*Corresponding Author's Email: shuxin_1028@qq.com
Proceedings of the International Academic Conference on Education, Teaching and Learning
Vol. 1, Issue. 1, 2024, pp. 55-65
DOI: https://doi.org/10.33422/iacetl.v1i1.607

ISSN: 3030-1270 online

Individual refresh ability modulates irrelevant speech effect in reading: Evidence from eye movements

Sanmei Wu[1,2], Liangsu Tian[3], Jingxin Wang[2], Min Chang[4], and Xin Shu[1*]
[1] School of Foreign Language, Guangdong AIB Polytechnic College, Guangzhou, China
[2] Faculty of Psychology/Academy of Psychology and Behavior, Tianjin, China
[3] School of Psychology, South China Normal University, Guangzhou, China
[4] School of Education Science, Nantong University, Nantong, China

Abstract

This study randomly recruited 245 college students aged between 18 and 21 years old who had never studied Spanish and selected 60 subjects (30 with high refresh ability and 30 with low refresh ability) based on their scores on a refresh ability test. The mixed experimental design of 2 (refresh ability: high, low) ×3 (background sound: meaningful, meaningless, silent) was adopted. The Eyelink1000 eye tracker was used to record the eye movement data of the subjects when reading the sentences of scientific papers. At the same time, meaningful (news broadcasting) or meaningless (Spanish) background sounds are played. Based on this, the moderating effect of individual refresh ability with the impact of irrelevant speech was investigated. According to the results, the interaction between refresh ability and the meaningful background sound condition was significant, and it had an impact on the total reading time, gaze count, regression count, total fixation time, and regression-path duration. However, the interaction with the meaningless background sound condition was not significant. The results showed that: (1) refresh ability significantly regulates the irrelevant speech effect in reading, compared with individuals with high refresh ability. The meaningful background sounds have a greater negative impact on the reading of individuals with low refresh ability; (2) the regulating effect of refresh ability occurs in the late stage of vocabulary processing and semantic integration. The results supported the attentional capture theory and found that the irrelevant speech effect in Chinese reading is modulated by individual refresh ability, which mainly acts on semantic components in late reading processing.

Keywords: irrelevant speech effect, individual refresh ability reading, eye movements.

1. Introduction

Irrelevant speech effect refers to a phenomenon in which task-independent background speech interferes with the visual processing of individual information (Colle & Welsh, 1976; Meng et al., 2020; Salamé & Baddeley, 1982; Meng Zhu, Yan Guoli, 2018). The researchers believe that individuals with greater working memory capacity will have less activation of irrelevant information in cognitive processing (Schmiedek, et al., 2009). Refresh refers to the process in which the executive function constantly changes the working memory content according to the newly presented information, which requires that the old and irrelevant information be discarded, and the relevant new information be incorporated. Whether this ability can modulate irrelevant speech interference in complex reading processing or not deserves attention.

Individual refresh function plays an important role in reading comprehension. The understanding text needs to keep a large amount of information activated, and it needs to be constantly updated during the reading process and exclude irrelevant information to successfully build coherent text representations, which processing is related to the central executive function, especially the refresh function (Palladino et al., 2001; Radvansky & Copeland, 2001). As pointed out by Palladino (2001) et al., refresh execution processing completes the first two functions of reading comprehension: one is to activate relevant information to interpret the text within a given time and update information in working memory, and the other is to maintain related information for reading comprehension. Palladino et al. (2001) believed that refresh is related to reading comprehension in adolescents and adults and that those with high reading comprehension perform better on refresh tasks than those with low comprehension. Davelaar et al. (2005) research results also found low reading comprehension compared to high reading comprehension ability on refresh task performance leads to worse grades, and more intrusion errors (remembering related but non-target information), the results showed that people with poor understanding may have poor refresh ability so that they update information in different refresh tasks with difficulties. Carretti et al. (2005) mentioned the core problem of low-skill readers is that they find it difficult to control the information activated in working memory, poor refresh function related to poor reading comprehension, due to the persistence of irrelevant information and the subsequent invasion of irrelevant information, lead to poor refresh ability readers difficult to activate related useful information. García-Madruga et al. (2014) used the word update task to measure the refresh function and found that the refresh could predict the reading comprehension processing of Spanish third-grade children, which included the inference and integration of prior knowledge and text information during reading.

At the same time, from the study of irrelevant speech effect individuals with different working memory capacities differ in their performance in reading with sound interference. Sörqvist, Ljungber, and Ljung (2010) explored the effects of aircraft noise and meaningful background language on the memory of the passages read by teenagers and found that individuals with low working memory capacity were more sensitive to aircraft noise than those with higher working memory capacity. Sörqvist (2010) believes that the relationship between working memory and reading is essentially the relationship between the subcomponents of working memory and reading, and different subcomponents can be measured by different working memory tasks. Sörqvist, Halin, and Hygge (2010) found that individuals with different working memory capacities had different sensitivity to sound interference and that individuals with lower working memory capacity (calculated as the number of numbers correctly answered in the digital update task) were more likely to be disturbed by irrelevant speech. Due to the operation span test working memory span task and refresh task correlation is very high, the working memory capacity to a certain extent, adjusts the background sound on reading, and the refresh function is closely related to reading comprehension, so the refresh function will adjust the influence of background sound on reading, namely high/low refresh function individuals in the background sound interference reading performance differences, this is the problem to be discussed in this study.

More importantly, previous researchers have suggested that irrelevant speech effects are the result of competing simultaneous input of visual information (the task itself) and auditory information (irrelevant interference) (Jones et al.,1992), Attention capture (Attentional Capture) theory holds that competition is attention resources, When the background tone shifts attention resources from the primary cognitive task to the irrelevant sound stimulus through the orientation response (Orienting Response), Will produce attentional capture, Decrease the cognitive processing efficiency of the current task (Cowan, 1995), In this process, Individuals can make interference controllable by increasing top-down cognitive input or enhancing control of attention, Thus the individual differences in irrelevant speech effect (Hughes, 2014). An in-depth exploration of the role of refresh in irrelevant speech effects can provide empirical support for compliance with the attention capture theory.

Research using eye tracking technology, by comparing different refresh abilities (high/low) of individuals in different irrelevant speech conditions (meaningful background sound / meaningless background sound / silent) under the eye movement index, explore the following problems: whether individual refresh ability to read irrelevant speech effect and verify the attention to capture the correctness of the theory. If the refresh works, then compared with the high refresh ability, the low refresh ability is more affected by the irrelevant speech, and the individual differences meet the attention capture theory; if the refresh does not produce the regulating effect, then the low refresh ability is not significantly different by the irrelevant speech, which does not conform to the attention capture theory.

With complex sentences as the reading content, we explore the function of refresh function in reading sentences with sound interference. The experimental hypothesis is that if the refresh function adjusts the influence of background sound on sentence reading, then the background sound has little influence in the sentence reading of individuals with high refresh ability, while the background sound has great influence in the sentence reading of individuals with low refresh ability; conversely, if the refresh ability does not produce the adjustment effect, the influence of background sound is not significantly different in the sentence reading of individuals with high/low refresh ability.

2. Methods

2.1 Subjects

Through the test platform of the three universities, 245 students aged 18-21 were randomly recruited to participate in the experiment, including 141 girls and 104 boys, all of whom were right-handed and had not learned Spanish. The refresh ability test is implemented to understand the participants' refresh ability and divide them into a high refresh ability group and a low refresh ability group.

Refresh test reference color refresh task: the experiment begins in the center of the computer screen and presents a "+" for 500 ms, then presents a 4X4 grid for 4000 ms, which has three color (red, green, blue) dots. The participants are required to remember the location of three dots in the grid. After the dots disappear, the colored arrows (red, green, blue) are presented at the center of the grid at a refresh rate of 2000 ms (rendering for 1500 ms, blank for 500 ms). With each occurrence of the arrow, the participants are required to move the dots with the same color in the direction of the arrow in the brain. When the arrow was presented, the subject was required to point out the position of the three color points and respond with a mouse click. One correct answer got 1 point, and 3 points represented their answers were completely correct. The series of arrows was 3, 4, and 5 lengths, and each of the three arrows was arranged randomly in the experiment, and the subjects did not know in advance when the presentation of the arrows ended. Before the experiments, each participant practiced 3 times. During the test, they were tested 4 times for each length, namely 12 times in total, with the full score of 36 points. The higher the score, the stronger the refresh ability.

The sample size required for eye movement experiments is calculated through the G * Power software: to obtain the moderate effect size (d =0.25) and the high statistical test force (1- β =0.9), 60 subjects are needed, and the lowest sample size is 30 subjects. In Experiment 1, the top 15% of the subjects with refresh test results were selected as the high refresh ability group, and the bottom 15% of the subjects were selected as the low refresh. The ability group (Xing Qiang et al., 2017; Yearning, Wen Ping, 2013), and 37 subjects with high and low refresh ability were obtained. After balancing the number of subjects under each module, 60 subjects in the high and low group with normal vision or corrected vision, and 30 subjects in the high and low groups.

2.2 Experimental Design

The experiment is based on the mixing of two factors (2 refreshes and 3 background sounds), in which refresh ability is the between-subject factor of level 2 (high and low), and the background sound is the 3-level factor (meaningful speech, meaningless speech, no background speech). The dependent variables include both the overall analysis indicators reflecting the overall reading rate and reading characteristics in the eye-movement reading, and the local analysis indicators for the target words.

2.3 Experimental Materials

The experimental materials are divided into two parts: reading material and background sound material.

Reading material: These are taken from the scientific and technological papers of China National Knowledge Infrastructure (CNKI), and 245 sentences are written with a length of 33 Chinese characters.

Background sound materials: there are two kinds of speech materials used in the experiment. One is to use news broadcast as meaningful speech (Yan et al., 2018), this meaningful speech contains both semantic components and acoustic characteristic changes, divided into 27 paragraphs; one is Spanish as meaningless background sound, this speech contains acoustic feature change but no semantic component, material from Sophie's World, into Spanish through speech software, into 27 paragraphs, each material in about 60 seconds. The 54 paragraphs of speech materials are all male voices, with no repetition in the content, the 48 paragraphs as experimental materials, and the 6 paragraphs as practice materials. The volume of the background was adjusted with Cooledit software and kept at 60 dB.

To balance the background sound order, 81 sentences are divided into three modules, each module 27 sentences (experimental sentence 24 sentences, practice 3 sentences), sentence module and three background sounds (meaningful speech, meaningless background sound, silent) Latin square balance, make each background sound applied in each sentence, each subject randomly accept one of the stimulus presentation order, each background sound under the experimental sentence at random, sound presentation order is completely random.

2.4 Experimental instruments

The experimental instrument was Eyelink1000 with a sampling frequency of 1000 Hz, a refresh frequency of 85 Hz, and a resolution of 1024768 pixels. The distance between the subject eyes and the screen was 76 cm, the size of each Chinese character appearing on the screen was 3131 pixels, and the eye movement track of the right eye was recorded. Sound stimuli were presented to participants at around 60 dB through noise-canceling headphones.

2.5 Experimental procedures

Throughout the experiment, participants wore headphones, which presented meaningful and meaningless background sounds. Ask participants to focus on what they want to read and ignore any sounds they might hear. At the beginning of the experiment, the eye tracker was calibrated at three points, and the average error was less than 0.3°. After the calibration, the fixation point "+" would appear on the left side of the screen, requiring the subjects to watch the "+" to trigger the sentence reading, enter the practice sentence reading (nine sentences, three sentences under each background sound), and then the experimental sentence reading. Do a three-point calibration between each three sentences, and a little calibration for each other sentence. The whole experiment process requires subjects to read the sentence carefully and understand after pressing the space into the next sentence, 81 sentences with questions, need to be answered to ensure the subjects read carefully, if the answer is "yes", press "F" key, "no" press "J" key, the experiment lasted about 40 minutes. In order to ensure the validity of the data, after the end of the experiment, the participants were asked to answer several questions about the experiment, such as "whether they had ever learned Spanish before" and "heard several background sounds during the experiment", to exclude irrelevant factors, such as whether the participants could understand Spanish and the sound did not appear during the experiment.

3. Results

Before formal data analysis, unqualified data were removed. (1) Delete 0 subjects with an accuracy rate of less than 70% and excessive blinking times. (2) The data with fixation time less than 80ms or more than 1200ms and missing data were deleted, and the invalid data accounted for 4.97% of the total data. (3) Delete data other than 3 standard deviations.

Experiments were performed using R statistical software (R Core Development Team, 2016) and the lme4 package (Bates et al., 2011), using linear mixed-effects models (Baayen et al., 2008) performed the statistical analysis of the data. After the standardized transformation of the eye movement indicators, the refresh ability and the background tone condition and the interaction between them were included in the model as fixed factors, while considering the two random factors of the subject and the item. First, starting with the maximum effect model, the gradual decrease principle is adopted until the model is fitted successfully.

The reading accuracy rate of Individuals with low refresh ability under meaningful speech, meaningless speech, and silent conditions is 87%, 81%, and 89%, respectively, and the accuracy rate of individuals with high refresh ability is 90%, 86%, and 87%, respectively. In terms of accuracy rate, the main effect of background sound, the main effect of refresh, and the interaction between the two are not significant ($ps > 0.05$).

3.1 Overall Analysis

The results of the experiments showed that there was a significant interaction between refresh ability and meaningful background sounds in sentence reading time ($t=2.75$, $p=0.008$), as demonstrated by the simple effects test. For individuals with high refresh ability, there was a significant difference between meaningful speech conditions and silent conditions ($t=5.23$, $p<0.001$), and the sentence reading time in the meaningful speech condition was significantly longer than that in the silent condition. For individuals with a low refresh ability, the difference between meaningful speech conditions and silent conditions is significant ($t=14.05$, $p<0.001$), and the sentence reading time in the meaningful speech condition was significantly longer than that in the silent condition. In terms of sentence fixation frequency, the interaction between refresh ability and background sound is significant (t=2.51, p=0.02), and the simple effect test shows that. For individuals with high refresh ability, there is a significant difference between meaningful speech conditions and silent conditions (t=5.25, p<0.001), and the number of sentence fixations under meaningful speech conditions is significantly greater than that under silent conditions. For individuals with low refresh ability, there was a significant difference between meaningful speech conditions and silent conditions (t=13.33, p<0.001), and the number of sentence fixations in the meaningful speech condition was significantly greater than that in the silent condition. In terms of mean fixation time, the interaction between refresh ability and meaningful background sounds was not significant (t=0.17, p=0.87), and the interaction with meaningless background sounds was also not significant (t=0.10, p=0.92). In terms of regression count, the interaction between refresh ability and background sound was significant (t=2.35, p=0.02), and the simple effect test was obtained. For individuals with high refresh ability, there was a significant difference between the meaningful speech condition and the silent condition (t=6.27, P<0.001), and the regression count in the meaningful speech condition was significantly greater than in the silent condition. For individuals with low refresh ability, There was also a significant difference between the meaningful speech condition and the silent condition (t=14.17, p<0.001), and the regression count condition of meaningful speech was significantly greater than that of the silent condition. However, the interaction between refresh ability and meaningless background tone condition was not significant on sentence reading time, sentence fixation time, mean fixation time, and regression count.

Table 1: The average and standard error of various eye movement indicators in the overall analysis

Metric	Low			Tall		
	Noiseless	Meaningless voice	Meaningful voice	Noiseless	Meaningless voice	Meaningful voice
Sentence reading time (ms)	13558(275.52)	13740(271.62)	16980(305.84)	6681(126.63)	7323(139.03)	7801(135.44)
Number of sentence fixations	44(0.86)	45(0.87)	54(0.93)	24(0.43)	26(0.45)	27(0.45)
Mean fixation time (ms)	266(1.53)	266(1.47)	270(1.47)	244(1.49)	245(1.57)	249(1.57)
Regression count	12(0.35)	13(0.38)	17(0.41)	7(0.17)	8(0.18)	9(0.2)

Table 2: Analysis results of linear mixed model on sentence indicators

Variable	Sentence reading time (ms)				Number of sentence fixations			
	β	SE	t	p	β	SE	t	p
Nodal increment	11051.16	526.84	20.98	<0.001	36.60	1.73	21.21	<0.001
Meaningless speech-silent	423.64	312.38	1.36	0.18	1.28	0.99	1.29	0.20
Meaningful speech-silent	2301.79	407.97	5.64	<0.001	6.79	1.27	5.36	<0.001
renovate	7613.70	1023.76	7.44	<0.001	22.70	3.37	6.73	<0.001
(Senseless speech-silent) refresh	-506.30	628.03	-0.81	0.42	-1.74	1.99	-0.88	0.39
(Meaning speech-silent) refresh	2200.31	800.92	2.75	0.008	6.26	2.49	2.51	0.02
Variable	Average fixation duration (ms)				Regression count			
	β	SE	t	p	β	SE	t	p
Nodal increment	256.82	4.32	59.40	<0.001	11.04	0.74	14.83	<0.001
Meaningless speech-silent	0.63	1.39	0.45	0.65	0.86	0.41	2.09	0.04
Meaningful speech-silent	5.08	1.92	2.65	0.010	3.17	0.58	5.50	<0.001
Renovate	21.28	8.58	2.48	0.02	6.79	1.47	4.63	<0.001
(Senseless speech-silent) Refresh	0.26	2.73	0.10	0.92	-0.39	0.82	-0.48	0.63
(Meaning speech-silent) refresh	0.63	3.81	0.17	0.87	2.64	1.13	2.35	0.02

3.2 Local Analysis

The experimental results showed that there was no significant interaction between refresh ability and background sound in terms of first fixation time and gaze time. On regression-path duration, the interaction between refresh ability and background sound was significant (t=2.30, p=0.03), and the simple effect tests show that. For individuals with high refresh ability, there was a significant difference between the meaningful speech condition and the silent condition (t=5.64, p<0.001), and the regression-path duration condition of meaningful speech was significantly greater than that of the silent condition. For individuals with a low refresh power, there were also significant differences between the meaningful speech and silent conditions (t=10.82, p<0.001), Regression-path duration in the meaningful speech condition was significantly greater than that in the silent condition. In terms of total fixation time, the interaction between refresh ability and background tone was significant (t=3.11, p=0.003), and the simple effect test was obtained. For individuals with high refresh ability, there was a significant difference between the meaningful speech condition and the silent condition (t=10.07, p<0.001), and the total fixation time in the meaningful speech condition was significantly greater than that in the silent condition. For individuals with low refresh ability, there was also a significant difference between the meaningful speech condition and the silent condition (t=18.90, p<0.001), and the total fixation time in the meaningful speech condition was significantly greater than that in the silent condition. The interaction between refresh ability and nonsense background tone on the regression path time (t=-0.24, p=0.81) and total fixation time (t=-0.43, p=0.67) was not significant.

Table 3: The average and standard error of various eye movement indicators in the local analysis

Metric	Low			Tall		
	noiseless	Meaningless voice	Meaningful voice	noiseless	Meaningless voice	Meaningful voice
First fixation time (ms)	260(1.53)	264(1.46)	266(1.66)	245(1.45)	243(1.57)	245(1.58)
Gaze time (ms)	323(2.6)	324(2.47)	331(2.98)	276(2.05)	273(2.22)	269(2.13)
Regression-path duration (ms)	913(18.7)	910(19.49)	1257(26.77)	589(9.65)	665(11.68)	695(12.75)
Total fixation time (ms)	728(6.35)	743(6.57)	892(7.9)	428(3.7)	452(3.93)	472(4.07)

Table 4: Analysis results of linear mixed model on target words

Variable	Time of first fixation (ms)				Gaze time (ms)			
	β	SE	t	p	β	SE	t	p
Nodal increment	251.98	4.68	53.79	<0.001	293.84	7.95	36.98	<0.001
Meaningless speech-silent	-0.59	2.12	-0.28	0.78	-3.18	4.51	-0.71	0.48
Meaningful speech-silent	1.39	2.91	0.48	0.64	0.98	5.68	0.17	0.86
Renovate	18.99	9.30	2.04	0.05	53.32	15.70	3.40	0.001
(Senseless speech-silent) refresh	4.25	4.26	1.00	0.32	-2.16	8.80	-0.25	0.81
(Meaning speech-silent) refresh	3.46	5.84	0.59	0.56	6.01	11.18	0.54	0.59
Variable	Regression-path duration (ms)				Total fixation time (ms)			
	β	SE	t	p	β	SE	t	p
Nodal increment	894.45	42.67	20.96	<0.001	609.18	23.81	25.59	<0.001
Meaningless speech-silent	43.12	31.13	1.39	0.17	21.32	15.04	1.42	0.16
Meaningful speech-silent	222.43	39.44	5.64	<0.001	110.26	19.31	5.71	<0.001
renovate	410.07	60.64	6.76	<0.001	345.60	45.71	7.56	<0.001
(Senseless speech-silent) refresh	-15.21	63.17	-0.24	0.81	-12.77	29.95	-0.43	0.67
(Meaning speech-silent) refresh	180.25	78.31	2.30	0.03	118.00	37.90	3.11	0.003

4. Discussion

In this study, the role of the refresh function in sentence reading with sound interference was discussed, and the following experimental results were obtained: (1) there is a significant interaction between the refresh function and background sound at the time of sentence reading, the number of sentence fixations and regression count. For individuals with a high refresh function, the meaningful background tone condition in the sentence reading time, sentence gaze times, and sentence gaze times of the background tone condition is greater than the silent condition; for the individuals with a low refresh function, the sentence reading time and sentence gaze times under the meaningful background sound are also significantly greater than the silent condition. The results show that the refresh function plays an obvious role in sentence reading with sound interference. (2) from the target words in the local analysis, the interaction between background sound and refresh ability was not significant in the first gaze time and gaze time, while the interaction between refresh ability and background sound was significant in regression-path duration and total gaze time.

4.1 The Role of Refresh in Reading with Sound Interference

There is a significant interaction between the refresh function and the background sound at the time of sentence reading, sentence fixations, and regression count. For individuals with a high refresh function, the meaningful background tone condition in the sentence reading time, sentence gaze times, and regression count of the background tone condition is greater than the silent condition; for the individuals with a low refresh function, the sentence reading time and sentence gaze times under the meaningful background sound are also significantly greater than the silent condition. The results show that the refresh function has an obvious effect in sentence reading with sound interference, that is, the refresh function significantly modulates the irrelevant speech effect, compared with the individuals with high refresh function, the meaningful background sound is more interference the individuals with low refresh function.

4.2 The Role of Refresh in the Reading Process with Sound Interference

From the target words in the local analysis, the background tone interaction with refresh power is not significant in first gaze time and gaze time, and background tone interaction in regression-path duration and total gaze time. The regression-path duration and the total gaze time are significantly greater than the silent condition, while the time and the total gaze time are also significantly greater than the silent condition. The results present that at the lexical level, the refresh function has an obvious effect on reading with sound interference, and this regulatory effect exists in the late stage of word processing and the later stage of semantic integration.

4.3 Interpretation Based on Attentional Capture Theory

This study finds that the interference of irrelevant speech and individuals with high refresh ability are less disturbed by irrelevant speech than those with low refresh ability. This finding suggests that there is an individual variability in irrelevant speech effect in reading, inconsistent with the theoretical expectation of attention capture.

Attention-capture theory suggests that when background sounds distract attention from the primary task and shift attention resources from the primary task to irrelevant sound stimuli. It reduces the cognitive processing efficiency of the current task (Cowan, 1995; Hughes, 2014; Meng et al., 2020). However, in this process, individuals with high refresh ability may strengthen the control of working memory content by increasing top-down cognitive input. Therefore, the interference has certain controllability, showing that sound has little impact on or even no impact on their reading processing efficiency. However, individuals with low refresh ability have more negative effects on reading processing due to insufficient top-down cognitive control ability, which shows individual differences in irrelevant speech effects in reading.

From the perspective of the interference type, the individuals in such interference can have a certain controllability through top-down cognitive control. In the past, researchers believed that individuals with different working memory capacities had different sensitivity to sound interference. The effects of sound by capturing attention were subject to top-down cognitive control, and individuals with low working memory capacity were more sensitive to sound interference (Sörqvist, Halin & Hygge, 2010). Through the sentence and chapter reading experiment, this study more systematically explains that refresh can regulate the interference of irrelevant words to reading so that the interference presents individual differences.

4.4 Summary and Reflection of the Research

This study for the first time systematically discusses the role of individual refresh ability in irrelevant speech effect. It is found that the refreshing ability to read irrelevant speech interference can produce adjustment, and the strong ability to refresh individual refresh ability is weaker than the negative influence of irrelevant speech interference results strengthened the refresh and (interference) reading. This work further discusses the internal mechanism of the irrelevant speech effect. It also further enriches the perception of individual differences, which has more important significance.

It is worth mentioning that although the research results regulate the irrelevant speech effect, they can only infer the relationship, not the causality and the relationship, which limits the interpretability, generalization, and intervenability of the research results to some extent. Therefore, a future research direction is to try to refresh the ability of training (Zhao et al., 2018) by improving the control ability of refresh individuals, and further explore the performance of individuals in reading with background sound interference, to investigate the effect of refresh on reading with sound interference and try to make inferences of causality. In addition, in the future, event-related potentials (ERPs) or functional magnetic resonance imaging (fMRI) can be used to explore the effect of refresh on irrelevant speech effects, and the mechanism of refresh on irrelevant speech effects can be clarified by the brain mechanism.

5. Conclusion

Under the present experimental conditions, the following conclusions are drawn:

(1) Refresh significantly modulated the irrelevant verbal effect in reading, and meaningful background sounds have a greater negative impact on reading in individuals with low refresh ability, supporting the theory of attention capture.

(2) The modulation of irrelevant speech effect in the reading process exists in the late lexical processing and semantic integration stages.

Acknowledgment

This paper is an output of the Humanity and Social Science Fund of Ministry of Education of China (20YJC190024)

References

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, 59, 390-412.

Bates, D., Maechler, M., & Bolker, B. (2011). *LME4: Linear mixed-effects models using* S4 classes. R Package Version 0.999375-39. Retrieved from http://CRAN.R-project.org/package=lme4

Carretti, B., Cornoldi, C., De Beni, R., & Romanó, M. (2005). Updating in working memory: A comparison of poor and good comprehenders. *Journal of Experimental Child Psychology*, 91, 45-66.

Colle, H. A., & Welsh, A. (1976). Acoustic masking in primary memory. *Journal of Verbal Learning and Verbal Behavior*, 15(1), 17-31.

Cowan, N. (1995). Attention and memory: An integrated framework. *New York: Oxford University Press*.

Davelaar, E. J., Goshen-Gottstein, Y., Ashkenazi, A., Haarmann, H. J., & Usher, M. (2005). *The demise of short- term memory revisited: empirical and computational investigations of recency effects*. *Psychological Review*, 112, 3-42.

García-Madruga, J. A., Vila, J. O., Gómez-Veiga, I., Duque, G., & Elosúa, M. R. (2014). Executive processes, reading comprehension and academic achievement in 3th grade primary students. *Learning and individual differences*, 35, 41-48.

Hughes, R. W. (2014). Auditory distraction: A duplex-mechanism account. *PsyCh Journal,* 3, 30-41.

Jones, D., Madden, C., Miles, C. (1992). Privileged access by irrelevant speech to short-term memory: the role of changing state. Quarterly Journal of Experimental Psychology. *A, Human Experimental Psychology*, 44, 645-669.

Meng, Z., Lan, Z., Yan, G., Marsh, J. E., Liversedge, S. P. (2020). Task Demands Modulate the Effects of Speech on Text Processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 46(10), 1892-1905.

Palladino, P., Cornoldi, C., De Beni, R., & Pazzaglia, F. (2001). Working memory and updating processes in reading comprehension. *Memory and Cognition*, 29, 344-354.

R Development Core Team. (2016). R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.R-project.org/

Salamé, P., & Baddeley, A. (1982). Disruption of short-term memory by unattended speech: Implications for the structure of working memory. *Journal of Verbal Learning and Verbal Behavior*, 21, 150-164

Schmiedek, F., Hildebrandt, A., Lövdén, M., Wilhelm, O., & Lindenberger, U. (2009). Complex span versus updating tasks of working memory: the gap is not that deep. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 35(4), 1089-1096.

Sörqvist, P., Halin, N., & Hygge, S. (2010). Individual differences in susceptibility to the effects of speech on reading comprehension. *Applied Cognitive Psychology*, 24, 67-76.

Sörqvist, P., Ljungberg, J. K., & Ljung, R. (2010). A subprocess view of working memory capacity: Evidence from effects of speech on prose memory. *Memory*, 18, 310-326.

Sörqvist, P. (2010). High working memory capacity attenuates the deviation effect but not the changing-state effect: Further support for the duplex-mechanism account of auditory distraction. *Memory & Cognition*, 38, 651-658.

Vasilev, M. R., Parmentier, F. B. R., Angele, B., & Kirkby, J. A. (2019). Distraction by deviant sounds during reading: an eye-movement study. *Quarterly Journal of Experimental Psychology.* 72(7), 1863-1875.

Yan, G., Meng, Z., Liu, N., He, L., & Paterson, K. B. (2018). Effects of irrelevant background speech on eye movements during reading. *The Quarterly Journal of Experimental Psychology*. 71(6), 1-6.

Zhao, X., Chen, L., & Maes, J. H. R. (2018). Training and transfer effects of response inhibition training in children and adults. *Developmental Science*, 21(1), e12511.