Latency of immediately repeated real words and pseudowords in Japanese and English with Japanese adults

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Abstract

This paper reports on an immediate word repetition experiment using a voice key to measure verbal response latency. Four types of words were auditorially presented: real words and pseudowords in both Japanese and English. Five adults, all native Japanese speakers, heard each stimulus word and repeated it as accurately as possible immediately following the end of the stimulus. Overall, longer response latency and more production errors were found for English words and pseudowords. English pseudowords produced longer latencies than did English real words. In contrast, latencies for Japanese real words and pseudowords were similar. These findings suggest that foreign words, especially foreign pseudowords, require greater cognitive-linguistic processing than native words for second-language learners.

Key words : immediate repetition, pseudoword, second-language learner, response latency, voice key

Introduction

A well established finding in behavioral research is that complex, novel, or unusual words take longer to produce, produce more errors and cause greater delay in response in a number of experimental paradigms. [1-6] Phonotactic studies indicate that the relative speed of word recognition is related to phonotactic probability.[7, 8] This body of research suggests that how rapidly we process a word we hear or read has more to do with our familiarity with the sound combinations of the word than with our familiarity with the word's meaning.

The measure of the time between hearing and vocally repeating a word is referred to as "response latency." In the current experiment we used a voice-activated microphone (voice key) to measure the extent of delay of a participant's verbal response after hearing a word or word-like stimuli (pseudowords).

A goal of this study was to explore the use of voice key (SV-1 voice key with Super-Lab experimental software, Cedrus Corporation, San Pedro, CA, USA) as a research tool with the immediate repetition paradigm. A voice key is a microphone, which is connected to a device that detects a preset sound level. When a participant responds vocally, the voice triggers the timing of the onset of the response. There has been some concern over using voice keys in research because possible signal delays between the device and the experiment computer could make the data unreliable. The Super-Lab's voice key (SV-1) attempts to resolve this problem by using a small microprocessor unit in the detection device. Having a reliable voice key is very desirable for research using verbal response latency, because the alternative is a fairly laborious process of measuring with a spectrogram.

With use of the voice key, we can measure response latency in immediate repetition paradigm. It is probable that processing foreign words and/or pseudowords (a

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sequence of sounds) is difficult for second- language learners, and response latency can be a index of cognitive-linguistic processing load. Therefore, the main purpose of the present study is to examine if there is any difference in response latencies of adults for real words and pseudowords in their own language (Japanese) and second language (English).

II. Method

1. Participants

Seven adult volunteers, ages 22-70 (mean = 47.3), participated in the study. All participants were native Japanese speakers. Volunteers received no compensation, nor any course credit for participation. Participants were fully informed on the purpose of the experiment and informed that they could stop participating at any time.

One participant's data were excluded from analysis because of excessive errors (over 50%) and timing problems (i.e., very short latencies due to false starts) during the recording. Another participant was very tense and distracted during the experiment, which appeared to have influenced longer response latencies. Therefore, we report findings only on the remaining five participants.

2. Stimuli

In the present experiment we have used matched pairs of short two syllable words in Japanese, composed of consonant-vowel-consonant-vowel structure (CVCV), and one syllable words in English, composed of consonant-vowel-consonant structure (CVC), with a few two syllable English stimuli, with a consonant-vowel-consonant-vowel structure (CVCV). Simple high frequency words in Japanese are largely CVCV in structure, but simple high frequency words in English tend to have a CVC structure. For this reason, we created a pool of stimuli which had matched onset (CV) for real words and for pseudowords in both language conditions.

A total of 80 stimuli were created for this experiment. 40 stimuli were simple, commonly used 2 syllable Japanese words. Another set of stimuli were Japanese pseudowords that were matched with the same first syllable of the Japanese real word stimuli. English real word stimuli and pseudoword stimuli were created using the same method as used with Japanese stimuli. Voices on all stimuli were male and native speakers of the language.

3. Procedure

All stimuli were presented and verbal responses were recorded with a laptop computer, connected with voice key (SV-1, Cedrus Corp) and experiment control software (SuperLab 4, Cedrus Corp).

Stimuli were presented from a computer with loud speakers, which were directed at the participant. The voice key microphone was set at a distance of approximately 10 cm from the mouth. A secondary recording of the session was made using a mini-disc recorder (MD-DR77-Sharp, Tokyo), which recorded both the stimuli and the responses. Stimuli were presented every 2600 milliseconds.

Each participant read a brief explanation of the experiment and was then given a practice round of 8 samples similar to the stimuli used in the experiment. Following the practice round, all of the 80 stimuli were randomly presented in a single presentation. Participants were instructed to repeat each word as accurately as possible and to respond immediately after hearing the end of each stimulus word.

3. Analysis

Non responses and responses with recording errors were rejected. Production errors were treated in three ways: (1) word-pseudoword pairs were rejected; (2) only the erred item was removed; (3) no errors removed. Due to the matching of stimuli onset syllables, a non-response or major error on either of the pair led to rejection of the matched stimuli as well.

Responses were also analyzed in two other conditions: with only word production errors and with no rejection of responses. These three methods of analyzing the data could then be compared.

Latency was measured as the difference between stimuli onset and response onset times. The software output file was transferred to an Excel spreadsheet for data analysis.

III. Results

As can be seen in Table 1, in both language conditions the pseudowords had greater latency than real words.

The latencies in the upper part of the table are for responses remaining after all pairs of stimuli having an error have been removed.

Table 1. Mean, standard deviation (SD), and range (minimum -maximum) of response latency (in ms) in four stimulus types for three methods of treating production errors

Method: Rejected pairs removed			
En Real	En Pword	Jp Real	Jp Pword
1257 (212)	1381(288)	1371(340)	1404(401)
473-2262	286-1646	800-1908	753-3221
Method: Only errors removed			
En Real	En Pword	Jp Real	Jp Pword
1233 (217)	1389 (273)	1353 (319)	1419 (424)
473-2145	286-2262	800-1908	753-3221
Method: No errors removed			
En Real	En Pword	Jp Real	Jp Pword
1293 (190)	1380 (283)	1375 (333)	1408 (404)
473-2262	286-2262	800-1908	753-3221

"En" refers to English stimuli; "Jp" refers to Japanese stimuli; "Real" refers to real words and "Pword" refers to pseudowords.

The middle section of Table 1 shows the averaged scores for all responses where only items with production errors were removed and the matching item retained. The bottom section of Table 1 shows the combined averages of all participants without removing those responses that had production errors.

There seems to be only a slight difference between methods.

Table 2 shows the individual mean response times for each category of stimuli using the method of removing pairs, which we presume to be the most restrictive of the three methods. Note that each participant is ranked by second language skill level, as was determined during an interview prior to the experiment. Thus the participant with the highest level of second language skill was designated as P1 and the lowest as P5.

Table 2. Mean, standard deviation (SD), range (minimum - maximum) of response latency (ms) for each participant by number(Pn)

P1			
En Real	991(154)	Jp Real	870 (40)
	908-1504		800-932
En Pword	973 (122)	Jp Pword	885 (103)
	847-1338		573-1126
P2			
En Real	1354 (256)	Jp Real	1237(110)
	1162-2262		1100-1424
En Pword	1575 (287)	Jp Pword	1203 (137)
	1173-2001		1020-1539
P3			
En Real	1509 (191)	Jp Real	1400 (105)
	1248-1887		1168-1560
En Pword	1646 (163)	Jp Pword	1402 (132)
	1452-2030		1230-1763
P4			
En Real	1086 (340)	Jp Real	1610 (179)
	632-1778		947-1752
En Pword	1186 (568)	Jp Pword	1576 (179)
	286-1768		913-1730
P5			
En Real	1344 (527)	Jp Real	1740 (382)
	473-2145		840-1908
En Pword	1526 (364)	Jp Pword	1956 (382)
	928-2262		1667-3221

"En" refers to English stimuli; "Jp" refers to Japanese stimuli; "Real" refers to real words and "Pword" refers to pseudowords. Note that participants were ranked in order of their English skill; e.g. P1, P2, etc

As can be seen in Table 2, all of the participants had greater latency for L2 pseudowords than for L2 real words. However, there was generally less latency for Japanese (L1) pseudowords than for real words. For participants P1, P2, and P3, the repetition latency was greater for both types of English (L2) stimuli and for both types of Japanese stimuli. These three participants had high levels of L2 skill and some exposure to English language on a regular basis. In contrast, participants P4 and P5 had very low English skills and little or no exposure to English language in adult life.

Table 3. Number of Production errors by each participant (Pn) for each stimuli type

P1	errors		errors
En Real	0	Jp Real	0
En Pword	0	Jp Pword	0
P2			
En Real	2	Jp Real	0
En Pword	2	Jp Pword	0
P3			
En Real	4	Jp Real	0
En Pword	6	Jp Pword	0
P4			
En Real	1	Jp Real	0
En Pword	1	Jp Pword	0
P5			
En Real	6	Jp Real	2
En Pword	5	Jp Pword	5

"En" refers to English stimuli; "Jp" refers to Japanese stimuli; "Real" refers to real words and "Pword" refers to pseudowords.
Note that participants were ranked in order of their English skill; e.g. P1, P2, etc

There are three anomalous results. P1 was the only participant to have less average latency for English (L2) pseudowords than for English real words. P2 and P4 had slightly less latency for Japanese pseudowords than for real words in Japanese. P4 also had greater overall latency for Japanese stimuli than for English stimuli, contrary to our expectations.

IV. Discussion

We found evidence of response time facilitation for native language stimuli over foreign language stimuli. Also, we found greater latency from pseudowords than for real words in the L2 condition, with one exception-P1. P1 is a highly fluent speaker of English and familiar with word repetition tasks, which may explain the slightly faster times for pseudowords over real words. Surprisingly, Japanese pseudowords did not have the expected effect: latencies were very similar between stimuli, which may suggest that these stimuli did not present much of a challenge to these participants. Looking at error rates, we find that, indeed, there were very few errors with the native language for either real words or for pseudowords. However, there was one notable exception: P5, who was our oldest participant, had a comparatively high number of errors on Japanese pseudowords and surprisingly longer latencies than younger participants. Therefore, a future area of investigation may be immediate repetition with the aged.

There is one additional finding which deserves notice. In this experiment all stimuli were presented in a random order. On closer inspection it was noted that whenever there was stimulus change from native language to L2 the response latency increased over the levels of latency following L2 words or pseudowords. To investigate further we summarized the pattern of changes in the P1 data (table 4), who in our opinion would be least affected by changes from L1 to L2.

In Table 4 note that the negative sign indicates increased latency, because these means were subtractions of a reaction time from the previous reaction time (difference measures).

Table 4. Changes in response latency (ms) due to previous item type for P1

change	J to J	change	J to E
RJ to PJ	13	RJ to RE	-89
PJ to RJ	-10	RJ to NE	-70
		PJ to RE	-90
		PJ to NE	-121
change	E to E	change	E to J
RE to PE	49	RE to RJ	17
PE to RE	15	RE to NJ	108
		PE to RJ	90
		PE to NJ	128

*note:
negative sign indicates greater change;
RJ=Real word Japanese; PJ = pseudoword Japanese; RE=real word English; PE=pseudoword English

Clearly, there seems to be a dramatic increase in latency when an English stimulus comes after a Japanese stimulus. Could the sequencing of words between native language and foreign language have caused the anomalous results for P1 with English stimuli, and for P2 and P4 with Japanese stimuli? In a future experiment we hope to compare blocked presentation of these same stimuli with the randomized presentation to determine if the sequencing may impact the data.

V. Conclusion

Although we used stimuli that due to size and simplicity must be minimally challenging to the phonological systems of our adult participants, we nevertheless found a generalized increase in latencies for nonwords over real words in the L2 condition. This finding we interpret as evidence of increased cognitive activity for L2 words, especially for L2 pseudowords. Additionally, we found the functioning of the voice key to be a valuable tool for research in latency. Our other goal of exploring for differences in response latencies between ages of participants was realized with the finding of increased latency and errors with our older participant. Larger and more complex future studies now seem justified in these areas.

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日本語と英語の有意味・無意味語の即時復唱での反応潜時

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要　約

本稿では、即時復唱実験でのボイス・キー使用による音声言語反応潜時測定を報告する。この実験では、４種類の刺激を用いた：日本語と英語の有意味語と無意味語である。日本語を母語とする成人5名に個々の刺激語を聞かせ、なるべく正確に、すばやく復唱させた。全体的に、英語の有意味・無意味語で反応潜時が長く、発語の誤りが多くみられた。英語では、無意味語が有意味語よりも長い反応潜時となっていた。一方、日本語では、有意味語と無意味語での反応潜時はほぼ同じであった。以上の結果より、第二言語学習者にとって、外国語の語は、特に無意味語で、母国語の語と比べて、より多くの認知－言語処理を要求することを示している。

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