

The experiment demonstrated that sentences containing productive phrases were comprehended significantly faster compared to those with only comprehensive or uncomprehensive phrases. This finding strongly supports the beneficial effect of productive vocabulary knowledge on sentence comprehension. In this study, the time difference observed between sentences with productive phrases and those with only comprehensive phrases was about 430 ms. This time gap is notably significant in the context of sentence listening comprehension, considering that language comprehension involves rapid processing of various elements like phonemes, vocabulary, grammar, and pragmatic meanings (Rayner & Clifton, 2009; Thompson & Kielar, 2014). It is reported that adults can recognize spoken words in their first language within an average of 200 milliseconds (Ojima et al., 2011), and some written words are understood even faster, within about 100–200 ms (Davis et al., 2019). This indicates that a substantial amount of information can be processed within a 430-millisecond timeframe.

Regarding the comprehension of sentences containing only comprehensive phrases, there were no significant differences in the speed of comprehension compared to sentences with uncomprehensive phrases, even though the participants were familiar with the meanings of these phrases. It is possible that while processing sentences with either only comprehensive or uncomprehensive phrases, participants might have relied on context to deduce the meanings or translated the phrases into their first language for understanding, as suggested by Vandergrift (2003). In such cases, the time taken to understand sentences with either only comprehensive or uncomprehensive phrases could have been longer.

3.4.2 Possible mechanisms of productive knowledge effects on comprehension

Fast sentence comprehension could be attributed to the automaticity of semantic processing. Segalowitz and Hulstijn (2005) proposed that the advancement in vocabulary proficiency leads to quicker processing. They noted that as vocabulary proficiency improves, a range of processing modifications occurs, including accelerated processing, reduced need for attentional control, unconscious processing, effortless processing, ballistic processing, increased efficiency, and reliance on memory-based processing. Consequently, these overlapping changes in processing contribute to the automatic processing of vocabulary (Segalowitz & Hulstijn, 2005). Additionally, Ito and Pickering (2021) noted that the automaticity of lexical processing in a second language appears to improve as learners' proficiency increases. In the current study, this could mean that sentences containing a productive phrase were understood automatically, thus reducing the time needed for comprehension. Schmitt (2010) also highlighted that the automatic processing of vocabulary is advantageous not only for vocabulary itself but also for the processing of grammar and pragmatics.

A plausible explanation for faster comprehension could be the chunking of incoming words into phrases. Chunking enhances language processing efficiency by decreasing the cognitive load on the brain and shortening response times (Tang, 2013). Moreover, through repeated comprehension and use of learned vocabulary, learners can memorize and chunk phrases, thereby enhancing their processing speed (Segalowitz & Hulstijn, 2005). The findings of this study could be attributed to the participants having memorized productive phrases in chunks. As Wray and Perkins (2000) suggested, acquired formulaic sequences are typically stored in memory as chunks. Consequently, these productive phrases might have been recalled as chunks during the listening comprehension tasks, thereby positively influencing the speed of sentence comprehension.

An alternative explanation for the acceleration of comprehension could relate to the prediction effect for comprehension. Pickering and Gambi (2018) suggested that listeners constantly predict upcoming words during language comprehension. While Martin et al. (2013) did not find evidence supporting the prediction of phonology in second language studies, it is feasible that the concept of prediction in language comprehension can be applied to semantic and syntactic information. Based on the prediction-by-production theory proposed by Pickering & Gambi (2018), the speed of prediction is limited by the capability of the comprehender's production system. Words and phrases that can be produced are anticipated by accessing the mental lexicon and retrieving them before the phrases are presented, even in a second language, facilitating quick processing. Given that productive knowledge is crucial for making predictions, the absence of productive vocabulary knowledge during sentence comprehension could result in slower predictions and, consequently, longer response times.

According to the motor theory of speech perception (Liberman et al., 1957; Wilson et al., 2004; Iacoboni, 2008), the motor system plays a role in converting acoustic signals into phonetic codes, and listening performance can be enhanced through motor cortex activity at the perception level. Hence, the observed quicker comprehension in this study could be linked to motor cortex activity. Although this experiment cannot fully dismiss the possibility of such perceptual effects, the response time gap between processing sentences with productive phrases versus comprehensive and uncomprehensive phrases would be too large to be explained only by perceptual factors (Rayner & Clifton, 2009; Ojima et al., 2011; Thompson & Kielar, 2014; Davis et al., 2019). The process of mapping acoustic signals to phonetic codes in speech perception typically occurs in less than 175 ms (Bidelman et al., 2013). Therefore, the 430 ms difference observed between sentences with productive phrases and those with only comprehensive phrases might be more indicative of cognitive effects, such as memory and chunking.

3.4.3 Limitations

While the findings of this study highlight the significance of acquiring productive knowledge for enhancing sentence comprehension speed, there are some limitations to consider. First, participants were queried about their confidence in comprehending phrases during the screening phase, not at the time when response times were recorded. Consequently, there could be a discrepancy between the confidence levels reported during the visually presented screening session and those in the behavioral experiment where stimuli were delivered auditorily. Despite the disadvantages of inquiring about confidence during the screening experiment, there are also distinct advantages to this approach.

In the screening phase, since the target phrases were underlined, participants rated their confidence specifically in understanding these phrases rather than the entire sentences. While it is possible that they inferred the meanings of these phrases from the context of the whole sentence, thereby affecting the level of confidence in comprehension, focusing the confidence inquiry solely on the target phrases, instead of the entire sentence, may have yielded a more accurate prediction of their comprehension confidence. Moreover, including confidence queries in the behavioral experiment could have extended the experiment's duration, potentially impairing participants' concentration and slowing down their comprehension. Due to these considerations, confidence data was collected during the screening experiment.

Additionally, the accuracy of vocabulary knowledge in the screening experiment was assessed instead of during the behavioral experiment. While there could have been a discrepancy in comprehension accuracy between the screening and behavioral experiments, the aim of this study was to investigate the impact of already acquired vocabulary knowledge on the speed of sentence listening comprehension. Therefore, the accuracy of listening comprehension was not a central focus of this research.

Lastly, Stein et al. (2006) claim that second language learners can develop their language proficiency by neural plasticity in the language system. The brain possesses a remarkable capacity to adapt and modify both its function and physical form in reaction to external stimuli, cognitive demand, or experiential learning (Li et al., 2014). Although a rapid response time is observable in the current study, this alone does not elucidate the underlying functional changes in the brain. To further investigate and clarify how the presence or absence of productive vocabulary knowledge affects brain function during sentence listening comprehension, a brain recording experiment was conducted in Chapter 4.

Chapter 4

Neural Activity Related to Productive Vocabulary Knowledge Effects during Second Language Comprehension

4.1 Introduction

Recent studies in cognitive neuroscience have deepened our understanding of the neurological foundations of second language acquisition. Looking beyond behavioral observations, analyzing brain functions and structures offers a biological perspective on how acquiring a language as a skill and knowledge process can change the human brain (Osterhout et al., 2008; Luk et al., 2020). The human EEG has served as a key source of data in exploring the neural mechanisms that underpin human cognitive processes. It is believed that the varying synchronization of brain rhythms, known as oscillation, influences diverse perceptual and cognitive functions, which include language as well (Benítez-Burraco & Murphy, 2019).

Bakker et al. (2015) conducted an in-depth investigation into the neural power changes detectable through EEG and their relationship to the speed of reading comprehension. This study made a comparative analysis between novel words and words that were recently learned. Their findings highlighted that the processing speed for newly acquired words was slower compared to novel words. Moreover, a phenomenon was observed even in the initial stages of language learning. This slowdown in processing speed was accompanied by significant changes in neural activity patterns, indicating a direct neurological response to the learning process. Similarly, Grabner et al. (2007) examined neural activity changes during the translation of words with varying frequencies from a second language to a first language. Their study underscored the significant role of word frequency, a key aspect linked to lexical proficiency as outlined by Zareva et al. (2005). The relationship between word frequency and lexical proficiency suggests that as one's vocabulary knowledge develops, it could lead to observable changes in brain activity.

However, a critical aspect to consider is that these studies predominantly concentrated on the impact of comprehensive vocabulary knowledge and the potential influence of productive vocabulary knowledge on comprehension processes was largely overlooked. This oversight points to a gap in the research, as productive knowledge is an integral component of overall lexical proficiency. Exploring the effects of productive vocabulary knowledge, therefore, becomes essential to capture the entire picture of lexical proficiency.

This study examines the neural changes in EEG during the listening comprehension of sentences in a second language, based on the vocabulary knowledge levels: productive, only comprehensive, and uncomprehensive (Allal-Sumoto et al., 2024). To detect neural changes, a time-frequency-based analysis of participants' EEG data was applied (Cohen, 2014). The hypothesis of this study was that distinct neural pathways responsible for rapid processing would manifest in variations of EEG power modulation, contingent on levels of vocabulary knowledge. To enhance the depth of the analysis, both conventional EEG analysis using an encoding model and advanced EEG analysis techniques applying a decoding model were utilized. An encoding model is commonly used to predict brain activity based on stimuli, whereas a decoding model operates in reverse, predicting stimuli or cognitive states based on observed brain activity. These models serve complementary functions (Naselarls et al., 2011). In this study, the encoding model offers insights into how the brain reacts to specific linguistic inputs, while the decoding model is employed to identify patterns of neural activity that may indicate different levels of vocabulary knowledge. Even if the encoding model analysis does not reveal any neural activity changes, the decoding model has the potential to detect them.

Exploring neural function accompanying the contribution of productive vocabulary knowledge to sentence comprehension speed may lead to efficient pedagogical suggestions such as ample repetition of input or an emphasis on productive vocabulary knowledge acquisition. This research shows that neural alterations linked to lexical knowledge play a significant role in the speed of sentence listening comprehension in a second language.

4.2 Materials and methods

4.2.1 Participants

In this study, twenty-seven undergraduate and graduate students from Kyoto University (14 males and 13 females) participated. From these, two were excluded from the EEG experiment based on a screening experiment described later, leaving 25 participants whose EEG data were collected. The minimum number of participants required for the statistical analysis was set at 15, determined before the experiment through a power analysis using GPower (Version 3.1.9.7), with the following criteria: tail(s) = two, $\alpha = 0.05$, $1-\beta = 0.8$, and effect size $d = 0.8$. The EEG data from these 25 participants were split into two groups for preliminary and main analyses. The finalized analysis process was applied to the EEG data of 15 participants in the main analysis. The EEG data from the other ten participants, not included in the main analysis, were utilized for the preliminary analysis to finalize the overall analysis procedure, which is explained in further detail below.

The mean age of the participants was 22.4 ± 2.06 (range: 20–30 years). The criteria for participation in this study were as follows; a native Japanese speaker, right-handed as determined by the Edinburgh Handedness Inventory (Oldfield, 1971), not having any hearing problems, and achieving the same requirement of

English proficiency as the behavioral study described in Chapter 3. All participants were compensated for their involvement. The study was conducted with ethical approval from the research ethics committee of the Kyoto University Psychological Science Unit (approval number: 1-P-2).

4.2.2 Stimuli

The stimuli employed in this EEG experiment were basically identical to those used in the earlier behavioral study focusing on changes in comprehension speed with different participants and methods. As the additional task to the behavioral experiment, which is explained in further detail below, one more sentence for each of the 200 phrases from examples in dictionaries was selected and adjusted according to the same criteria of the behavioral study (The sentences can be seen in Appendix 2). The tasks were auditory, with English sentences generated using Google's Text-to-Speech at a rate of 150 words per minute, aligning with the average speaking speed of native English speakers (Wang, 2021). Sentences translated into Japanese were recorded by a native Japanese speaker.

4.2.3 Task procedure

The experiment consisted of two segments: a screening experiment and an EEG experiment. The screening experiment aimed to verify each participant's familiarity with the target phrases and to select suitable participants for the EEG experiment who responded with at least 30 phrases applicable to each knowledge category. This screening was conducted using Google Forms and encompassed both a production task and a comprehension task, each with two sets of 100 trials. For the production task, designed to test participants' ability to generate target phrases, an English sentence along with its Japanese translation was displayed in text format. The last word in the target phrase of the English sentence was omitted, and participants were required to type in the missing word using a keyboard. Exact spelling was not compulsory; spellings that were nearly correct were also accepted as valid responses.

Next, in the comprehension task, a full English sentence was shown. To assess their understanding of the target phrases, participants were required to enter Japanese translations for only the highlighted target phrase. They were advised to complete 100 questions within 30 minutes and to take breaks between tasks. The results from the screening experiment were used to categorize the phrases into three knowledge groups: phrases that could be both produced and comprehended by a participant, phrases that could be comprehended, and phrases that could not be comprehended. Phrases that participants could produce in English but did not understand were omitted. It was determined that only the participants with more than 30 target phrases in each of the three vocabulary knowledge categories in the screening would advance to the EEG experiment. Consequently, two out of the 27 participants were excluded at this stage.

The EEG experiment was conducted at least a week after the screening to reduce the impact of memory recall from the screening experiment. The EEG recording was performed while participants were engaged in the production and listening comprehension tasks. For each participant, a unique set of stimuli for the EEG experiment was developed, based on their results from the screening. The EEG experiment involved three sets of 40 trials for the production task and two sets of 60 trials for the comprehension task, totaling 240 stimuli for each participant to respond to. These stimuli were presented by using Psychtoolbox (Brainard, 1997; Kleiner, Brainard, & Pelli, 2007; Pelli, 1997) on MATLAB (Mathworks).

First, the participants adjusted the audio volume and completed five practice questions before starting each production and comprehension task. The timing of a single trial in the production task was as follows (Fig. 4.1a): a 300 ms beep sound, followed by a random silent period of 1000 ms, 1500 ms, or 2000 ms.

This was followed by the presentation of a Japanese sentence. After another silent period of 1500 ms, an English sentence was played, ending with a phrase of three or four words, with the final word of this phrase missing. The participants were instructed to press any key as quickly as they could when they came up with the missing word and then to say their answer aloud within 10 seconds. This was followed by a 1000 ms silent period after the 10 seconds of response time.

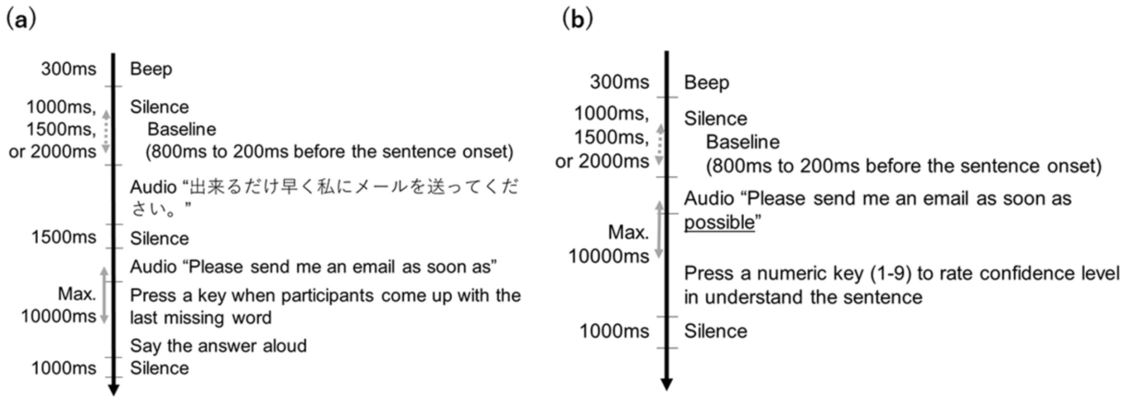

Figure 4.1 The procedures for production task **(a)** and comprehension task **(b)**. The black arrow shows the sequence of events in a single trial. The durations listed on the left side represent the length of each activity. Every trial starts with a beep sound and ends with a silence period of 1000 ms. Time of Interest (marked by the gray arrow) spans from 1000 ms before to 1500 ms after the target word onset. In the comprehension task **(b)**, the target words are the final words of the target formulaic sequences. In the production task **(a)**, although the last word is not actually presented, it corresponds to the moment when the target word would have appeared. Each sentence is played only once.

In the comprehension task, the timing of each trial was structured as follows (Fig. 4.1b): a 300 ms beep sound, then a randomly chosen silent period of 1000 ms, 1500 ms, or 2000 ms. Subsequently, an English sentence was played, with its last three or four words always forming the target phrase. Participants were asked to press a numeric key to rate their confidence in understanding the sentence, using a Likert scale: 9: strong confidence, 8: confidence, 7: confidence to some extent, 6: a little confidence, 5: neutral, 4: relatively less confidence, 3: less confidence, 2: no confidence, and 1: no confidence at all. The purpose of this confidence rating was to encourage participants to focus on the task.

4.2.4 EEG recording

EEG data were recorded using a 32-channel EEG amplifier (BrainVision MR, Brain Products, Germany) equipped with an electrode cap according to the International 10-20 system. To record the vertical and horizontal electrooculogram (VEOG and HEOG), four electrodes were utilized. The measurement reference was linked to the earlobes, and the ground electrode was positioned at the inion. EEG signals were collected using recording software (Brain Vision Recorder 1.22, BrainProducts, Germany), at a 5 kHz sampling rate with a 1 Hz high-pass, a 250 Hz low-pass, and a 60 Hz notch software filter. The EEG signals were recorded at an unnecessarily high sampling rate due to equipment constraints. Electrode impedances were maintained below approximately 10 kΩ. All EEG experiments took place in an electromagnetic shielded and soundproofed room. The participants were instructed to keep their eyes closed and minimize movement during EEG recording.

4.2.5 EEG preprocessing

Preprocessing of EEG data was conducted with the Fieldtrip toolbox (Oostenveld et al., 2011) in Matlab, which was commonly used for both time-frequency-based EEG analysis (TFR) and multivariate pattern analysis (MVPA). Preprocessing was done in the following pipeline: trial definition, filtering, EOG artifacts reduction, data resampling, bad-trial rejection, and wavelet transformation.

During the trial definition phase, three types of triggers were utilized for epoching the EEG data: the onset of target words, the termination of audio files in the comprehension task, and the termination of audio files in the production task. The audio file endings in the production task correspond to the onset of the last word in the formulaic sequences, the same as the target word onsets in the comprehension task. The duration of each epoch is from 1000 ms before to 1500 ms after these triggers. To prevent boundary distortion in the wavelet analysis, the lengths of the epochs were initially extended by an additional 3500 ms both before and after the time of interest frame and then reduced back to the specified epoch lengths described above following the wavelet transformation. In the filtering stage, specific filter and reference adjustments were applied: high-pass and low-pass processing at 1 Hz and 30 Hz using a fifth-order Butterworth filter from two directions; average reference for all EEG electrodes. For reducing EOG artifacts, the VEOG and HEOG were multiplied by the multiple regression coefficients of the EOG and EEG and subtracted to eliminate EOG artifacts from the EEG data (Gratton et al., 1983). The data was then downsampled to 200 Hz. Bad trials were excluded from the analysis based on the following criteria: maximum amplitude greater than 50 microvolts, the first derivative of the time series greater than 200 microvolts/ms, and minimum amplitude less than 0.5 microvolts for more than 100 ms. On average, these criteria led to the exclusion of 2.33±3.51% of trials from further analysis. The complex Morlet wavelet ranging from 1 Hz to 30 Hz in 1 Hz steps was applied to the data cleaned. The width of the wavelet was set at 7 indicating that the mother wavelet encompasses 7 cycles of the wave.

4.2.6 Time-frequency analysis (TFR)

For both the comprehension and production tasks, time-frequency analyses with a one-sample t-test were conducted to identify EEG activities associated with the presentation of the target word. Additionally, a paired t-test was employed to detect EEG activities contingent on whether the participant acquired productive knowledge or not.

In the one-sample t-test, this study evaluated whether the percentage change in power from the baseline was influenced by the presentation of the target word. The baseline period was set from 800 ms to 200 ms before the onset of the sentence stimulus. This analysis combined data from all three knowledge levels and was aimed at identifying any changes in activity related to the target word regardless of the knowledge level. For multiple comparisons involving time steps, frequency steps, and the number of electrodes, cluster correction was applied (Maris & Oostenveld, 2007). In this correction method, a cluster was defined as a continuous time, frequency, and electrode space with $p<0.05$ (two-tailed).

A change was deemed significant if the total of t-statistics within a given cluster (i.e. cluster statistics) surpassed the 95th percentile in an empirical distribution that was established based on 500 random permutations of conditions. To visualize the spatial distribution of these significant clusters on the scalp, cluster statistics for each electrode were plotted using a toolbox available in EEGLab (Delorme & Makeig, 2004). Additionally, the percentage of signal change within these clusters was compared across different levels of vocabulary knowledge. For this comparison, the % power change within a cluster for each individual was computed as the average across time, frequency, and electrode. A one-way ANOVA was then conducted to determine if the mean values varied among participants across conditions; the levels of the ANOVA were three different levels of vocabulary knowledge.

In the paired t-test, whether the percentage change in power was contingent on the participants possessing or lacking productive vocabulary knowledge was assessed. The only distinction from the one-sample t-test mentioned earlier is that the percentage power change was calculated separately for the two groups:

those with productive knowledge and those without it.

4.2.7 Multivariate pattern analysis (MVPA)

The MVPA was conducted using the support vector machine (SVM) functions ("fitcsvm" and "predict") available in Matlab, following the approach typical in conventional MVPA research (Sarraf & Tofighi, 2016; Adeli et al., 2016; Jang et al., 2018; Gao et al., 2021). The MVPA pipeline included these steps: trial averaging, standardization, dimension reduction, SVM classifier training and prediction, and statistical analysis of prediction results.

In the trial averaging step, several trials were randomly chosen from the original set, and their wavelet power average was used to create a new trial (supertrial) (Grootswagers et al., 2017; López-García et al., 2022). This approach aimed to enhance the signal-to-noise ratio and ensure a balanced number of trials across each class. The chosen number of trials for averaging was fixed at 5. The number of supertrials was set at 200 for each class and participant, a decision guided by a grid search detailed below. Standardization of the wavelet power's scalp distribution was achieved through a z-transformation across electrodes. The data from 28 EEG channels (dimensions) were dimension-reduced by Principal Component Analysis (PCA) and were utilized as training and test data for an SVM. The number of PCA components was optimized based on a grid search to achieve 60% explanatory power. SVM training involved a leave-one-participant-out cross-validation method, using the EEG electrode distribution of wavelet power as input and classifying them as either "productive/unproductive words." The kernel of SVM was selected as "linear" by performing a grid search. This process, from trial averaging to SVM prediction, was repeated 20 times to avoid initial value dependence. The mean prediction accuracy from these repetitions was calculated and used as the representative value for each participant.

To assess whether the mean prediction accuracy across participants was significantly different from the chance level (50%), a statistical test was conducted. As the multiple testing of time and frequency steps occur in this context, a cluster-level correction was applied (Maris & Oostenveld, 2007). This cluster-level correction involved calculating the empirical distribution of the null hypothesis through 500 permutation tests. Clusters were identified as contiguous activities in time and frequency where the t-statistic was $p<0.05$ (two-tailed). During the permutation tests, the cumulative distribution of the highest summation of t statistical value within a cluster was determined when data were randomly shuffled at the chance level. A significant difference was identified if the cluster statistics surpassed the upper 5% of this empirical distribution.

The hyperparameters tested in this study included the kernel function representing the hyperplane of the SVM, the number of PCA components used for dimension reduction, and the quantity of supertrials formed by randomly combining five original trials. These hyperparameters were determined through a grid search during the preliminary analysis using data from 10 participants. The dataset for this grid search was entirely separate from that of the 15 participants whose data contributed to the final results. The kernel function options were "linear" or "RBF"; the kernel scale was set at 1 for the RBF, and the box constraint was also fixed at 1 as hyperparameters, in line with previous studies (Parvar et al., 2015; Lee et al., 2022; Raghu et al., 2020). The number of PCA components considered for determining the explanatory power rate included five different levels: 20%, 40%, 60%, 80%, and 100% (i.e. with no dimension reduction). As for the number of supertrials, six different patterns were evaluated: 10, 20, 50, 100, 200, and 500, to identify the count that would minimize the variance in prediction accuracy. This grid search was specifically conducted for an instantaneous frequency of 5 Hz and a time point 500 ms after the completion of the stimulus in the comprehension task. The selection of these hyperparameters was based on the average and variance of prediction accuracy obtained from 100 rounds of SVM training and prediction, using the leave-one-participant-out approach. The outcomes of the grid search indicated that setting the kernel function to "linear" yielded greater accuracy. With this kernel function, the highest accuracy was achieved when the number of PCA components provided 60% explanatory power. Additionally, it was observed that the variance in accuracy significantly increased when the number of supertrials was fewer than 200. Consequently, based on these findings, the kernel function was finalized as "linear," the number of supertrials was set at 200, and the PCA components were chosen to offer 60% explanatory power.

4.3 Results

4.3.1. Behavioral results

The analysis of reaction time relative to different knowledge levels during the comprehension task was conducted using a one-way repeated measures ANOVA with a Greenhouse–Geisser correction (Fig. 4.2a).

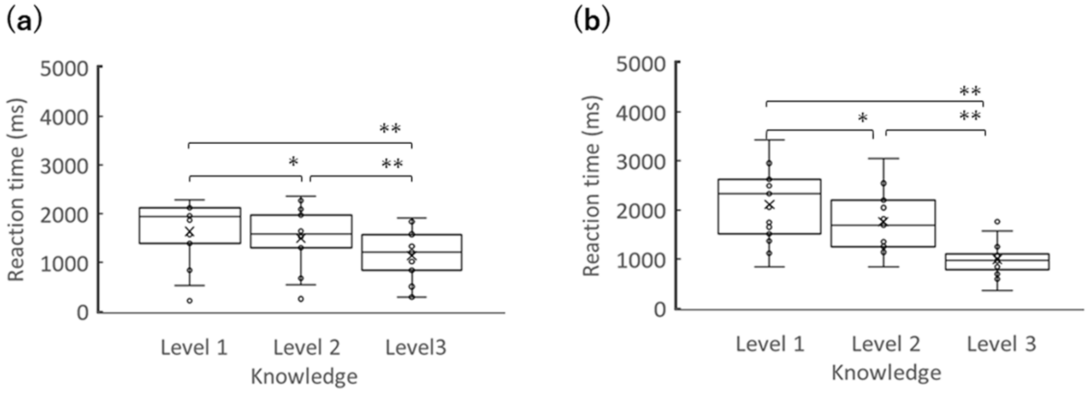

Figure 4.2 The reaction time results for comprehension task **(a)** and production task **(b)**. The numbers at the bottom indicate the level of knowledge: 1. Uncomprehensive, 2. Only comprehensive, and 3. Productive. In the box plots, the central line indicates the average reaction time for sentence comprehension confidence judgment for participants at each level of knowledge. The box contains the middle 50% of the data range. The upper and lower whiskers extend to the maximum and minimum values of the dataset, respectively. Each plot depicts the average comprehension time for each participant (N = 15). The asterisks indicate the significance of the speed differences in judgments between each knowledge level, as determined by multiple comparisons using Bonferroni correction applied to log-transformed reaction times (***$p < 0.001$, **$p < 0.01$, *$p < 0.05$).

Mauchly's test revealed a violation of the sphericity assumption ($\chi 2(2) = 16.272$, $p < .001$), leading to an adjustment of the degrees of freedom based on the Greenhouse-Geisser estimates of sphericity ($\varepsilon = .58$). The findings indicated a statistically significant influence of knowledge on the speed of comprehension confidence judgments ($F(1.167, 16.336) = 22.657$, $\eta 2 = 0.62$, $p < .001$). A post-hoc paired samples t-test with Bonferroni correction revealed that judgments of comprehension confidence were quicker for sentences containing productive phrases compared to those with only comprehensive phrases ($t(14) = 7.983$, $p < .001$, Cohen's $d = 2.061$) and compared to sentences with uncomprehensive phrases ($t(14) = 5.019$, $p < .001$, Cohen's $d = 1.296$). Additionally, it was found that comprehension confidence judgment for sentences with only comprehensive phrases was made more quickly than for sentences with uncomprehensive phrases ($t(14) = 2.402$, p = .031, Cohen's $d = .620$).

For assessing the impact of knowledge levels on response time in the production task, a one-way repeated measures ANOVA with Greenhouse–Geisser correction was performed as well (Fig. 4.2b). Mauchly's test showed a violation of the sphericity assumption ($\chi2(2) = 10.176$, $p < .006$), thus, adjustments were made to the degrees of freedom based on the Greenhouse-Geisser sphericity estimates ($\varepsilon = .65$). The analysis demonstrated a significant influence of knowledge on the reaction time needed to respond with the missing word in a phrase during the production task ($F(1.296, 18.148) = 50.423$, $\eta2 = 0.78$, $p < .001$). A paired samples t-test with Bonferroni correction revealed that the response time for providing the final word of productive phrases was quicker compared to those with only comprehensive phrases ($t(14) = 9.881$, $p < .001$, Cohen's $d = 2.551$) and those with uncomprehensive phrases ($t(14) = 7.376$, $p < .001$, Cohen's $d = 1.904$). Additionally, responses to the last word of phrases that were only comprehensive were quicker than for those phrases that were uncomprehensive ($t(14) = 2.934$, $p = .011$, Cohen's $d = .758$).

4.3.2. Power modulation regarding target word presentation

An EEG activity associated with the target word's presentation was examined using a one-sample t-test. In the comprehension task, the analysis revealed a notable decrease in power around 10 Hz both before and after the target word's presentation, particularly in the central-parietal areas (Fig. 4.3a & 4.3b).

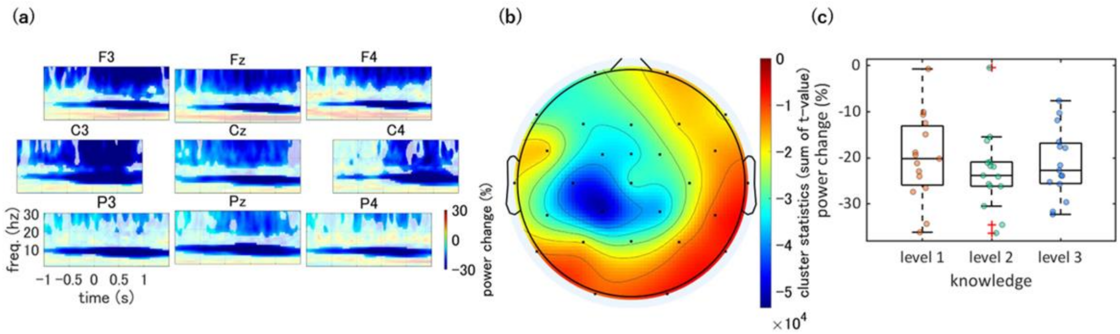

Figure 4.3 Results of the % power change associated with the presentation of target words in the comprehension task. **(a)** Time-frequency results at representative electrodes. The color bar represents the average % power change between participants. Regions with $p \leq 0.05$ determined by cluster correction, are depicted as fog-free, others ($p > 0.05$) as foggy. **(b)** Topographic map of the cluster illustrating decreased % power change around 10 Hz before and after the target onset compared to the baseline. **(c)** The box and whisker plot with jitter of % power change of each individual at each knowledge level. The numbers at the bottom indicate the level of knowledge: 1. Uncomprehensive, 2. Only comprehensive, and 3. Productive.

To examine EEG power changes in relation to the presence or absence of productive knowledge in participants, a repeated measures ANOVA was conducted within the identified cluster. However, this analysis did not find a significant main effect ($F(2, 28) = 1.222$, $\eta2 = 0.02$, $p < .310$) (Fig. 4.3c).

During the production task, a notable increase in power at around 15 Hz was observed following the onset of the target (Fig. 4.4a), particularly in the central and occipital sites (Fig. 4.4b).

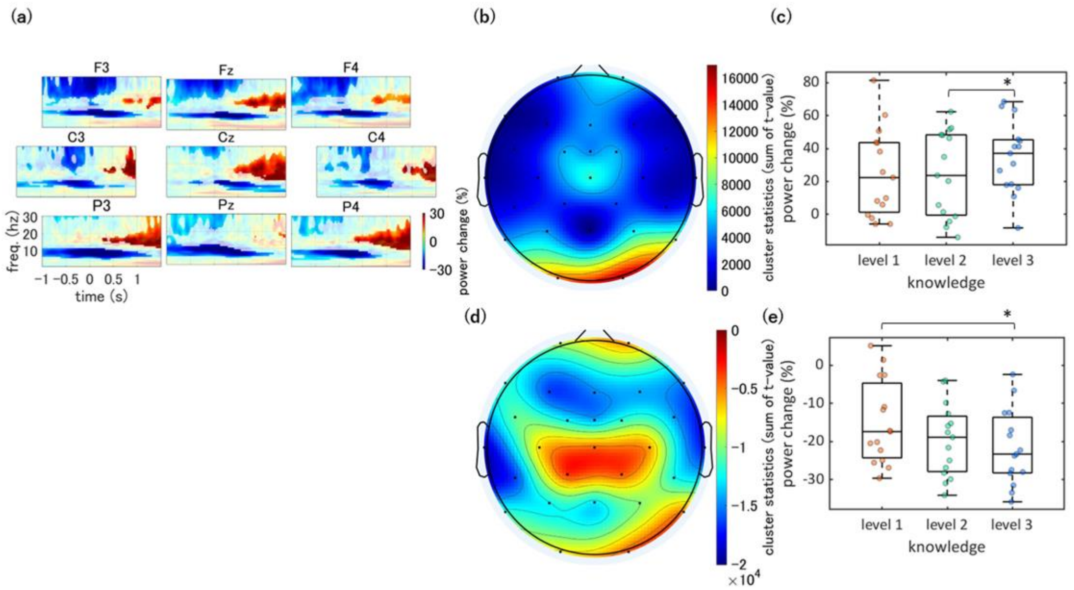

Figure 4.4 Results of the % power change associated with the presentation of target words in the production task. **(a)** Time-frequency results at representative electrodes. The color bar represents the between-participants average of the % power change. Regions with $p \leq 0.05$ identified through cluster correction, are displayed as fog-free and others ($p > 0.05$) as foggy. **(b)** Topographic map of the cluster showing increased % power change around 15 Hz after the target onset compared to baseline. **(c)** The box and whisker plot with jitter of % power change of each individual at each knowledge level for the cluster (b) (*$p < 0.05$). The numbers at the bottom indicate the level of knowledge: 1. Uncomprehensive, 2. Only comprehensive, and 3. Productive. **(d)** Topographic map of the cluster showing reduced % power change around 10 Hz before and after the target onset compared to baseline. **(e)** The box and whisker plot with jitter of % power change of each individual at each knowledge level for the cluster (d) (*$p < 0.05$). The numbers at the bottom indicate the level of knowledge: 1. Uncomprehensive, 2. Only comprehensive, and 3. Productive.

A repeated measure ANOVA revealed a significant main effect in EEG activity related to different levels of knowledge ($F(2,28) = 3.595$, $\eta^2 = 0.04$, $p < .041$). There was a marked distinction between sentences containing phrases with productive knowledge compared to those with only comprehensive knowledge ($p < .025$) (Fig. 4.4c). Furthermore, a significant decrease in power around 10 Hz was noted both before and after the target onset (Fig. 4.4a) across the extensive parietal and frontal electrodes (Fig. 4.4d). The ANOVA results indicated the main effect of EEG activity associated with the level of knowledge ($F(2, 28) = 5.631$, $\eta^2 = 0.07$, $p < .009$). A Significant difference was found in cluster EEG power between sentences that comprised phrases with productive knowledge versus those lacking comprehension ($p < .042$) (Fig. 4.4e).

4.3.3. Comparison of productive vs unproductive trials

A paired t-test was performed to detect the impact of productive knowledge on EEG activity. The results indicated no notable change in power during the comprehension task (Fig. 4.5).

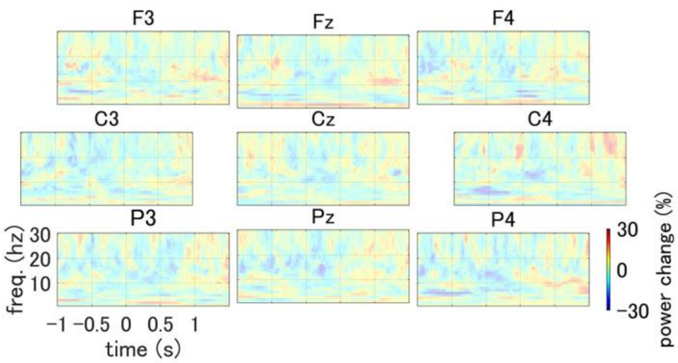

Figure 4.5 Results of the difference of % power change between productive (level 3) and unproductive (levels 1 & 2) trials associated with the presentation of target words in the comprehension task. Time-frequency results at representative electrodes. The color bar shows the between-participants average of the difference of % power change (level 3 – levels 1 & 2). No significant regions of $p \leq 0.05$ following cluster correction are found.

During the production task, a notable increase in power was observed in trials where production was possible compared to those where it was not, particularly around 27 Hz, approximately 1000 ms following the onset of the target (Fig. 4.6a), specifically at the occipital site (Fig. 4.6b).

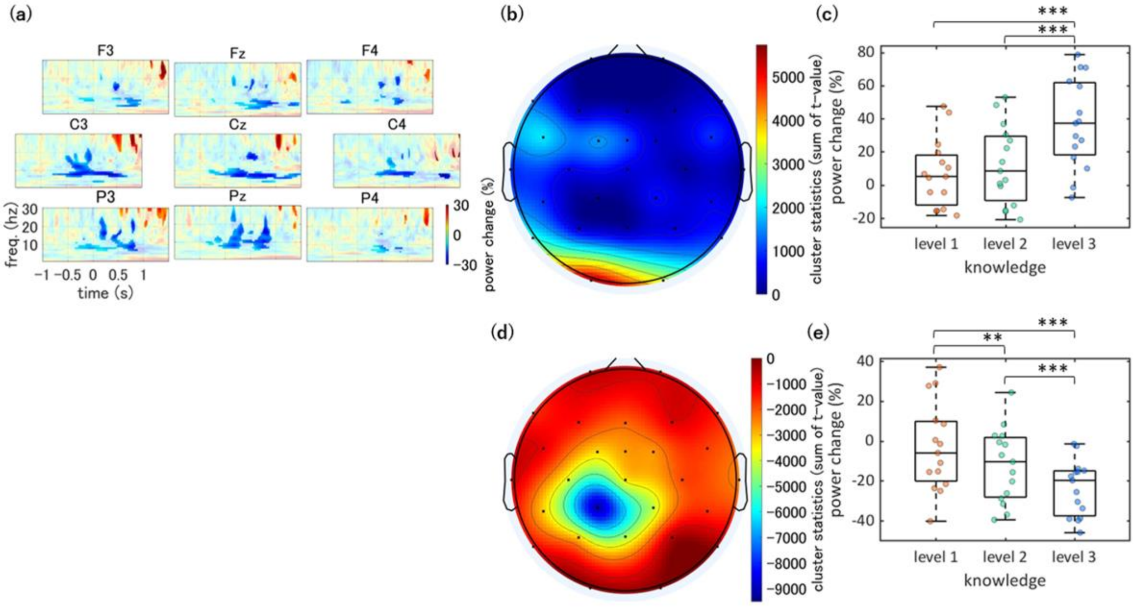

Figure 4.6 Results of the difference of % power change between productive (level 3) and unproductive (levels 1 & 2) trials associated with the presentation of target words in the production task. **(a)** The time-frequency analysis results from selected electrodes are displayed. The color bar represents the between-participants average of the difference of % power change (level 3 – levels 1 & 2). Areas with $p \leq 0.05$ identified through cluster correction are shown as fog-free and others (p>0.05) as foggy. **(b)** The topographical map highlights the cluster where there is an increased % power change around 27 Hz about 1000 ms after the target onset in levels 1 & 2 compared to level 3. **(c)** The box and whisker plot with jitter of % power change of each individual at each knowledge level for the cluster (b) (***p < 0.001). The numbers at the bottom indicate the level of knowledge: 1. Uncomprehensive, 2. Only comprehensive, and 3. Productive. **(d)** The topographic map shows the cluster where there is a reduced % power change around 10 Hz when the target presentation is expected in levels 1 & 2 compared to level 3. **(e)** The box and whisker plot with jitter of % power change of each individual at each knowledge level for the cluster (d) (***p < 0.001, **p < 0.01). The numbers at the bottom indicate the level of knowledge: 1. Uncomprehensive, 2. Only comprehensive, and 3. Productive.

A post-hoc ANOVA analysis focusing on the cluster EEG power across different levels of knowledge revealed a significant main effect of EEG activity in relation to knowledge level ($F(2, 28) = 24.530$, $\eta^2 = 0.25$, $p < .000$). Significant disparities were found between sentences containing phrases with productive knowledge versus those with only comprehensive knowledge ($p < .001$), and between productive knowledge and uncomprehensive ($p < .001$) (Fig. 4.6c). A significant decrease in power was also observed around 10 Hz (Fig. 4.6a) at the central-parietal sites in instances where the target word was expected but absent (Fig. 4.6d). There was a significant main effect of EEG power that related to the level of knowledge ($F(2, 28) = 24.266$, $\eta^2 = 0.18$, $p < .000$). Significant variations in cluster EEG power were found between sentences containing phrases with productive knowledge versus those with only comprehensive knowledge ($p < .001$), between productive knowledge and uncomprehensive ($p < .001$), and between only comprehensive knowledge and uncomprehensive ($p < .020$) (Fig. 4.6e).

4.3.4. Multivariate pattern analysis (MVPA)

MVPA was utilized to verify if the brain activities accurately reflect the levels of vocabulary knowledge that are either productive or unproductive (Fig. 4.7).

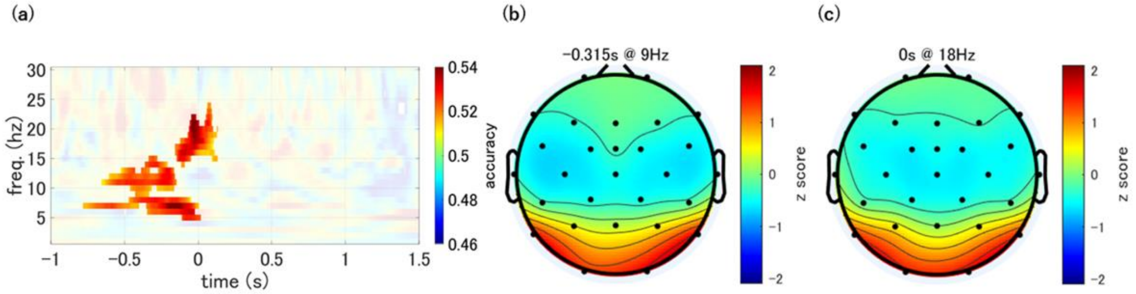

Figure 4.7 Results of decoding accuracy for productive/unproductive word trials in relation to target word presentation in comprehension task. **(a)** Time-frequency representation of the prediction accuracy derived from data across all channels. Time is aligned to the appearance of the final word (the target word) in formulaic sequences. The color bar reflects the between-subjects average of prediction accuracy in MVPA (n=15). Areas with $p > 0.05$ determined by the cluster correction are depicted as foggy. Topographic maps highlight significant clusters (0.315s before (b) and just around (c) the onsets of target words at the theta/alpha and beta frequencies). The color bar represents z-transformed values of EEG power across electrodes. Shown as time, frequency, and subject averages within clusters.

During the comprehension task, it was observed that the different levels of knowledge could be distinguished by theta or alpha oscillations approximately 315 ms prior to the target word's onset around the inferior temporal site (Fig. 4.7b), and by beta oscillation at the moment the target word appeared around the inferior temporal site (Fig. 4.7c).

During the production task, beta oscillation was detected approximately 355 ms prior to the target word's appearance around the inferior temporal site (Figs. 4.8a & 4.8b), and alpha oscillation was observed around 375 ms following the onset of the target word around the inferior temporal site. These EEG activities were found to be indicative of different knowledge levels (Figs. 4.8a & 4.8c).

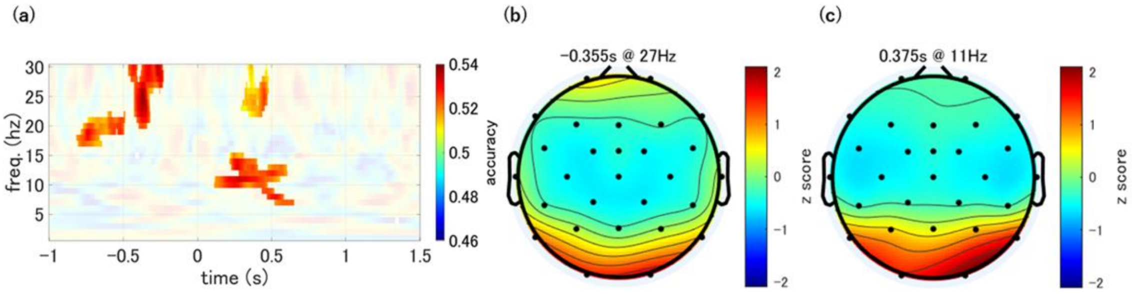

Figure 4.8 Results of decoding accuracy for productive/unproductive word trials in relation to target word onsets in production task. **(a)** Time-frequency representation of the prediction accuracy derived from data across all channels. Time is aligned to the end of the sentence presentation, which coincides with the start of the last word (target words) in formulaic sequences. The color bar represents the between-subjects average of prediction accuracy in the MVPA (n=15). Regions with $p \leq 0.05$ determined through cluster correction, are depicted clearly as fog-free and others ($p > 0.05$) as foggy. Topographic maps highlight significant clusters occurring 0.355s before (b) and 0.375s after (c) the onset of the target words at beta and alpha frequencies, respectively. The color bar shows z-transformed EEG power values across electrodes. Shown as time, frequency, and subject averages within clusters.

4.4 Discussion

4.4.1. Effects of productive vocabulary knowledge on sentence comprehension

Building on the sophisticated statistical analysis of behavioral data from this earlier research, the contribution of productive vocabulary knowledge to faster sentence comprehension was demonstrated (Allal-Sumoto et al., 2023). In this current study, behavioral data collected alongside EEG reaffirmed that sentence comprehension is accelerated by productive vocabulary knowledge. This quicker comprehension might occur alongside neural functional change.

This study aimed to investigate whether different levels of vocabulary knowledge would lead to distinct neural processing during sentence comprehension. To explore this, neural activity changes were assessed by comparing EEG responses to the presentation of productive and unproductive vocabulary. Using multivariate pattern analysis (MVPA), it was possible to predict the inclusion of productive vocabulary in sentences based on the scalp distribution of EEG power during comprehension. This suggests that certain neural processing alterations, manifested as changes in EEG power, are linked to productive vocabulary knowledge. This EEG research builds upon previous findings that link the speed of lexical processing with neural activity changes during vocabulary learning (Bakker et al., 2015). Consequently, the notion that productive vocabulary knowledge influences neural activity changes in the context of sentence comprehension can be supported.

However, it is noteworthy that such EEG power changes were not evident in the conventional time-frequency representation (TFR) analysis. This discrepancy might arise because TFR examines data from each EEG channel separately, in contrast to MVPA, which assesses neural activities across several channels (Zafar et al., 2018; Treder, 2020). MVPA's collective analysis enhances the impact of channels exhibiting weaker activities. In MVPA, the strength of information from individual channels is less crucial, since the association of particular cognitive behavior with neural activity patterns as a whole is crucial. Enhancing prediction accuracy could be achieved by integrating and analyzing weaker activities alongside activities from multiple channels (Norman et al., 2006; Fahrenfort et al., 2017). Another factor could be the reduction of the component. Noise can be reduced by conducting PCA (Thomas, 2002). In this study, the number of PCA components was reduced to account for 60% of the explanatory variance. Consequently, information with less explanatory power might be considered as noise and thus eliminated. A combination of these factors likely enabled the MVPA analysis to successfully detect traces of neural changes.

4.4.2. Motor theory of speech perception

An alternative explanation for the enhanced speed of sentence comprehension could be the motor theory of speech perception, despite the prior dismissal of this theory in previous behavioral research (Allal-Sumoto et al., 2023). This theory posits that when listening to speech, the brain simulates the speaker's motor information, which in turn enhances speech intelligibility (Liberman et al., 1957; Wilson et al., 2004; Iacoboni, 2008). The prior behavioral study contended that the response time outcomes were challenging to interpret as simply the result of perception affecting comprehension speed, as the time lag between productive and unproductive phrases is sufficiently long. Likewise, the behavioral data collected in the current EEG study also demonstrate a substantial time difference, approximately 400 ms, between trials involving productive and unproductive phrases.

The possible involvement of this motor activity is also discussed based on EEG results. In the time-frequency analysis of the production task, alpha suppression occurred around the beginning of the silence, coinciding with when the last word of the phrase was expected. Alpha suppression has connections with the somatosensory response, as well as movement planning and execution in the motor cortex (Hari, 2006; Mizuhara, 2012). It is also related to motor preparation for non-verbal tasks (Rommers et al., 2013). The intensity of alpha suppression was markedly higher in sentences that contained productive phrases compared to those with unproductive phrases. In this instance, the activity related to speech preparation may lead to alpha suppression, and this was identifiable through the conventional TFR analysis. During the production task, oscillations in the alpha power band were triggered at the moment when the absent target word was expected, as also shown in the MVPA analysis. However, this activity was not observed in the comprehension task in either the TFR or MVPA analyses. These EEG findings support the arguments derived from behavioral experiments and suggest that the motor theory alone cannot adequately account for the accelerated comprehension of sentences.

4.4.3. Possible mechanisms of neural activities during comprehension

This discussion section explores potential neural mechanisms underlying rapid sentence comprehension due to productive knowledge, drawing on EEG findings. One such mechanism might be explained by lexical retrieval. Increases in theta and alpha EEG power have frequently been observed in response to lexical retrieval processes (Bastiaansen & Hagoort, 2006; Rossi et al., 2023). These oscillatory patterns have also been noted in relation to the retrieval of verbal information from working memory or long-term memory during the comprehension of sentences (Meyer, 2017). A multitude of research utilizing functional magnetic resonance imaging (fMRI) has demonstrated the involvement of superior and inferior temporal regions in the process of lexical retrieval (Price, 2000; Rivas-Fernández et al., 2021; Roos et al., 2023). Such findings align with the region-of-interest (ROI) estimation made in this research. Detailed discussions based on specific brain areas should be reserved for future research, considering the constraints of EEG in accurately identifying specific locations of brain activity. In the MVPA analysis, the influence of productive knowledge was anticipated prior to the onset of the target word at theta or alpha frequencies during the comprehension task. This suggests that productive phrases in the mental lexicon could be accessed and retrieved even before the presentation of a phrase's last word. In contrast, for unproductive phrases, it may be necessary for the entire phrase to be presented to achieve comprehension. Such variations in lexical retrieval processes could account for the observed differences in reaction times. The theta and alpha oscillations that were noticeable before the onset of the target word during the comprehension task were not present in the production task, despite it also requiring comprehension. In the production task, the brain prioritizes the more demanding speech production over comprehension, which may result in a reduction in the detectable theta and alpha activities.

An alternative explanation could be related to the effect of prediction. According to Clark (2013), listeners continuously predict upcoming words in their first language. In the comprehension task, theta or alpha oscillation was detected just before the final word's onset. For this experiment, formulaic sequences were utilized as target words. These phrases are memorized and retrieved not as isolated words but as a sequence with strong word-to-word connections (Wray & Perkins, 2000). The meanings of productive phrases could be anticipated without hearing every word in the phrase, as these are stored in the mental lexicon as entire units. Thus, those productive phrases are accessed and retrieved as chunks rather than word by word. This mechanism could positively influence the response time.

The beta oscillations observed around the onset of the target word could be indicative of syntactic unification processes. Beta oscillations are particularly crucial for syntactic unification (Bastiaansen et al., 2010) and have been noted in the processing of comprehensive sentences (Pefkou et al., 2017). Syntactic unification plays a role in integrating the information from individual words to form an overall representation of the phrase or sentence (Bastiaansen et al., 2010). The presence of beta oscillations around the onset of the target word could indicate the combination of a series of individual words and the recognition of the phrase's grammatical role within the sentence. Productive phrases may be identified as complete phrases before the final word is heard, leading to quicker recognition compared to unproductive phrases.

Possible mechanisms that have been discussed above such as lexical retrieval, prediction effects, and syntactic unification processes may be related to rapid comprehension of sentences. The EEG activity suggested the possibility that productive vocabulary knowledge enables the brain to access and retrieve phrases even before the final word of a phrase is presented. This anticipatory retrieval could significantly reduce the time required for comprehension, as it allows for rapid access to the meanings of phrases stored in the mental lexicon. The variance in reaction times observed could be attributed to this mechanism, where phrases that are part of the learner's productive vocabulary are recognized faster than those that are not, due to the pre-activation of relevant lexical entries.

The second mechanism involves the prediction effect, where listeners anticipate upcoming words based on their existing vocabulary knowledge. Theta or alpha oscillation just before the final word's onset indicates that the brain is actively predicting the next word in a phrase, leveraging the strong word-to-word connections of memorized formulaic sequences. This predictive processing means that phrases can be comprehended as whole units rather than through sequential word-by-word recognition, thereby speeding up comprehension. This aligns with the concept that productive phrases, which are more likely to be stored and retrieved as chunks, facilitate quicker response times due to the brain's predictive capabilities.

Finally, beta oscillations around the onset of the target word point to syntactic unification processes can be a sign of the final part of the listening comprehension processing according to Anderson’s framework of cognitive processing in second language listening comprehension (Anderson, 1995). This neural activity suggests that the brain is rapidly recognizing the grammatical role of phrases within sentences, a process that is expedited for productive phrases. The quicker recognition of productive phrases, identified as complete phrases before the final word is heard, contrasts with the processing of unproductive phrases, leading to faster comprehension.

It is plausible that one or more of these potential functions enhanced sentence comprehension via productive knowledge. However, the EEG frequencies and timings highlighted in these results were not pre-determined but instead uncovered through an exploratory time-frequency analysis. The experimental results from this study contribute by proposing the hypothesis that these functions play a significant role in improving sentence comprehension. Further research is needed to confirm whether these functions indeed facilitate sentence listening comprehension.

4.4.4. Limitations

While this study demonstrated the impact of productive knowledge on listening comprehension in sentences, there are limitations. The assessment of vocabulary knowledge levels was based on the outcomes of a screening test rather than on performance accuracy during the EEG recording. It is possible that participants who correctly answered the screening test might have struggled to identify the missing word in the production task. Consequently, there could be a mismatch between the screening test results and the EEG recording, potentially resulting in varied neural activities.

In addition, studies by Segalowitz and Segalowitz (1993) and Segalowitz and Hulstijn (2005) have called for caution in interpreting response times. A rapid response time alone does not clarify whether it results from simple acceleration or actual changes in neural pathways. While comparing response times between instances with and without productive knowledge may not fully elucidate the possible cause, the observed change in response time does signify that something is happening from the change in response time. To determine if there are processing differences in scenarios with and without productive vocabulary knowledge during comprehension, further investigation is necessary.

Lastly, while EEG analysis utilizing TFR and MVPA effectively identifies and elucidates brain activity patterns, it has limitations in accurately locating specific areas of brain activity. Although, as Benítez-Burraco and Murphy (2019) have highlighted, language arises from the collaborative functioning of various extensive brain networks, and simply identifying these regions does not fully explain their functions, comprehending where brain activity occurs can shed light on the potential mechanisms driving these cognitive processes. Consequently, integrating EEG with methodologies such as fMRI, known for their high spatial resolution, can lead to a more thorough understanding. The concurrent use of fMRI and EEG aims to combine the spatial precision of fMRI with the temporal acuity of EEG, thereby overcoming the limitations encountered when these techniques are employed independently (Mizuhara et al., 2004; Mizuhara et al., 2005; Mizuhara and Yamaguchi, 2007).

Chapter 5

General Discussion

5.1 Integrating behavioral and neuroscientific approaches to understand the impact of productive vocabulary knowledge on sentence comprehension

The current study on the effects of productive vocabulary knowledge on sentence comprehension delved into the intricacies of how the mastery of productive vocabulary accelerates the understanding of sentences, emphasizing the synergy between behavioral and neuroscientific perspectives. Research findings from behavioral experiments reveal that sentences incorporating productive phrases are comprehended significantly faster than those containing only comprehensive or uncomprehensive phrases, with a notable time difference. This substantial disparity underscores the critical role of productive vocabulary knowledge in the efficiency of sentence comprehension, a process that necessitates the rapid assimilation of phonemes, vocabulary, grammar, and pragmatic meanings. The rapid processing capabilities of the human brain highlight the potential for significant amounts of information to be processed swiftly, reinforcing the value of productive vocabulary.

Building on these insights, further investigations utilizing EEG alongside behavioral data have explored the neural underpinnings that facilitate this accelerated comprehension. By employing sophisticated statistical techniques such as MVPA, which is capable of detecting subtler changes across multiple EEG channels, the distinct neural processing patterns associated with the presence of productive vocabulary in sentences were unraveled. The findings suggest that specific alterations in neural processing, as evidenced by changes in EEG power distribution, are linked to the knowledge of productive vocabulary.

In theoretical terms, the process of understanding a phrase involves retrieving its meaning from the mental lexicon, and also guessing the meaning or verifying it using contextual information. Within the listening modality, information processing occurs simultaneously through both bottom-up and top-down approaches, allowing for interaction and integration of information (Bonk, 2000; Hulstijn, 2003). The extent to which listeners depend on one process over the other varies, and influenced by the learner's language proficiency (Vandergrift, 2011). Since comprehensive phrases are not fully acquired and stored in the mental lexicon, top-down processing can play a crucial role in deciphering the meanings of comprehensive phrases. This reliance often necessitates repeated engagement of both top-down and bottom-up processing for accurate comprehension. The inability to fully rely on the mental lexicon for comprehension forces listeners to parse each word of the phrase from the input and then recognize it as a cohesive phrase. This requirement for repeated processing and the necessity to listen to the whole phrase likely result in a longer processing time compared to the understanding of productive phrases. Surprisingly, no significant difference in processing time was observed between understanding comprehensive phrases and uncomprehensive phrases. Therefore, merely acquiring the meanings of words and phrases is insufficient to support effective listening comprehension.

On the other hand, productive phrases, being fully acquired as strongly associated word sequences, suggest that bottom-up processing plays a significant role in the retrieval of phrase meanings. This reduces the need for frequent interactions and verifications between top-down and bottom-up processes. Moreover, significant differences in neural activities between producible and unproducible phrases were detected in both MVPA and some TFR results before the target word onset. Since the meaning of productive phrases can be understood without the necessity of listening to the entire phrase, the initiation of comprehension may occur earlier compared to that of both comprehensive and uncomprehensive phrases. This reliance on memory-based processing, coupled with the early onset of meaning retrieval, potentially facilitates faster comprehension.

Neuroplasticity in the context of second language acquisition involves the brain's capacity to adjust and form new neural connections. According to Li et al. (2014), neuroplasticity encompasses both structural and functional plasticity. Learning a second language can result in structural changes within the brain, including an increase in gray matter density in regions involved in language processing and memory. In addition to these structural alterations, learning a second language also influences brain functionality. The current study has demonstrated that comprehension speed varies, reflecting changes in neural activity correlated with vocabulary knowledge. Although this research indicates that functional plasticity accompanies the development of vocabulary knowledge, it has yet to establish conclusively whether changes in comprehension speed are directly caused by the engagement of distinct neural pathways. Achieving automatic language processing, akin to that of highly proficient bilingual and multilingual individuals, is a goal for language learners, yet this process appears to differ from that of monolingual native speakers of the target language. Exploring how neural processing evolves across developmental stages and identifying the underlying causes can shed light on the optimal neural mechanisms for enhancing listening comprehension.

5.2 Contributions of this study

The research highlighted a significant gap in previous studies regarding the specific role of productive vocabulary knowledge in listening comprehension processing. While many studies have focused on comprehensive vocabulary knowledge, the direct influence of productive vocabulary knowledge on listening comprehension has not been adequately explored. This gap is especially significant given the importance of vocabulary acquisition in language learning and the potential impact that an in-depth investigation into productive vocabulary knowledge could have in this area.

This research underscores the significant role of productive vocabulary knowledge in improving the speed and effectiveness of understanding sentences in second language acquisition, as demonstrated by both behavioral results and alterations in neural activity. Any information that listeners are unable to immediately process and integrate into long-term memory requires controlled processing. This controlled processing, unlike automatic processing, is more time-consuming, given the constraints of working memory, and the rapid arrival of new input can hinder comprehension (Vandergrift, 2011). Learners who encounter a few comprehensive words or phrases in a sentence may struggle to catch up with the flow of input if productive knowledge of these words is not acquired. If there are several comprehensive words in a sentence, it may largely affect the capturing of a message.

In addition, the findings underscore the necessity of investigating how productive vocabulary knowledge contributes to listening comprehension processing. This investigation is crucial for several reasons: First, it could provide a more comprehensive understanding of the cognitive processes involved in listening comprehension, particularly in the context of second language acquisition. Second, understanding the role of productive vocabulary knowledge could lead to more effective language teaching and learning methodologies, emphasizing not only comprehension but also the active application of vocabulary. Finally, this exploration could offer valuable insights into the theory of second language comprehension, highlighting the interplay between different types of vocabulary knowledge and cognitive processing during listening.

The interplay between vocabulary knowledge and listening comprehension in language learning is multifaceted and significant. The process involved in productive vocabulary knowledge may play a significant role in the success of listening comprehension. While the acquisition of productive vocabulary knowledge might take longer compared to simply understanding or recognizing words, the effort is justified. Productive vocabulary knowledge is crucial for comprehending spoken language, particularly in situations involving natural conversation with native speakers. Relying solely on comprehensive vocabulary knowledge may leave learners struggling to keep up with the pace and nuances of spoken language. This can be one of the reasons why recognizing most of the words in the speech input does not guarantee comprehension. In addition, traditionally, language learners often focus on memorizing vocabulary through flashcards, establishing a basic one-to-one relationship between a word and its definition. However, language educators and textbook authors stress the importance of contextual learning of vocabulary. Understanding how words are used within various contexts is key for their effective use in both oral and written forms. The acquisition of productive vocabulary knowledge can facilitate learners' focus on practical usages. This approach to vocabulary learning extends beyond mere expression and plays a pivotal role in enhancing listening comprehension. Thus, emphasizing productive vocabulary in language learning and providing opportunities for learners to actively employ target words or phrases in speaking or writing exercises can significantly support listening comprehension success, rendering it a valuable focus in educational settings.

Finally, this study highlighted the importance of investigating behavioral data with neural activity measurements to comprehensively understand the cognitive and neural dynamics of second language processing. It brought to light that many observable behaviors of language learners, which language teachers frequently report and discuss, have yet to be fully explored and understood from a scientific perspective. By integrating behavioral observations with insights from neural activity, researchers can uncover the underlying mechanisms that drive these behaviors, thereby bridging the gap between anecdotal teaching experiences and empirical cognitive science. This comprehensive approach not only enriches our understanding of language learning processes but also has the potential to inform and transform teaching methodologies, making them more effective by basing them on evidence of how the brain actually learns and processes a second language.

5.3 Teaching methods to support productive vocabulary acquisition

Fostering productive vocabulary knowledge can enhance listening comprehension efficiency. To help learners acquire productive vocabulary knowledge, teachers should provide explicit learning opportunities and maximize output. For example, it seems to be efficient to instruct learners to use the target words in their speech or writing. This can apply not only to newly learned words but also to already learned words to develop learners' uncomprehensive and comprehensive vocabulary into productive vocabulary.

To maximize output in class, there are several activities: 1. *Information gap*. Group students into pairs and provide each with maps, pictures, or pieces of information that vary slightly between them. They are required to engage in questioning each other in English to bridge the gaps in their knowledge, fostering dialogue and the exchange of information. Especially for low-proficient learners, this activity would be a good starter since the materials for output are prepared. 2. *Speed chatting*. Students have brief conversations with multiple partners for a few minutes each on the same topic. This activity promotes the development of learners' fluency by encouraging repeated conversations on a consistent topic and is suitable for low to upper-intermediate-level learners. 3. *Interactive storytelling*. Invite students to collaboratively construct a story. The storytelling begins with one student, and each following student contributes an additional sentence or two. This activity encourages creative use of language and requires active involvement. This exercise would be suitable for young learners such as K-12 with low to intermediate proficiency. 4. *Presentation*. Encourage students to develop and deliver presentations on subjects in which the target vocabulary often appears. This approach not only enhances language output by using the target vocabulary but also improves public speaking abilities and provides an opportunity for students to refine their ability to structure their ideas in a second language. Presentation can be adopted in all proficiency levels. 5. *Discussion circle*. Arrange students into small teams to engage in discussions about a specific topic, narrative, or piece of writing. Assigning roles such as summarizer, questioner, and connector to each student allows them to prepare what to say beforehand, and can help guarantee active engagement and fair chances to speak (Allal-Sumoto, 2018). This activity can apply to intermediate to high proficiency learners. 6. *Debate*. Debate can be adapted to high proficient learners. Organize debates around engaging subjects or recent news. Debates compel students to express their ideas in a clear and persuasive manner, increasing their linguistic output and encouraging them to use intricate sentence constructions and advanced vocabulary. Since debate requires a large amount of research and preparation, the usage of the target vocabulary can be learned from reading. This activity can foster both input and output, and also accuracy and fluency.

Integrating these activities and intentional use of the target vocabulary can support productive vocabulary knowledge acquisition and enhance learners' listening comprehension efficiency. It may also advance their fluency in both listening and speaking, and confidence in utilizing English in a variety of contexts.

Chapter 6

Conclusion

This research showed how the acquisition of productive vocabulary knowledge can lead to measurable changes in listening comprehension speed and neural activity. In Chapter 3 of this research, the findings provide compelling evidence that the ability to actively use phrases in a second language, referred to as productive knowledge, significantly enhances the speed at which individuals comprehend spoken sentences. This positive correlation between productive vocabulary knowledge and sentence listening comprehension speed underscores the importance of practical language skills in real-time understanding. Furthermore, the research presented in Chapter 4 extends these insights by demonstrating that productive knowledge of second language phrases is directly linked to observable changes in neural activity. These neural changes are instrumental in improving the efficiency of sentence listening comprehension, highlighting the brain's adaptability in response to linguistic proficiency.

The study also sheds light on a common trend among second language learners as identified by Laufer (2005), where learners tend to accumulate a more extensive vocabulary in terms of comprehension than what they can actively use or produce. This disparity often arises because learners focus more on understanding the meanings of words and phrases – a process that involves absorbing and internalizing information (input) – rather than on the practical application or production (output) of these learned words in the learning process and in real-life situations. While acquiring a broad and comprehensive vocabulary is undoubtedly a crucial foundation for sentence comprehension, it represents only the initial step toward full linguistic proficiency.

The importance of moving beyond mere vocabulary recognition to efficient and consistent processing of vocabulary becomes especially pronounced in dynamic settings such as online communication and conversation. In these scenarios, the ability to quickly understand and respond appropriately is key. Therefore, the acquisition of productive vocabulary knowledge emerges as a critical factor in enhancing the overall quality of language comprehension. This dual aspect of vocabulary knowledge, encompassing both comprehension and production, is essential for achieving a higher level of language mastery and effective communication in a second language.

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Appendices

Appendix 1: The List of Questions for the Screening Experiment

Production task: Japanese to English	**Comprehension task: English to Japanese**
1. 昔は、私は全く勉強しなかった。 In the [ ], I didn't study at all.	1. I was fat [in the past].
2. 結果として、選挙は予定通り進まなかった。 As a [ ], the election did not go as planned.	2. That company went bankrupt [as a result].
3. ところで、私の鍵をどこかで見ましたか？ By the [ ], have you seen my keys anywhere?	3. How was your trip to Hawaii, [by the way]?
4. 私が帰るまでに、それを終わらせるべきです。 You'd better have finished it by the [ ] I get back.	4. [By the time] we meet again, I will have studied English.
5. しばらくここに座って景色を見ましょう。 Let's sit here for a [ ] and look at the view.	5. I will be absent from class [for a while].
6. 彼らは彼に去るよう頼んだ。―言い換えれば彼は解雇された。 They asked him to leave, in other [ ] he was fired.	6. He is a man of honor, [in other words].
7. 私は自身の卒業式で初めて泣いた。 I cried for the first [ ] at my graduation ceremony.	7. I came here [for the first time].
8. 彼は様々な仕事を試し、結局俳優になった。 He tried various jobs and in the [ ] became an actor.	8. We decided not to buy it [in the end].
9. 私たちはそのチケットを買うために長い間待った。 We waited for a long [ ] to buy that ticket.	9. I haven't seen him [for a long time].
10. まず初めに、手を洗いなさい。 First of [ ], wash your hands.	10. He went to the station [first of all].
11. 私はクラスではいつも友達といた。 I was with my friend all the [ ] when I was in class.	11. He stays at home [all the time].
12. 彼は家までずっと歩かなければならなか	12.

った。　He had to walk all the [　　　　　　　　] home.	I kept running [all the way].
13.　その時、彼はたった５才だった。　At that [　　　　　　　　], he was only 5 years old.	13.　I was reading a book [at that time].
14.　今私たちは忙しい。　At the [　　　　　　　　] we are busy.	14.　He is out [at the moment].
15.　将来、私は留学したい。　In the [　　　　　　　　], I want to study abroad.	15.　What do you want to be [in the future]?
16.　人口は総じて健全な方に向かっている。The population as a [　　　　　　　　] is getting healthier.	16.　The plan seems to be good [as a whole].
17.　脚注は各ページの一番下に提示されている。　Footnotes are given at the [　　　　　　　　] of each page.	17.　The book I want is right [at the bottom].
18.　あれらの椅子が邪魔になっている。Those chairs are in the [　　　　　　　　].	18.　There was a bus [in the way].
19.　私はパーティーをとても楽しんだ。I enjoyed the party a great [　　　　　　　　].	19. Your English has improved [a great deal].
20.　大抵、人々はとても友好的だった。　For the most [　　　　　　　　], people seemed pretty friendly.	20. The participants were [for the most part] women.
21.　私は家に帰る途中買い物に行く。　I go shopping on the [　　　　　　　　] home.	21.　I met my teacher [on the way].
22.　まったくもって彼女は歌が上手だ。She sings well, to be [　　　　　　　　].	22.　It is a mistake, [to be sure].
23.　私たちは昨日電話で話した。　We talked on the [　　　　　　　　] last night.	23.　He is [on the phone] right now.
24.　私は最後まであなたをサポートします。I will support you to the [　　　　　　　　].	24.　You don't have to stay [to the end].
25.　彼は危険と隣り合わせの感覚が好きだった。　He liked the feeling of being on the [　　　　　　　　].	25.　When the stock market crashed, their whole future was [on the edge].
26.　突然明かりが消えた。All of a [　　　　　　　　] the lights went out.	26. The accident happened [all of a sudden].
27.　かつて私たちはお互いによく話した。We use to talk with each [　　　　　　　　] a lot.	27.　They competed [with each other].
28.　長い目でみれば本革を使う方が安くつくだろう。　It'll be cheaper in the long [　　　　　　　　] to use real leather.	28.　That cost me a lot [in the long run].

29. 彼は今勤務中で、しばらくあなたに会えません。 He's on the [ ] now and can't see you for a while.	29. I often drink coffee [on the job].
30. かつて彼女は看護師になりたかった。 At one [ ] she wanted to be a nurse.	30. [At one time] Nigeria was a British colony.
31. 彼は遠くで叫び声がするのが聞こえた。 In the [ ], he could hear a scream.	31. Thunder was rolling [in the distance].
32. しばらくして私の目は暗さに慣れた。 After a [ ] my eyes got used to the dark.	32. He come back [after a while].
33. ホテルのドアの鍵はいつも閉めておきなさい。 Keep your hotel door locked at all [ ].	33. Hot water is available [at all times].
34. 私たちの指紋は恐らくあちらこちらに付いている。 Our fingerprints are probably all over the [ ].	34. They're putting up new offices [all over the place].
35. 難しいかもしれないが、それでも私は試してみるべきだ。 Although it may be difficult, at the [ ] I should try.	35. I ran as fast as I could, but I was late [all the same].
36. 駐車場が裏にある。 There is a car park at the [ ].	36. Your belt is twisted [at the back].
37. 私は休暇を 5 日連続で取った。 I took vacation for 5 days in a [ ].	37. I won the lottery three times [in a row].
38. その頃あなたは若かった。 You were young in those [ ].	38. I was very poor [in those days].
39. この犬は、いわば家族の一員だ。 This dog is, so to [ ], a member of our family.	39. A camel is, [so to speak], a ship on the desert.
40. 先日、私はその女の子を見かけた。 The other [ ] I saw the girl.	40. I emailed you [the other day].
41. 今何が放送されてますか？ What's on the [ ] now?	41. This drama will be [on the air] tomorrow.
42. 何故だか私はとても疲れている。 For some [ ] I'm very tired.	42. My son woke up early [for some reason].
43. あのレストランは 2 カ月前に倒産した。 That restaurant went out of [ ] two months ago.	43. Two or three small shops have gone [out of business] since the supermarket was opened.

44. その飛行機今見えない。 The plane is out of [ ] now.	44. She stood there even after the train was [out of sight].
45. 私は今朝、急いでいた。 I was in a [ ] this morning.	45. He returns [in a hurry].
46. この理由で、私はミーティングに参加できない。 For this [ ] I cannot attend the meeting.	46. [For this reason], I cannot go with you.
47. 何とかして私はヨーロッパに行く。One way or [ ], I'm going to go to Europe.	47. We must finish the work by tomorrow [one way or another].
48. 彼は突然どこからともなく現れた。 He suddenly appeared out of [ ].	48. We then heard a voice coming [out of nowhere].
49. 彼は、いわば大きな赤ちゃんだ。 He is, as it [ ], a grown up baby.	49. He is a Japanese Edison, [as it were].
50. 彼は時々映画に行く。 Once in a [ ] he goes to a movie.	50. He comes to see me [once in a while].
51. 毎日毎日、何千台もの中古車が売られている。 There are thousands of used cars for sale every single [ ].	51. I study English [every single day].
52. 彼は一年失業中だ。 He has been out of [ ] for a year.	52. I am [out of work].
53. 私は彼女に、彼女とは買い物に行かないときっぱりと言った。 I told her once and for [ ] that I would not go shopping with her.	53. We should solve the problem [once and for all].
54. 昔々、美しいお姫様がいました。 Once upon a [ ] there was a beautiful princess.	54. After all, it is [once upon a time].
55. 私は何冊かの本を同時に買った。 I bought several books all at [ ].	55. Should we send the packages [all at once]?
56. あのカジュアルなセーターはこのミーティングにふさわしくない。 That casual sweater is out of [ ] at this meeting.	56. His criticisms were [out of place].
57. 水面下で、両者が合意に向けて動いている。 Behind the [ ], both sides are working towards an agreement.	57. There seems to be something [behind the scenes].
58. あなたは今、彼と交際していますか？ Are you in a [ ] with him now?	58. We are [in a relationship].

59. 私はもう一度始めから数え直さなければならない。 I have to count all over [ ] from the beginning	59. Please start that [all over again].
60. そのプロジェクトは決定していない。 The project is up in the [ ].	60. The date of the party is still [up in the air].
61. 念の為、私の電話番号をお伝えします。 Just in [ ], I will tell you my phone number.	61. I'm emailing you one more time [just in case].
62. 彼女はこの問題について言及しないことを、報道において批判されている。 She has been criticized in the [ ] for not speaking out on this issue.	62. The scandal was reported [in the press].
63. 私たちは今月は黒字だ。 We are in the [ ] this month.	63. We somehow kept our accounts [in the black].
64. 出来るだけ早く私に知らせて下さい。 Please let me know as soon as [ ].	64. I'll come here [as soon as possible].
65. 世界の多くの子どもたちが不公平な状況の中、生活の為に働いている。 Many children in the world work for a [ ] under unfair conditions.	65. She writes a financial column [for a living].
66. 彼らは英語の試験を定期的に受けなければならない。 They must take English tests on a regular [ ].	66. We are collecting trash [on a regular basis].
67. 製造業において仕事が一律に無くなるだろう。 Jobs will be lost across the [ ] in manufacturing.	67. The market prices have fallen [across the board].
68. おおむね彼の予測は正しいという結果になった。 By and [ ], his prediction has turned out to be right.	68. [By and large], your idea is better than mine.
69. このオフィスの人全員が、同じ認識でなければならない。 Everyone in the office has to be on the same [ ].	69. Parents should be [on the same page] about raising their children.
70. その情報は日々更新されている。 The information is updated on a daily [ ].	70. I don't use English [on a daily basis].
71. 信じられないかもしれないが、彼女は９０歳だ。 Believe it or [ ], She is 90 years old.	71. [Believe it or not], I went skydiving.
72. 私たちは問題に一つずつ取り組まなけれ	72. The teacher called the

ばならない。　We have to tackle problems one at a [ ].	students [one at a time].
73.　私は近いうちにロンドンで働く。　I will work in London in the near [ ].	73.　She will probably move [in the near future].
74.　私は今日一日中寝ていた。 I slept all day [ ] today.	74. He worked [all day long].
75.　鳥たちは四方八方に飛び立った。　The birds flew away in all [ ].	75. The boy's curiosity was pushing out [in all directions].
76.　私はこれからサッカーの試合を観る。　I will watch a soccer game from now [ ].	76.　I'll do my best [from now on].
77.　気分転換に飲みに行きませんか？　How about going for a drink for a [ ]?	77.　Mother advised me to take a walk [for a change].
78.　その国は差し当たり安全だ。 The country is safe for the time [ ].	78.　She is keeping her car in our garage [for the time being].
79.　この報告書は誠意を持って発表された。 This report was published in good [ ].	79.　The company had acted [in good faith].
80.　経費は自然と議題に挙がるだろう。 The expense will naturally be on the [ ].	80.　The issue will be [on the agenda].
81.　彼は彼女を信用していない、そして逆もまた同様である。　He doesn't trust her, and vice [ ].	81.　You have to give me what I need, [and vice versa].
82.　事あるごとに問題が彼の行く手を阻む。 At every [ ], problems blocked his path.	82. He was frustrated by the rules [at every turn].
83.　私は直接彼女に会ったことがない。 I've never met her in the [ ].	83.　Thousands of fans gathered to see the band [in the flesh].
84.　私は今日、犬と散歩に行った。　I went for a [ ] with my dog today.	84.　He is out [for a walk].
85.　私たちの会社は昨年はいつも赤字だった。　Our company was always in the [ ] last year.	85.　Our family budget is [in the red].
86.　もしミーティングがキャンセルなっても、大したことではない。 It's no big [ ] if	86.　If I don't win it's [no big deal].

the meeting is canceled.	
87. 私たちの雑誌は最新のファッション情報を提供し続けます。 Our magazine will keep you up to [ ] with fashion.	87. The software is kept [up to date].
88. 彼は堅実的で、誰にでも正直だ。 He is down to [ ] and honest with everyone.	88. It brought me [down to earth].
89. 誰に聞いても、彼は信用できる男ではない。 By all [ ], he is not a man to be trusted.	89. Elephants, [by all accounts], were pretty strong too.
90. 私たちは現在赤字経営である。 We are now operating at a [ ].	90. They sold their house [at a loss].
91. 彼らは学校から無事に家に帰った。 They arrived home in one [ ] from school.	91. All she wanted was for me to come back [in one piece].
92. 昨晩の恐怖にも関わらず、ホワイトハウスは今日、普段通りだった。 Despite last night's scare, it was business as [ ] in the White House today.	92. Less than a week after the fire it was [business as usual].
93. 今年は海外旅行は不可能だ。 Traveling abroad is out of the [ ] this year.	93. It is just [out of the question] for me to finish the work in a day.
94. 私はその状況を一目見た。 I took in the situation at a [ ].	94. He knew what had happened [at a glance].
95. ほぼ間違いなく、すべてが上手くいくだろう。 In all [ ] everything will go to plan.	95. [In all likelihood], it will rain this afternoon.
96. あなたは間違いなく大切な人です。 You are without a [ ] an important person.	96. She is [without a doubt] one of the best students I've ever had.
97. 株式市場は勢いに乗っている。 The stock market is on a [ ].	97. He is [on a roll] today.
98. 同様に、あなたは言われたこと全てを守りなさい。 By the same [ ], you must listen to everything being said.	98. He is guilty and [by the same token] so are you.
99. 彼らはそれを終わらせるためにずっと働いている。 They're working around the [ ] to get it done.	99. The machine operates [around the clock].

100. 発展途上国では優秀な技術者が不足している。 Good technicians are in short [ ] in the developing countries.	100. Temporary workers are [in short supply].
101. 未だに時々彼女は私に電話をかけてくる。 Every so [ ] she still phones me.	101. I play golf [every so often].
102. 彼はすぐに戻ってくる。 He will come back in no [ ].	102. His English improved [in no time].
103. 我が家のパーティーが盛り上がっていた時に、嵐が来た。 Our party was in full [ ] when the thunderstorm hit.	103. The party was [in full swing].
104. 彼の車は事故のため故障してる。 His car is out of [ ] because of the accident.	104. The telephone is [out of order].
105. 私たちは至る所を旅行してきた。 We have traveled far and [ ].	105. His fame spread [far and wide].
106. 日本の人は平均的にヨーロッパの人より長生きする。 Japanese people, on the [ ], live longer than Europeans.	106. [On the average], about 15 percent of the freshmen class will drop out before graduation.
107. 私たちは経済が悪い方向に変化しているのを見ている。 We're seeing a change for the [ ] in the economy.	107. Things have definitely taken a turn [for the worse].
108. 彼は忍耐力をぎりぎりまで試された。 His patience was tested to the [ ].	108. The amount of medicine she takes is getting close [to the limit].
109. 彼女は丘を登り下りして息切れがした。 She was out of [ ] from walking up and down hills.	109. He is talking himself [out of breath].
110. いろんな出来事が次々に起こった。 Several incidents happened one after [ ].	110. The planes arrived [one after another].
111. 私たちは彼女の提案を心から喜んで歓迎した。 We welcomed her offer with open [ ].	111. We will welcome you [with open arms].
112. アメリカではすべての事が大規模に行われる。 Everything is conducted on a large [ ] in America.	112. The factory is run [on a large scale].
113. 簡単に言えば、こういった状況だ。	113. He told me what his

This, in a [ ], is the situation.	company did [in a nutshell].
114. あなたが責任者ならプロジェクトは大丈夫だ。 The project will be in good [ ] with you in charge.	114. Your mother is [in good hands] with our team of nurses.
115. 近いうちに、その歌手は有名になるだろう。 One of these [ ] the singer will be famous.	115. She will write another book [one of these days].
116. 再度考えた結果、私も彼らに加わることにした。 On second [ ], I decided to join them.	116. I changed my mind [on second thought].
117. 私たちは必ずこれを成し遂げるだろう。 We will, by all [ ], accomplish this.	117. [By all means], please come here.
118. 私の肌は良い状態だ。 My skin is in good [ ].	118. The goods have arrived [in good condition].
119. 景気回復はもうすぐのようだ。 Business recovery seems to be just around the [ ].	119. Christmas is [just around the corner].
120. うまくいけば、私たちのプロジェクトは資金提供され、撮影を開始できる。 With any [ ], our project will get funded, and we can start filming.	120. We will see some dolphins [with any luck].
121. 彼の約束を言葉通りにとってはいけない。 Don't take his promise at face [ ].	121. You shouldn't take anything she says [at face value].
122. 今、共産主義は軽んじられている。 Communism is now at a [ ].	122. Safety shouldn't come [at a discount].
123. あなたはやがてその結果の通達を受け取るだろう。 You will receive notification of the results in due [ ].	123. They will get married [in due course].
124. あなたのアイデアはすべて古い。 Your ideas are all out of [ ].	124. That radio looks so [out of date].
125. 私たちは次のプロジェクトが複数ある。 We have several projects in the [ ].	125. Trouble is [in the offing].
126. 彼は2カ月間ダイエットをしている。 He has been on a [ ] for two months.	126. She is [on a diet] to lose weight.

127. 彼女の声は電話だと誰が聞いても彼女の母親の声のように聞こえる。 She sounds for all the [ ] like her mother on the phone.	127. She looked [for all the world] like a movie star.
128. 彼らは晩年に結婚した。 They were married late in [ ].	128. They had a child [late in life].
129. あのようなオファーは一生に一度だけ来るだろう。 An offer like that will come just once in a [ ].	129. This is the kind of book you see [once in a lifetime].
130. 私は数学では誰にも劣らない。 I am second to [ ] in math.	130. Our scientific research is [second to none].
131. 明後日は私の誕生日だ。 The day after [ ] is my birthday.	131. Let's meet [the day after tomorrow].
132. この古い車は格安で買える。 This old car can be bought for a [ ].	132. we bought the house [for a song].
133. 彼女が慌てて電話をかけた直後に、私たちは到着しました。 We arrived at a moment's [ ] after she hurriedly called.	133. That book may be obtained [at a moment's notice].
134. 彼らは私に、もう必要ないとはっきりと言った。 They told me in so many [ ] that I was no longer needed.	134. I told her, [in so many words], to stop interfering.
135. そのコピー機は現在使用不可である。 The copier is currently out of [ ].	135. The elevator is currently [out of service].
136. 彼は息子に激怒した。 He was in a [ ] with his son.	136. He left the room [in a rage].
137. その上院議員は昨年、圧倒的な勝利を収めた。 The senator won by a [ ] last year.	137. She won the contest [by a landslide].
138. 私の知る限り、彼はイタリアで生まれた。 For all I [ ], he was born in Italy.	138. I opened the window, and [for all I know] it's still open.
139. 彼は口が軽い。 He is such a big [ ].	139. Even a shy person can have [a big mouth].
140. 彼は絶好調だととても面白い。 He can be very funny when he is in the [ ].	140. I'm not [in the vein] for studying.
141. 私の叔父は交通事故の後快方に向かっている。 My uncle is on the [ ] after his traffic accident.	141. He had flu, but he is [on the mend].

142. 今のところ５人のゲストだけが到着した。 Up till [ ], only five guests have arrived.	142. [Up till now] they have worked very hard.
143. グラフ作成はコンピューターだと簡単だ。 Creating graphs is a piece of [ ] on the computer.	143. The exam was [a piece of cake].
144. 最近、この国の経済は飛躍的に成長している。 This nation's economy is growing by leaps and [ ] in recent years.	144. The company is growing [by leaps and bounds] this year.
145. この版はすぐに絶版になるだろう。 It seems that this edition soon became out of [ ].	145. We found out that the book you had ordered was [out of print].
146. 私は危ない橋を渡っていると自覚している。 I was on thin [ ], and I knew it.	146. He's skating [on thin ice] by lying to the police.
147. 子どもたちは苗字のアルファベット順に座らされていた。 The children were made to sit in alphabetical [ ] according to their surname.	147. The names are published [in alphabetical order].
148. 私はこんな正装をしていると落ち着かなかった。 I felt ill at [ ] in such formal clothes.	148. I feel [ill at ease] in their company.
149. 私は一昨日あなたからの手紙を受け取った。 I received your letter the day before [ ].	149. We played tennis [the day before yesterday].
150. あの商品は現在在庫がない。 That product is currently out of [ ].	150. The new car is currently [out of stock].
151. この問題を解くことは私にとって不可能に近い。 It is next to [ ] for me to solve this problem.	151. It is [next to impossible] to change his mind.
152. 逆ならうまくいく。 It only works the other way [ ].	152. Students practice translating from French to English and [the other way around].
153. 私は何のためらいもなくそのオファーを受け入れた。 I accepted the offer without a second [ ].	153. [Without a second thought], she ran after the thief.
154. スリに警戒しなさい。	154. We were

Be on the [ ] for pickpockets.	all [on the alert].
155. 口コミによる宣伝はたびたび提案される。 Advertising by word of [ ] was frequently suggested.	155. The new product was spread [by word of mouth].
156. 彼は何よりも真実を尊んだ。 He put truth before anything [ ].	156. We must put safety [before anything else].
157. 私たちは一晩野外で過ごした。 We passed a night in the open [ ].	157. He likes to cook [in the open air].
158. 私たちはこのプロジェクトを完了させるために時間と戦っている。 We're racing against the [ ] to complete this project.	158. The medical staff worked [against the clock] to save the baby's life.
159. 彼は猛スピードで走り去った。 He drove away at breakneck [ ].	159. The motorcycle started in pursuit [at breakneck speed].
160. 今や私たちの工場はフル回転です。 Our factories are now going full steam [ ].	160. He talked [full steam ahead] for another five minutes.
161. 彼はただの金もうけに夢中なセールスマンだ。 He was just a salesman on the [ ].	161. I believed his story, but she thought he was just [on the make].
162. 私の友人はその問題について長々と説明した。 My friend explained the matter at great [ ].	162. Our boss spoke [at great length] at the ceremony.
163. もし欲しいなら、その花をあなたにあげます。 The flower is yours for the [ ].	163. You may have it [for the asking].
164. 彼はどこかこの辺りに住んでいる。 He lives somewhere around [ ].	164. It seems that I dropped my notebook [somewhere around here].
165. 彼女はプリンを一気に食べた。 She ate the pudding in one [ ].	165. He swallowed his drink [in one gulp].
166. 配達は営業時間中のみお受けします。 Deliveries are only accepted during business [ ].	166. All showrooms are staffed [during business hours].
167. 彼女が引き継いだ時、その会社はめちゃくちゃだった。 The company was in a [ ] when she took over.	167. His house is always [in a mess].
168. 締め切りは間近だ。 The	168. The rainy

deadline is near at [ ].	season is [near at hand].
169. 私はましな仕事を急いで見つける必要がある。 I need to find a better job on the [ ].	169. The ambulance arrived [on the double].
170. その少年は裸足で走っていた。 The boy was running in bare [ ].	170. Don't walk around outside [in bare feet].
171. 彼女はニューヨークへの転勤が決まって有頂天です。 She is on cloud [ ] about her transfer to New York.	171. The whole soccer team was [on cloud nine] after winning the championship.
172. 予想に反して彼らは簡単にそのゲームに勝った。 Contrary to [ ], they won the game easily.	172. [Contrary to expectations], the share price actually increased.
173. 面白半分で、私は彼の誕生日を忘れていたふりをした。 Just for [ ], I pretended that I'd forgotten it was his birthday.	173. He decided to go along with them [just for laughs].
174. あなたは万が一に備えてお小遣いをいくらか置いておくべきだ。 You should keep some extra allowance for a rainy [ ].	174. I put aside a portion of my wages each month [for a rainy day].
175. 彼女は今までに私が教えた生徒の中でとびきり優秀だ。 She is out and [ ] the best student I have ever taught.	175. He's [out and away] the best pitcher in the league.
176. 選手のうちの一人が急に棄権した。 One of the players dropped out at short [ ].	176. The trip was planned [at short notice].
177. 彼の稼ぎはただ同然だ。 He earns next to [ ].	177. It costs [next to nothing] to go to an afternoon movie.
178. 彼が来るかどうかは私にとって重要ではない。 It's of no [ ] to me whether he comes or not.	178. Such a thing is [of no account].
179. あなたはファイルを正しい順序で保管するべきだ。 You should keep your files in the correct [ ].	179. Put the words [in the correct order].
180. 彼女は推測ではその家は戦時中に建てられたものだと思った。 At a [ ], she thought the house must have been built between the wars.	180. She was, [at a guess], thirty.

181.　彼は彼らの仕事を直接体験した。　He experienced their work at first [　　　　　　　　].	181. I got the information [at first hand].
182.　バンコクは一年中暑い。　Bangkok is hot all the year [　　　　　　　　].	182.　I play tennis [all the year around].
183.　最後の手段として、私たちはいつでも家まで歩いて帰ることができる。　In the last [　　　　　　　　] we can always walk home.	183.　They would [in the last resort] support their friends whatever they did.
184.　柔らかい色は目に優しい。　Soft colours are easy on the [　　　　　　　　].	184.　The monitor's display is [easy on the eyes].
185.　彼は永遠に去っていった。　He has gone away for good and [　　　　　　　　].	185.　I want to stay in Hawaii [for good and all].
186.　もし彼女が私の提案を承認してくれたら、私は幸運の絶頂だろう。　I will be in seventh [　　　　　　　　] if she approves my proposal.	186.　My husband is [in seventh heaven] when playing golf.
187.　彼は犬が死んで以来落ち込んでいる。　He's been looking down in the [　　　　　　　　] since his dog died.	187.　You look [down in the mouth] today.
188.　私たちの計画はまだ再考中だ。　Our plans are still in the melting [　　　　　　　　].	188. The game was still [in the melting pot].
189.　彼は今朝、急用で東京に向けて発った。 He left for Tokyo on urgent [　　　　　　　　] this morning.	189.　I come [on urgent business].
190.　彼女の兄が亡くなって、彼女は一年悲嘆にくれていた。　After her brother died, she was in deep [　　　　　　　　] for a year.	190.　He was [in deep mourning] for his father.
191.　日本語で丁寧にお願いするにはどのように言ったらよいでしょう？　How to make a request in a polite [　　　　　　　　] in Japanese?	191.　They have to speak [in a polite way].
192.　もし会社が予告なしにあなたの予定を変えたのであれば、あなたの会社はあなたに罰金を払わなくてはならない。　Your company must pay you a penalty if they change your schedule without advance [　　　　　　　　].	192.　The website's contents may be changed [without advance notice].
193.　彼はマラソンを走るには調子が悪すぎる。　He was too out of [　　　　　　　　] to	193.　He is overweight and [out of condition].

run a marathon.	
194.　彼はその著者を間接的に引用している。　He is citing that author at second [　　　　　　　].	194.　I have the news [at second hand].
195.　申込書は全て記入済みであることを確認し、十分前もって提出して下さい。　Please ensure your application is fully completed and submitted in sufficient [　　　　　　　].	195.　Your application should be reviewed [in sufficient time] before the term starts.
196.　学習者は箇条書きで書く事の利点を認める。　Learners recognize the benefits of writing in bullet [　　　　　　　].	196.　I made my points [in bullet points].
197.　最終集計で私の手紙に１５通の返答があった。　At the last [　　　　　　　], I had 15 responses to my letter.	197. [At the last count], the wom an candidate won.
198.　ざっと見積もって、その仕事は二週間かかるだろう。　At a rough [　　　　　　　], I would say the job will take two weeks.	198.　The coins are worth about ten million yen [at a rough estimate].
199.　寄付は昨年に比べて下向きだ。　Donations have been on the down [　　　　　　　] compared to previous years.	199.　His career has been [on the downgrade].
200.　その犬は彼を軽蔑した顔で見た。　The dog looked at him with a scornful [　　　　　　　].	200.　She replied [with a scornful look].

Appendix 2: The List of Questions for the Behavioral (Comprehension task) and EEG Experiment (Comprehension & Production tasks)

Production task: Japanese to English	**Comprehension task: English to Japanese**
1. 私は過去に５回ハワイに行ったことがある。 I have been to Hawaii five times in the [ ].	1. My father was a teacher [in the past].
2. 結果としてその問題は解決された。 The problem has been resolved as a [ ].	2. The island population is decreasing [as a result].
3. ところで、いくつか質問があります。 I have a few questions, by the [ ].	3. I have something to tell you, [by the way].
4. それまでに私の仕事は終わるでしょう。 My work will have been finished by the [ ].	4. I will have finished preparing dinner [by the time].
5. 私はしばらく休憩します。 I will take a break for a [ ].	5. I will look over that situation [for a while].
6. 言い換えれば、彼女はその提案を拒否したいと思っている。 She wants to refuse the proposal, in other [ ].	6. You are going to be late [in other words].
7. 私は初めてインド料理を食べた。 I had an Indian dish for the first [ ].	7. I learned that word [for the first time].
8. 結局彼らはクリスマスは家で過ごすことに決めた。 They decided to spend Christmas at home in the [ ].	8. She went back to England [in the end].
9. 彼はいつも私を長い時間待たせる。 He always keeps me waiting for a long [ ].	9. He has been sick [for a long time].
10. まず初めに、私たちは部屋を片付ける必要がある。 We need to clean the room first of [ ].	10. Every member will do a self-introduction [first of all].
11. 彼はいつも仕事で忙しい。 He is busy with the work all the [ ].	11. Instead of working, he is playing [all the time].
12. 彼女はその山に最後まで登るつもりだ。 She is going to climb the mountain all the [ ].	12. You must watch your step [all the way].

13. 私はその時お風呂に入っていた。 I was taking a bath at that [ ].	13. I was in the garden [at that time].
14. 彼は今、席を外しています。 He is away from his desk at the [ ].	14. She is on vacation from work [at the moment].
15. 私の夢は、将来医者になる事です。 My dream is to become a doctor in the [ ].	15. I want to buy a house [in the future].
16. 私たちはそれを全体として判断する必要がある。 We need to judge that as a [ ].	16. The climate of Japan is mild [as a whole].
17. 景気は低迷したままだ。 The economic conditions has been remaining at the [ ].	17. In Canada I had to start [at the bottom].
18. 彼は車を邪魔なところに停めた。 He parked his car right in the [ ].	18. I pushed aside boxes that are [in the way].
19. 私の新しいアシスタントは私をとても助けてくれる。 My new assistant helped me a great [ ].	19. His new house must have cost [a great deal].
20. 彼らの内大体は私の友達だ They are my friends for the most [ ].	20. I could understand your explanation [for the most part].
21. 私は途中で銀行に寄ります。 I will stop at the bank on the [ ].	21. We took a short rest [on the way].
22. まったくもって彼は賢い少年だ。 He is a clever boy to be [ ].	22. It is a good method, [to be sure].
23. 私はちょうど電話でピザを注文したところだ。 I have just ordered a pizza on the [ ].	23. She talked to her family [on the phone].
24. 私はその事に最後まで責任があるでしょう。 I will be responsible for that to the [ ].	24. I have read the letter carefully [to the end].
25. スカイダイバーは明らかに危険と隣り合わせで生きることを楽しまなければならな い。 Skydivers obviously must enjoy living on the [ ].	25. The future of refugees are [on the edge].
26. 私たちは突然大きな音を聞いた。 We heard a loud noise all of a [ ].	26. She began to laugh [all of a sudden].
27. その２社は互いに競合している。 The two companies are in competition with each	27. We sat face to face [with each other].

[ ].	
28. 私は長い目でみれば正直さが勝ると信じている。 I believe the honest will win in the long [ ].	28. Expensive things often prove more economical [in the long run].
29. 私は勤務中に気分が悪くなり、倒れた。 I felt sick and collapsed on the [ ].	29. Employees are not allowed to smoke while [on the job].
30. ここにはかつて家があった。 There used to be a house here at one [ ].	30. She was a famous actress [at one time].
31. 私たちは遠くに船が見えた。 We could see the ship in the [ ].	31. We can see Mt. Fuji [in the distance].
32. しばらくして彼らはまた歩き始めた。 They began to walk again after a [ ].	32. He found out the answer [after a while].
33. このドアはいつも閉じたままにしなければならない。 This door must be kept closed at all [ ].	33. I have to wear a tie [at all times].
34. あちらこちらに汚れた服があった。 There were dirty clothes all over the [ ].	34. I searched for my lost wallet [all over the place].
35. 彼は自分勝手だが、それでも私は彼が好きだ。 He is selfish, but I like him all the [ ].	35. Although they were tired, they continued walking [all the same].
36. 彼女は髪を後ろで束ねた。 She had her hair tied up at the [ ].	36. There is a small door [at the back].
37. 彼は１０日間連続で働いている。 He has been working 10 days in a [ ].	37. He came to school late 2 days [in a row].
38. その頃私は一日中音楽を聴いていた。 I was listening to music all day in those [ ].	38. It was expensive to travel abroad [in those days].
39. 私の父は、いわば歩く辞書だ。 My father is a walking dictionary so to [ ].	39. He is a star player, [so to speak].
40. 私は先日道で彼に会った。 I met him on the street the other [ ].	40. I watched a very funny movie [the other day].
41. 私のドキュメンタリー番組が放送される。 My documentary program will	41. The Olympic games will be [on the air].

be on the [ ].	
42. なぜか頭とお腹が痛い。 My head and stomach hurt for some [ ].	42. He was absent from that meeting [for some reason].
43. 私のお気に入りのお花屋さんが倒産した。 My favorite flower shop is out of [ ].	43. Recently, many public bath-houses have gone [out of business].
44. 私は彼の車が見えなくなるまで手を振った。 I waved until his car was out of [ ].	44. She quickly put the money [out of sight].
45. 彼女は急いで階段を下りた。 She went down the stairs in a [ ].	45. He went to the airport [in a hurry].
46. この理由により、私はあなたに賛成だ。 Many people agree with you for this [ ].	46. The story was rewritten for a textbook [for this reason].
47. 私はその問題は何とかして解決されると思う。 I think problem will be resolved one way or [ ].	47. We will find the money, [one way or another].
48. 私は鳥のさえずりをどこからともなく聞いた。 I heard bird tweets coming out of [ ].	48. Suddenly a sports car appeared [out of nowhere].
49. いわば日本は彼の第二の故郷だ。 Japan is his second home as it [ ].	49. They are victims of the war, [as it were].
50. 私はかつて時々ゴルフをした。 I used to play golf once in a [ ].	50. You should rest yourself [once in a while].
51. 私は毎日毎日彼に会うのを楽しみにしている。 I look forward to seeing him every single [ ].	51. I decided to study English [every single day].
52. 多くの人々が失業中だ。 A lot of people are out of [ ].	52. Because of the depression, many people are [out of work].
53. 彼はきっぱりとタバコを止めた。 He gave up smoking once and for [ ].	53. I must make up my mind [once and for all].
54. 昔は、子供たちは言われたことをした。 Children did what they were told once upon a [ ].	54. I did anything for you [once upon a time].
55. 桜の木はいっせいに開花した。 The cherry trees started blossoming all at [ ].	55. I should do this job [all at once].
56. 私はこの場にふさわしくないと感じる。 I feel like I	56. In the expensive restaurant, I felt [out of place].

am out of [ ].	
57. 多くの交渉が水面下で行われてきた。 A lot of negotiations have been made behind the [ ].	57. I will support your success [behind the scenes].
58. それ以来、私たちは交際している。 Since then, we have been in a [ ].	58. We got married after almost 4 years [in a relationship].
59. 私はエッセイをもう一度書き直さなければならない。 I have to write the essay all over [ ].	59. We had to search the room [all over again].
60. 私たちの旅行の計画はまだ決まっていない。 Our travel plans are still up in the [ ].	60. Description of the new project is [up in the air].
61. 念の為、私は傘を持っていく。 I will take my umbrella just in [ ].	61. Please prepare for the typhoon [just in case].
62. そのニュースは報道において多くの注目を集めた。 The news received much attention in the [ ].	62. The issue was widely reported [in the press].
63. その会社は黒字経営を保っている。 The company has kept the business in the [ ].	63. The newly reorganized company is now [in the black].
64. 出来るだけ早く私にメールを送って下さい。 Please send me an email as soon as [ ].	64. I need the money [as soon as possible].
65. 多くの夫婦が生活の為に共働きしている。 There are many couples working together for a [ ].	65. He used to sell cars [for a living].
66. 私たちは毎週定期的に会っている。 We meet every week on a regular [ ].	66. I decided to exercise [on a regular basis].
67. その会社は賃金を一律に上げる事を決めた。 The company decided on a pay increase across the [ ].	67. The government is planning to lower taxes [across the board].
68. おおむね彼らは良い仕事をする。 They do a fine job by and [ ].	68. I enjoyed my time at school, [by and large].
69. 私は、私たちは同じ土俵にいると思う。 I think we are all on the same [ ].	69. It is difficult to get everybody [on the same page].
70. 多くの人々は日常的に外食をする。 Many people eat out on a daily [ ].	70. The department sends reports [on a daily basis].

71. 信じられないかもしれないが、彼は上の階で宿題をしている。　He is upstairs doing his homework, believe it or [ ].	71. They have six children, [believe it or not].
72. 問題は一つずつ解決しなさい。　Try to solve the problems one at a [ ].	72. We went out of the theater [one at a time].
73. 近いうちに、私たちのコンピューター設備は交換されるでしょう。 Our computer equipment will be replaced in the [ ].	73. There will be a great earthquake [in the near future].
74. 私は一日中家にいた。　I was in the house all day [ ].	74. We walked and looked around Kyoto city [all day long].
75. その山火事は四方八方へと広がり始めた。　The forest fire began to spread in all [ ].	75. I saw some small animals running away [in all directions].
76. これからはもっと気を付けて運転します。　I will drive more carefully from now [ ].	76. I will be at home [from now on].
77. 私は気分転換に何か新しいことを試したい。　I want to try something new for a [ ].	77. You should listen to music [for a change].
78. 差し当たり、あなたのスーツケースはここに置いていて良いですよ。　You can leave your suitcase here for the time [ ].	78.　The hot days will continue [for the time being].
79. 私は彼らは誠意を持って行動していると信じていた。　I believed that they were acting in good [ ].	79. The detail in this guide is reproduced [in good faith].
80. 従業員数の削減は議題に挙がっている。　Cutting the number of workers is on the [ ].	80. There were several important items [on the agenda].
81. ほとんどの猫は犬が嫌いで、逆もまた同様だ。　The majority of cats hate dogs and vice [ ].	81. Everybody knows that he likes her [and vice versa].
82. 事あるごとに新たな問題がある。 There is a new problem at every [ ].	82. She has managed to succeed [at every turn].
83. 私はそれの実物が見たい。　I want to see that in the [ ].	83. I have seen the actor [in the fresh].
84. 私は近所の犬を散歩に連れて行った。 I took my neighbor's dog for a	84. Every afternoon she takes her grandfather out [for a

[ ].	walk].
85. 私の息子の銀行口座はたいてい赤字だ。 My son's bank account is usually in the [ ].	85. You will pay interest when you are [in the red].
86. 彼は、それは大したことではないと父親を説得した。 He convinced his father it is no big [ ].	86. He said that a business budget is [no big deal].
87. 私たちはデータベースを最新に保つために一生懸命働いている。 We work hard to keep our database up to [ ].	87. We always keep our records [up to date].
88. 彼らのアイデアは現実的なようだ。 Their ideas seem to be down to [ ].	88. She is very friendly and very [down to earth].
89. 誰に聞いても彼は素晴らしい教師だ。 He is a great teacher by all [ ].	89. They are a happy couple [by all accounts].
90. 私は私の古い車を損をして売った。 I sold my old car at a [ ].	90. The store has been selling items [at a loss].
91. 彼は幸運にも無事に戻れた。 He was lucky to get back in one [ ].	91. He found his house still [in one piece].
92. ロサンゼルスに戻ると、普段通りだった。 Back in Los Angeles it was business as [ ].	92. It will soon be back to [business as usual].
93. 彼らは貧しく、休暇など不可能だ。 They are poor and vacations are out of the [ ].	93. A pay rise is [out of the question].
94. 私は一目で息子が分かった。 I could recognize my son at a [ ].	94. I understood the whole story [at a glance].
95. 彼は間違いなくその試験に落ちるだろう。 He will fail the exam in all [ ].	95. She will be found innocent [in all likelihood].
96. 皆が彼は間違いなく有罪だと思った。 Everyone thought he was guilty without a [ ].	96. He is the most talented player [without a doubt].
97. 勢いに乗れば私はもっと早く走れる。 I can run faster once I get on a [ ].	97. The team which won the game are [on a roll].
98. 同様に、多くの支持者がいる。 There are a lot of supporters by the same [ ].	98. You can sell your items [by the same token].
99. 緊急電話回線は２４時間ずっと開設されている。	99. The police are investigating the

The emergency telephone lines operate around the [ ].	case [around the clock].
100. 彼らは日本人労働者が不足している為、外国人を雇用している。 They employ foreigners because Japanese workers are in short [ ].	100. Due to a drought, food has been [in short supply].
101. 私は時々外で変な音を聞いた。 I heard a strange noise outside every so [ ].	101. I come and visit him [every so often].
102. あなたはすぐにこの仕事に慣れるでしょう。 You will get used to this job in no [ ].	102. You will be able to swim [in no time].
103. 大学フットボールシーズンは今真っ最中だ。 The college football season is now in full [ ].	103. The winter sports season is still [in full swing].
104. そのエアコンは故障した。 The air conditioner has got out of [ ].	104. The elevator seems to be [out of order].
105. 彼に関するその噂は広範囲に広まった。 The rumor about him has spread far and [ ].	105. Western commercial culture has spread [far and wide].
106. 生徒数は平均して 5,000 人だ。 The number of students is 5,000 on the [ ].	106. He watches three movies a week [on the average].
107. 天気は悪い方に変わってきているようだ。 It looks like the weather is changing for the [ ].	107. The doctor says her condition has changed [for the worse].
108. 私たちのキャパシティーは限度に達した。 Our resources have been stretched to the [ ].	108. We reduced the prices of these goods [to the limit].
109. 私は息を切らして教室に走って入った。 I ran into the classroom out of [ ].	109. She arrived at the station [out of breath].
110. 生徒たちは次々に教師に質問をした。 The students asked their teachers questions one after [ ].	110. They went out of the room [one after another].
111. 彼女は心から喜んで夫の帰りを迎えた。 She welcomed her husband back with open [ ].	111. She always welcomes the guests [with open arms].
112. その商品はまもなく大々的に市場に出る。 This	112. He gave a party [on a large scal

product will soon be marketed on a large [ ].	e].
113. 彼は彼の研究課題を簡単に要約した。 He summed up his research topic in a [ ].	113. She told me what happened [in a nutshell].
114. 私は、あなたは大丈夫だと思う。 I know you will be in good [ ].	114. The teacher told us your children are [in good hand s].
115. あなたは近いうちに深刻な問題に見舞われるだろう。 You will get into serious trouble one of these [ ].	115. We will visit you [one of these days].
116. やっぱり１杯のワインをお願いします。 I would like a glass of wine on second [ ].	116. I have decided to stay here [on second thought].
117. あの境界線は必ず守られなければならない。 That border needs to be protected by all [ ].	117. You must come to the party [by all means].
118. 母子共に健康だ。 Both mother and child are in good [ ].	118. The goods which I ordered arrived [in good condition].
119. 大学入試は間もなくだ。 The university entrance exam is just around the [ ].	119. The summer vacation is [just around the cor ner].
120. うまくいけば、暗くなるまでに家に着けるだろう。 We will be home before dark with any [ ].	120. There may still be some tickets left [with any luck].
121. 彼は私が言ったことを言葉通りに受け取った。 He accepted what I said at face [ ].	121. I decided to take the offer [at face value].
122. 誠実さは軽んじられているようだ。 Honesty seems to be rather at a [ ].	122. Those who speak only one language are[at a discount].
123. さらなる詳細は追って知らされるだろう。 Further details will be announced in due [ ].	123. I look forward to hearing from you [in due course].
124. 旅行ガイドの情報は古い。 The information in the tourist guide is out of [ ].	124. Your opinion seems to be [out of date].
125. 彼女は卒業が間近であることを喜んだ。 She was happy that graduation was in the [ ].	125. I hear there are more staff changes [in the offing].
126. 私はダイエット中なので、健康的に食べている。 I am eating healthy because I am	126. The doctor instructed me to go [on a diet].

on a [ ].	
127. あなたは全くあなたのお姉さんのようだ。 You look like your sister for all the [ ].	127. He looks like his brother [for all the world].
128. 彼は晩年ついに京都に落ち着いた。 He finally settled down in France late in [ ].	128. He became famous as an actor relatively [late in life].
129. このような機会は一生に一度くる。 An opportunity like this comes once in a [ ].	129. You can take the test only [once in a lifetime].
130. テニスの事になれば、彼は誰にも劣らない。 When it comes to tennis, he [ ].	130. As a soccer player he is [second to none].
131. 私はあさってから休暇を取る。 I will take a vacation from the day after [ ].	131. We will go to Hong Kong [the day after tomorrow].
132. オークションで、彼女はそのベッドを格安で買った。 At an auction, she bought the bed for a [ ].	132. She bought that antique watch [for a song].
133. どんな料理もすぐに準備できるだろう。 Any dish will be ready at a moment's [ ].	133. We are ready to start [at a moment's notice].
134. 私は彼に気を付けるようはっきりと言った。 I told him to be careful in so many [ ].	134. She told me to stop smoking [in so many words].
135. この電車は運転休止になる。 This train is going to be not in [ ].	135. I noticed the bus was [out of service].
136. 私は彼が激怒しているのを見てショックを受けた。 I was shocked to see him in a [ ].	136. He stood up with his hands trembling [in a rage].
137. 彼女は圧倒的な勝利を収めると予想されていた。 She was expected to win by a [ ].	137. He won last month's presidential election [by a landslide].
138. 彼女は私の知る限り、まだハワイにいる。 She is still in Hawaii for all I [ ].	138. He is a good man [for all I know].
139. あなたの妹は口が軽い。 Your little sister really has a big [ ].	139. I know you think I have [a big mouth].
140. その子ども達は調子が良いとよく学ぶ。 The children learn well when it is in the [ ].	140. She can perform very well [in the vein].

141. 私はあなたが快方に向かっているのを見て嬉しい。 I am glad to see you are on the [ ].	141. The economy now seems to be [on the mend].
142. 私はこれまでにシェイクスピアの作品を３冊読んだ。 I have read three Shakespearian works up till [ ].	142. It is the best score [up till now].
143. 彼にとってはテストを受けることは朝飯前だ。 For him, taking tests is a piece of [ ].	143. Finishing the job by tomorrow is [a piece of cake].
144. その女性たちの自信は飛躍的に増えた。 The women's confidence increased by leaps and [ ].	144. Progress in medicine is going ahead [by leaps and bounds].
145. 彼女の最初の小説は今絶版になっている。 Her first novel is now out of [ ].	145. The book you ordered is currently [out of print].
146. もしそれを試すと、あなたは危ない橋を渡ることになるだろう。 If you try that you will be on thin [ ].	146. I felt as if I was walking [on thin ice].
147. 来賓者の名前はアルファベット順にリストされている。 The guests' names are listed in alphabetical [ ].	147. His books are neatly arranged [in alphabetical order].
148. 彼らはとても恐れていて、落ち着かない様子だった。 They seemed very frightened and ill at [ ].	148. Before the exam, the students were [ill at ease].
149. 私は一昨日映画を観た。 I saw that movie the day before [ ].	149. They arrived in London [the day before yesterday].
150. あなたが注文した商品は現在在庫切れだ。 The item you ordered is now out of [ ].	150. The book you want is [out of stock].
151. この新しいクロスワードは不可能に近い。 This new crossword puzzle is next to [ ].	151. Finishing the report by tomorrow is [next to impossible].
152. 私は机を逆方向に動かそうとしていた。 I tried turning the desk the other way [ ].	152. You have to turn it [the other way round].
153. 彼女は何のためらいもなく、その車を買った。 She bought the car without a second [ ].	153. He jumped into the river [without a second thought].
154. 運転している時は、あなたは警戒する	154. Since tsunami is coming,

べきだ。 When you drive, you should be on the [ ].	you should be [on the alert].
155. そのニュースは口コミで広まった。 The news has spread by word of [ ].	155. I learned about that shop [by word of mouth].
156. 私はあなたの幸せをなによりも想っている。 I think of your happiness before anything [ ].	156. You must do the homework [before anything else].
157. 毎年の夏、彼らは野外で劇を行う。 Each summer, they perform a play in the open [ ].	157. A tea ceremony was held [in the open air].
158. 彼女の命を救う為、医者たちは時間と戦っている。 To save her life, doctors are working against the [ ].	158. To meet the deadline, everyone was working [against the clock].
159. 彼は猛スピードでコーナーを駆け巡った。 He came racing round the corner at breakneck [ ].	159. We drove to the hospital [at breakneck speed].
160. そのプロジェクトを終えるために、私たちは全力で働いていた。 To finish the project, we were working full steam [ ].	160. We as a company are moving [full speed ahead].
161. その映画は、金もうけに夢中なビジネスマンの話だ。 The movie is about a businessman on the [ ].	161. In his company, he is always [on the make].
162. 私たちはすでに、その議題について長々と話し合った。 We have already discussed the subject at great [ ].	162. My teacher explained the passage [a t great length].
163. 彼は、私が欲しければ、彼の切手のコレクションは私の物だと言った。 He said his stamp collection was mine for the [ ].	163. All our catalogues are free [for the asking].
164. 私はこの辺りに家を買うつもりだ。 I am going to buy a house somewhere around [ ].	164. I must have put my key [somewhere around here].
165. 私はその本を一気に読んだ。 I read the book all in one [ ].	165. He drank the whole bottle of beer [in one gulp].
166. あなたは営業時間中に電話相談サービスに電話することができる。 You can call the helpline during business	166. The office is open only [during business hours].

[ ].	
167. その地震のせいで、彼の部屋はめちゃくちゃだ。 Because of the earthquake, his room is in a [ ].	167. He said his company's finances are [in a mess].
168. 年末は間近だ。 The end of the year is near at [ ].	168. Our tenth wedding anniversary is [close at hand].
169. 彼は急いで家に戻るよう言われた。 He was told to get back home on the [ ].	169. I need a copy of the report [on the double].
170. 彼女は裸足で歩き回ることが好きだ。 She likes to walk around in bare [ ].	170. It is better to do yoga [in bare feet].
171. 私の息子が生まれたとき、私は最高に幸せだった。 When my son was born I was on cloud [ ].	171. After hearing the news, he was [on cloud nine].
172. 予想に反して、天気は良くなった。 The weather has turned out fine, contrary to [ ].	172. Interest rates did not rise [contrary to expectations].
173. 私たちは面白半分で、ヘリコプターに乗った。 We took the helicopter ride just for [ ].	173. I dove into the sea [just for laughs].
174. 幸運にも、彼女は万が一に備えてお金を貯めていた。 Luckily she had saved some money for a rainy [ ].	174. You should really save that mon ey [for a rainy day].
175. この辞書はとびきり良い。 This dictionary is the best out and [ ].	175. Skiing is the most popular winter sport [out and away].
176. 急にビザを取得することは不可能だ。 It is impossible to get a visa at short [ ].	176. He had to leave for Tokyo [at short notice].
177. 彼は彼の土地をただ同然で売った。 He sold his land for next to [ ].	177. She bought the book [for next to nothing].
178. 肌の色は重要ではない。 The colour of someone's skin should be of no [ ].	178. His past achievements seem to be [of no account].
179. その文章を正しい順序に書き直して下さい。 Please rewrite the sentence in the correct [ ].	179. Put the books back [in the correct order].

180. そこには推測で約１０名の人がいた。 There were about ten people at a [ ].	180. She has never been abroad [at a guess].
181. 大統領はその状況を直接見る為に来た。 The President came to see the situation at first [ ].	181. The data is collected by the researcher [at first hand].
182. 一年中、泳ぐには十分温かい。 It is warm enough to swim all the year [ ].	182. Here in Thailand, the weather is warm [all year around].
183. 最後の手段として、彼はいつでも仕事を辞めることができる。 He can always quit the job in the last [ ].	183. I went to the police box [in the last resort].
184. 彼女の絵はとても目に優しい。 Her paintings are very easy on the [ ].	184. The book's layout is [easy on the eyes].
185. 私はタバコを永遠に止めた。 I have given up smoking for good and [ ].	185. This time she is leaving [for good and all].
186. 試合に勝ったので、私たちは幸せの絶頂だった。 Having won the game, we were in seventh [ ].	186. Since they got married, they are [in seventh heaven].
187. 彼は落ち込んでいるようだった。 He seemed a bit down in the [ ].	187. The bad news left her feeling [down in the mouth].
188. その新しいプロジェクトは現在再考中だ。 The new project is currently in the melting [ ].	188. The business plan is still [in the melting pot].
189. 彼は急用で大阪に行った。 He has gone to Osaka on urgent [ ].	189. He had to return home [on urgent business].
190. この国の多くの人々が喪に服している。 Many people in this country are in deep [ ].	190. The citizens of this town are [in deep mourning].
191. 私はありがとうを丁寧に言いたい。 I want to say thank you in a polite [ ].	191. He declined a gift [in a polite way].
192. そのワークショップは予告なしにキャンセルされた。 The workshop has been canceled without advance [ ].	192. The details may be changed [without advance notice].
193. 時々彼は青白く調子が悪いように見える。 Sometimes he looks pale and out of [ ].	193. I drink and smoke and am [out of condition].

194. 私たちはその出来事について間接的に聞いただけだ。　We have only heard of the incident at second [　　　　　　　　　].	194. I learned of her marriage [at second hand].
195. その通知は十分時間をかけて行われなければならない。　The notification must be made in sufficient [　　　　　　　　　].	195. Please go to the check-in desk [in sufficient time].
196. スライドの情報は箇条書きで提示されるべきだ。　Information on the slides should be presented in bullet [　　　　　　　　　].	196. We want to show our data [in bullet points].
197. 彼女は最終集計で３０社に応募していた。　She had applied for 30 jobs at the last [　　　　　　　　　].	197. 50 people came to this event [at the last count].
198. 修理はざっと見積もって、２週間かかる。　The repair will take two weeks at a rough [　　　　　　　　　].	198. It will cost ten thousand yen [at a rough estimate].
199. その会社の利益は悪化している。　The profits of the company are on the [　　　　　　　　　].	199. Since last year, business is [on the down grade].
200. その男性は軽蔑した顔で去って行った。　The man walked away with a scornful [　　　　　　　　　].	200. He sat on the table [with a scornful look].