Cross-modal correspondences between vowel intrinsic duration and the length of musical notes: implications for the *mil/mal effect*

Vowels are the main drivers in 'size-sound symbolism' or 'magnitude sound symbolism', i.e., the association between size (large/small) and sound. In a classic study, Sapir (1929) demonstrated that subjects associate meaningless words containing low and back vowels like /a/ (e.g., as in *mal*) with large concepts and meaningless words containing high and front vowels like /i/ (e.g., as in *mil*) with small concepts. This *mil/mal effect* (Sidhu & Pexman, 2018) could be replicated in numerous experimental studies showing the postulated association between vowel quality and size (e.g. Shinohara and Kawahara, 2016). Likewise, statistical studies in typologically diverse languages found associations between the high front vowel /i/ and the concept of 'small' and between the low back vowel /ɑ/ and the concept of 'large' (e.g. Ultan 1978; Blasi et al. 2016). Several explanations have been suggested for these associations (for an overview see Sidhu & Pexman, 2018). Explanations include articulatory aspects such as a small/large space in the mouth depending on vowel articulation, as well as acoustic aspects such as Ohala's (1984) "frequency code" hypothesis, according to which size-symbolism mirrors the size of the vocalizers producing either lower or higher frequencies, or vowel intrinsic pitch and vowel intrinsic duration.

Here, I present the results of a recent study (author 2022) which suggest that vowel *intrinsic duration* might play a decisive role in size-sound symbolism. It is generally assumed that low vowels like [a ɔ o] have a higher intrinsic duration than high vowels like [i u y], and that there is a positive correlation between the first formant F1 and duration, i.e., the lower the vowel, the higher F1, and the higher the intrinsic duration of the vowel (House and Fairbanks, 1953; Peterson and Lehiste, 1960).

Hypothesis: In songs containing meaningless syllables, syllables with low vowels like [a ɔ o] should be favored for long notes and syllables with high vowels like [i u y] for short notes.

Method: The assumption was tested based on traditional Alpine yodels in Pommer's collection from 1906. All 20 yodels in the collection were analyzed. The total number of notes/syllables in the sample amounts to 1,836. I determined all relative note values in the sample: half notes (the longest note values in the sample), quarter notes, eighth notes, sixteenth notes, and thirty-second notes (the shortest notes in the sample).

The notes were assigned to the respective syllables containing either high vowels like [i u y] or low vowels like [a ɔ o]. Furthermore, all dotted notes—the dot increases the duration of the basic note by half of its original value—were identified and matched with the particular syllables.

Results:: Eighth notes are more often aligned with high vowels (590x) than with low vowels (255x), ($X^2 = 132.811$, $p < 0.0001$). Quarter notes are 405 times aligned with high vowels and 267 times with low vowels ($X^2 = 28.339$, $p < 0.0001$). Sixteenth notes are associated with high vowels 45 times and with low vowels 50 times $X^2 = 0.263$, n.s.). Thirty-second notes are 28 times aligned with high vowels and 6 times with low vowels ($X^2 = 14.235$, $p < 0.001$).

On the contrary half notes, the longest note values in the sample, are more often aligned with low vowels (135x) and less frequently associated with high vowels (55x), ($X^2 = 33.684$, $p < 0.0001$). This also holds for dotted notes which are 265 times associated with low vowels and only 83 times with high vowels ($X^2 = 95.184$, $p < 0.0001$).

Discussion: The analysis of 20 Alpine yodels demonstrates that short musical notes such as eighth notes, quarter notes and thirty-second notes tend to align with vowels with smaller intrinsic duration, whereas relative long notes such as half notes or dotted notes are associated with vowels with longer intrinsic duration.

The iconic associations between vowel intrinsic duration and length of musical notes may shed light on size-sound symbolism in general. Although 'duration' of musical notes only metaphorically corresponds to 'size' of notes, our data are in line with results by Knoeferle et al. (2017) suggesting F1 in combination with F2 and vowel duration are decisive factors in size-sound symbolism; F0 does not seem to play a role in their experiments on visual size judgements. Similarly, Vainio (2021) reports that F0 or Ohala's frequency code hypothesis did not show to be relevant in his study on magnitude sound symbolism.
Since our results demonstrate a direct match between vowel intrinsic duration and the 'size' of musical notes, there is no need to explain the 'size' of musical notes via Ohala's "frequency code" hypothesis. Therefore, a possible answer to the question "What is, for example, so small about *mil* and large about *mal*? (Vainio 2021, p. 2) might be: Small about *mil*, is the small intrinsic duration of the vowel /i/, and large about *mal* is the large intrinsic duration of the vowel /a/.

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