A Cross-linguistic Study of Sound Symbolism: The Images of Size

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Introduction

Although the sound-meaning relationship is often arbitrary (Saussure 1916), cases exist in which some sounds correspond to certain meanings. Such association between sounds and meanings is known as *sound symbolism*, and there has been a longstanding interest in the existence and the nature of sound symbolism.[1] This paper reports an experiment on size-related sound symbolism, which shows that certain sound symbolic patterns hold robustly across languages. In particular, we investigate how the images of size (small or large) are affected by three phonetic factors: the height of vowels, the backness of vowels, and voicing in obstruents. Our rating experiment of four languages—Chinese, English, Japanese, and Korean—shows that these three factors contribute to the images of size, with only a few exceptions. To explain the results, we offer phonetic grounding of these size-related sound symbolism patterns. We further raise the possibility that these phonetically grounded sound symbolic patterns are 'embodied' in the sense of Johnson (1987) and Lakoff and Johnson (1980, 1999).

1. Background

Sound symbolism refers to cases in which particular images are associated with certain sounds; for example, Sapir's (1929) seminal experimental work shows that English speakers tend to associate [a] with an image larger than that associated with [i]. Previous studies have argued that these sound symbolic patterns have phonetic bases (e.g. Eberhardt 1940; MacNeilage and Davis 2001; Ohala 1983b, 1994; Paget 1930; Sapir 1929); for example, [a] may be perceived as larger than [i] because [a] involves wider opening of the mouth than [i] (see section 5 for

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[1] There is a large body of literature on sound symbolism, which is too large to list in this short paper. For a recent summary of bibliographies on sound symbolism, see Akita (2009).

more discussion on the phonetic grounding of sound symbolism). Building on this tradition of research, our paper addresses the following three questions: (i) whether sound symbolic patterns hold robustly cross-linguistically, and if so (ii) how, and (iii) why.

Before we proceed, we clarify why studying sound symbolism is important for (cognitive) linguistic theories. First, sound symbolism possibly constitutes a counterargument against the thesis of arbitrariness, i.e. arbitrary relations between a signifiant and a signifié (Saussure 1916). Second, to the extent that sound symbolic connections between sound and meaning may have phonetic bases, sound symbolism may instantiate a case of iconicity (Haiman 1983, 1985a, b) between sound and meaning: phonetic factors affect—or even shape—meanings. Third, again to the extent that sound symbolism has phonetic bases, it may also constitute an instance of embodiment (Johnson 1987, Lakoff and Johnson 1980, 1999), which is one of the central tenets of cognitive linguistics. In short, sound symbolic patterns are, as we will argue, semantic patterns grounded in phonetic gestures (and/or their acoustic consequences). In other words, sound symbolic patterns are cases in which speakers reflect their phonetic behaviors upon the meaning of certain sounds. For these reasons, we take the study of sound symbolism to be an interesting topic of linguistic theories.

2. Research Questions

Many researchers have pointed out some existing relations between sounds and the image of size. For example, Sapir (1929) showed that given two nonce words [mil] and [mal] and two tables (small and large), English speakers tend to associate [mal], not [mil], with a large table: [a] evokes a larger image than [i] for English speakers. Building on this observation, this paper addresses three questions. The first issue is whether this size-related sound symbolism holds across languages, beyond English. Building on previous work, our current experiment shows that it does (see also Ultan 1978 for a cross-linguistic lexical study).

The second issue that this paper explores is exactly which phonetic dimensions determine the image of size. Previous researchers have offered different answers to this question. Some previous studies suggested that back vowels are perceived as larger than front vowels. For example, Newman (1933) found that English speakers judge all back vowels to be larger than all front vowels. Others found that it is vowel height that determines the images of size (Kawahara et al. 2005). Ultan (1978) argued that both height and backness affect the images of size. Furthermore, in addition to vocalic differences, Newman (1933) found that English speakers consider voiced obstruents to be larger than voiceless obstruents. In short, it remains controversial as to which phonetic factors determine the images of size. The second aim of this project is to address this question. Our experiment shows that both height and backness affect the images of size, but backness does so more robustly. In addition, obstruent voicing backness does so more robustly. In addition, obstruent voicing also affects the images of size.

The final issue concerns phonetic grounding of sound symbolism. Some scholars have suggested that size-related sound symbolism is grounded on the size of the oral cavity (e.g. Berlin 2006, Paget 1930, Sapir 1929). Building on these proposals, we attempt to clarify phonetic grounding of the size-related sound symbolic patterns. We further raise the possibility that the phonetically grounded sound symbolism instantiates a case of embodiment (Johnson 1987, Lakoff and Johnson 1980, 1999).

3. Method

The current study is a questionnaire-based rating experiment, in which the participants rated the size of various nonce words. To test whether sound symbolism holds cross-linguistically, we tested speakers of Chinese, English, Japanese, and Korean. The stimuli consisted of 40 disyllabic nonce words with VCVC form, in which the two vowels and the two consonants were identical (e.g. ibib). The consonants were four voiced obstruents [b, d, g, z] and four corresponding voiceless obstruents [p, t, k, s]. The vowels were [i, u, e, o, a], which are the five vowels that all the target languages have. These factors were fully crossed (2 voicing types * 4 types of obstruents * 5 vowels) as in Table 1. All of these stimuli are nonce words in all the target languages.

(1) Table 1. List of stimuli.

Voiced	b	d	g	z
i	ibib	idid	igig	iziz
u	ubub	udud	ugug	uzuz
e	ebeb	eded	egeg	ezez
o	obob	odod	ogog	ozoz
a	abab	adad	agag	azaz

Voiceless	p	t	k	s
i	ipip	itit	ikik	isis
u	upup	utut	ukuk	usus
e	epep	etet	ekek	eses
o	opop	otot	okok	osos
a	apap	atat	akak	asas

The participants were 20 Chinese (Mandarin) speakers, 22 English speakers, 42 Japanese speakers, and 19 Korean speakers. In the experiment, participants were presented with the stimuli on a written questionnaire[2] and asked to rate the size of each nonce word on a 1-4 scale (1=very small, 2=relatively small, 3=relatively large, 4=very large). They were instructed to imagine an exotic language in which the stimuli were spoken, and speculate on the meanings of these words, as in the instructions in (2). A sample question is shown in (3).

(2) Instructions:

Imagine an exotic language that you don't know. The language has a rich lexical inventory of adjectives that express a variety of "largeness" or "smallness". Now, a speaker of this language looks inside a box and finds a jewel. She verbally expresses how large or small it looks using one of these adjectives. Your task is to read each of the following words and guess its meaning — i.e., how large or small it is.

(3) Sample question:

ibib

1	2	3	4
very small	relatively small	relatively large	very large

The stimuli were presented using Roman alphabet in a randomized order. To assess the results statistically, a mixed linear model (Baayen 2008, Chapter 7) was used in which the main fixed factors were (i) vowel height, (ii) vowel backness, and (iii) voicing of obstruents. We also included additional fixed factors (place and continuancy) to distinguish different consonants and to soak up variability. For expository reasons, these two factors are not discussed in this paper. The model also included the speaker as a random factor. Because the exact procedure to calculate degrees of freedom has not been known, the *p*-values were instead calculated by the Markov chain Monte Carlo method. After the general analysis, we carried out post-hoc analyses comparing three levels of height. To avoid the inflation of type I error, no multiple comparisons between each of the five vowels were conducted.

4. Results

Figure 1 shows the average ratings of all the five vowels in all four languages. Here and throughout, the error bars represent 95% confidence intervals.

[2] For Japanese participants, the first author pronounced these stimuli. We were particularly concerned about our Japanese participants assigning "Japanized reading" of alphabets on our stimuli. For a possible impact of reading on sound symbolism, see Kunihira (1971).

(4) Figure 1. Overall results. The error bars represent 95% confidence intervals.

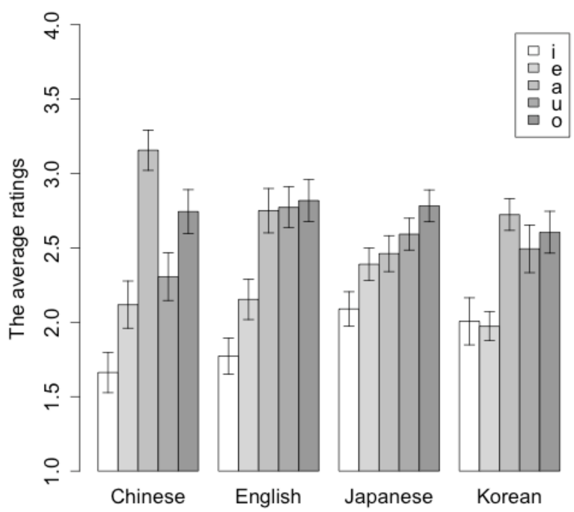


Figure 2 shows the effects of backness on the image of size. In all four languages, back vowels evoked significantly larger images than front vowels (Chinese, t=9.05, p<.001; English, t=13.37, p<.001; Japanese, t=7.89, p<.001; Korean, t=8.56, p<.001).

(5) Figure 2. The effect of vowel backness on size ratings.

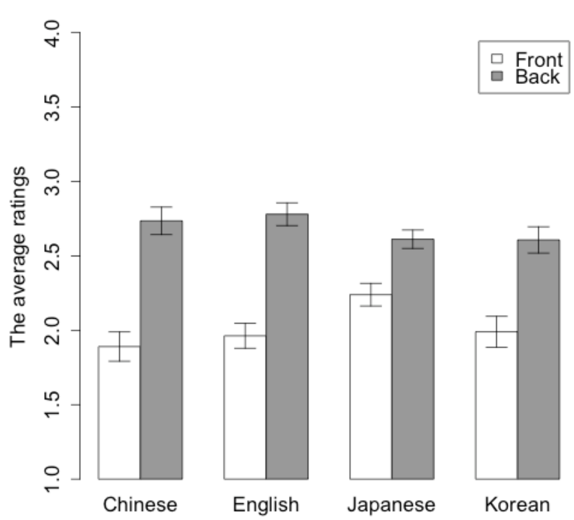


Figure 3 shows the effects of height on the image of size. Within each language, the left bar shows high vowels, the middle bar shows mid vowels, the right bar shows low vowels. There is a general trend in which the lower the vowel, the larger the image, although only Chinese showed a statistically significant effect of height in the general mixed model analyses (Chinese, t=9.48, p<.001; English, t=1.74, *n.s.*; Japanese, t=.25, *n.s.*; Korean, t(758)=1.95, *n.s*).

However, post-hoc comparisons of each level of height reveal that the high vowels [i, u] evoked significantly larger images than mid vowels [e, o] in Chinese, English, and Japanese (Chinese t=6.32, p<.001; English, t=3.45, p<.001; Japanese, t=5.04, p<.001), though not in Korean (t=1.27, *n.s.*). Second, mid vowels [e, o] evoked larger images than low vowel [a] in Chinese to a statistically significant degree (Chinese, t=4.19, p<.001), but not in English and Korean (English; t=-.86, *n.s.*; Korean, t=0.6, *n.s.*). Japanese showed a significant reversal (t=-5.00, p<.001). This result conflicts with our previous study (Kawahara et al. 2005), which found the opposite pattern: Japanese speakers rated mid vowels to be smaller than low vowel, which better accords with the hypothesized association between vowel height and the images of size. To summarize, although the overall effect of vowel height reached statistical significance only in Chinese, a closer inspection of the data shows the evidence of height effects in the other languages as well.

(6) Figure 3. The effect of vowel height on size ratings.

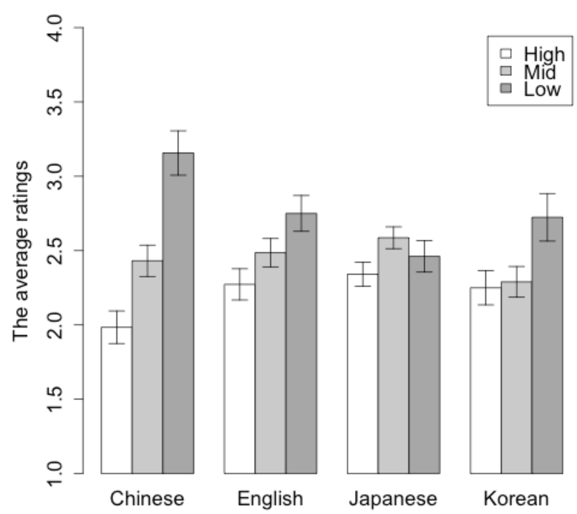
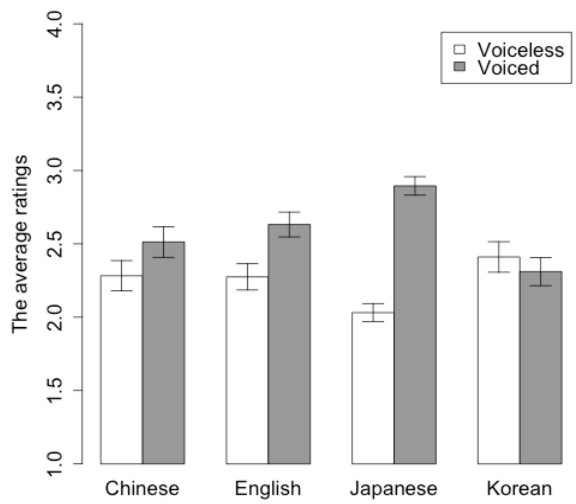


Figure 4 shows the effects of voicing of obstruents on the image of size. In Chinese, English, and Japanese, speakers rated voiced obstruents [b, d, g, z] to be larger than voiceless obstruents [p, t, k, s] (Chinese, t=3.57, p<.001; English, t=6.57, p<.001; Japanese, t=19.97, p<.001). Korean showed a non-significant reversal (t=-1.61, *n.s.*).[3]

(7) Figure 4. The effect of obstruent voicing on size ratings.



In summary, we find the following three general patterns: (i) a cross-linguistically robust effect of backness: back > front, (ii) a less robust effect of height: low > mid > high, and (iii) an effect of obstruent voicing: voiced > voiceless.

5. Discussion: Phonetic Grounding

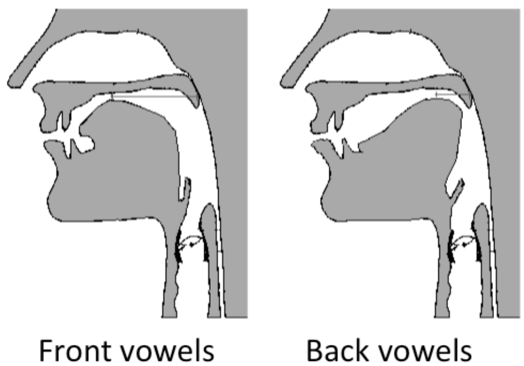
Among the three factors we have examined—vowel backness, vowel height, and obstruent voicing—vowel backness and obstruent voicing affect the image of size in all the four languages (with the exception of Korean for obstruent voicing). We now discuss phonetic bases of these effects by considering both articulatory and acoustic explanations.

5.1. Vowel Backness: An Articulatory Explanation

3 Young Ah Do (p.c.) suggested the following explanation for this exceptional behavior. In Korean, voiceless obstruents are realized as voiced in intervocalic position, and therefore Korean speakers may have perceived the voiceless stimuli (e.g. itit, ipip) as containing medial voiced consonants. Relatedly, Seunghun Lee (p.c.) shared his intuition that Korean speakers may be sensitive to size differences due to other laryngeal contrasts in such a way that aspirated consonants are larger than tense consonants, which are in turn larger than plain consonants.

Back vowels evoke larger images, presumably because they have a larger sub-oral cavity in front of the tongue. Figure 5 compares the oral cavities in front vowels and back vowels.

(8) Figure 5. Articulatory configuration of front and back vowels.[4]



As illustrated in Figure 5, the sub-oral cavity in front of the tongue is larger in back vowels. Furthermore, non-low back vowels [u, o] are usually rounded, which enlarges the sub-oral cavity (Stevens et al. 1986). Speakers also lower their larynx in pronouncing back vowels to lengthen the entire oral cavity (Diehl and Kluender 1989: p.126 and references cited there). These articulatory gestures result in larger sub-oral cavities in front of the tongue, which in turn, may yield larger images.

5.2. Vowel Backness: An Acoustic Explanation

The explanation above is articulatory, but we can offer an acoustic-based explanation based on the frequency code hypothesis (Ohala 1983b, 1994; see also Newman 1933; O'Boyle and Tarte 1980). This hypothesis builds on the correlation between the size of a resonator (or a resonating cavity) and its resulting frequency: lower frequencies imply large resonance cavities or resonators because the resonance frequency inversely correlates with its size.

We find that the second resonance frequency (F2)—acoustic correlates of backness and rounding—inversely correlates well with the judgments of size in our current experiment. Table 2 shows F2 values in Chinese (Howie 1976), English (Nishi et al. 2008), Japanese (Nishi et al. 2008), and Korean (Yang 1996).[5] In Figure 1, the judged size of five vowels (roughly) follows the order of

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[4] Figures 5 is taken from http://www.ic.arizona.edu/~lsp/Phonetics/Vowels/.

[5] The values for English, Japanese, and Korean are averaged over male and female speakers, while the Chinese data is based on one male speaker. To obtain data from comparable phonetic contexts, the values in Chinese are taken from those in the following context: in the 4th tone (high-falling) syllable near the midpoint of the vowel; non-low back vowels had [w]-onset, front

[i] < [e] < [a] < [u] < [o], and the F2 values (from high to low) follow the reserve order: [i] > [e] > [a] > [u] > [o] (with a reversal between the last two in Chinese).

(9) Table 2. F2 values of five vowels in four languages (Hz).

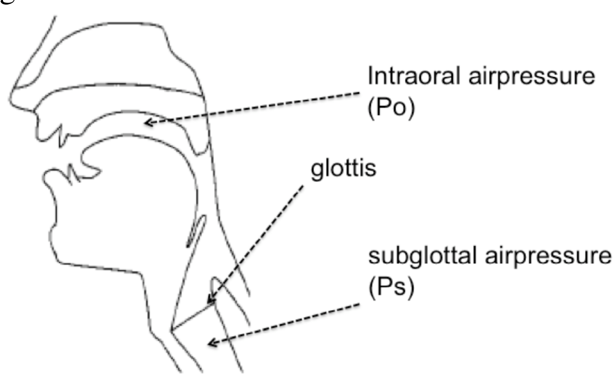
	i	e	a	u	o
Chinese	2640	2200	1480	620	1080
English	1805.5	1622.5	1210.5	1175.0	921.0
Japanese	2076.5	1777.5	1158.0	1120.0	790.5
Korean	2516.5	2172.5	1583.0	1001.0	987.0

Thus, the frequency code hypothesis predicts the right associations between resonance frequencies and the images of size, to the extent that the major acoustic correlate of images of size is F2.[6]

5.3. Voicing in Consonants: An Articulatory Explanation

We now turn to the effect of voiced obstruents, which are associated with large images. This association may have its roots in the articulation of voiced obstruents. Speakers expand their oral cavities when they pronounce voiced obstruents (Ohala 1983a), as illustrated in Figure 6.

(10) Figure 6. The oral cavity consisting of two sub-cavities separated by the glottis.[7]



We can consider the entire oral cavity as consisting of two smaller spaces separated by the glottis: the oral cavity and the sub-glottal cavity. We call the airpressure in the oral cavity "Po" (for "intraoral airpressure") and the airpressure in the

vowels had [y]-onset, and [a] had no onsets.

6 One systematic exception is [a] in Chinese and Korean, which were judged to be the largest. It may be possible that [a] is considered to be large because [a] generally has a low F0 (Whalen and Levitt 1995) (for the discussion of F1, see subsection 5.5).

7 The picture is taken from http://www.chass.utoronto.ca/~danhall/phonetics/. The illustration is ours.

sub-glottal cavity “Ps” (for “subglottal airpressure”) (Figure 6).

Po must be lower than Ps in order for the air to flow across the glottis. However, Po rises when the airway is significantly obstructed, which makes the condition Po < Ps difficult to meet. In order to keep Po sufficiently low, speakers execute several articulatory maneuvers to expand their oral cavity, such as larynx lowering, velum raising, and cheek expansion (Ohala 1983a). This articulatory expansion of the oral cavity may lead to the sensation of large images.

5.4. Voicing in Consonants: An Acoustic Explanation

An acoustic explanation is also possible for the association between voiced obstruents and large images. Recall that a lower frequency implies larger objects (Ohala 1983b, 1994). Cross-linguistically, vowels have lower F0 next to voiced obstruents than next to voiceless obstruents (see Kingston and Diehl 1994 among others). Due to the lowering of F0, voiced obstruents may evoke larger images, because low F0 implies larger resonators.

5.5. Summary: Articulatory or Acoustic?

In summary, then, our results make either articulatory or acoustic sense. A question naturally arises at this point which type of explanation—articulatory or acoustic—better explains the sound symbolic patterns in natural languages. One challenge to the acoustic view is that we would have to postulate that speakers ignore F1, because low vowels have higher F1, yet evoke larger images. Another challenge may come from Eberhardt’s (1940) finding that deaf children are sensitive to symbolic relations, although they showed behaviors slightly different from normal hearing children. She concludes that “while characteristic vowel frequency seemed to be the most important general factor involved in the choices of both deaf and normal subjects kinaesthetic data apparently played a relatively greater part in some cases with the deaf” (p. 36). At least deaf children seem to be sensitive to their articulatory gestures in the context of sound symbolism.

John Ohala (p.c.) pointed out however that the articulatory view alone cannot explain why high tones are sometimes associated with small images (e.g. in African languages: Ohala 1983a). He also points out that the articulatory view predicts that nasals may be associated with larger images because nasals include the nasal cavity in addition to the oral cavity. With these issues in mind, we would like to leave this question open at this point, and wait for future experimentation.

One line of research that could bear on this issue would consist of experiments using non-speech stimuli, which has been used to bear on the articulation/acoustic debate in other domains of phonetic theories—especially on the debate about the objects of speech perception (see Diehl et al. 2004 for a review). One such non-speech experiment on sound symbolism was conducted by O’Boyle and Tarte

(1980), who did not find a significant correlation between frequencies of pure tones and the figures that they represent. They moreover cite (unpublished) results of Tarte (1976), which found that speakers associated low tones with small figures significantly more often than with large objects—a correlation opposite of the one that the frequency code hypothesis predicts. More work using non-speech stimuli thus seems necessary.

Another line of approach may be to present to listeners non-native sounds, whose articulations cannot be guessed by the listeners.[8] If the sound symbolic patterns have articulatory bases, then listeners would not be able to associate the non-native sounds with particular images. If sound symbolism patterns have psychoacoustic bases, then the listeners should have no trouble associating them to an image.

5.6. A Final Issue: Inferences from the Lexicon?

One final issue that we would like to raise here—without offering a definite answer—is whether our results can be explained based on inferences from existing lexical items. Stochastic patterns in the lexicon are known to affect our linguistic behaviors (e.g. Hay et al. 2004). Appling this explanation to sound symbolism, for example, in English the word *large* has a low vowel; English also has a dimunitive suffix *-y* to represent small objects. From these lexical items, English speakers could have associated large images with low vowels and small images with a high front vowel [i][9] (see also Ultan 1978 for an extensive cross-linguistic lexical study). However, such analogical lexicon-based explanations face a non-negligible number of exceptions; e.g., *small* has a back vowel, while *big* has a high front vowel.

Another systematic argument against this lexicon-based explanation comes from Korean. Korean has two sets of sound symbolic vowel categories, the bright category (e.g. [a, o]) and dark category (e.g. [u, ɨ]) (Garrigues 1995: 367-371). Among other sound symbolic meanings, the bright category can denote "lightness, smallness and quickness" (Garrigues 1995: 368, citing Kim 1977: 69). Here non-high, back vowels correspond to the small images. It is unlikely therefore that the Korean participants in our experiment produced the results above based on inferences from existing items in their lexicon.

Although this Korean example is telling, it is beyond the scope of this short paper to make a definitive conclusion about a systematic lexicon-based explanation of sound symbolism. The question would ultimately boil down to: are the lexicons of the four languages we studied (and beyond) stochastically skewed enough to explain the sound symbolic patterns we observe? We would thus like to

8 We would need to use those sounds that do not perceptually assimilate to native sounds.

9 Alternatively, sound symbolism may diachronically affect the coinage of lexical words, skewing the lexicon in the direction that conforms to sound-symbolic patterns.

leave the testing of this question for future research.

6. Summary and Conclusion

Cross-linguistically, vowel backness, height, and voicing of obstruents all affect the perception of size, at least to some extent. Vowel backness most robustly evokes the image of largeness, vowel height does so to a lesser extent, and obstruent voicing strongly affects the images of size. These patterns make phonetic sense (articulatory and/or acoustic). Speakers can project their articulatory gestures (or their acoustic consequences) to the sensation of image.

Patterns of sound symbolism can be a counterargument against the thesis of arbitrariness (Saussure 1916). Speakers have some non-arbitrary intuition about connections between sounds and meanings/images. They may have embodied motivations and may instantiate iconicity (e.g. Haiman 1983, 1985a, b) between sound and meaning. The study of sound symbolism thus can be an interesting topic in cognitive linguistics.

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