Korean Journal of English Language and Linguistics
Vol. 20, June 2020, 180–208
10.15738/kjell.20..202006.180

Cross–modal Mapping in L1 Korean and L2 English Sound Symbolism*

Gwanhi Yun
(Daegu University)

Yun, Gwanhi. 2020. Cross–modal mapping in L1 Korean and L2 English sound symbolism. *Korean Journal of English Language and Linguistics* 20, 180–208. We have investigated whether the association of sounds and shapes is observed in Korean L1 ideophones and L2 English words and pseudowords. First, we found that the linkage between shapes and sounds emerges in a limited scale with respect to Korean L1 ideophones and vowel harmony. This finding may stem from the fact that light/dark vowel distinction relating to Korean vowel harmony differs from the common vowel distinction based on front/back dimensions observed across languages. Second, in lexical decision task and explicit association test, we have shown that the correlation of visually and auditorily presented sounds and shapes takes place with regard to stop/fricative distinction. Moreover, the number of consonants contained within the words predicted the robustness of the association of the consonant type and shapes. Furthermore, it was found that round shapes were preferred for back rounded vowels and spiky shapes were associated with front vowels in L2 English. Thus, the presence or strength of the bondage of shapes and sounds might differ according to L1–specific phonological rules, L2 sound types or the type of behavioral task.

Keywords: sound symbolism, Korean vowel harmony, cross–modal correspondence, sound–shape association, lexical decision task, explicit association test

1. Introduction

Sound symbolism refers to the extensive, symbolic correspondence between sound (form) and lexical meaning (Childs 2015: 287). It is a comprehensive umbrella term couching onomatopoeia and mimetic words. It has long been treated as a marginal case to linguistic studies because it is traditionally put aside as the showcase of non–arbitrary relations between form and meaning in the view of structural and

* This research was supported by the Daegu University Research Grant, 2019. I am grateful to three anonymous reviewers for their constructive and thorough feedback and comments. All remaining errors are mine.

generative traditions (Saussure 1916, Hockett 1982). However, numerous recent studies have revealed that the iconic connection between sound and meaning not only facilitates lexical acquisition at early stages but the learning of novel or new words (Imai, Kita, Nagumo and Okada 2008, Laing 2014. Nygaard, Cook and Namy 2009).

Sound symbolism has been observed across languages such as English, French, German, Hebrew, Korean, Japanese, Mandarin, Polish, Spanish, Zulu, etc (Akita, Imai, Saji, Kantartzis and Kita 2011, Childs 2015, Imai and Kita 2014). It is classified into many kinds according to the type of correspondence between a linguistic form and its meaning: (i) onomatopoeia, i.e., natural sound-linguistic sound correspondence (e.g., bow-wow, cock-a-doodle-do, meow), (ii) the bouba-kiki effect (Köhler 1947), i.e., sound-shape correspondence (e.g., "maluma" for the round shape vs. "takete" for the spiky shape), (iii) ideophone, i.e., sound-movement mapping (e.g., *kete* "chatter" - *khete* "babbble" - *gede* "chatter loudly", Zulu; Van Rooyen et al. 1976).

In view of the linguistic unit, sound symbolism varies in the unit, ranging from feature, phoneme, two-consonant onset to the whole word (e.g., voicing feature, Sicoli 2010; consonant, Van Rooyen et al. 1976, Imai et al. 2008; onset, Bergen 2004). For example, Farmer et al. (2006) showed that there is some phonological difference between nouns and verbs. Berlin (1994, 2006) proposed "frequency theory" where symbolic sounds directly signal or are associated with physical properties of the speakers or referents, arguing that vowel /o/ pronounced with round mouth and low frequency represents the larger or round objects in the behavioral task of naming objects. Previous studies seem to indicate that the size rather than the sound of the objects affects naming task. Interestingly, Thompson and Estes (2011) show that the larger numbers of large-sounding phonemes such as /a, u, o, m, l, w, b, d, g/) seem to be associated with the naming of the larger objects than small-sounding phonemes such as /i, e, t, k/. In English, word-initial onset clusters named phonaesthemes contribute to the shared meaning of specific clusters of words. For example, words beginning with 'gl' share the meaning related to light: 'glow', 'glare', 'glitter.'

In addition, psychological reality of sound symbolism has increasingly been investigated for L2 as well as L1 past decades (Bergen 2004, Bolinger 1950, Kanero et al. 2014, Kwon and Round 2015, Ramachandran and Hubbard 2001, Yun 2018). For example, Bergen's (2004) priming study found that the target sharing a phonaestheme with the prime (e.g., *gleam-glimmer*) was processed faster than the pairs that do not share a phonaestheme (e.g., *frill-barn*). On the basis of the findings, they suggested that English phonaesthemes (e.g., 'gl-, sn-, fl-, sl-', etc), a recurring

sound-meaning pattern should be represented in the mental lexicon as a morphological unit lying between the phoneme and the morpheme.

Given this background, the present study is mainly concerned with the iconicity of sound symbolism expressed in Korean vowel harmony of onomatopoeia or ideophones and with Korean L1 speakers' processing of L2 English sound symbolism.

1.1 Korean Sound Symbolism: Vowel Harmony

It is well-known that vowel harmony is observed in sound-symbolic or mimetic words such as onomatopoeia and ideophones as illustrated in (1). In these words, dark vowels /i, ɨ, u, e, ə/ contrast with light vowels /a, o, ɛ/: dark vowels co-occur with dark vowels whereas light vowels are accompanied by light vowels. (Note that the opposition of /e/ and /ɛ/ is still observed in vowel harmonic words in orthography although these two vowels have undergone merge at phonemic level in Modern Korean (e.g., "데굴데굴" /tekultekul/ vs. "대굴대굴" /tɛkultɛkul/, Lee 1994). However, vowels such as /i, ɨ/ co-occur either with light or with dark vowels. For this reason, these are called neutral vowels and have been handled as exceptions to vowel harmony as exemplified in (2) (Park 2007). As in (2a), when the vowel in the first syllable is one of these neutral vowels, all the other following vowels are dark vowels in the domain of vowel harmony and the neutral vowel seems to function as dark one. In contrast, when the second vowel is a neutral vowel, the ambient vowels are either dark or light within the domain of vowel harmony as in (2b).

		Light	Dark
(1)		$p^hoŋtaŋp^hoŋtaŋ$	$p^huŋtəŋp^huŋtəŋ$
		sopoksopok	supuksupuk
		alloktallok	əlluktəlluk
		pasakpasak	pəsəkpəsək
(2)	a.	sɨlc'ək	*sɨlc'ak
		tiluktiluk	*tiloktilok
	b.	əkicək	akicak
		təlkɨləkk	talkɨlak
		pəŋsil	paŋsil

Despite numerous studies have been conducted to identify the appropriate harmonic features and to characterize the vowel alternation patterns, there has been

comparatively rare research on the psychological validity of sound symbolism in Korean ideophones.

Furthermore, few psycholinguistic studies have been performed to investigate whether two types of sound symbolic lexical items are associated with size, shape or any other iconic meanings (Chae 2003). To fill this research gap, the present study seeks to look into whether vowel alternation patterns shown in Korean sound symbolism represented in ideophones mark contrast in shape. It has been consensus that impressionistically, light vowels elicit the nuance of being "diminutive, light, small, delicate, thin, fast, narrow" whereas dark vowels are associated with the nuance of being "augmentative, dark, heavy, large, thick, slow, broad". Kim and Lee (1993) state that light vowels in the ideophones are primarily low vowels and this fact seems to be contrary to rather universal tendency suggested by Sapir (1929) and Newman (1933) as illustrated in (3).

(3) a. /i/ – /ɛ/ : pipi/pɛpɛ, siŋkɨl/sɛŋkɨl
b. /ə/ – /a/ : səpək/sapak, təpək/tapak, əcəŋ/acaŋ
c. /u/ – /o/ : sukun/sokon, pukɨl/pokɨl, ututuk/ototok

However, few psycholinguistic tests have been conducted to see what types of meanings affect the processing of Korean ideophones. Considering complex nuance of Korean ideophones, those involving vowel harmony seem to elicit a multitude of semantic properties such as size, shape, weight, speed, etc. Out of these, the present study aims to examine whether the alternations between dark and light vowels mediate the sound-shape type of sound symbolism.

1.2 English Sound Symbolism

A growing number of previous corpus studies have shown that English lexicon is composed of more systematic sound-meaning correspondences than the conventional expectation (Farmer et al. 2006, Monaghan et al. 2014). This seems to lead to the conjecture that sound-meaning mapping is not exclusively arbitrary in English. The units of sounds which match specific meanings in sound symbolism vary from features and phonemes to sub-morphemic phonaesthemes.

An example of phoneme-meaning correspondence comes from the original studies conducted by Köhler (1929, 1947) and Newman (1933). Sapir (1929) shows that a large table prefers the label 'mal' to 'mil'. Additionally, it is shown that the spiky shape is

matched to the label 'kiki' rather than 'bauba' (Ramachandran and Hubbard 2001). These behavioral tests of the effects of sound-meaning relations indicate that phoneme sounds are associated with the semantic concepts of objects such as their size or shape. To be specific, low vowels are implicitly associated with the large size and curvy shape whereas high vowels with the small size and spiky shape. Additionally, mimetic theory and frequency theory claim that phoneme /o/ which is articulated with round mouth and low frequency represents the larger or more round objects in the behavioral task such as naming objects (Berlin 1994, 2006). English high front vowels /i, ɪ/ are also known to have the connotation of being small as evident from *teeny-weeny, itsy-bitsy*, etc. Furthermore, it is suggested that stop consonants are linked with the spiky shape whereas continuant consonants with the curvy shape (Köhler 1929, Westbury 2005). Interestingly, Thompson and Estes (2011) argue that sound symbolism is gradient, showing in their naming task that the larger number of large-sounding phonemes such as /a, u, o, m, l, w, b, d, g/ seem to be associated with the naming of the larger objects than small-sounding phonemes such as /i, e, t, k/.

Features also serve as the unit of cross-modal correspondence in English. For instance, Westbury (2005) suggests that articulatory features like [+nasal] are associated with the curvy shape whereas [-continuant] with the spiky shape.

Phonaesthemes which consist of a cluster of consonants or vowel in English serve the sound symbolic words (Hutchins 1998, Childs 2015). For example, English onset clusters such as 'gl-, sl-, tw-, fl-, sn-, cl-' are associative or indicative of meanings such as 'light, pejorative, twist, moving fast, nose, a cohesive aggregate', respectively. Bergen (2004) found in his lexical priming task that target words elicited faster reaction times (henceforth, RT) when they shared a phonaesthemic onset with the primes than they were not related in meaning and form (e.g., prime : target = *glitter : glow* vs. *dial : ugly*). Thus he interprets this finding to suggest that phonaesthemes have psychological reality in English L1 speakers' mental lexicon.

Compared to a multitude of studies on sound symbolic relations with L1 speakers, few behavioral studies have been made as to L2 speakers' processing of their correspondence in view of their psychological status. As previously mentioned, 'bouba-kiki' effect refers to cross-modal (i.e., sound-shape) correspondence whereby some consonants or vowels show correlation with certain degrees of size or shape of objects (Bremner et al. 2013, Cuskley et al. 2017, Parise and Spence 2012, Ramachandran and Hubbard 2001). Fort et al. (2015) suggest that sound-shape cross-modal correspondence is affected by consonants more than by vowels. For

instance, Westbury (2005) suggests that oral stops are correlated with the spiky shape whereas nasals or fricatives are associated with the curvy shape. Against this background, in the present study, we investigate whether the sound-shape correspondence observed for L1 speakers is found for Korean L2 English speakers.

1.3 The Current Research

The present study is concerned with two issues related with the processing of sound-symbolic expressions. First, is the integration of sound and shape manifested in the phonological rule expressed in Korean ideophones? Previous research showed sound symbolic iconicity exists at many linguistic units such as features, phonemes, words, etc. In the current experiment, we attempt to examine whether Korean vowel harmony, i.e., a prevalent phonological rule mediates the perceived correspondence between vowel harmonic sound sequences and spiky/curvy shape. In other words, this is to test whether a phonological rule serves the medium to show sound symbolic relations expressed in the ideophones. As aforementioned, it has not been studied via behavioral tests whether sound-shape cross-modal correspondences are extant in Korean vowel harmonic ideophones. Hence, we investigate whether Korean ideophones contain the implicit connotation of shape in their meanings. To be more specific, it is examined whether the ideophones obeying light vowel harmony are associated with the spiky shape and those with dark vowel harmony are connected with the curvy shape (e.g., *k'angchongk'angchong* vs. *k'əngchungk'əngchung*). If the ideophones with the match between shape and vowel harmony type elicit facilitatory effect, i.e., faster reaction times than those without it, it indicates that words with Korean vowel harmony are associated with shape contrast. If such facilitatory effects do not emerge, it means that Korean vowel harmonic words have no connotation of shape. To elicit the effect of sound-shape associations, we employed the lexical decision task adopted by Peiffer-Smadja and Cohen (2019). The present study has significance in the sense that it might be the novel behavioral experiment to look into the possibility of integrating such cross-modal correspondence that might be potentially present in Korean ideophones.

Another aim of the current study is to see whether sound-symbolic iconicity is observed in real Korean ideophones. One of the controversial issues regarding the nature of sound symbolism is whether the connection is observed only in nonwords as is evident from object-naming tasks or lies in real words as well. To test this, we

examined whether the extra connotation of shape is associated with Korean real word ideophones expressed via vowel harmony apart from the existing nuance difference.

The third aim of this study is to explore the issue on whether the effect of shape-sound link is found for L2 speakers. We presented Korean learners of L2 English with a series of two types of novel frames embedding English stops and fricative consonants. The frames with the spiky shape contained English words only with stop consonants and those with the curvy shape had English words only with fricatives. We asked Korean undergraduates to make judgment on the wordhood of each trial. This lexical decision task will reveal whether the presumed sound (i.e., English phonemes)-shape (i.e., spiky/curvy shape contrast) associations hold psychological status in the L2 learners' mental lexicon. This cross-modal correspondence model predicts that the spiky frames with stops and the curvy frames with fricatives are accessed more rapidly than those mismatched with their corresponding phonemes. This prediction was tested by visual lexical decision task with Korean L2 speakers of English. If this prediction is supported by the results of this study, it is conceivable that shape-sound (i.e., phonemes) cross-modal correspondence is rather modulated by universal mechanism of sound symbolism.

The present paper is organized as follows. In Section 2, two visual lexical decision tasks (LDT) and one explicit association test (EAT) are explicated with subjects, stimuli and experimental methods in a series of three blocks of tasks. Results of the experiment are also analyzed and reported in Section 2. Results on RT obtained in the processing efficiency for Korean L1 sound symbolism and L2 English shape-sound relations are discussed in Section 3. Section 4 includes conclusion.

2. Behavioral Experiment: Visual Lexical Decision Tasks and Explicit Association Test

2.1 Participants

Thirty-one undergraduates at Daegu University in Korea took part in the two blocks of the lexical decision tasks and one block of explicit association test and were paid an appropriate amount of compensation. They are native speakers of Korean who studied English as major or minor in college. They were 20 to 29 years old and their mean age

was 23.5 years old. Twenty-five were females and six males. The average period of receiving English education at formal school system was 11 years. Their self-rating English proficiency was 4.7 out of 10 point-scale and their mean TOEIC score was 630. They had normal vision and reported no vision impairment.

2.2 Material

Block I: LDT

The present study consists three blocks of experiments. First, in block I, Korean stimuli were used to see the processing efficiency of Korean words and nonwords which include or do not include light/dark vowel harmony. Three groups of stimuli were employed. The first group of stimuli were 60 real Korean ideophones with 4 syllables, varying along one dimension: vowel harmony type (light vowel sequences /a+a/, /o+o/, /o+a/, /a+o/ vs. dark vowel sequences /ə+ə/, /u+u/, /u+ə/, /ə+u/). 30 ideophones with light vowel harmony and 30 words with dark vowel harmony were picked randomly out of the set of Korean ideophones. Most of these words were reduplicated forms created from the disyllabic base words. We also designed a set of one spiky frame and one curvy shape frame. These two types of frames were the same size with black background and a white figure within them (Peiffer-Smadja and Cohen 2019, Westbury 2005). The stimuli written in Korean orthography were embedded in conceptually-matched spiky or curvy frames. In other words, words which obey light vowel harmony (e.g., *acaŋacaŋ*) were placed in the center of the spiky frames (4a) and those which obey dark vowel harmony (e.g., *əcəŋəcəŋ*) were embedded inside the curvy frame as illustrated in (4b). The ideophones were presented in Korean orthography (See the Appendix for the full list of stimuli).

(4) a. Light vowel harmony word b. Dark vowel harmony word

The second set of stimuli were quadrisyllabic pseudo-ideophone words, which resemble reduplicated forms created from the disyllabic nonwords (e.g., "$p^hakaŋp^hakaŋ$" vs. "$p^həkəŋp^həkəŋ$"). This set of stimuli had the same set of vowel harmony sequences as the first group of words: Light vowel harmony sequences such as /a+a/, /o+o/, /o+a/, /a+o/ and dark vowel harmony sequences such as /ə+ə/, /u+u/, /u+ə/, /ə+u/. The former amounted to 30 nonword pseudo-ideophones and the latter also 30. Like the first group of words, this group of stimuli were also placed inside the two types of frames with the black background and white spiky/curvy shapes. Nonword pseudo-ideophones with light vowel harmonic sequences were embedded in the spiky figure (5a) whereas those with dark ones in the curvy figure as illustrated in (5b).

(5) a. Pseudo-ideophone with light VH b. Pseudo-ideophone with dark VH

The third group of stimuli were 40 quadrisyllabic nonwords, which were created by manipulating the vowels contained in the second group of words. The difference between these two groups lies in that the former obey vowel harmony in the word domain whereas the latter violate vowel harmony. Namely, the stimuli in the third group contained the identical consonants to those in the second group, but they did not obey vowel harmony based on light/dark contrast. To be specific, all the 40 stimuli contained a mixture of light and dark vowels and were embedded in the curvy/spiky frames (e.g., "$p^hakəŋp^hakəŋ$" vs. "$p^həkaŋp^həkaŋ$"). Thus, in total, 8 types of vowel sequences were created in the nonword stimuli: /a+ə/, /o+u/, /o+ə/, /a+u/, /ə+a/, /u+o/, /ə+o/, /u+a/

In sum, a total of 160 stimuli were yielded and presented in Korean orthography embedded in the spiky/curvy frames to 31 Korean speakers (4900 = 160 × 31 subjects).

Block II: LDT

As the goal of the second part of this study is to see whether L2 sound symbolic

correspondence is processed by L1 Korean speakers, L2 English words were extracted, and nonwords were manipulated as baseline. The same type of frames (i.e., spiky and sharp) that were used in block I were employed in block II.

Three groups of English real words and nonwords were employed. All the stimuli were monosyllabic (CVVC) or disyllabic (CVCV), and contained stops or fricatives. The first group of stimuli is divided into two sets according to their manner of articulation: (i) 16 words with two stops (/p, b, t, d, k, g/), and (ii) 16 words with two fricatives (/f, v, s, z, ð, ɵ, ʧ, ʤ/. English words were conceptually-matched with the spiky/curvy shapes. In other words, words with two stops were embedded in the spiky frames while those with fricatives were associated with the curvy frames as is illustrated in (6). This cross-modal (sound-shape) correspondence between stops/fricatives and spiky/curvy shapes follows from previous studies (Westbury 2005).

(6) a. Stops with spiky b. Fricatives with curvy

The second group of stimuli were also monosyllabic or disyllabic English words. Additionally each stimulus contained only two consonants. However, unlike the first group of stimuli which consisted of only stops or fricatives, a set of 16 stimuli contained a stop and a fricative in this order whereas the other set of 16 stimuli with a fricative and a stop was randomly selected (e.g., 'pass' vs. 'sap'). In total, 32 stimuli were randomly extracted. The former were presented in the curvy frame and the latter in the spiky frame. This set was designed to see if shape-sound cross-modal correspondence is contingent on the number of the iconic sounds, i.e., whether sound symbolism is gradient.

Thirty two nonwords of CVCC, CVCV or CC(V)VC form were constructed. They were used as control stimuli and thus did not contain any stop or fricatives. The set of nonwords were created with only approximants such as /l, r, w, j/ and vowels (e.g, "lawr, rroal". 16 stimuli were embedded in the spiky shape frame and the other 16 half of the stimuli in the curvy frame. Thus a total of 32 stimuli were manipulated.

For this block of lexical decision task, 96 real words or nonwords were presented in

English orthography in the frames of the spiky or curvy shape to each of 31 Korean native speakers (5952 pairs = 96 × 31 participants).

Block III: EAT

The aim of this block of experiment is to confirm that pseudowords containing stops/fricatives and front/back vowels are tightly associated with a particular shape, and to examine the linkage of auditory sound and visual shapes. We created 4 groups of pseudowords with a CVCV structure, varying along consonant type (stops /p, t, k/ and fricatives /f, s, ʧ/ and vowel type (front vowels /i, e/ and back vowels /u, o/). 24 pseudowords were created for each of the 4 conditions of vowel and consonant type (e.g., "piti", "putu", "fisi", "fusu". (See the full list of stimuli in the Appendix).

2.3 Procedure

First, each Korean participant completed the questionnaire form to gain their background information.

Next, two blocks of visual lexical decision tasks (henceforth, LDT) were performed in succession in a quiet phonetics lab at Daegu University. Participants were given an oral instruction on how to perform the task by the researcher.

In the first block, each participant sat in front of a computer. Stimuli were the rectangular frames with black background which embedded the white spiky or curvy shapes with words or nonwords written in Korean orthography. Each visual frame was presented in full on the computer screen. Each subject was explicitly instructed to determine whether the stimulus shown inside the white shape is a Korean word or not. Then, they were asked to press 1 if it is and to press 2 if it is not. They were told to press the button as rapidly and accurately as possible. They were asked to press it within 1 second if possible after they reached judgment. The participants performed a set of 5 practice trials containing frames and stimuli similar to those employed in the main experiment.

In the second block, the Korean participants who completed the first block of lexical decision task with Korean stimuli were asked to perform another similar lexical decision task with English stimuli. This block of experiment proceeded in the identical procedure as in the first block. Each participant was instructed to decide whether the stimulus was an English word or not. They were told to press the key (1 or 2).

Stimuli were shown in English orthography on the screen for 200ms.

The presentation and randomization of the frames with stimuli was carried out with the software E-Prime Professional 2.0. In both the blocks, 5 practice trials preceded the main session. The entire experiment lasted approximately 30 minutes.

In the third block, the identical participants listened to a pseudoword once over headphones while at the same time, two visual stimuli, i.e., a spiky shape within the black background and a round or curvy shape within the black background were shown on the left and right side of the screen, respectively. The size of the background frame and the size of the shapes were the same. Thirty one participants were asked to choose which visual stimulus shape would match the meaning of the pseudoword most. They had to answer by pressing 1 or 2 on the keyboard as quickly as possible. They were also explicitly told that there were no correct answers and they could follow their intuition as much as possible. In this Explicit Association Test, the rates of the responses they made on the round shapes were obtained and analyzed. This task lasted approximately 10 minutes.

Since all the same stimuli were presented to each participant, the data were subjected to a repeated-measures ANOVA with RT as the dependent variable and others such as vowel harmony type, consonant type and vowel type as independent variables.

2.4 Results

2.4.1 Korean speakers' processing of Korean ideophones

In order to obtain reliable data for RT analyses, the data elicited from subjects who made more than 25% errors in their lexical decision task were removed from further analyses of RT (Fleming 1993). This eliminated four subjects, who had an average of 63.5% correct decision rate (SD 8.5%). The remaining 26 subjects elicited an average 87% correction rates (SD 5.6%). Furthermore, additional step of data mining was carried out. After data cleaning, RT analyses were performed only with responses with correct decisions. Responses whose RT ranged over 1,500 ms also were removed as outliers for further analyses.

Figure 1 shows the RT data by vowel harmony type and association type where real words are presented within each frame type (spiky or curvy). Analysis revealed that there was no main effect of vowel harmony type ($F(1, 25) = 2.89$, $p > .05$) or the

main effect of frame type on the lexical decision latencies ($F(1, 25) = 1.09$, $p > .05$). The interaction between the two did not reach significance ($F(1, 25) = 1.27$, $p > .05$). These results indicate that RT were not affected by the vowel harmony type, i.e., whether the real words show light or dark vowel harmony. Additionally, they seem to imply that the words containing light vowel harmony are not associated with a spiky shape or those with dark vowel harmony with a curvy shape. Nonetheless, despite this lack of significant differences, real words with light vowel harmony within the spiky frame led to shorter RT than those with dark vowel harmony within the curvy shape (693 ms vs. 711 ms, $F(1, 25) = 2.38$, $p > .05$).

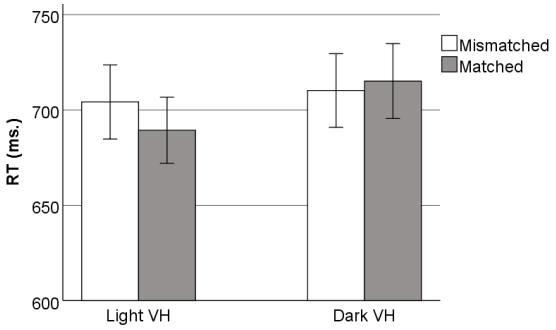

Figure 1. RT for correct decisions to real words. 'Matched' refers to decisions made in a spiky frame with light vowel harmony words and a curvy frame with dark vowel harmony words. 'Mismatched' refers to decisions made in a spiky frame with dark vowel harmony words and a curvy frame with light vowel harmony words.

To examine whether lexical decisions are affected by the cross-modal association between vowel harmony and frames and by word-initial consonant or vowel, a two-way repeated-measures ANOVA was performed. Interestingly, analysis revealed that there were a main effect of the association ($F(1, 25) = 16.68$, $p < .05$) and a main effect of the word-initial segment (i.e., a vowel vs. a stop vs. a fricative) ($F(2, 50) = 3.95$, $p < .05$). The interaction of the two, however, did not emerge and the effect was marginally significant ($F(2, 50) = 2.92$, $p = .06$). As illustrated in Figure 2, the words beginning with a fricative (e.g., /sukunsukun/ "수군수군", /sokonsokon/ "소곤소곤") led to shorter RT than those with a vowel or a stop (e.g., /umukumuk/ "우묵우묵", /omokomok/ "오목오목", /p^{h}ontangp^{h}ontang/ "퐁당퐁당", /p^{h}ungtəngp^{h}ungtəng/ "풍덩풍덩")(682 ms vs. 715 ms vs. 729 ms). Furthermore, the association between light

vowel harmony and the curvy frame and the connection between dark vowel harmony and the spiky frame elicited slightly longer RT than the opposite association pattern (709 ms vs. 708 ms). Looking into detail as seen in Figure 2, the expected latency pattern emerged in cases where the words begin with a stop. That is, real words containing light vowel harmony with the spiky frame resulted in the shorter RT than those with the curvy frame (695 ms vs. 730 ms, $F(1, 25) = 6.71$, $p < .05$). However, for the cases where real words begin with a vowel or a fricative, the differences in RT did not reach significance ($p > .05$).

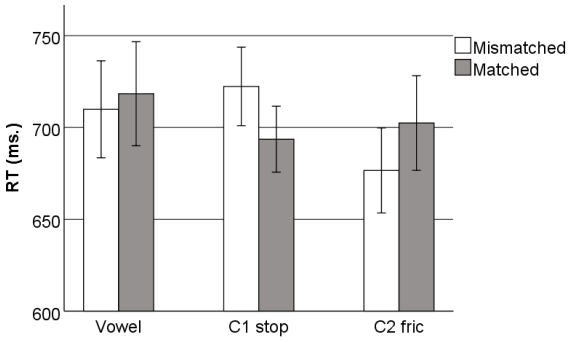

Figure 2. RT for correct decisions to real words by word-initial segment type and the type of association between vowel harmony and the frame shape

For real words, the overall results did not pattern after an association between light vowel harmony and spiky shapes, and between dark vowel harmony and curvy shapes, only showing such a tendency of dim association patterns. However, for real words beginning with a stop, we observed the expected tendency of the association between phonological rules and shapes in Korean ideophones.

Figure 3 shows the RT data by vowel harmony type and association type where nonwords are presented within each frame type (spiky or curvy). For nonword stimuli, there was no main effect of the association type on the RT either by subject ($F(1, 25) = 0.44$, $p > .05$) or by item ($F(1, 39) = 0.01$, $p > .05$). However, there was a marginally significant main effect of vowel harmony type ($F(1, 25) = 3.24$, $p = .08$) and the interaction between the two did not reach significance ($F(1, 25) = 1.42$, $p > .05$). The average RT were shorter for the congruent association between light vowel harmony and the spiky frame and between dark vowel harmony and the curvy shape than for the opposite pattern (730 ms vs. 735 ms), thus showing that the

expected pattern is merely a tendency, not a reliable association.

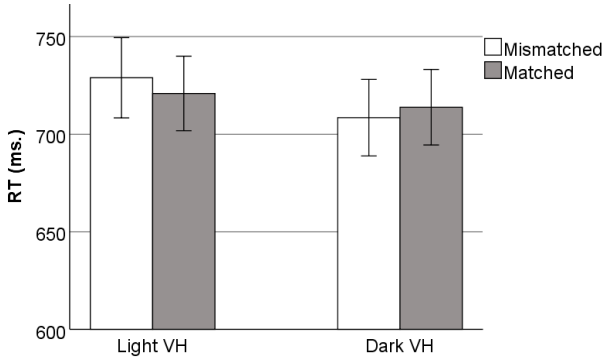

Figure 3. RT for correct decisions to nonwords by vowel harmony type and the type of association between vowel harmony and the frame shape

Unlike the results found for real words, there was no main effect of the association type on the recognition of the stimuli ($F(1, 25) = 0.46$, $p > .05$), but the significant main effect of the word-initial segment type emerged ($F(2, 50) = 5.73$, $p < .05$). Furthermore, the interaction of the two did not arise as illustrated in Figure 4 ($F(2, 50) = 0.80$, $p > .05$). The nonword stimuli which begin with a vowel and show the association between light/spiky and between dark/curvy were recognized faster than those containing the opposite patterns (680 ms vs. 699 ms), but the differences were not significant.

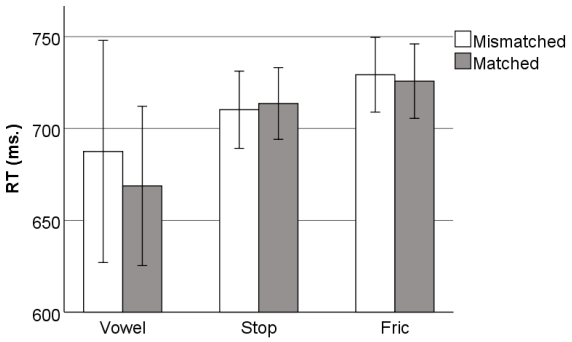

Figure 4. RT for correct decisions to nonwords by word-initial segment type and the type of association between vowel harmony and the frame shape

Next, we examined whether shape association with ideophones containing Korean vowel harmony holds robust representations in the L1 lexicon. The analyses were limited as follows: The ideophones with light vowel harmony were presented in the spiky frame whereas those with dark one in the curvy frame. As illustrated in Figure 5, there was an effect of the shape association with ideophones on RT ($F(2, 50) = 4.95$, $p < .05$). To be specific, a post-hoc LSD test revealed that real words with vowel harmony led to faster RT than nonwords without vowel harmony (596 ms vs. 606 ms, $p < .05$) and nonwords with vowel harmony resulted in faster RT than nonwords without vowel harmony (596 ms vs. 606 ms, $p < .05$). However, there was no significant difference between nonwords with vowel harmony and real words with vowel harmony ($p > .05$). This result suggests that Korean phonological rule, the vowel harmony seems to hold psychological status in the lexicon regardless of whether the embedding stimuli are real words or not.

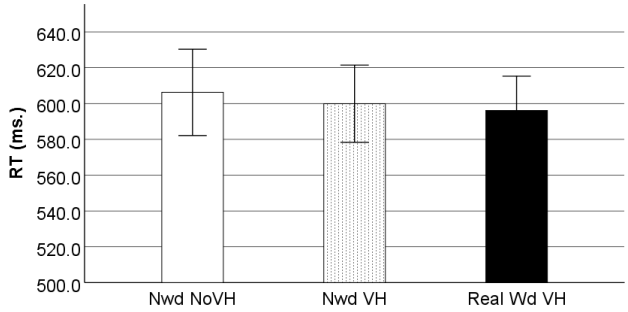

Figure 5. RT by wordhood and the type of association between vowel harmony and the frame shape

In sum, the results obtained in this LDT indicate that Korean ideophones containing vowel harmony seem to be associated with spiky/curvy shapes partly as the elements of their semantic composition and that the Korean phonological rule, i.e., vowel harmony is encoded in the mental lexicon.

2.4.2 Korean speakers' processing of English sound symbolism

In block II, the Korean L2 speakers who participated in the previous LDT took part in the LDT with English stimuli. The RT data for one subject who had accuracy below 75% were removed from the analyses, and other procedures of data cleaning are

identical to those in block I. Mean accuracy with 29 subjects was 91% (SD 4.0%). As previously delineated, to examine whether L2 speakers have implicit knowledge about the association between stops/fricatives and the spiky/curvy shapes, words containing one or two stops (e.g., *pop*) were presented within the spiky frame whereas those with one or two fricatives (e.g., *faith*) within the curvy frame. As illustrated in Figure 6, the effect of the type of sound-shape association reached significance ($F(3, 84) = 13.78$, $p < .05$). Responses to stop-words within spiky shapes yielded faster RT than those to fricative-words within curvy frames, nasal-words (e.g., "mma") and spiky frames or nonwords with incongruent frames (553 ms vs. 598 ms vs. 593 ms vs. 612 ms). This finding suggests that the cross-modal matching between stops and spiky shapes holds more robust representations in L2 lexicon. Post-hoc LSD test revealed that fricative-words also led to marginally significant shorter RT than nonwords ($p = .06$) and the differences in RT to nasal-words and nonwords also were marginally significant ($p = .08$). However, responses to fricative-words and nasal-words were not significantly different ($p > .05$). This implies that fricatives and nasals pattern together with curvy shapes rather than sharper pieces. Overall, the differences in RT between matching of stop, fricatives and nasals to shapes and that of nonwords indicate that L2 sound-shape association, i.e., the cross-modal correspondence had an impact on L2 speakers' behavior of interest in this study.

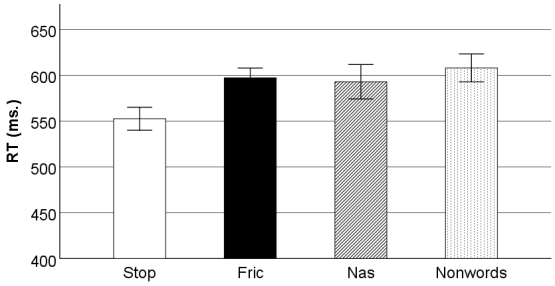

Figure 6. RT by the type of sound-shape association

What is of more interest is that the responses to words containing double stops or fricatives resulted in faster RT than those containing single stop or fricative (e.g., "pop, faith" : "pass, sap", 581 ms vs. 605 ms, $F(1, 28) = 16.01$, $p < .05$). That is, the larger number of stops or fricatives associated with the spiky or curvy shape elicited shorter RT and lower error rates (10% vs. 12%) in the LDT. Interestingly enough, this finding supports the idea that even the relationship between L2 sound and shape is gradient as

suggested by Tompson and Estes (2011), and Chen et al. (2016).

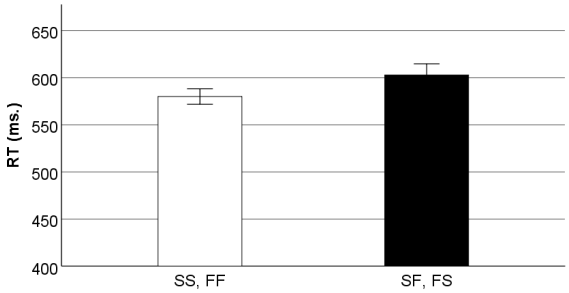

Figure 7. RT by the type of the number of stops or fricatives associated with spiky or curvy shapes

Finally, we examined whether the incongruent correspondence or mismatching between consonants and shapes, i.e., the association between stops and curvy frames or between fricatives and spiky shapes makes any differences in RT. Analysis exhibited that there was the effect of congruence although the difference was slight. That is, congruent associations yielded slightly faster responses than incongruent ones (574 ms. 576 ms. $F(1, 28) = 15.36$, $p < .05$). This result confirms that L2 sounds such as stops and fricatives have strong cross-modal correspondence with shapes.

In block III, we investigated whether shapes (i.e., round or spiky) are associated with L2 auditory sounds (i.e., stops or fricatives). Figure 8 shows the average percent choice of the round shape over spiky shape which L2 English speakers matched to the four types of pseudowords. Analyses revealed that back rounded vowels [o] and [u] were more associated with round shapes than front vowels whereas front unrounded vowels [e] and [i] with spiky shapes, showing the main effect of vowel type (64% vs 26%, $F(1, 29) = 94.44$, $p < .05$). The main effect of consonant type, however, did not emerge. That is, either stops or fricatives were found to be associated with spiky shapes with the similar amount of percentages (46% vs. 44%, $F(1, 29) = .13$, $p > .05$). Additionally, there was no interaction of consonant type and vowel type ($F(1, 29) = 1.89$, $p > .05$). This finding is consistent with that found for English L1 speakers (Peiffer-Smadja and Cohen 2019).

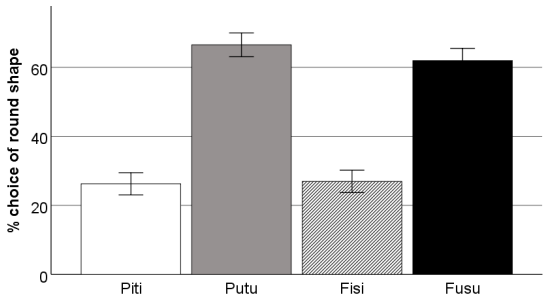

Figure 8. Mean % choice of the round over the spiky shape to match to 4 types of pseudowords

To check whether this auditory sound-shape correspondence is observed across vowel type, the percent choice of round shape was plotted for each of the vowel type as shown in Figure 9. The round shape preference for back round vowels over for front unrounded vowels was robust across the vowel sequence type. The preference for round shapes significantly varied depending on the vowel sequence type ($F(1, 29) = 101.20$, $p < .05$). Pseudowords containing /o-u/ ranked highest for the preference for curvy round shapes whereas those with /i-i/ elicited the lowest preference (69% vs. 21%).

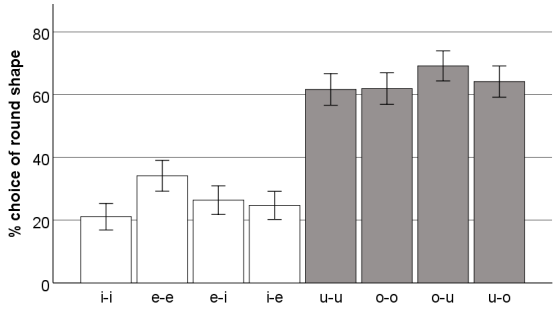

Figure 9. Mean % choice of the round over the spiky shape to match to 8 types of vowels in pseudowords

These findings are indicative of a strong association between shape and (auditory) sounds for L2 speakers. Interestingly, front vowels were associated with spiky shapes while back vowels with curvy and round shapes. This is overall in agreement with previous research with English L1 speakers (D'Onofrio 2014). Nonetheless, the effect

of the association between consonants (stops/fricatives) and shapes did not emerge in the present study unlike previous studies (Fort et al. 2015).

3. Discussion

The present study conducted behavioral experiments to examine whether cross-modal sound symbolism, which was once outside the scope of theoretical formal linguistics, holds a significant status in L2 as well as L1 speakers' mental lexicon. First, we examined whether Korean ideophones marked by vowel harmony are processed in a differential manner, depending on the shape-sound association type. The results indicate that cross-modal correspondence is observed in the limited cases of vowel harmony (Kovic et al. 2010, Maurer et al. 2006, Ramachandran and Hubbard 2001). That is, Korean participants responded faster when the light vowel harmony real words were presented with spiky shapes than when those with curvy shapes. The association between dark vowel harmony words and curvy shapes, however, was not found for real words. This asymmetry suggests that sound-shape association is more robust in the former than in the latter. This finding is interesting and significant in the sense that cross-modal link between Korean vowel harmony and sharp/curvy shapes exists though the effect is not substantial. From the results, it is plausible to mention that the nuance of shapes is a meager indicator to make a distinction between light vowel harmony and dark vowel harmony words, but that the spiky or sharp shapes are more strongly associated with light vowel harmony words than the case where curvy shapes are with dark vowel harmony words as evident from shorter RT for the former than for the latter.

A possible account for the lack of robust association of Korean vowel harmony (sound) and shapes is that the distinction between Korean light and dark vowels is vague in its association with acoustic properties predicted by "frequency theory" (Berlin 2006, Knoeferle et al. 2017). This theory suggests that visual shapes are predicted by the F2 and F3 whereas the size by the F1 and F2. Unlike the prediction of this, Korean light vowels /a, o/ and dark vowels /u, ə/ are not quite distinct in the ranges of the F2 and F3 because they are central or back vowels. This peculiar distinction might need alternative appropriate explanations for the differences in nuance underlying Korean vowel harmony. Furthermore, "mimetic theory" viewing the correlation between speech gestures and the shapes of the objects might provide an

account that since Korean light vowel /o/ and dark vowel /u/ involve similar degree of lip rounding gesture in terms of articulation, the mapping of sounds and shape is not evidently reflected in the behavioral tasks in this study (Berlin 1994). Nonetheless, it is worthwhile investigating the different degree of lip roundness of Korean /o, a/ and /u, ə/ as a reliable, potential gestural cue to make a distinction in the future research. Alternatively, it is probable that sound symbolic relation is universal, but the relation realized in Korean ideophones via vowel harmony contrast is deviant from this universal tendency (Nuckolls 1999). That is, in many languages including English, low vowel /a/ marks round-like shapes and this universality might have confused Korean participants in judging the cross-modal linkage.

Another interesting finding is that the initial consonant in vowel harmonic words mediates the cross-modal correspondence between vowel harmony and shapes. To be specific, as reported in Figure 2, the effect of sound symbolism emerged when the words begin with stops rather than with fricatives (e.g., /pʰoŋtaŋpʰoŋtaŋ/ "퐁당퐁당", /pʰuŋtəŋpʰuŋtəŋ/ "풍덩풍덩", /tolantolan/ "도란도란", /tuləntulən/ "두런두런", etc.). It might be the case that word frequency plays a role in highlighting the sound-shape correlation for these words, but this account needs further investigation.

Despite the overall behavioral characteristics with regard to sound symbolism in Korean L1 ideophones, our study makes another contribution in revealing that Korean vowel harmony along with the matching of shapes enjoys the robust status in L1 mental lexicon. It is evident from the finding that Korean participants responded in LDT when the stimuli contain vowel harmonic sequences with spiky/curvy shapes whether real or nonwords faster than when the stimuli do not show vowel harmony. This can be interpreted to suggest that Korean phonological rule, vowel harmony is stored in mental lexicon although it is difficult to describe with relevant phonological features (Chung 2000, Finley 2006).

Another significant finding in this study is that the effect of sound symbolic correspondences between consonants and shapes emerged for L2 English. Interestingly, stops with spiky shapes were responded to faster than fricatives or nasals with curvy shapes (e.g., "pop" vs. "faith" vs. "mom", 553 ms : 598 ms : 593 ms). This finding can be taken as supportive evidence for "the bouba-kiki" effect found for L1 speakers in a great bulk of previous research (Chen et al. 2016, Cuskley et al. 2017, Köhler 1947, Kovic et al. 2010, Maurer et al. 2006, Peiffer-Smadja and Cohen 2019). Furthermore, this is indicative of the stronger association of stops and spiky shapes than the integration of fricatives or nasals and curvy shapes. Given the prediction of the

combination of "gestures" and "acoustics" of sounds, it is conceivable that the abrupt spectral changes with a release to produce stops are associated with the nuance of spiky shapes whereas the continuous airflow involved with fricatives is linked with curvy shapes (Berlin 2006, Pickett 1999). The finding that Korean participants show the bouba-kiki effect in L2 English suggests that this effect might be quite universal across language and cultures although some sound-shape matching is language-specific (Diffloth 1994). Moreover, it was found that RT were shorter for stimuli with double stops or fricatives than for those with single ones, indicating that the larger number of consonants are more strongly associated with the symbolic meanings. This gradient nature is congruent with the findings obtained for L1 speakers (Thompson and Estes 2011).

In addition to the cross-modal linkage between visual sounds and shapes in the LDTs conducted in block I and II, the Explicit Association Test (EAT) performed in block III also yielded interesting results with respect to another type of cross-modal correspondence, i.e., the match between auditory pseudowords (/piti/ vs. /fisi/) and the visual shapes (spiky vs. curvy). Round shapes were preferred for pseudowords with auditory stimuli, i.e., back rounded vowels /o/ and /u/ while spiky shapes for those with front unrounded vowels /i/ and /e/ (64% vs 26%). This correlation is in agreement with findings for L1 speakers and predicted by "gesture theory" and "frequency theory" (Peiffer-Smadja and Cohen (2019). Ramachandran and Hubbard (2001) and Parise and Spence (2012) interpret this finding as such that round vowels mimic rounded lip shapes to produce round vowels and low F2 and F3 formant frequencies are reflected in round vowels. Conversely, unlike their study, the current study did not show the shape preference with respect to consonant type (stops vs. fricatives). In this sense, the results in block III are not consistent with those found in block II in this study. Thus, it is likely that the effect of consonant type varies according to the type of cross-modal correspondence or the behavioral tasks. Putting together the results in block Il and III concerning the effect of sound symbolism for L2 speakers, they indicate that the cross-modal correspondences between sounds and shapes emerge either in the dimension of the consonants or vowels.

Finally, the findings of the present study buttress the effect of sound symbolism obtained both in the auditory and visual presentations of the stimuli (auditory: Peiffer-Samadja and Cohen 2019, visual: Westbury 2005). While most previous work employed auditory presentations, this study used both visual and auditory presentations through visual LDT and auditory EAT as described. This commonality in the two

distinct modes of stimuli presentations is possibly given a neurological account whereby the inferior temporal lobe or the left lateral posterior temporal lobe might be a locus for cross-modal association between (auditory or visual) sounds and shapes (Price and Devlin 2003, Ramachandran and Hubbard 2001).

4. Conclusion

We conducted a series of cross-modal processing experiments, i.e., LDT and ETA to examine the effect of sound symbolism in L2 as well as L1. First, in LDT, we have shown that the associations between shapes and light/dark vowels based on Korean vowel harmony is loose and limited to a certain condition where the link is evident for light vowel harmony or the ideophones begin with a stop consonant. This suggests that the distinction between light and dark vowels marked in Korean vowel harmony differs from the prevalent vowel distinction patterns observed across many languages. Second, using the LDT and ETA, we found that the cross-modal sound-shape correspondences influenced lexical decision behavioral tests in the domain of consonants or vowels in L2. Thus, though the degree of sound-symbolism phenomena might differ according to language-specific L1 ideophones or the type of processing behavioral tasks, the linkage provides an interesting implication as to its status in L1 and L2 mental lexicon.

References

김영석・이상억(Kim, Y. and S. Lee). 1993. 『현대형태론』(*Modern Morphology*). 학연사(Hakyeonsa).

박동근(Park, D.). 2005. 울음 표현 흉내말의 연구(A study on mimetic words of crying expressions). 《한글》(*Han-Geul*) 247, 141-175.

박동근(Park, D.). 2007. 한국어 화자의 음성상징에 대한 인지 실험(A perceptual experiment on Korean speakers' sound symbolism). 《한말연구》(*Korean Language Research*) 21, 67-86.

이덕영(Lee, D). 1994. 한국어의 모음 조화에 대한 새로운 해석-ATR 조화(A new interpretation of Korean vowel harmony-ATR harmony). 《한글》(*Han-Geul*) 223, 157-199.

채완(Chae, W.). 2003. 『한국어의 의성어와 의태어(Onomatopoeia and Mimetic Words in Korean)』. 서울대학교 출판부(Seoul National University Press).

Akita, K., M. Imai, N. Saji, K. Kantartzis and S. Kita. 2011. Mimetic vowel harmony in Japanese. In P. Sells and B. Frellesvig, eds., *Japanese/Korean Linguistics,* 1-15. Stanford, CA: CSLI.

Bergen, B. 2004. The psychological reality of phonaesthemes. *Language* 80(2), 290-311.

Berlin, B. 1994. Evidence for pervasive synesthetic sound symbolism in ethnozoological nomenclature. In L. Hinton, J. Nichols and J. Ohala, eds., *Sound Symbolism,* 76-93. Cambridge, UK: Cambridge University Press.

Berlin, B. 2006. The firs congress of ethnozoological nomenclature. *The Journal of the Royal Anthropological Institute* 12(1), 23-44.

Bolinger, D. L. 1950. Rime, assonance, and morpheme. *Word* 6, 117-136.

Bremner, A. J., S. Caparos, J. Davidoff, J. Fockert, K. J. Linnell and C. Spence. 2013. "Bouba" and "Kiki" in Namibia? A remote culture make similar shape-sound matches, but different shape-taste matches to Westerners. *Cognition* 126, 165-172.

Chen, Y. C., P. C. Huang, A. Woods and C. Spence. 2016. When "Bouba" equals "kiki": cultural commonalities and cultural differences in sound-shape correspondences. *Scientific Reports* 6, 26681.

Childs, G. 2015. Sound symbolism. In J. Taylor ed., *The Oxford Handbook of Word*, 284-302. Oxford University Press.

Chung, C. W. 2000. An optimality-theoretic account of vowel harmony in Korean ideophones. *Studies in Phonetics, Phonology and Morphology* 6, 431-450.

Cuskley, C., J. Simner and S. Kirby. 2017. Phonological and orthographic influences in the bouba-kiki effect. *Psychological Research* 81, 119-130.

Diffloth, G. 1994. i:big, a:small. In L. Hinton, J. Nichols and J. Ohala, eds., *Sound Symbolism,* 107-114. Cambridge, UK: Cambridge University Press.

D'Onofrio, A. 2014. Phonetic detail and dimensionality in sound-shape correspondences: Refining the bouba-kiki paradigm. *Language and Speech* 57, 367-393.

Farmer, T., M. Christiansen and P. Monaghan. 2006. Phonological typicality influences on-line sentence comprehension. *Proceedings of the National Academy of Sciences* 103(32), 12203.

Finley, S. 2006. Vowel harmony in Korean and morpheme correspondence. *Harvard*

Studies in Korean Linguistics 11, 131-144.

Fleming, K. K. 1993. Phonologically mediated priming in spoken and printed word recognition. *Journal of Experimental Psychology: Learning, Memory, & Cognition* 19, 272-284.

Fort, M., A. Martin and S. Peperkamp. 2015. Consonants are more important than vowels in the bouba-kiki effect. *Language and Speech* 58, 247-266.

Hockett, C. 1982. The origin of speech. In W. S.-Y. Wang, ed., *Human Communication: Language and Its Psychobiological Bases,* 4-12. New York: Freeman.

Hutchins, S. 1998. *The Psychological Reality, Variability, and Compositionality of English Phonaesthemes*. Doctoral dissertation, Emory University. ProQuest Dissertations & Theses Global.

Imai, M., S. Kita, M. Nagumo and H. Okada. 2008. Sound symbolism facilitates early verb learning. *Cognition* 109(1), 54-65.

Imai, M. and S. Kita. 2014. The sound symbolism bootstrapping hypothesis for language acquisition and language evolution. *Philosophical Transactions of the Royal Society B*. 369: 20130298.

Kanero, J., M. Imai, J. Okuda, H. Okada and T. Matsuda. 2014. How sound symbolism is processed in the brain: A study on Japanese mimetic words. *PLoS ONE* 9(5), e97905.

Knoeferle, K., J. Li, E. Maggioni and C. Spence. 2017. What drives sound symbolism? Different acoustic cues underlie sound-size and sound-shape mappings. *Scientific Report* 7, 5562.

Köhler, W. 1929. *Gestalt Psychology*. New York, USA: Liveright.

Köhler, W. 1947. *Gestalt Psychology* (2nd ed.). New York, USA: Liveright.

Kovic, V., K. Plunkett, and G. Westermann. (2010). The shaped of words in the brain. *Cognition* 114(1), 19-28.

Kwon, N. and E. R. Round. 2015. Phonaesthemes in morphological theory. *Morphology* 25, 1-27.

Laing, C. E. 2014. A phonological analysis of onomatopoeia in early word production. *First Language* 34(5), 387-405.

Maurer, D., T. Pathman, and C. Mondloch. 2006. The shape of boubas: Sound-shape correspondences in toddlers and adults. *Developmental Science* 9(3), 316-322.

Monaghan P., R. C. Shillcock, M. H. Christiansen and S. Kirby. 2014. How arbitrary is language? *Phil. Trans. R. Soc. B* 369, 20130299.

Newman, S. 1933. Further experiments in phonetic symbolism. *American Journal of Psychology* 47, 286-848.

Nuckolls, J. 1999. The case of sound symbolism. *Annual Review of Anthropology* 28, 225-252.

Nygaard, L., A. Cook and L. Namy. 2009. Sound to meaning correspondences facilitate word learning. *Cognition* 112, 181-186.

Parise, C. V. and C. Spence. 2012. Audiovisual crossmodal correspondences and sound symbolism: a study using the implicit association test. *Experimental Brain Research* 220, 319-333.

Peiffer-Smadja, N. and L. Cohen. 2019. The cerebral bases of the bouba-kiki effect. *NeuroImage* 186, 679-689.

Pickett, J. M. 1999. *The Acoustics of Speech Communication*. Allyn & Bacon.

Price, C. J. and J. T. Devlin. 2003. The myth of the visual word form area. *NeuroImage* 19, 473-481.

Ramachandran, V. S. and E. M. Hubbard. 2001. Synaesthesia-A window into perception, thought and language. *Journal of Consciousness Studies* 8, 3-34.

Sapir, E. 1929. A study in phonetic symbolism. *Journal of Experimental Psychology* 12, 225-239.

Saussure, F. 1916. *Course in General Linguistics*. London Duckworth.

Sicoli, M. 2010. Shifting voices with participant roles: Voice qualities and speech registers in Mesoamerica. *Language in Society* 39, 521-553.

Thompson, P. D. and Z. Estes. 2011. Sound symbolic naming of novel objects is a graded function. *The Quarterly Journal of Experimental Psychology* 64(12), 2392-2404.

Van Rooyen, C. S., P. C. Taljaard and A. S. Davey. 1976. *The Sounds of Zulu*. Pretoria: University of South Africa.

Westbury, C. 2005. Implicit sound symbolism in lexical access: Evidence from an interference task. *Brain and Language* 93, 10-19.

Yun, G. 2018. Production and processing of phonaesthemes in L2 English. *Korean Journal of Linguistics* 43(4), 781-806.

Examples in: English
Applicable Languages: English
Applicable Level: Tertiary

Yun, Gwanhi (Professor)
Dept. of English Literature and Language
Daegu University
201 Daegudaero, Jinryang
Gyeongsan Gyeongbuk 38453
Tel: 053-850-6025
E-mail: ghyun@daegu.ac.kr

Received: May 22, 2020
Revised: June 20, 2020
Accepted: June 30, 2020

Appendix

Stimuli

Stimuli for block I: Korean vowel harmony stimuli

	Real words		Nonwords	
	Light VH	Dark VH	Light VH	Dark VH
/a+a/:/ə+ə/	아장아장	어정어정	파강파강	퍼겅퍼겅
	반짝반짝	번쩍번쩍	안빡안빡	언뻑언뻑
	팔락팔락	펄럭펄럭	살막살막	설먹설먹
	찰싹찰싹	철썩철썩	할싹할싹	헐썩헐썩
	달싹달싹	덜썩덜썩	반착반착	번척번척
/o+o/:/u+u/	소복소복	수북수북	노복노복	누북누북
	오목오목	우묵우묵	도목도목	두묵두묵
	올록볼록	울룩불록	졸록졸록	줄룩줄룩
	오돌토돌	우둘투둘	소몰쏘몰	수물쑤물
	소곤소곤	수군수군	고록고론	구룬구룬
/o+a/:/u+ə/	퐁당퐁당	풍덩풍덩	송방송방	숭벙숭벙
	도란도란	두런두런	호만호만	후먼후먼
	촐랑촐랑	출렁출렁	놀망놀망	눌멍눌멍
	모락모락	무럭무럭	고락고락	구럭구럭
	폴짝폴짝	풀쩍풀쩍	쏠팍쏠팍	쑬펙쑬펙
	쏙닥쏙닥	쑥덕쑥덕	쪽막쪽막	쭉먹쭉먹
	꼴깍꼴깍	꿀꺽꿀꺽	쏠깍쏠깍	쑬꺽쑬꺽
	몰랑몰랑	물렁물렁	몹방몹방	뭅벙뭅벙
/a+o/:/ə+u/	알록달록	얼룩덜룩	살목갈목	설묵걸묵
	깡총깡총	껑충껑충	빵퐁빵퐁	뻥풍뻥풍

Block II: English stimuli

stop+stop	fric+fric	stop+fric	fric+stop	filler nonwords	
pop	faith	pass	sap	lawr	rroal
puppy	forth	pussy	zip	wolj	wruw
Bob	vivo	boss	zinc	ruli	lwier
baby	vive	base	zag	yawu	wway
date	sage	toss	zoom	yuwe	lrejr
dad	sash	tooth	saga	weyu	ljeer
tote	juice	deaf	sing	liya	rwool
data	zoo	defy	zig	royu	rjay
good	judge	gaze	foot	yila	yyoow
gut	church	gauge	food	wayi	jjaal
cook	this	case	check	loru	lwseew
cake	thus	cozy	choke	reya	lleerr
mom	chase	mass	soon	yaye	wlurj

mama	chief	miss	foam	wuru	rjoll
name	vase	nose	funny	lewe	jlarw
menu	face	noose	sunny	reyu	wjujl

Block III: English pseudowords

stop+stop	fric+fric	stop+fric	fric+stop	filler nonwords	
piti	piki	tipi	tiki	kipi	kiti
pete	peke	tepe	teke	kepe	kete
peti	peki	tepi	teki	kepi	keti
pite	pike	tipe	tike	kipe	kite
putu	puku	tupu	tuku	kupu	kutu
poto	poko	topo	toko	kopo	koto
potu	poku	topu	toku	kopu	kotu
puto	puko	tupo	tuko	kupo	kuto
fisi	fichi	sichi	sifi	chifi	chisi
fese	feche	seche	sefe	shefe	chese
fesi	fechi	sechi	sefi	chefi	chesi
fise	fiche	siche	sife	chife	chise
fusu	fuchu	suchu	sufu	chufu	shusu
foso	focho	socho	sofo	chofo	choso
fosu	fochu	sochu	sofu	chofu	chosu
fuso	fucho	sucho	sufo	chufo	chuso