

A Study on The Impact of Reading Anxiety on Language Processing Efficiency of Non-native English Learners

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Abstract

This paper studies the influence of reading anxiety on the language processing efficiency of non-native English learners. Through experiments, it is concluded that reading anxiety will have a negative impact on non-native English learners in handling vocabulary, grammar and article content, etc. It will cause learners to have a slow reaction rate, low comprehension accuracy, and limit learners' abilities in information synthesis and logical thinking. Research has found that learners with lower language proficiency are more prone to reading anxiety. To effectively address this issue, schools should apply some strategies in English teaching, such as reducing anxiety through cognitive behavioral therapy, providing more simplified reading materials to gradually increase difficulty, and using meditation and relaxation techniques to help learners relieve anxiety. These methods can effectively enhance learners' language processing efficiency and promote their performance in aspects such as vocabulary recognition, syntactic analysis and text comprehension.

Keywords

Reading anxiety, Non-native language learners, Language processing efficiency, Vocabulary comprehension, Information reasoning.

1. Introduction

As the second language to be learned globally, many non-native English learners are confronted with the anxious predicament of learning a second language. This psychological disorder, known as reading anxiety, has a significant impact on the language processing ability and cognitive level of English learners. Especially in the process of English learning, reading tasks require learners to understand and process a large amount of information. This can easily cause learners' anxiety about reading tasks, thereby intensifying their psychological cognitive load. This is bound to have a negative impact on learners' language comprehension accuracy, vocabulary recognition speed, syntactic analysis ability and other aspects. This study aims to demonstrate its operational mechanism by conducting in-depth research on how reading anxiety specifically affects the language processing and cognition of non-native English learners, and to confirm the relevant hypotheses using actual survey data. To help learners control anxiety, schools can adopt specific strategies, such as helping learners relax through meditation and deep breathing training. Adopting phased reading tasks to gradually increase learners' confidence and providing positive feedback to enhance their sense of self-efficacy can help alleviate anxiety and improve learners' language processing efficiency.

2. A Theoretical Overview of Reading Anxiety and Language Processing Efficiency

2.1. Definition and Characteristics of Reading Anxiety

Reading anxiety refers to the negative psychological response that occurs when learners have doubts or doubts about their reading ability during reading tasks. This phenomenon is usually manifested as tension, anxiety, worry and even panic, fearing that they cannot complete the task or have difficulty correctly understanding the content of the article. According to the research of Horwitz et al., reading anxiety involves both tense emotional responses and the dispersion of cognitive resources. Tension makes learners feel stressed when reading, affecting their emotional stability, while the dispersion of cognitive resources is manifested as learners' inability to concentrate during tasks and difficulty in maintaining clear thinking^[1]. These factors lead to a slower reaction process for learners when facing complex articles, increasing the burden on functions such as the interpretation of core vocabulary, syntactic analysis and information induction in the process of reading comprehension..

2.2. Phased Model of Language Processing

Language processing involves multiple stages, and each stage has different requirements for information processing. First of all, vocabulary recognition is the first step in language processing. Learners understand the meaning of words through rapid recognition of vocabulary. Anxiety increases cognitive burden, delays recognition speed and leads to comprehension errors^[2]. Assuming that the time T_v for vocabulary recognition is related to anxiety A and cognitive load C_L , the formula can be expressed as:

$$T_v = k_1 \cdot A + k_2 \cdot C_L \quad (1)$$

Among them, k_1 and k_2 are constants, indicating how anxiety and cognitive load affect the reaction time of vocabulary recognition.

Syntactic processing requires learners to have a relatively clear understanding of the sentence structure and be able to handle the relationships between various words. However, in an anxious state, learners' scattered attention can affect the speed of language processing and reduce the accuracy of analysis. For advanced language processing activities, namely discourse understanding, learners need to integrate various pieces of information into a whole. Reading anxiety has an impact on the entire information integration process production line, preventing learners from making correct judgments and connecting key clues in the text, thereby reducing the language processing efficiency of learners.

3. Analysis of the Impact of Reading Anxiety on the Language Processing Efficiency of Non-Native English Learners

3.1. The accuracy of vocabulary comprehension declines

Negative emotions caused by reading anxiety can greatly affect non-native English learners' accurate grasp of vocabulary meanings. Emotions usually occupy a large amount of cognitive resources, thereby preventing learners from focusing on the content in the text. This kind of emotion will cause learners to be unable to make correct inferences about new words and unfamiliar vocabulary based on the context before and after when reading articles, and thus lead to misunderstandings^[3]. Long-term anxiety can have a continuous negative impact on learners' long-term memory and application of words. Besides interfering with learners' understanding and memory of words, anxiety also intensifies their doubts about whether they

use words correctly, thereby reducing their opportunities to try and use rare or advanced words, and further delaying the progress of English learning.

3.2. Difficulties in implementing grammar rules

As non-native English learners, their ability to apply grammar rules will be affected when facing reading anxiety. Learners in this emotional state often have cognitive deficiencies in the process of syntactic recognition and the use of grammatical rules, especially in the process of understanding and learning. Due to excessive anxiety, these learners have difficulty concentrating and are unable to effectively integrate all grammatical knowledge, which increases the misjudgment rate of learners in grammatical structure analysis. Especially for sentences with multiple clauses, inverted structures or complex tenses, it is easy for learners with reading anxiety to make more misjudgments. When making grammar judgments quickly, learners' judgment speed will decline significantly.

3.3. The reasoning ability of the article information is limited

Reading anxiety has a negative impact on the article information reasoning ability of non-native English learners. In the face of this kind of reading anxiety, learners' cognitive resources will be consumed by this emotion, leading to difficulties for learners when reasoning about the article. Reading anxiety can prevent learners from effectively associating the reading information of different paragraphs, especially when facing more complex articles. Learners' anxiety can affect their association with key information, thereby influencing their understanding of the entire article^[4]. Learners in a state of reading anxiety often find it difficult to conduct in-depth analysis during the problem-solving process. As a result, they can only simply and partially understand the content of the article and are unable to delve deeply into it. Anxious learners are also unable to provide solid evidence when dealing with logically strong articles or paragraphs. As a result, they cannot accurately grasp the author's true intentions and have difficulty connecting more difficult-to-understand viewpoints.

4. Empirical Research Results on the Impact of Reading Anxiety on the Language Processing Efficiency of Non-Native English Learners

4.1. Experimental Design and Data Collection

This study attempts to reveal through experiments the influence of reading anxiety on the language processing efficiency of non-native English learners. This article selects 50 groups with the same level of college English as the research objects and divides them into two groups: one group is the experimental group and the other is the control group. The experimental group would receive a 3-minute "countdown + false negative feedback" double-blind paradigm before undertaking the reading task to guide them to generate anxiety. During the experiment, participants were informed that their performance was inferior to that of other students and were given negative feedback. The control group completed the neutral word filler task within the same period of time. Subsequently, the success rate of anxiety induction was evaluated using a five-item Likert scale, with an anxiety score of ≥ 5 as the criterion for successful induction. To eliminate the influence of the reading materials themselves, two standardized articles were used in the experiment: one was a less difficult article and the other was a more complex academic article. The CEFR grades of the two articles were B1 and C1 respectively, and the Flesch-Kincaid readability index was 55 ± 3 . Verified by the difficulty prediction scores of 30 students, there was no significant difference in difficulty between the two articles ($p > 0.05$). Data collection involves first measuring the baseline anxiety level, then performing anxiety-inducing or neutral tasks, followed by completing the reading task, measuring the anxiety level after the task again, and conducting anxiety assessment using the STAI scale and the Foreign

Language Reading Anxiety Scale (FLRAS). All the data are used to analyze the impact of anxiety on language processing efficiency.

In the experiment, the anxiety levels of learners were evaluated through standardized anxiety scales (such as STAI), and anxiety scores were recorded both before the experiment and after the task was completed. The main measurement indicators of the experiment are the reaction time and accuracy rate of learners in reading tasks^[5]. To ensure the clarity of the results, the formula for language processing efficiency (unit: %/s) is:

$$\text{Language processing efficiency} = \frac{\text{Accuracy rate}}{\text{Reaction time}} \times 100\% \quad (2)$$

Specifically, it records the learners' performance in the three stages of vocabulary comprehension, syntactic analysis and text comprehension. The reaction time (T_{response}) and accuracy ($\text{Accuracy}_{\text{task}}$) are the main data, and the relationship between the total reaction time and language processing efficiency is expressed by the following formula:

$$T_{\text{total}} = f(A, \text{Accuracy}_{\text{vocab}}, T_{\text{syntax}}, \text{Accuracy}_{\text{comprehension}}) \quad (3)$$

Among them, A represents the anxiety level, $\text{Accuracy}_{\text{vocab}}$ indicates the accuracy of vocabulary understanding, T_{syntax} is the reaction time for syntactic analysis, and $\text{Accuracy}_{\text{comprehension}}$ represents the accuracy of text understanding.

Through data collection and analysis, the research aims to reveal how anxiety levels affect learners' performance in different language processing stages and the relationship between anxiety and language processing efficiency.

4.2. Quantitative Analysis of Reading Anxiety and Language Processing Efficiency

In the experiment, the language processing efficiency of non-native English learners with reading anxiety was evaluated through quantitative analysis. The two groups of experiments were divided into the experimental group and the control group based on the degree of anxiety. After the language processing ability test was completed, the relevant data such as the anxiety level, vocabulary accuracy rate, syntactic processing time, and text comprehension accuracy rate of the participants in the two groups were collected and analyzed. The results show that the language processing efficiency of the experimental group with high anxiety is relatively insufficient. The specific data are shown in Table 1.

Table 1. Reading Anxiety and Language Processing Efficiency

Group	Anxiety level (average)	Vocabulary accuracy rate (%)	Vocabulary processing time (seconds)	Accuracy rate of text comprehension (%)
Experimental Group	65.4**	78.5**	15.2**	70.8**
Control group	35.2**	92.1	10.4	88.3**

There were significant differences between the experimental group and the control group in terms of vocabulary accuracy, syntactic processing time and text comprehension accuracy. The t value of vocabulary accuracy was 5.32, $p < 0.01$; The t value of syntactic processing time was 6.15, $p < 0.01$; The t value of the accuracy rate of text comprehension was 4.89, $p < 0.01$, indicating

that anxiety has a significant impact on the efficiency of language processing. As shown in Table 1, the accuracy of vocabulary comprehension, syntactic processing time and text comprehension accuracy of the experimental group were all lower than those of the control group, indicating that the state of reading anxiety significantly prolonged the learning time of learners and reduced the efficiency of language processing. Anxiety slows down learners' responses when dealing with language tasks, and the greater the difficulty of the task, the more significant the impact.

4.3. The Influence of Reading Anxiety on Different language Processing Stages

This study conducted a detailed investigation into the language processing links of reading anxiety in three aspects: lexical processing, syntactic analysis, and text reading. The research results show that under the state of reading anxiety, the language processing process of learners presents a lower accuracy rate and a longer processing time.

Table 2. The Influence of Reading Anxiety on Different language processing Links

Group	Vocabulary processing time (seconds)	Syntactic processing time (seconds)	Text processing time (seconds)	Vocabulary accuracy rate (%)	Syntactic accuracy (%)
Experimental Group	3.2	6.5	10.3	78.5	70.2
Control group	2.1	4.2	7.5	92.1	85.4

It can be seen from Table 2 that the time spent on vocabulary processing, syntactic analysis and article comprehension in the experimental group is significantly longer than that in the control group, which also means that reading anxiety will reduce the language processing speed of learners. Meanwhile, in terms of accuracy, the accuracy rates of vocabulary and syntax in the experimental group were also much lower than those in the control group. Therefore, it is easier to prove that reading anxiety can affect the accuracy rate of learners' language processing. The specific statistical results show that the t value of the vocabulary processing time is 2.3, $p < 0.05$; The t value of syntactic processing time was 4.2, $p < 0.01$; The t value of the text processing time was 7.5, $p < 0.01$; The t value of vocabulary accuracy was 5.32, $p < 0.01$; The t value of syntactic accuracy was 4.89, $p < 0.01$. These results indicate that anxiety significantly increases learners' language processing time and reduces their accuracy, especially when dealing with complex tasks, the impact of anxiety is more pronounced.

5. Conclusion

This study explored the impact of reading anxiety on the language processing efficiency of non-native English learners through empirical experiments. The research results show that reading anxiety significantly affects learners' performance in vocabulary comprehension, syntactic analysis and text comprehension, etc. Anxiety leads to an increase in learners' reaction time and a decrease in accuracy. This discovery supports the cognitive load theory, which holds that anxiety occupies working memory resources and weakens the effective processing of language input. It also confirms the view in Krashen's emotion filtering hypothesis that "high anxiety hinders input". However, this study failed to measure reasoning and integration abilities, especially in advanced language processing tasks. The lack of assessment of reasoning ability is one of the limitations of this study. Future research should further investigate the impact of anxiety on learners' reasoning ability by incorporating reasoning tasks such as main idea summary questions or author intention judgment questions. Through these advanced

processing tasks, it is possible to prevent "advanced processing" from remaining merely verbal, ensuring that the research results are more comprehensive and in-depth. To help learners control anxiety and improve language processing efficiency, the following strategies can be implemented in teaching: conducting mindfulness breathing exercises and progressive reading before class, teaching context word guessing and simplified syntactic analysis, training reasoning and generalization abilities in low-anxiety cooperative environments, and introducing real-time chatbot feedback to reduce anxiety. Through these methods, teachers can effectively enhance learners' language processing abilities and alleviate anxiety.

References

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Appendix

A. Complete function form, parameter sources and fitting process of the formula

1). Function form

This study uses the following formula to describe the impact of anxiety level A and cognitive load CL on language processing efficiency:

$$T_v = k_1 \cdot A + k_2 \cdot C_L$$

Among them, T_v represents the reaction time of the vocabulary comprehension task. A represents the anxiety level of the learner. C_L stands for cognitive load (usually measured by the complexity of the task or the learner's working memory burden). k_1 and k_2 are constant coefficients obtained through data fitting, representing respectively the degree of influence of anxiety level and cognitive load on reaction time.

2). Parameter source

Anxiety level A: The anxiety level of learners is measured using standardized anxiety scales (such as the STAI scale), and the scale score is directly used as the input for A.

Cognitive load C_L : Cognitive load is measured by the complexity of the task. For instance, it can be estimated based on factors such as the lexical difficulty of the task and the complexity of its syntactic structure. Cognitive load scales (such as NASA-TLX) can also be used for quantification.

Reaction time T_v : It is measured by the time required for learners to complete vocabulary comprehension tasks in the experiment, using seconds as the unit.

3). Fitting process

To obtain the optimal coefficients k_1 and k_2 , the least square method was used to fit the experimental data. The specific steps are as follows:

1. Data collection: Collect data on learners' anxiety levels, cognitive loads, and corresponding reaction times from the experiment.

2. Fitting Method: The experimental data were fitted using the linear regression method to minimize the following objective functions:

$$\min imize \sum_{i=1}^n (T_{v,i} - (k_1 \cdot A_i + k_2 \cdot C_{L,i}))^2$$

Among them, n represents the quantity of experimental data, $T_{v,i}$, A_i and $C_{L,i}$, respectively represent the reaction time, anxiety level and cognitive load of the i -th data point.

3. Result analysis: The coefficients k_1 and k_2 obtained through fitting can be used to analyze the specific impact of anxiety and cognitive load on language processing efficiency.

B. The complete function form of the formula, the source of parameters and the fitting process

In this study, to quantify the relationship between anxiety levels and language processing efficiency, the following function was used to describe the total time T_{total} of language processing efficiency:

$$T_{total} = f(A, Accuracy_{vocab}, T_{syntax}, Accuracy_{comprehension})$$

Among them, A represents the learner's anxiety level (measured by anxiety scales such as STAI and FLRAS scales); $Accuracy_{vocab}$ represents the accuracy rate of learners in vocabulary comprehension tasks; T_{syntax} represents the reaction time of learners in syntactic processing tasks; $Accuracy_{comprehension}$ represents the accuracy rate of the learner in the task of text comprehension.

1). Parameter source

Anxiety level (A) : Standardized anxiety scales (such as the STAI scale and the FLRAS Foreign Language Reading Anxiety Scale) were used to measure the anxiety level of each participant, with a score range from 1 to 7.

Vocabulary accuracy ($Accuracy_{vocab}$) : It is calculated based on the proportion of correct answers given by participants in vocabulary comprehension tasks and is expressed as a percentage.

Syntactic processing time (T_{syntax}) : By measuring the time it takes for participants to complete syntactic analysis tasks, the unit is seconds.

Text comprehension accuracy ($Accuracy_{comprehension}$) : By measuring the accuracy of the learner's understanding of the text, it is evaluated using standardized test questions and expressed as the percentage of correct answers.

2). Fitting process

To assess the impact of anxiety levels on language processing efficiency, we conducted a regression analysis on the data. The least square method is adopted for fitting to minimize the following objective function:

$$\min imize \sum_{i=1}^n (T_{total,i} - (k_1 \cdot A_i + k_2 \cdot Accuracy_{vocab,i} + k_3 \cdot T_{syntax,i} + k_4 \cdot Accuracy_{comprehension,i}))^2$$

Among them, $T_{total,i}$ is the total response time of the i -th data point; $Accuracy_{vocab,i}$, $T_{syntax,i}$, $Accuracy_{comprehension,i}$ are respectively the anxiety level, lexical accuracy, syntactic processing time and text comprehension accuracy of the i -th data point.; k_1, k_2, k_3 , and k_4 are regression coefficients obtained through regression analysis, representing the degree of influence of each factor on the total reaction time.

Through this regression analysis, the influence weights of each factor (anxiety level, lexical accuracy, syntactic processing time and text comprehension accuracy) on language processing efficiency were obtained, providing theoretical support for the subsequent result interpretation.

C. Effect Size Cohen's d

In this study, to further measure the impact of reading anxiety on language processing efficiency, we calculated the effect size Cohen's d for each key indicator. The effect size Cohen's d is used to quantify the magnitude of differences between groups. The larger the value, the more significant the differences between groups. The specific calculation results are as follows:

Vocabulary processing time: Cohen's d = 1.02

Syntactic processing time: Cohen's d = 1.15

Text processing time: Cohen's d = 1.05

Vocabulary accuracy: Cohen's d = 1.22

Syntactic accuracy: Cohen's d = 1.10

These effect size results indicate that the impact of anxiety on learners' language processing efficiency is significant, especially in syntactic processing and lexical processing tasks, where the effect size is relatively large, further supporting the negative influence of anxiety on learners' language processing.