Frequency Inheritance in the Production of Korean Homophones*

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ABSTRACT

The present study investigates the so-called frequency inheritance effect in word production. According to some earlier studies (e.g. Jescheniak & Levelt, 1994), retrieval of a low-frequency homophone benefits from its high-frequency homophone twin, and more specifically word-retrieval RT is determined by the frequency of the phonological form of the word (sum of homophone frequencies) rather than the frequency of the specific word. This result, however, has been challenged by later studies (e.g. Caramazza et al., 2001) and one possible resolution is that languages differ in the extent to which the inheritance effect occurs. Two experiments are reported to test whether the frequency inheritance effect depends on the target language, namely, if a language such as Korean with relatively many homophones tend not to show frequency inheritance, which is compared with the language with fewer homophones such as Dutch and German (Jescheniak & Levelt, 1994; Jescheniak et al., 2003). Experiment 1 was picture naming, and Experiment 2 used an English-to-Korean translation task. In both experiments, the homophones were actually slower than the low-frequency controls, suggesting that there was no evidence for the inheritance effect. These results imply that the issue of whether specific word or homophone frequency determines production can be properly assessed by taking into account the language-specific nature of the lexicon such as the percentage of the homophone words in that language.

Keywords: frequency inheritance effect, Korean, homophones

1. Introduction

There are two major hypotheses on how homophones are represented and accessed in speech production. Garrett (1988), Dell (1990), Levelt et al. (1991, 1999), Levelt (1999), Roelofs et al. (1998), and Jescheniak and Levelt (1994) argue that the representations of words in the mental lexicon have two stages, their syntactic representations (referred to as lemmas) and their phonological representations (referred to as lexemes), and that homophones share the lexical representations, specifically, lexemes. <Figure 1a> schematically represents this

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hypothesis. These two-stage representation of the lexicon is supported by the so-called 'frequency inheritance effect' in the production of homophones. Namely a low-frequency word with a high-frequency homophone twin is produced about as easily as control word matched in frequency to the sum frequency of the low-frequency word and its twin (Dell, 1990). For example, Dell (1990) asked the participants to produce some phrases and checked the rate of sound errors in producing the function word-content word pair of homophones (e.g. would vs. wood). It was found that frequency affected the error rate, with higher frequency words resulting in fewer errors; and that the error rate of the function words was similar to that of their homophonic content words. Jescheniak and Levelt (1994) reported similar results that when Dutch-English bilinguals were given English words and asked to produce their Dutch equivalents, mean naming latencies for the low-frequency homophonic words that have a high-frequency homophone twin were faster than those for the non-homophonic words matched to the homophones on specific-word frequency, and roughly equal to those for the nonhomophonic words matched to the homophones on homophone frequency (sum-word frequency). Jescheniak and Levelt (1994) consider these findings as evidence that homophones share a common lexeme, and the frequency effect is located at the stage of lexeme retrieval.

On the other hand, Caramazza (1997), Caramazza and Miozzo (1997; 1998), Miozzo and Caramazza (1997), and Caramazza et al. (2001) argue against the special status of homophones. They argue that both homophonic and nonhomophonic words are represented independently and there is no separate stage of lemmas, as schematically represented in <Figure 1b>. First, when they asked English participants to perform a picture-naming, they found that pictures with high-frequency names without homophones were named faster than pictures with low-frequency names without homophones and pictures with low-frequency names and high-frequency homophone twins with no significant difference between the latter two. They also failed to replicate the frequency inheritance effect when they tested English-Spanish bilinguals, using a translation task, even though the frequency difference between the high-frequency and the low-frequency words was even larger than in the original experiment by Jescheniak and Levelt (1994). These results are clearly at odds with what would have been predicted on the basis of Jescheniak and Levelt's and Dell's findings.

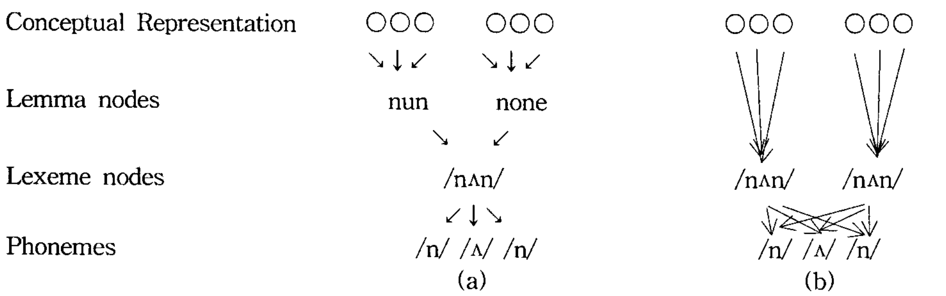

Figure 1. Schematic representations of the mental lexicon proposed by Jescheniak and Levelt (1994) (Panel a), and Caramazza et al (2001) (Panel b).

Many explanations have been put forth for the discrepancy between these two kinds of studies (Jescheniak et al., 2003; Caramazza et al., 2001; Jurafsky, 2003). For example, the frequency contrast was shown to be smaller in Caramazza et al. (2001) than Jescheniak and Levelt (1994). Or differences in experimental methodology were discussed in various places, namely, whether homophone words are homographic or heterographic, whether they are included in the same syntactic class or not, or whether they are related in meaning or not, etc.

However, as briefly mentioned in Jescheniak et al. (2003), the target language seems to be crucial to the discrepancy for frequency inheritance effect. Speakers of different languages might retrieve words in slightly different ways spending more or less time for monitoring or verification processes. The languages revealing the frequency inheritance effect clearly are Dutch and German which have relatively few homophones (Jescheniak & Levelt, 1994; Jescheniak et al., 2003), while Chinese has relatively many homophones and showed no inheritance effect (Caramazza et al., 2001).

Thus in view of the conflicting findings, we assess the language effect to the frequency inheritance by replicating two experimental tasks such as picture-naming and translating with Korean as the target language. Since the existing evidence on the representation of homophones is inconclusive, additional empirical findings would be certainly necessary. Korean is chosen because around 30% of the lexical entries in a comprehensive Korean dictionary are homophone words, whose syntactic class is nouns, and 30% of those nouns are homonyms (Kang, 2005). The large amount of homophones in Korean were generated as a result of the influx of Sino-Korean words, namely, Korean language vocabulary composed of the Chinese characters. Much like Japanese and Vietnamese, a great deal of Sino-Korean vocabulary was directly borrowed from Chinese; however, the tonal contrast, which was crucial to the distinction of the Sino-Korean words, disappeared now, and thus a number of homophones have been introduced into the lexicon of Korean, causing potential difficulty in processing.

2. Experiment 1: Picture Naming

Using the experimental criteria of Jescheniak and Levelt (1994) and Caramazza et al. (2001), we selected three sets of pictures: a) homographic homophones, b) low-frequency (LF) controls, and c) high-frequency (HF) controls. The homophones were matched in frequency with the LF controls, and the HF controls were matched in frequency to the sum frequency of the low-frequency homophones and their high-frequency twins. The issue addressed in this experiment is whether picture-naming latencies are determined by a picture's specific word frequency or by its sum frequency of the LF homophones and their HF twins. Following Jescheniak and Levelt (1994), we predict that naming latencies for the homophone words should be comparable with those for the sum frequency of the LF homophones and their HF twins, whereas Caramazza et al. (2001) predicts that it should be comparable with those for the LF controls, provided that the frequency of the homophone words are equivalent to that of the LF controls.

2.1 Method

2.1.1 Participants

Thirty (19 males, 11 females) native speakers of Korean who were all undergraduate students at Konkuk University served as participants in the experiment, and they were paid for their participation.

2.1.2 Materials

One-hundred twenty pictures, 14 pictures each of homophone names, HF names, and LF names, and 78 fillers, were sampled partly from a picture database by Snodgrass and Vanderwart (1980) and partly created by a drawing program designer. The pictures were line drawings of simple objects that were digitized by using a AGfa Snapscan-e50 scan program. The name agreement of the pictures was checked in an informal screen test by 10 Korean natives. The specific word frequencies of each test word were obtained from the database called 'A Survey of Word Frequency of the Modern Korean (SWFMK)' (Cho, 2001), which was produced by the National Institute for the Korean Language. This database consists of 58,437 words, extracted from a large body of material in books, magazines, dialogue scripts of the TV sitcoms, etc., for a total of 176 kinds of material. The words in the database show their type frequency ranged from 1 through 25,567, among which two groups of words were chosen for this task, one group of which ranged from 25,567 through 69 in word frequency (upper 5%) (HF controls), the other, with the frequency of one to 26 (approximately lower 30%) (LF controls). To test the reliability of the database, a separate survey to examine the subjects' own type frequency was done at the end of the experiment (Kreuz, 1987). The mean frequencies of each set of words were presented in <Table 1>, and the specific picture names were provided in Appendix I with its specific frequencies.

Table 1. Mean frequencies of the three sets of pictures

pictures sets	example	mean frequency	sum frequency
homophones	kaʧi 'eggplant' (cf. kaʧi 'branch')	9.6 (1-19)	346 (103-1350)
LF controls	kiwa 'tile'	9.6 (2-23)	
HF controls	koʧʰu 'pepper'	347 (72-1303)	

2.1.3 Procedure

Before the picture-naming task was given to the participants, the entire set of 120 pictures were provided to them, and participants were asked to name each of the pictures. If they produced a name that differed from the one expected by the experimenters, they were asked to use the designated name (See Caramazza et al., 2001 for a similar experimental procedure). In the picture-naming task, each participant saw the randomized set of pictures and fillers in the computer screen and was asked to name the pictures as fast as possible without making errors. Each trial had the following structure: a warning signal (*) was shown in the center of the screen for 700 ms, and was then replaced by the picture, which remained on the screen for 400 ms. Participants initiated the next trial by pressing the space bar. Response latencies were measured from the onset of the stimulus to the beginning of the naming response by means of a voice key (Cedrus). The task was controlled by the SuperLab Pro (Cedrus), and response accuracy was manually checked by the experimenter. Right after the picture-naming experiment, a familiarity test was given to the participants to check their own frequency for the stimuli from the scale of 0 (least familiar) to 6 (most familiar). The purpose of this test was to ensure that the test words were familiar to the participants tested in the picture-naming experiment.

2.2 Results and Discussion

<Table 2> shows the mean naming latencies and error rates for each picture set.

Table 2. Mean naming latencies and error rates for the Picture Naming Task

pictures sets	example	naming latencies (ms)	error rate (%)
homophones	kaʧi 'eggplant'	1143 (865-1447)	1.9
LF controls	kiwa 'tile'	999 (819-1287)	1.7
HF controls	koʧʰu 'pepper'	886 (702-1103)	1.4

Analyses of variance (ANOVAs) on the naming latencies revealed a significant effect of picture set [F (2, 39)=11.25, $p<.05$]. Additionally, Post Hoc LSD tests show that the naming latencies between the homophone set and LF controls, those between the homophone set and the HF controls, and difference between the LF controls and HF controls were all significantly different [$p<.05$].

The results of the picture naming reveal that there was no frequency inheritance effect in the production of the Korean speakers: even though some specific words have homophone twins, they do not have any benefit for naming the pictures. The pictures with homophone twins were shown to be named slower than the HF controls, and even than the LF controls. Thus these results are at odds with those of Jescheniak and Levelt (1994), but are in good agreement with those of Caramazza et al. (2001).

3. Experiment 2: Translation

3.1 Method

3.1.1 Participants

Twenty-seven (11 males, 16 females) native speakers of Korean who were undergraduate or graduate students at Konkuk University served as participants in the experiment. Either they had experience of studying in English-speaking countries for more than two years, or they received high scores of the English tests (580 (PBT) and 237 (CBT) for TOEFL, 900 for TOEIC, and 819 for TEPS), but all of them had at least 7-11 years of experience in speaking and reading English. Thus it was assumed that they had some substantial second-language experience. Also all of the participants took the English vocabulary test, and participants who got less than 60 % were excluded for analysis. Participants were paid for their participation.

3.1.2 Materials

Similar to the picture-naming task, stimuli consisted of three sets of test words, homographic homophones, LF controls, and HF controls. The test words were all two-syllabled sino-Korean words, with the same syntactic class, namely, nouns. Each set had 14 test words and an additional set of 78 fillers was included. The criteria for selecting words in terms of word-frequencies were similar to that of Experiment 1. The mean frequencies of each set of the test words were given in <Table 3> and the specific words with frequencies were presented in Appendix II.

Table 3. Mean frequencies of the three sets of test words

pictures sets	example	mean frequency	sum frequency
homophones	toŋhwa 'assimilation' (cf. toŋhwa 'fairy tale')	15 (1-27)	566 (71-2797)
LF controls	koŋʧu 'princess'	13 (1-22)	
HF controls	kwahak 'science'	574 (129-1491)	

3.1.3 Procedure

Experiment 2 was also run using a SuperLab Pro (Cedrus). Participants were tested individually in a quiet room. After a warning signal (*) was shown in the center of the screen for 700 ms, the probe word was displayed on the screen for 400 ms. Participants were asked to translate the probe word (English) to the appropriate Korean word as soon as possible, and response latencies were measured from the onset of the stimulus to the beginning of the translating response by means of a voice key (Cedrus). Response accuracy was manually checked by the experimenter. Given the fact that Korean has many homophones, they were informed in advance that the Korean translations they produced should be two-syllable Sino-Korean words. Right after the translation experiment, each participant performed the semantic decision task with the same English words. The purpose of this task was to exclude the possibility that participants perform the translation task through a shallow lexeme-to-lexeme route (Jescheniak & Levelt, 1994). Normally the translation task consists of recognizing the visually presented English word and translating it to the corresponding Korean word, which will be reflected in the translation latency. However, it is not necessarily a pure measure of accessing the target word. To control for this additional variable, such tasks as the semantic decision task is necessary. For this task, participants were asked to decide the animacy of each test word: if they think the English word denoted an animate entity, they had to push the button for 'o' and if not, push the button for 'x' on the keyboard. Again for the translation task, a familiarity test was given to the participants to check their own word familiarity for the stimuli from the scale of 0 (least familiar) to 6 (most familiar). As the test words for the translation task were all inanimate entities except three words, 75 words out of the 78 fillers consisted of animate entities to avoid any biases in the semantic decision task; the numbers of animate vs. inanimate objects were the same. All other procedural details were identical to those in the experiment by Jescheniak & Levelt (1994).

3.2 Results and Discussion

<Table 4> shows the mean translation latencies, and error rates for each item set. The results for the two participants whose error rates were more than 15% were not included in the analysis, and thus the analysis was based on the results from 25 subjects.

Table 4. Mean translation latencies (in ms) and their error rates (in percentages) for the Translation Task

pictures sets	example	translation latencies (ms)	error rate (%)
homophones	toŋhwa 'assimilation'	1701	28.9
LF controls	koŋʧu 'princess'	1509.6	22.6
HF controls	kwahak 'science'	1208.5	4

This data pattern shows that the mean difference scores were largest for homophone names, intermediate for LF controls, and smallest for HF controls. These differences according to the picture set were significant [$F(2, 39)=5.08$, $p<.05$]. Post Hoc LSD tests revealed that homophones and LF controls were not significantly different ($p>.05$), but HF controls were significantly different from homophones ($p<.05$) and the differences between HF controls and LF controls were marginally significant ($p=.06$). The error rates were also different according to the picture sets [$F(2, 39)=7.33$, $p<.05$]. It was shown from the Post Hoc LSD tests that homophones and LF controls were not significantly different (p>.05), but HF controls were significantly different from homophones (p<.05) and the differences between HF controls and LF controls were also significant (p<.05).

One thing to note here is that the error rates were very high for homophones and LF controls as compared to those in previous analysis such as Caramazza et al. (2001) which showed 14.6% of the error rate for the homophone words in the Spanish-English translation task, even though participants in their experiment read the printed list of Spanish words and their English translations at the beginning of the experiment and they were instructed to produce the English words included in the list. Participants in the present study seemed to have more difficulties in translating the English words to the corresponding Korean words without being provided by such a list, which led to the high rate of errors such as 28.9% for homophones, for example.

The semantic decision latencies were also different among the picture sets. The mean difference scores were largest for homophone names, intermediate for LF controls, and smallest for HF controls.

Table 5. Mean semantic decision latencies (in ms) and their error rates (in percentages) for the Translation Task

pictures sets	example	semantic decision latencies (ms)	error rate (%)
homophones	toŋhwa 'assimilation'	984.5	5.7
LF controls	koŋʧu 'princess'	864.1	0.6
HF controls	kwahak 'science'	831.5	0.6

These differences according to the picture set were significant [$F(2,39)=3.76$, p<.05]. Post Hoc LSD tests revealed that HF controls and LF controls were not significantly different (p>.05), but HF controls were significantly different from homophones (p<.05) and also the differences between LF controls and homophones were significant (p<.05). These results show that it took longer to recognize the homophone words than LF or HF controls.

In sum, low-frequency homophones were translated more slowly than HF controls and even LF controls, being at odds with the results of Jescheniak and Levelt (1994). Again, however, the results of the present study are in good agreement with those of Caramazza et al. (2001).

4. Discussion

The results of the two experiments provided in this paper show that both picture-naming latencies and translation latencies are determined by a specific word frequency, not by its sum frequency of the LF homophones and their HF twins. In fact, the results of the translation experiment (Experiment 2) showed that the mean translation latencies were not significantly different between homophones and LF controls; the results of the picture-naming (Experiment 1) further showed that the pictures with homophone twins were named even slower than the LF controls. Thus in lexical access for production, the naming of homophones did not benefit from the existence of other words that had the same phonological representation (lexeme). Rather, in each experimental setting, subjects seemed to have difficulties in having access to the lexicon of homophone words in production, at least as equally difficult as with the LF control. The pattern of the results is in line with the hypothesis by Caramazza (1997) or Caramazza and Miozzo (1998), but is seemingly incompatible with the hypothesis by Dell (1990), Levelt, Roelofs, and Meyer (1999), or Jescheniak and Levelt (1994).

However, before determining whether the results of the present study directly support the model of the mental lexicon proposed by Caramazza (1997), it should be noted that the exhibition of the frequency inheritance effect seems to be greatly influenced by the target language. Languages which have relatively a large amount of homophones tend not to show a frequency inheritance as in Korean as well as in Chinese (Caramazza, 1997). On the other hand, languages with relatively few homophones tend to show such effect as in Dutch and German (Jescheniak & Levelt, 1994). Languages with a large number of homophone words might need more time to get access to the lexicon of the homophone twin of a certain word, due to the great number of homophones in those languages. It is important to note that in a picture-naming, Chinese LF controls and homophones did not show any significant difference, but Korean homophones were shown to be named slower than the LF controls. It seems that Korean speakers (with extremely a large number of homophone words) had lots of difficulties in monitoring and verifying the names of the specific homophones among a lot of homophone words. Thus the issue of whether homophones share the lexicon, or whether there is a distinction of lemma and lexeme cannot be simply determined based on the results of specific languages.

Caramazza et al. (2001) also pointed out the role of language differences. But the language differences meant by Caramazza et al. (2001) are mainly orthographical differences. Dutch used as the target language in Jescheniak and Levelt (1994) had a transparent orthography; on the other hand, Chinese and English used in Caramazza et al. (2001) showed opaque orthographies: many of the homophones had heterographic spellings such as none and nun. However, based on the present results that Korean with homographic homophones did not show the frequency inheritance effect, it is clear that the orthographic difference between the stimuli was not responsible for the contrasting results. Unlike Chinese and English, Korean is orthographically transparent such as '발' for both 'foot' and 'shade'. Rather it is telling that the percentage of homophone words in the lexicon of a specific language seems to play more role in the frequency inheritance effect.

Another thing to note in interpreting the results of the translation experiment is that the error rates in translation in the present study were very high for homophones as compared to those in previous studies such as Caramazza et al. (2001). As both reviewers pointed out, English proficiency difference between these two subject pools may also be another possible factor for such results. The Korean subjects had studied English as a foreign language, not as a second language as in Spanish-English bilinguals. Thus even though they received high scores in various English tests, they could have more difficulties in translating the English words spontaneously.

To conclude, a clear implication from the results of the present study is that the frequency-inheritance effect is closely tied to the language-specific differences in the percentage of homophone words in the vocabulary of the specific language. This implication is based on the observation that languages with relatively many homophones seem to show less frequency-inheritance effect. The present results do not provide direct evidence to assess the frequency inheritance effect, but they suggest that the exact number of homophone words in a given language should be carefully taken into account to determine under which conditions evidence for frequency inheritance between homophones can be obtained.

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Appendix I

Picture Names with specific frequencies for Experiment 1

homophones	LFcontrols	HF controls
kaku 'furniture'(22), cf. 'household'(69)	upʰjo 'stamp'(11)	koʧʰu 'pepper'(102)
kaʧi 'eggplant'(8), cf. 'branch'(102)	ʧamʧali 'dragon fly'(6)	k'oʧʰ 'flower'(397)
san 'acid'(3), cf. 'mountain'(440)	suʧə 'spoon & chopsticks'(19)	kʰəmpjutʰə 'computer'(675)
kaʧʰi 'false teeth'(2), cf. 'value'(386)	talimi 'iron'(5)	tampæ 'cigarette'(322)
kæ 'Yut' (1), cf. 'dog'(145)	cæpoŋtʰil 'sewing machine'(1)	manil 'garlic'(129)
koŋki 'a king of play'(4), cf. 'air'(159)	toʧaŋ 'stamp'(2)	twæʧi 'pig'(72)
kisa 'knight'(4), cf. 'article'(171)	tiŋtæ 'lighthouse'(14)	pjəŋwən 'clinic'(344)
nam 'south'(19), cf. 'others'(538)	tok'i 'axe'(11)	ʧʰimtæ 'bed'(136)
nas 'sickle'(10), cf. 'day'(194)	kiwa 'tile'(15)	jaŋpʰa 'onion'(103)
tol 'first birthday'(3), cf. 'stone'(166)	pəsən 'Korean socks'(5)	hak'jo 'school'(1303)
pal 'bamboo blind'(4), cf. 'foot'(380)	p'altæ 'straw'(3)	usan 'umbrella'(139)
saʧən 'dictionary'(23), cf. 'before'(80)	ʧʰənsa 'angel'(13)	ʧʰæk 'book'(886)
pam 'chestnut'(29), cf. 'night'(694)	ʧaŋmi 'rose'(11)	ankjəŋ 'glasses'(80)
wi 'stomach'(21), cf. 'above'(1321)	soŋpʰjən 'rice cake'(18)	kʰo 'nose'(173)

Appendix II

Names with specific frequencies for Experiment 2

homophones	LF controls	HF controls
kwakə 'Chosun civil exam'(18) cf. 'past'(387)	koŋʧu 'princess'(19)	kwahak 'science'(559)
toŋhwa 'assimilation'(1) cf. 'nursery story'(74)	tæʧo 'contrast'(22)	kjojuk 'education'(967)
puin 'denial'(14), cf. 'wife'(140)	toʧʰak 'arrival'(17)	noljək 'effort'(420)
puʧəŋ 'negaton'(2) cf. 'corruption'(199)	toŋsaŋ 'frost heaving'(12)	tæhak 'university'(732)
sawən 'temple'(12), cf. 'office worker'(70)	mjənto 'shaving'(2)	munhak 'literature'(703)
jənki 'postponement'(27), cf. 'acting'(131)	panpok 'repetition'(18)	ənə 'language'(327)
isəŋ 'opposite sex'(15), cf. 'reason'(78)	susul 'operation'(1)	jesul 'art'(945)
ʧənki 'biograph'(22), cf. 'electricity'(121)	amki 'memorizing'(40)	wihəm 'danger'(129)
ʧipang 'fat'(21), cf. 'rural area'(695)	jojak 'summary'(12)	ʧaju 'freedom'(286)
tæki 'waiting'(25), cf. 'atmosphere'(100)	jukwe 'kidnapping'(7)	ʧənʧæŋ 'war'(399)
tokʧa 'only son'(6), cf. 'reader'(184)	pʰjənʧip 'editing'(21)	ʧoŋkjo 'religion'(240)
sahwe 'chairmanship'(18), cf. 'society'(2770)	mjənʧəp 'interview'(16)	sikan 'time'(1491)
ipʧaŋ 'admission'(6), cf. 'situation'(453)	hæŋʧin 'march'(13)	pʰjəŋhwa 'peace'(167)
join 'important person'(8), cf. 'cause'(217)	hjəptoŋ 'cooperation'(16)	hwankjəŋ 'environment'(683)