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Sound symbolism in infancy: Evidence for sound–shape cross-modal correspondences in 4-month-olds

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ABSTRACT

Perceptual experiences in one modality are often dependent on activity from other sensory modalities. These cross-modal correspondences are also evident in language. Adults and toddlers spontaneously and consistently map particular words (e.g., 'kiki') to particular shapes (e.g., angular shapes). However, the origins of these systematic mappings are unknown. Because adults and toddlers have had significant experience with the language mappings that exist in their environment, it is unclear whether the pairings are the result of language exposure or the product of an initial proclivity. We examined whether 4-month-old infants make the same sound–shape mappings as adults and toddlers. Four month-olds consistently distinguished between congruent and incongruent sound–shape mappings in a looking time task (Experiment 1). Furthermore, mapping was based on the combination of consonants and vowels in the words given that neither consonants (Experiment 2) nor vowels (Experiment 3) alone sufficed for mapping. Finally, we confirmed that adults also made systematic sound–shape mappings (Experiment 4); however, for adults, vowels or consonants alone sufficed. These results suggest that some sound–shape mappings precede language learning, and may in fact aid in language learning by establishing a basis for matching labels to referents and narrowing the hypothesis space for young infants.

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Introduction

The mapping between labels and referents has been considered arbitrary in mainstream linguistics (De Saussure, 1916/1983). However, research findings suggest some systematicity between specific labels and referents; adults and toddlers spontaneously and consistently map particular shapes to particular words even when there appears to be no obvious physical basis for the mapping (e.g., Köhler, 1947; Maurer, Pathman, & Mondloch, 2006). However, because adults and toddlers already have significant experience with language mappings in their environment, it is unclear whether these biases are the result of an acquired sensitivity or an initial proclivity. Here we investigated the origins of these sound–shape mapping biases by examining whether 4-month-old infants share the same sound–shape mapping biases as adults and toddlers.

A fundamental tenet of modern linguistics is that there is no systematic relationship between linguistic labels and the meaning they convey (De Saussure, 1916/1983). Some have even proposed that this arbitrary connection between linguistic labels and their referents is a fundamental feature of human language (e.g., Monaghan, Fitneva, & Christiansen, 2011; Ramachandran & Hubbard, 2001) and the basis for its referential power (e.g., Gasser, 2004). Moreover, if the sound structure of words was related in a systematic way to their referents, we would expect similarities across languages, with similar inventories of sounds corresponding to similar types of meaning. This is clearly not the case because even a simple concept such as *tree* is realized with phonologically distinct words in different languages—*ağaç* in Turkish, *zuhaitza* in Basque, *árbol* in Spanish, and *dendro* in Greek. Indeed, most linguistic labels have different sound structures in different languages; these labels are conventions agreed on by the speakers of the languages with no apparent systematic relationship to their referents (Hockett, 1977).

However, not all label–referent mappings appear to be arbitrary. Cross-linguistic observations suggest that there are words in natural language whose sounds are systematically related to their meanings. Ideophones—words that are used by speakers to evoke vivid associations with particular sensory perceptions (e.g., smell, color, shape, sound, action, or movement across languages)—are widely attested in the languages of the world (Voeltz & Kilian-Hatz, 2001). West African, East Asian, and Southeast Asian languages, and to a lesser extent Amerindian languages, are known for their large inventories of ideophonic vocabulary, but many other languages also make use of ideophones (e.g., Turkish *citir citir* 'crispy'; Basque *mara mara* 'falling softly, said of rain'; Ewe *gbadzaa* 'flat, spreading out over a wide area'; English *bling bling* 'glitter, sparkle'). However, the sounds of these words evoke or imitate the meaning, creating systematic nonarbitrary connections.

People also systematically map particular speech sounds to properties of objects cross-linguistically. For instance, across languages, there are phonetic classes of speech sounds that are systematically found in vocabulary related to size (e.g., /i/ vs. /a/ for size as in Ewe *kitsikitsi* 'small' vs. *gbaggbagba* 'big', Greek *micros* 'small' vs. *macros* 'large') or distance (e.g., words for *here* are more likely to include an /i/ sound and words for *there* are more likely to include an /a/ sound; see Tanz, 1971). Experimental findings also support this idea of sound–size relations. Syllables containing low back vowels (e.g., *mal*) are consistently matched to large objects, whereas syllables containing high front vowels (e.g., *mil*) are consistently matched to small objects (Sapir, 1929). Recently, cross-modal mapping of sound and size has also been demonstrated in infants, with 4-month-olds matching [o] or [a] to large objects and [i] or [e] to small objects (Peña, Mehler, & Nespor, 2011). Thus, systematic mapping of sound to size is widespread and observed even during infancy.

Cross-modal correspondences between sound and size have been noted for centuries (Descartes, 1641/1986; Gibson, 1966; Ohala, 1997; Walker et al., 2010) and appear to be grounded in physical reality. High front vowels such as [i] and [e] tend to have higher fundamental frequencies (F_0) than low back vowels such as [o] and [a] (Whalen & Levitt, 1995). At the same time, objects that are physically thinner or smaller tend to produce a higher pitch than wider larger objects. For instance, the pitch of a cello is lower compared with the pitch made by its smaller cousin, the violin. Similarly, the vocal folds of a larger animal are longer, and longer vocal folds tend to generate sounds that are lower in pitch (Shayan, Ozturk, & Sicoli, 2011; Zbikowski, 1998). Peña and colleagues (2011) proposed that infants may map vowels to object size based on their experience in seeing mouths open to