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Early sound symbolism for vowel sounds

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Abstract. Children and adults consistently match some words (e.g., kiki) to jagged shapes and other words (e.g., bouba) to rounded shapes, providing evidence for non-arbitrary sound–shape mapping. In this study, we investigated the influence of vowels on sound–shape matching in toddlers, using four contrasting pairs of nonsense words differing in vowel sound (/i/ as in feet vs. /o/ as in boat) and four rounded–jagged shape pairs. Crucially, we used reduplicated syllables (e.g., kiki vs. koko) rather than confounding vowel sound with consonant context and syllable variability (e.g., kiki vs. bouba). Toddlers consistently matched words with /o/ to rounded shapes and words with /i/ to jagged shapes ($p < 0.01$). The results suggest that there may be naturally biased correspondences between vowel sound and shape.

Keywords: sound symbolism, cross-modal perception, naturally biased associations, sensory associations, perceptual development.

Some relationships between sound and meaning are not arbitrary and can be understood universally (e.g., Berlin, 1994; Imai, Kita, Nagumo, & Okada, 2008; Nuckolls, 1999; Nygaard, Cook, & Namy, 2009). For example, across languages, objects that are larger or darker tend to be named by words containing the vowels *a* and *o* (e.g., Day, 2004; Nuckolls, 1999; Tanz, 1971). These sound symbolic regularities allow adults to categorize words in unknown foreign languages (e.g., Berlin, 1994).

Sound symbolism is also evident in the associations between objects and nonsense words. Adults and children as young as 2.5 years associate rounded and jagged shapes with different nonsense words (e.g., bouba; maluma vs. takete; kiki, respectively; Davis, 1961; Kohler, 1929; Lindauer, 1990; Maurer, Pathman, & Mondloch, 2006; Ramachandran & Hubbard, 2001). Our sensitivity to such sound symbolism may have affected the evolution of languages and may influence children's language development (e.g., Imai et al., 2008; Ramachandran & Hubbard, 2001). As a child acquires vocabulary, words that make use of these natural correspondences may be easier to learn (Nuckolls, 1999; Smith & Sera, 1992). These effects have been attributed to the roundness of the vowel, that is, the shape of the mouth and lips when producing it (Justice, 2001). However, there were also variations in the consonants (e.g., bouba vs. kiki) and in the amount of variability within the words (e.g., kiki vs. maluma).

The purpose of this study was to examine whether children at the age of the vocabulary explosion—namely 2.5-year-olds—are sensitive to sound symbolism for vowels. The method was identical to our previous study with toddlers (Maurer et al., 2006) except that the contrasting words differed only in their vowels, always in the context of a reduplicated consonant (see Table 1). The contrasting vowels (/o/ as in boat and /i/ as in feet) differed in vowel roundness, as well as whether the tongue is in the back or front of the mouth. Toddlers ($n = 20$, 11 male; range 30–36 months, mean = 34 months) participated in a "game" consisting of eight trials, at the start of which the experimenter attracted the child's attention to her face. The four experimental trials involved the presentation of two words (e.g., kiki and koko) with two contrasting unfamiliar shapes, one jagged and one smooth, and a forced choice to match one of the words to a shape (e.g., "Can you point to the koko?"). For each contrast, half of the children were asked for the object with the /i/ label and half for the object with the /o/ label, with each child receiving an equal number of /i/ and /o/ requests across the four trials. The four valid-

Table 1. The pairs of words used during the four experimental trials, each of which contrasted the rounded back vowel /o/ and the non-rounded front vowel /i/ (as in beet).

Stop consonants	Word lists	
G	Gigi	Gogo
B	Bibi	Bobo
K	Kiki	Koko
D	Didi	Dodo

ity trials were designed to evaluate understanding of the task and consisted of a forced choice between familiar objects (e.g., "Which one is the rooster?").

Children associated the words with /o/ with rounded shapes and the words with /i/ with angular shapes significantly more often than chance (mean = 0.65, $t(19) = 3.11$ $p = 0.006$, one-tailed; Figure 1). This effect was present whether the child was asked for the match to the /o/ vowel (mean = 0.68) or the /i/ vowel (mean = 0.63). It was consistent across consonant contexts (Figure 1) except for the consonant k.

These results show for the first time that when nonsense words differ *only* in vowel sound, children as young as 2.5 years old match rounded shapes to words with rounded back vowels and jagged shapes to words with non-rounded front vowels. There may also be an effect of consonant sound, as there is in adults (e.g., Nielsen & Rendall, 2011), but that possibility was not tested here.

Our findings may have resulted from children's learning the statistical regularities of English words. However, it is also possible that this effect represents a naturally biased association between the characteristics of the phoneme (its sound, the lip and mouth shape when someone else produces it or one produces it oneself) and the objects named and that these natural associations influenced the evolution of languages (Ramachandran & Hubbard, 2001). Within this framework, words used to represent more jagged objects would tend to have phonemes that do not round the mouth, taking

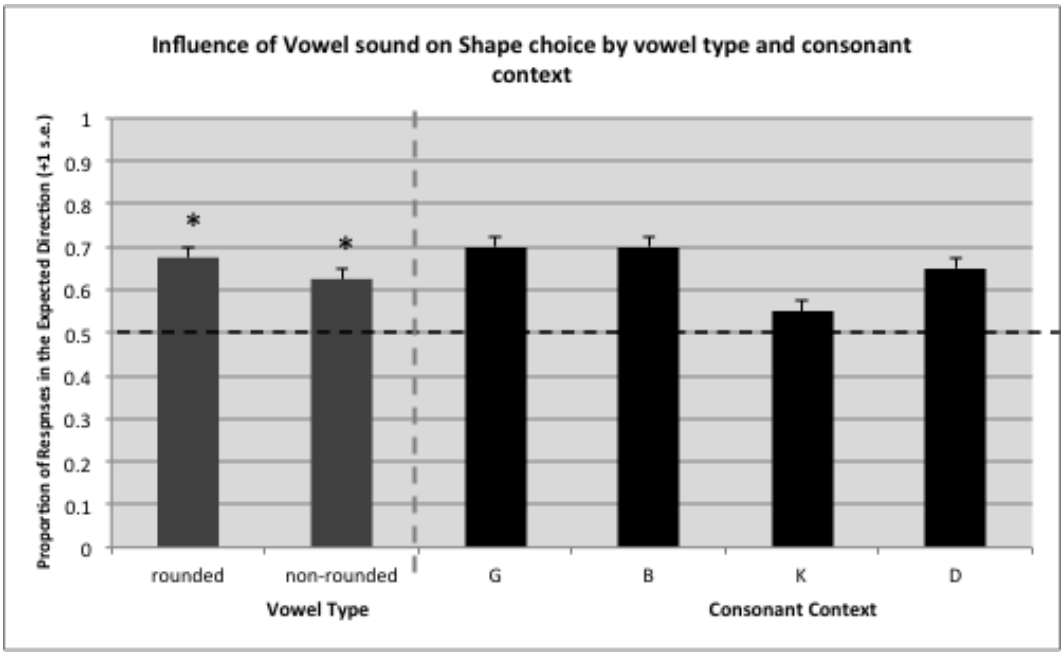

Figure 1. Mean proportion (+1 s.e.) of toddlers' choices in the expected direction (rounded back vowel – rounded shape; non-rounded front vowel – jagged shape). The black dotted line indicates the level expected by chance. Bars to the left indicate the overall influence of vowel sound on shape choice, and asterisks indicate proportions greater than chance. Bars to the right of the grey dotted line indicate the results for each consonant context. Because each child received only one trial of each type, we did not perform statistics separately for each consonant context.

advantage of natural biases. By the time a child is 2.5 years old, the combination of the natural bias and sensitivity to statistical regularities in sound–meaning mappings that evolved from it would jointly influence the continued acquisition of vocabulary. Whatever the origins, our results indicate that sound symbolism for vowels influences toddlers' mapping of words to objects and hence the ease with which they will acquire new vocabulary.

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