

## Bisensory association between sound and shape

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One of the compelling pieces of evidence for non-arbitrary audiovisual association is the *Bouba-Kiki effect*: people tend to label a round shape ‘bouba’ and a spiky shape ‘kiki’ (Köhler, 1947; Ramachandran & Hubbard, 2001). Previous studies, however, have not successfully disentangled phonetic features from other factors that might contribute to this association, such as linguistic and orthographical factors (D’Onofrio, 2014; Fort et al., 2015). To closely examine the influence of phonetic features, we used Haskins Articulatory Synthesizer to generate auditory stimuli that are not confined to any language or orthographic system. Twenty-five vowel sounds were created by equi-distantly manipulating the height and frontness of the tongue body position, and 12 consonant sounds were generated by parametrically manipulating the oral (lips, tongue tip, tongue body) and non-oral (glottis, velum) constriction gestures, with the vowel gesture fixed at its rest position. Multidimensional scaling analysis of the synthesized sounds confirmed that physical spaces conformed to perceptual space, showing the effectiveness of the manipulation of the physical parameters. Experiment 1: 40 participants listened to the vowel sounds and were asked to choose between round and spiky shapes. Results showed the main effects of height and frontness ( $p < .001$ ): high and front vowels (e.g., /i/) were associated with spiky shape, and low and back vowels (e.g., /a/) were linked with round shape. Experiment 2: 40 new participants listened to consonant sounds, with which they had to associate either round or spiky shape. Results showed that sounds generated with the lip organ (e.g., /be/, /me/) were associated with round shape whereas consonants with glottal gestures (e.g., /keh/, /kheh/) were associated with spiky shape, both significantly above chance ( $p < .001$ ). These results indicate that phonetic, not other features indeed play a vital role in the *Bouba-Kiki effect*, exemplifying a non-arbitrary relationship between sound and shape.

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