



## Repeated Phoneme Effect in Japanese Speech Errors

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### Abstract

Analyses of errors in the natural speech of Dutch, German, and English have shown that involuntary rearrangements of phonemes (e.g., left hemisphere → *heft lemisphere*) are more likely to occur when the two words involved in the error have the same phoneme before or after the phoneme on which the error occurred (e.g., /E/ in *left hemisphere*) [1, 2]. A study by Dell (1984) has revealed that phoneme repetition could also contribute to experimentally induced speech errors in English [3]. The present study explored the effect of repeated phonemes in Japanese speech errors by means of two error-inducing experiments. Analyses of subjects' errors showed that a sequence of syllables that share the same phoneme was more error-prone than one with a variety of phonemes, suggesting that phoneme repetition could contribute to Japanese speech errors. These results are consistent with the view that the repeated phoneme effect is common to all speakers regardless of language.

### 1. Introduction

Phoneme repetition has been recognized as one of factors that contribute to phonological speech errors, where one or more words are mispronounced. To take but one example, /ʌ/ and /ŋ/ in 'left hemisphere' will exchange and produce an error such as '*heft lemisphere*', more often than /p/ and /ŋ/ in 'right hemisphere' will. In this case, the same phoneme /E/ following /l/ and /h/ induces such an error. This finding, sometimes called the "repeated phoneme effect", is important because it reveals something about the mechanisms underlying speech production.

The repeated phoneme effect operates both forwards and backwards in the serial order of speech. An analysis of German and English spontaneous spoonerisms has shown that repeated phonemes precede the phonemes on which the errors occurred as frequently as they followed them [1].

Not only repeated vowels but also repeated coda consonants lead to the difficulty in speech. Using a large collection of about 4,000 English errors, Dell [3] has shown that the rate of errors on word-initial consonants increases

when the two words involved in the error have the same word-final consonant. He replicated this finding experimentally with the SLIPS technique, which was originally developed by Baars and Motley [4]. It elicits initial consonant exchanges (e.g., *beal dall* instead of deal ball), anticipations (e.g., *beal ball* instead of deal ball) and perseverations (e.g., *deal dall* instead of deal ball) using phonological priming. Subjects see several interference word pairs before a critical word pair, one at a time, with the instruction to prepare to say each pair as they see it. Eventually, they see a series of question marks that signals the subjects to speak. They must say aloud the last word pair that they saw, i.e. a critical word pair. The reason that speech errors are obtained is that critical stimuli (e.g., deal ball) are preceded by three to five interference stimuli (e.g., bet dart) that bias for a reversal of initial consonants. A final aspect of the procedure is that after saying each critical stimulus the subjects have to judge whether or not they said what they intended to say, and have to repeat slowly what they intended to say. This allows for errors of reading or memory to be separated from speech errors. The procedure demonstrated that the repeated /l/ in 'deal ball' is effective in increasing error rates of /d/ and /b/ just as the repeated /θ/ in 'mad back' in increasing error rates of /m/ and /b/.

What remains a question was whether the repeated phoneme effect is common to all speakers regardless of language. Previous studies on speech errors in a few Germanic languages are not sufficient to support the hypothesis that the effect of phoneme repetition is language independent, and to suggest that this phenomenon may reflect a universal aspect of mechanisms underlying speech production. Further research on speech errors in non-Germanic languages is required to test the generality of this effect.

In the present study, two error-eliciting experiments were conducted with native Japanese speakers to test the generality of the repeated phoneme effect. In both experiments, the stimuli with the repeated phonemes induced more speech errors than those with a variety of phonemes. Thus, the cross-linguistic robustness of the repeated phoneme effect was established. A point to note is that the rate of errors on syllable coda consonants increased when Japanese subjects intended to say aloud a sequence of syllables with repeated

coda consonants. This finding throws doubt on the hypothesis that repeated phonemes induce adjacent or next-to-adjacent phonemes to slip [3].

## 2. Experiment 1

The aim of this experiment was to replicate the repeated phoneme effect with Japanese speakers. Dell [3] has replicated this effect in English using the pairs of real words as stimuli; this experiment, using the sequences of syllables of Japanese.

This experiment made use of error-causing agents such as fast speech rate and time pressure to induce errors. To examine the natural effect of repeated phonemes, no phonological priming to induce phonological errors was used; thus, this error-inducing technique differs from the SLIPS technique used by Baars et al. [4] and Dell [3].

### 2.1. Materials

Ten sequences of CV (consonant-vowel) syllables, shown in Table 1, were used as stimuli. Each sequence consisted of eight CV syllables. Every syllable in a sequence either shared a vowel (ta.sa.ha.ra.na.ma.pa.ka) or did not (to.sa.hi.re.nu.mo.pi.ke). (The mark // indicates the syllable boundary.) Consonants appear in the same order in all sequences (t, s, h, r, n, m, p, and k) in both conditions. None of the stimuli items constituted a meaningful word in Japanese. Materials are created in such a way that factors such as phonemic similarity or word frequency would not affect the results [1, 2, 5, 6]. To examine the influence of repeated phonemes themselves, no interference stimulus that would serve to bias subjects was used in this experiment.

Table 1: Materials used in Experiment 1

Stimuli set	
Repeated vowel condition	Different vowels condition
ta.sa.ha.ra.na.ma.pa.ka	ta.so.fu.ri.ne.ma.pu.ki
τt.si.hi.ri.ni.mi.pi.ki	ti.se.ha.ru.no.mi.pa.ku
tu.su.fu.ru.nu.mu.pu.ku	tu.σi.he.ro.na.mu.pe.ko
te.se.he.re.ne.me.pe.ke	te.su.ho.ra.ni.me.po.ka
to.so.ho.ro.no.mo.po.ko	to.sa.hi.re.nu.mo.pi.ke

### 2.2. Subjects and procedure

Ten students from Sophia University participated in the experiment. All were native speakers of Japanese.

Subjects were tested individually in a soundproof studio. They were seated in front of a portable PC, Toshiba Dynabook Satellite 2710 P50/4CA, which ran Frame Editor for Windows Version 1.0 that controlled the progress of the experiment.

Stimuli were written in *kana*, i.e., Japanese syllabary characters, and visually presented on the screen. The subjects received each sequence of syllables one at a time. The whole stimuli set was presented twice, each time in a pseudo-random order. Four practice sequences preceded the set. They had to memorize each sequence in 8 seconds and repeat it as quickly and as many times as possible under time pressure. They were instructed to do so, because speech rate and time pressure are assumed to be error-causing factors.

Each trial had the following structure: Subjects saw a sequence on the screen following a signal sound. They had 8 seconds to read the sequence silently and to prepare to say it aloud. The sequence disappeared and then another signal sound was played. They were given 6 seconds to repeatedly recite the sequence as quickly as possible. Six seconds later, the screen presented the command with another signal: “ONCE MORE, SLOWLY” and subjects were to slowly recall and recite the sequence that they intended to say. Four seconds after this command, the screen presented the question: “DID YOU MEMORIZE CORRECTLY?” to which subjects were supposed to answer aloud yes or no, based on their judgment as to whether they memorized the sequence of syllables correctly.

The last additional recall task was included to identify errors that might have occurred during input, such as reading or memorizing. If, when presented /ta.sa.ha.ra.na.ma.pa.ka/, a subject said [ta.ha.sa.ra.na.ma.pa.ka], then recalled [ta.ha.sa.ra.na.ma.pa.ka] as her intended utterance and then said yes to the question: “Did you memorize correctly?”, the error was more likely a slip of the eye than a slip of the tongue. Such an error should not be counted as a speech error.

### 2.3. Results and discussion

In the repeated vowel condition, 56 out of 6320 segments uttered by 10 subjects were counted as errors. On the other hand, 43 out of 7745 segments were counted as errors in the different vowels condition. Errors were counted in the following way. In substitution errors (e.g., [ne] for /te/), only one segment was counted in. Likewise, in deletion (e.g., [pka] for /pa.ka/) and addition errors (e.g., [muo] for /mo/), only one segment was counted in. However, in exchange errors (e.g., [mu.nu] for /nu.mu/), two segments were counted in. Any stuttering such as [s, s, sa] was not counted in. As stated above, the errors that might have occurred during input, such as reading or memorizing were excluded. Incomplete sequences, which were left unfinished by subjects due to the time limit, were also excluded from analysis.

Error rates in both conditions were computed for each subject. The results are shown in Figure 1. Overall, stimuli with repeated vowel elicited more errors than those with different vowels ( $p < .05$ , by a sign test across subjects). This

experiment provided the first clear evidence that the repeated phoneme effect is found in Japanese speech errors.

There is another thing to note. The repeated vowels in this experiment increased the error rate of syllable onset consonants. This finding seems consistent with a study by Dell [3].

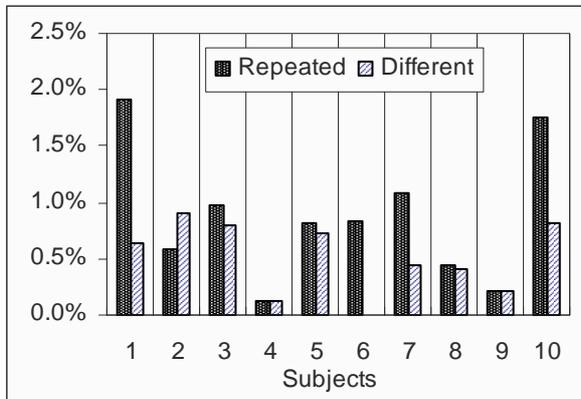


Figure 1: Error rate of each subject in repeated vowel and different vowels conditions

### 3. Experiment 2

The aim of this experiment was to examine the effect of repeated coda consonants. In this experiment, CVX syllables (where X stands for either a vowel or a consonant) of Japanese were used as stimuli.

#### 3.1. Materials

Stimuli for this experiment were created with caution. There were at least two reasons. One was that the Japanese language allows only four phonemes to close the syllable. They are /N/, /Q/, /R/, and /J/ (where /N/ is a nasal, /Q/ is the first half of a geminate, /R/ is the latter half of a long vowel, and /J/ is the latter half of a diphthong such as [ai]) [7, 8]. Another reason was that the phoneme /Q/ is not allowed in the word final syllable.

Ten sequences of syllables shown in Table 2 were used as stimuli. Each sequence consisted of five CVX syllables. A sequence either contained repeated /N/ and /Q/ (e.g., taN.soQ.fuN.puQ.kiN), or did not (e.g., taR.soQ.fuN.puJ.kiR). Onset consonants appeared in the same order in all sequences (t, s, h, p and k). None of the stimuli items constituted a meaningful word in Japanese.

Table 2: Materials used in Experiment 2

Stimuli set	
Repeated coda condition	Different codas condition

taN.soQ.fuN puQ.kiN	taR.soQ.fuN.puJ.kiR
τtN.seQ.haN paQ.kuN	ttR.seQ.haN.paJ.kuR
tuN.sɪQ.heN.peQ.koN	tuR.σiQ.heN.peJ.koR
teN.suQ.hoN.poQ.kaN	teR.suQ.hoN.poJ.kaN
toN.saQ.hiN.piQ.keN	toR.saQ.hiN.PiJ.keR

#### 3.2. Participants and procedure

The subjects and procedure were as in Experiment 1. A short break separated the two experiments.

#### 3.3. Results and discussion

The procedure resulted in 210 segmental errors in total. In the repeated consonant condition, 144 out of 6753 segments uttered by 10 subjects were counted as errors. On the other hand, 66 out of 8130 segments were counted as errors in the different codas condition.

As before, error rate was computed for each subject. The results are shown in Figure 2. Overall, repeated phoneme stimuli elicited more errors than their control stimuli did ( $p < .001$ , by a sign test across subjects). From these results, it appears that repeated coda consonants are contributory causes of speech errors for native Japanese speakers, just as repeated vowels are.

There is another important point to note. Contrary to expectation, the procedure almost always induced coda consonants to slip (e.g., a reversal of /Q/ and /N/ in /teN.suQ.hoN.poQ.kaN/ resulted in [ten.sun.hop.pok.kan]) in both conditions, and the error-rate of coda consonants increased in the repeated coda condition. This finding is not consistent with Dell's (1984) conclusion that repeated phonemes induce adjacent or next-to-adjacent phonemes to slip [3]. The reason for the disagreement is not clear. It may be attributed to factors such as the task differences [9] and structural differences of languages. As stated above, this experiment did not use interference stimuli that would serve to bias for the reversals of onset consonants. It may be the case that repeated vowels and codas in Dell's experiments just enhanced the capacity of interference stimuli to induce errors on onset consonants: repeated phonemes themselves did not induce onsets to slip. On the other hand, repeated codas in this experiment might have enhanced the capacity of some unknown factor to induce errors on coda consonants. It might be some aspect of linguistic structure of Japanese that induced such errors. It calls for further experimental research on Japanese speech error.

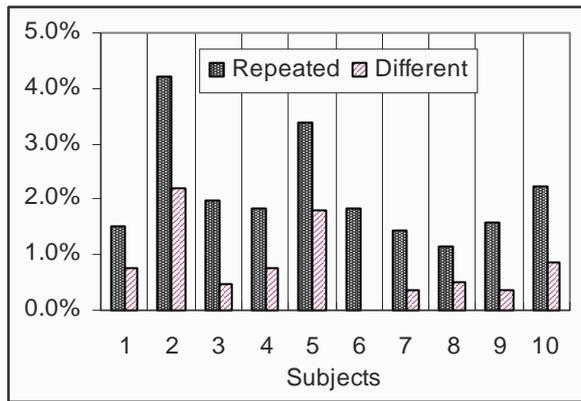


Figure 2: Error rate of each subject in repeated coda and different codas conditions

#### 4. Conclusion

This study revealed that the repeated phoneme effect is found in Japanese speech errors. It was shown that not only repeated vowels but also repeated coda consonants lead to the difficulty in speech. This is the first demonstration that phoneme repetition plays the same role in Japanese speech errors as in Germanic languages.

It was found that repeated coda consonants could increase the error-rate of coda consonants. This finding is not consistent with a view that repeated phonemes induce nearby phonemes to slip. A satisfactory explanation for this finding was not obtained in this study. Further studies are required to identify the cause for this inconsistency.

#### 5. References

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