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## Sound symbolism facilitates early verb learning

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### ABSTRACT

Some words are sound-symbolic in that they involve a non-arbitrary relationship between sound and meaning. Here, we report that 25-month-old children are sensitive to cross-linguistically valid sound-symbolic matches in the domain of action and that this sound symbolism facilitates verb learning in young children. We constructed a set of novel sound-symbolic verbs whose sounds were judged to match certain actions better than others, as confirmed by adult Japanese- as well as English speakers, and by 2- and 3-year-old Japanese-speaking children. These sound-symbolic verbs, together with other novel non-sound-symbolic verbs, were used in a verb learning task with 3-year-old Japanese children. In line with the previous literature, 3-year-olds could not generalize the meaning of novel non-sound-symbolic verbs on the basis of the sameness of action. However, 3-year-olds could correctly generalize the meaning of novel sound-symbolic verbs. These results suggest that iconic scaffolding by means of sound symbolism plays an important role in early verb learning.

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### 1. Introduction

Since the time of Saussure, the arbitrary relationship between the sound of a word and its meaning has been held as an important principle of language (e.g., [de Saussure, 1916/1983](#); [Newmeyer, 1993](#)). In mainstream linguistics, sound symbolism, in which the sound and meaning of words are systematically related, is considered to be a marginal phenomenon in language. For example, [Newmeyer \(1993\)](#) says that “the number of pictorial, imitative, or onomatopoeic non-derived words in any language is vanishingly small (p. 758)”.

Such a statement, however, turns out to be too strong when one looks beyond Indo-European languages. Many languages of the world have a large grammatically defined word class in which sound symbolism is clear. For example, in Japanese, mimetics (*giongo/gitaigo*) include

not only onomatopoeias for animal sounds (such as *nyaa* for cats) but also words referring to events and states in which sound is not essential. Sound symbolism in mimetics in Japanese can be illustrated in the words referring to motion events shown in [Table 1](#). The combination of ‘g’/‘k’ and ‘r’ often represents rotation as seen in (a)–(d). The voiced initial consonant is associated with larger mass and the voiceless initial consonant is associated with smaller mass, as seen in (a)–(f). Any of the forms in (a)–(f) can be reduplicated to indicate that the event took place repeatedly, as illustrated in (g). (See [Hamano, 1998](#); [Kita, 1997](#); [Kita, 2001](#), for more detailed accounts, including description of the grammatical properties which characterize this class.) In Japanese, mimetics can also refer to tactile, visual, and emotional experiences: e.g., *nurunuru* ‘being slimy’, *pika* ‘a flash of light’, and *sowasowa* ‘being restless’. Mimetics constitute a large open class of words, and new words can be easily created: one mid-sized dictionary of mimetics lists 1700 entries ([Atoda & Hoshino, 1995](#)). These words are frequently used

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**Table 1**  
Sound symbolism in Japanese mimetics

| Mimetics     | Meaning   |
|--------------|---|
| (a) goro     | 'a heavy object rolling'                                |
| (b) koro     | 'a light object rolling'                                |
| (c) guru     | 'a heavy object rotating around an axis'                |
| (d) kuru     | 'a light object rotating around an axis'                |
| (e) bota     | 'think/much liquid hitting a solid surface'             |
| (f) pota     | 'thin/little liquid hitting a solid surface'            |
| (g) potapota | 'thin/little liquid hitting a solid surface repeatedly' |

in everyday conversation and newspaper articles, as well as in various forms of verbal arts from comic books to novels and poems.

Japanese is by no means an exception among languages of the world. Many languages of the world have a similar grammatical class of words with clear sound symbolism (for an overview, see Hinton, Nichols, & Ohala, 1994; Nuckolls, 1999; Voeltz & Kilian-Hatz, 2001), including most sub-Saharan African languages (called “ideophones”; see Childs, 1994, for a review), and many of the South East Asian languages (called “expressives”; Diffloth, 1972; Diffloth, 1979; Enfield, 2005; Watson, 2001) and East Asian languages (for Korean see Lee, 1992; for Chinese dialects, see Bodomo, 2006; Mok, 2001). Sound-symbolic word classes are also found in some (non-Indo-European) languages in southern India (Emeneau, 1969), Australian Aboriginal languages (Alpher, 1994; McGregor, 2001; Schultze-Berndt, 2001), and indigenous languages in South America (Nuckolls, 1996). In Europe, Basque (Ibaretxe Antñano, 2006) as well as Finish and Estonian (Mikone, 2001) (all non-Indo-European languages) have an extensive sound-symbolic word class. Similar to Japanese mimetics, sound-symbolic words in these languages also express information from various perceptual modalities and affective states, as well as the temporal structure of events (see, e.g., Childs, 1994; Ibaretxe Antñano, 2006; Mikone, 2001; Nuckolls, 1999).

Thus, although ideophones or mimetics as a large grammatically defined word class are “conspicuously absent” (Nuckolls, 1999) in Indo-European languages, they are not at all rare in languages of the world. The words in these classes refer to concepts that are similar to Japanese mimetics. Furthermore, in these languages, sound-symbolic words are not limited to whimsical use to and by children. They are indispensable in adult language, especially in oral expression, but also in written language such as in novels and poetry.

Even in Indo-European languages such as English, there is clear sound symbolism in words such as *squeeze*, *squirt*, *squint*, *bump*, *thump*, and *plump* (e.g., Firth, 1935/1957), though such words do not form a distinct grammatically defined class. Systematic relations between certain phonemes and meanings have also been pointed out. For example, roughly half of the common English words starting with ‘gl-’ imply something visual, as in *glance*, *glare*, *gleam*, and *glimmer* (Bloomfield, 1933/1984; Bolinger, 1950). Thus, the literature suggests that the principle of arbitrary relationship between the sound of a word and its meaning is not as absolute as Saussure had proposed.

### 1.1. Psychological evidence for sound symbolism

Starting with Köhler (1929), there has been a body of empirical work which demonstrates the psychological reality of sound symbolism. Köhler found that when presented with a curvy round shape and a spiky angular shape, one has the intuition that *baluma* is a better name for the former and *takete* is a better name for the latter (see also Ramachandran & Hubbard, 2001; Westbury, 2004). Sapir (1929) also demonstrated that English speakers associate novel words containing the vowel /i/ with smallness more frequently than words containing /a/. This phenomenon has been described as magnitude sound symbolism.

More recently, empirical evidence for sound symbolism has been extended in two important directions. Maurer, Pathman, and Mondloch (2006) replicated Köhler's (1929) findings with 2.5-year-old English-speaking children and demonstrated that children as young as 2.5-years-old are sensitive to sound symbolism in matching novel words and novel shapes. Specifically, in a forced-choice task in which 2.5-year-olds were asked to select the object (out of two) that was referred to by a novel word, the children matched rounder shapes to words containing the vowels [ah] or [u] (e.g., *bamu*) and pointed shapes to words containing the vowels [i], [ej], or [^] (e.g., *kuh-tay*), just as adults did in Köhler's experiment. Westbury (2004) extended Köhler's findings using implicit interference in a lexical decision task, using English-speaking adults. He visually presented non-words containing either stop consonants (e.g., ‘kide’) or continuants (e.g., ‘lole’) inside a spiky shape or curvy shape. The participants were slower to reject non-words when there was a sound-symbolic match between the non-word and the figure in which it appeared (i.e., non-words with stop consonants in a spiky figure, and non-words with continuants in a curvy figure). In other words, the sound-symbolic match made the non-words look more like real words. These studies thus indicate that sound-symbolic matching between the sound of a word and its meaning (shape) occurs on-line and automatically, and that the sensitivity to matches between sound and shape is found early in childhood.

### 1.2. Universality of sound symbolism

There is also evidence that certain aspects of sound symbolism are universal. The magnitude sound symbolism mentioned above was also found in Chinese and Thai speakers (Huang, Pratoomraj, & Johnson, 1969). Köhler's (1929) sound symbolism for curvy round shapes vs. spiky angular shapes was found in speakers of Kitongwe in their middle to late childhood (aged 8- to 14-year-old) living in a remote part of Tanzania, who had little contact with Europeans (Davis, 1961). It has also been shown that people can correctly match antonym pairs such as *good-bad*, *strong-weak*, and *fast-slow* in foreign languages they do not know to the semantically equivalent pairs of words in their native language, using the sounds of the words alone to guess the meaning (e.g., Brown, Black, & Horowitz, 1955; Klank, Huang, & Johnson, 1971).

On the other hand, not all aspects of sound symbolism are universally recognized. Iwasaki, Vinson, and Vigliocco (2007) had native speakers of Japanese- and English speakers who have not studied Japanese rate conventional Japanese mimetic words describing different manners of walking on various conceptual dimensions (e.g., Big Person–Small Person, Graceful–Vulgar, Energetic–Dull, Steady–Clumsy, etc.) on semantic differential scales. They found that English and Japanese speakers' ratings were correlated on some semantic dimensions, but not others. For example, not only Japanese speakers but also English speakers rated mimetic words starting with a voiced consonant higher on the meaning component of "big person" than those starting with voiceless consonant. However, ratings of English and Japanese speakers did not agree on evaluative dimensions such as beauty or pleasantness. Furthermore, even when the directions of the ratings (on the polar scale) agreed across English and Japanese speakers, English-speakers ratings were not as clearly differentiated as Japanese speakers' ratings.

Taken together, sound symbolism in mimetics seems to involve both universally shared sound-meaning mappings and language-specific components that are embedded in the language's phonological characteristics. Sound-meaning mappings on dimensions involving magnitude suggested by Sapir or those suggested by Köhler on angular-round shape seem to have strong universal tendencies, as they are observed in different languages that are not typologically related, and even in languages that do not have mimetics/ideophones as a special word class.

### 1.3. Children's difficulty in learning action names, and caretakers' adjustment to the input

Previous research that empirically demonstrated sound symbolism has mostly dealt with the link between linguistic sound and shape (Davis, 1961; Köhler, 1929; Maurer et al., 2006; Ramachandran & Hubbard, 2001; Westbury, 2004). However, shape is not necessarily the major domain in which sound symbolism has been systematically observed in languages. In Japanese, for example, sound symbolism is much more frequently used in expressing tactile sensation, emotion, and manner of motion than in expressing shape (Oda, 2000, see above for examples).

An interesting observation is that sound-symbolic words, especially those which refer to action (*gitaigo*), are used abundantly in speech by and toward young children in Japanese (though use of these words is by no means limited to children's language, as mentioned earlier). In Nagumo, Imai, Kita, Haryu, and Kajikawa (2006), 22 Japanese mothers described pictures depicting a person acting in relation to an object (e.g., a boy throwing a ball, rolling a carpet, jumping over a flower, wiping a mirror with a cloth, etc.) to their children (18–20 months) as well as to an adult experimenter. Altogether, 577 references to the actions were made when the mothers were talking to their children, and 57% of the action references were made using mimetic words, and 39% were made using conventional verbs. In contrast, when the mothers described the pictures to the experimenter, 81% of the action references were made using conventional verbs, while only 12% were

using mimetic words. Thus, the mothers used mimetics five times more often with the child than with the adult when referring to actions (see also Yoshida & Smith, 2006, for similar findings).

An interesting possibility is that richness of mimetics in child-directed speech may play a scaffolding role in the acquisition of verbs. Verbs are known to be difficult for young children to learn compared to object names (e.g., Childers & Tomasello, 2006; Gentner, 1982). There are multiple reasons for the difficulty. For example, unlike objects, actions are ephemeral and difficult to individuate: it is not obvious when the action referred to by a given word starts and when it ends. Thus, the time at which young children are able to establish a word-referent relation tends to be delayed for verbs compared nouns (Cassasola & Cohen, 2000; Werker, Cohen, Lloyd, Casasola, & Stager, 1998). Second, in terms of syntax, unlike nouns, verbs require arguments, and arguments must be treated as variables that can change across instances. Thus, to learn the meaning of a verb, children need to understand what aspect of the action events they are observing at the moment they hear the verb are invariant, and what aspect of the event can vary across the different events the verb refers to. This understanding is critical for children to be able to generalize the verb correctly, i.e., generalizing it only on the basis of the essential component of the verb meaning, while allowing changes in the variables (Golinkoff et al., 2002; cf., Tomasello, 2000).

Previous research suggests that this cognitive process is not easy for children at 3 years of age or younger (e.g., Golinkoff, Jacquet, Hirsh-Pajsek, & Nandakumar, 1996; Imai, Haryu, & Okada, 2005; Kersten & Smith, 2002; Maguire et al., 2002). Studies investigating how English-speaking children generalize novel and familiar verbs demonstrated that young children tend to be very conservative in extending verb meanings (e.g., Forbes & Farrar, 1995; Forbes & Poulin-Dubois, 1997). In particular, they tend to be much less willing than adults to extend verbs when an actor (Forbes & Farrar, 1995; Kersten & Smith, 2002; Maguire et al., 2002) or an instrument (Behrend, 1995; Forbes & Farrar, 1995) is changed. For example, Kersten and Smith (2002) presented 4-year-old English-speaking children with a novel verb in an event in which an unfamiliar insect-like character was moving in a particular manner. The 4-year-olds in their study could not generalize the verb to the same-action when the actor of the action was changed.

Imai et al. (2008) demonstrated that the difficulty young children experience in verb generalization holds across different languages, including Japanese and Chinese, which have been assumed in the literature to be verb-friendly (e.g., Choi & Gopnik, 1995; Gentner, 1982; Tardif, 1996). Imai et al. introduced a novel verb to Japanese, Chinese, and English 3-year-olds while they were watching an event in which an actor was doing a novel action with a novel object. They then showed two test events. In the Action-Same event, the action was the same as the original event but the object that was acted upon (i.e., the theme object) was changed. In the Object-Same event, the object was the same but the action was changed. In all three languages, 3-year-olds failed to generalize a novel (non-



sound-symbolic) verb to the same-action when the theme object was changed.

Given the difficulty in learning verbs, perhaps caretakers' heavy use of sound-symbolic action words reflects their naive belief that the iconicity provided by sound symbolism may help children focus on the manner component of the action. Providing scaffolding when teaching a novel verb to young children is by no means limited to Japanese mothers. Gogate, Bahrick, and Watson (2000) demonstrated that English-speaking mothers provide multimodal scaffolding (auditory–visual–tactile synchrony) when they introduce new words to their infants; they do so more often for younger infants than for older infants, and, importantly, more often when introducing novel verbs than when introducing novel nouns, presumably to help to establish the word-referent relation. Use of mimetic words may serve a similar function even for toddlers and preschoolers, who still have difficulty in extracting the invariant component of the verb meaning (i.e., the action) from the complex events.

#### 1.4. Present research: Sound symbolism for actions and its role in learning action names

The purpose of the current study was twofold. We first wished to establish sound-symbolic relations between actions and words that hold cross-linguistically and hence might contain a universally shared component. For this purpose, we created a set of novel mimetics and tested Japanese-speaking adults and English-speaking adults to see whether they were able to match them to the intended corresponding actions (see Section 2.1.1.2). We then tested whether Japanese-speaking 2-year-olds (25-month-olds) and 3-year-olds (42-month-olds) were also sensitive to the sound-symbolic relations between these novel mimetic words and their corresponding actions, to examine how early in lexical development children are sensitive to the sound symbolism in the domain of actions (Experiment 2). As reviewed earlier, Maurer et al. (2006) demonstrated that 2.5-year-old English-speaking children were sensitive to the sound-meaning link for shapes. However, there is little previous research examining this phenomenon with action words either in children or adults. Thus, examining whether children as young as 2 years of age are able to detect a sound–action match between novel words and novel actions is in itself of great theoretical interest. Second, we investigated whether sound symbolism facilitates children's acquisition of action words. In particular, we tested whether the sound symbolism in mimetic verbs (a subtype of mimetics) that was detected by both Japanese- and English-speaking adults could provide scaffolding for 3-year-olds, who are known to have a difficulty separating an object involved in the event (whether the agent, patient, or the instrument) from the core verb meaning, to focus on the right component of action events when learning a novel verb (Experiment 3). Experiment 4 clarified whether children were truly generalizing verbs or simply matching the sound to the action at the test trial.

## 2. Experiment 1: Stimuli construction and establishment of sound symbolism

The aim of Experiment 1 was to see if there is any sound symbolism for actions that holds across different languages. This also serves to establish such cross-linguistic sound symbolism in the stimuli we will use for the following experiments. For this purpose, we first conducted a rating study by Japanese- and English-speaking adults (Experiment 1a). To further confirm the sound symbolism, we conducted a forced-choice task, asking Japanese as well as English adult speakers to select the action to which the target (sound-symbolic mimetic) word referred (Experiment 1b).

### 2.1. Experiment 1a: Rating of the degree of the match between sounds and actions

#### 2.1.1. Method

**2.1.1.1. Participants.** Fifteen native Japanese-speaking undergraduates living in Japan and 21 native British English-speaking undergraduates in the UK who had no knowledge of Japanese participated.

**2.1.1.2. Materials.** Based on Hamano's analysis (Hamano, 1998), we created six novel Japanese mimetics expressing different manners of walking along the fast–slow and heavy–light dimensions: *batobato* (for running with heavy steps, with “b” expressing heavy forceful movement and “t” expressing hitting, see Hamano, 1998 for the description of this sound symbolism and that used for the following novel words), *chokachoka* (for fast walking with small steps, “ch” expressing light, subdued movement and unreliability, “k” expressing outward movement), *hyaihyai* (for semi-swift walking with light, playful steps, with “h” expressing weakness and unreliability and “y” expressing leisurely, unreliable motion), *tokutoku* (for casual, normal-speed walking with small steps, with “t” expressing a light tapping movement and lightness and “k” expressing outward movement), *yotoyoto* (for staggering, as if very tired, with “y” expressing leisurely, unreliable motion, and “t” expressing hitting of a surface) and *nosunosu* (for slow walking with very heavy steps, with “n” expressing sluggishness and “s” expressing friction). For each of the six novel mimetic words, we created two video clips with a character walking in a manner that, to our judgment, sound-symbolically either matched or did not match the mimetic. Specifically, the non-matching video in each novel mimetic word was created so that it clearly differed from the matching video along dimensions such as heaviness of movement, size of steps (large steps vs. small steps), and speed of movement. Altogether 12 videos were created. The novel mimetic words were recorded by a male native speaker of Japanese. Care was taken so that each word was said in the same speed, and hence temporal synchrony (such as the speed of utterance) could not be used as a cue.

**2.1.1.3. Procedure.** Each of the 12 videos was presented together with the recorded target mimetics in a random

order, controlled by PowerPoint. Both Japanese and English participants were instructed to watch each video clip and listen to the associated novel mimetic, and judge how well the sound matched the action on a scale from 1 (“does not match at all”) to 7 (“matched very well”). The participants in both language groups were tested individually in a university psychology laboratory.

### 2.1.2. Results

The Japanese speakers on average judged the sound-symbolic fit to be better for the matching actions ( $M = 5.6$ ,  $SD = 0.59$ ) than the non-matching actions ( $M = 2.0$ ,  $SD = 0.52$ ),  $t(14) = 23.4$ ,  $p < .001$ ,  $d = 6.05$ . So did the English speakers: they rated the fit between the target novel mimetic word to the matching action ( $M = 4.2$ ,  $SD = 0.92$ ) significantly higher than the fit between the word and the non-matching actions ( $M = 3.6$ ,  $SD = 0.79$ ),  $t(20) = 2.77$ ,  $p < .05$ ,  $d = 0.603$ . English speakers' average rating scores for each of the 12 videos were correlated with those of Japanese speakers,  $r(N = 12) = .637$ ,  $p = .025$ . Thus, for item for item, the English speakers' ratings of the degree of sound–action match were overall in agreement with those of Japanese speakers. However, as is evident in the difference in the effect size for the  $t$ -tests (Japanese: 6.05 vs. English: 0.603), adult Japanese speakers' judgments for matching and non-matching actions were much more strongly differentiated than those of English speakers, consistent with the data from Iwasaki et al. (2007) with conventional Japanese mimetics.

## 2.2. Experiment 1b: Forced-choice matching task

### 2.2.1. Method

**2.2.1.1. Participants.** Fifteen native Japanese-speaking undergraduates and 18 native British English-speaking undergraduates in the UK who had no knowledge of Japanese participated. None of them had participated in Experiment 1a.

**2.2.1.2. Material and procedure.** The same six novel mimetics and the corresponding video clips with matching and non-matching actions as in Experiment 1 were used. The participants were tested individually. The stimuli, both visual (action videos) and auditory (target mimetics), were again presented in PowerPoint slides. For each target

mimetic, the sound-matching action and sound-non-matching action were presented simultaneously side by side, with the right–left position of the matching and non-matching videos counter-balanced across the six sets. Participants were instructed to select the action that they thought the word referred to.

### 2.2.2. Results and discussion

The Japanese adults selected the sound-symbolically matching action for each of the six novel mimetics 100% of the time. English adults selected the matching action above chance level, 64% ( $SD = 21$ ),  $t(17) = 2.69$ ,  $p < .05$ ,  $d = 0.63$ <sup>1</sup> (see Fig. 1). Even though the mimetics were newly created, Japanese adults were able to detect the match between the sound and the action perfectly, and this sound–action match was also detectable to a certain extent by people who had no knowledge of Japanese, although Japanese speakers' senses of matches (as well as non-matches) were much stronger than those of English speakers.

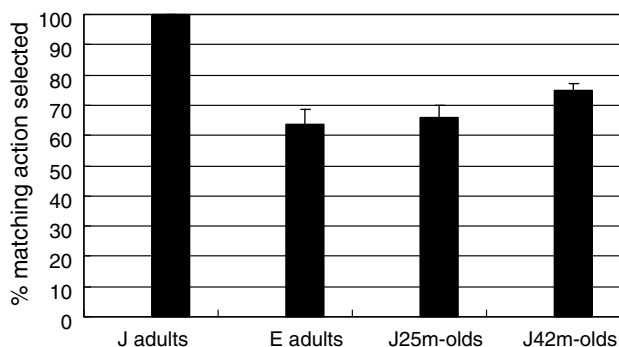
## 3. Experiment 2

The results of Experiment 1 showed that the stimuli used for Experiment 1 contained sound symbolism that could be detected by speakers of a language that belongs to a different language-family from Japanese and has very different phonological properties than those of Japanese. We next tested whether Japanese children who had just turned 2 (25-months-old) and 3-year-olds are also sensitive to the sound symbolism linking the novel mimetics and the corresponding actions. Two-year-olds were tested because we wished to see whether they have sensitivity to sound symbolism at initial stages of lexical development, a time at which their productive vocabulary of (conventional) verbs is still very small (Ogura, 2001). We also tested 3-year-olds. As mentioned earlier, previous literature has reported that children at 3 or younger have much difficulty in novel verb generalization. We thus wished to target children of this age to test the sound-symbolism bootstrapping effect in Experiment 3. To do this, however, it is necessary to first establish that 3-year-olds are indeed sensitive to the sound-meaning link detected by adult speakers of Japanese.

### 3.1. Method

#### 3.1.1. Participants

Eighteen 2-year-old (range = 23–26 months,  $M = 25$  months, 10 boys and 8 girls) and 17 3-year-old (range = 37–47 months,  $M = 42.7$  months, 9 boys and 8



**Fig. 1.** Percentage of the “sound-symbolically matching action” choice in Experiments 1b and 2. (The chance level is 50%).

<sup>1</sup> The current data were obtained from the frequency counts ranging from 0 to 6, and the frequency counts were converted to proportions. To satisfy the assumptions for conducting one sample (against chance level) and two sample  $t$ -tests (comparison across conditions as reported in Experiments 3 and 4), the proportion data reported hereafter in this paper were all transformed using the angular transformation method. Consequently, in all cases but one (3-year-olds' data in Experiment 2, see Footnote 2), the two assumptions for conducting  $t$ -tests, i.e., normality of distribution and homogeneity of variance (when two conditions were compared) were met. Note that the means and SDs reported in the main text and figures reflect the raw proportions before the transformation.

girls) monolingual Japanese children were tested. Six other 2-year-olds and two other 3-year-olds were also tested but excluded from the final sample due to failure to cooperate (4 2-year-olds) and position bias in their response (2 2-year-olds and 2 3-year-olds). Children were judged to be position biased if they consistently selected the video on one side (either the left or right) throughout the test trials. The children, mostly from middle class families, were enrolled in preschools in a suburban city in the Greater Tokyo Metropolitan area.

### 3.1.2. Materials and procedure

The same novel mimetics and corresponding video clips as in Experiments 1b were used and presented in PowerPoint slides. Unlike Experiment 1b, however, the mimetic words were presented live (rather than using recorded stimuli) by a female native speaker of Japanese. This was because the pointing procedure was extremely difficult for 2-year-old children with recorded instructions. Prior to testing, the children received four practice trials (e.g., they were asked to select a person jumping while they were shown two videos of the same person jumping and waving a hand) to familiarize them with the pointing procedure. As in Experiment 1b, during the test, children were shown two video clips side by side, one matching the target mimetic and the other non-matching, and they were asked to point to the video that was showing the action that the target novel mimetic referred to. (The experimenter asked: Mite! (look!) batobato-shiteru (batobato-doing) nowa (is) docchi (which) 'Look! Which (video) shows doing batobato?').

### 3.2. Results and discussion

Japanese children, both 2-year-olds and 3-year-olds, selected the "matching" action (i.e., the video that adult Japanese speakers had judged as a match for the target mimetic) significantly above chance (2-year-olds: 65.7%,  $t(17) = 3.81$ ,  $p < .01$ ,  $d = 0.90$ ; 3-year-olds: 75%,  $t(16) = 11.23$ ,<sup>2</sup>  $p < .01$ ,  $d = 2.72$ , see Fig. 1). The results of Experiment 2 together with those of Experiments 1a and 1b showed that not only Japanese adults but also English-speaking adults who had no exposure to Japanese mimetics as well as Japanese children as young as 25-months-old were able to detect the sound symbolism linking novel mimetic verbs and novel actions.

In Experiment 3, we next tested the sound-symbolism bootstrapping hypothesis.

## 4. Experiment 3

As discussed earlier, previous research has demonstrated that young children – as old as 3- and 4-years of

age – do not easily generalize a newly learned verb to the same-action when the object involved in the action event is changed (Kersten & Smith, 2002; Imai et al., 2005; Imai et al., 2008). If the sound symbolism hypothesis is borne out, children who are taught novel mimetics that match the referent action should be able to generalize it in the face of a change of the theme object or the actor, whereas children of the same age should fail without the help of the sound symbolism. To test this hypothesis, we taught 3-year-old Japanese children novel verbs that were shown to have sound-symbolic properties in the above experiments and novel verbs which did not carry such properties. As mentioned earlier, we chose to test 3-year-olds because previous research indicated that 3- and 4-year-olds have difficulty in generalizing a novel verb to the same-action in the face of the object change, whether it was the actor (e.g., Forbes & Farrar, 1995; Kersten & Smith, 2002; see also Maguire et al., 2002) or the theme object (Imai et al., 2005; Imai et al., 2008; but see Golinkoff et al., 1996),<sup>3</sup> whereas 5-year-olds are able to extract the invariant component (i.e., the action) and readily generalize the verb to the same-action with new objects. Here, we tested whether 3-year-old children were better able to generalize novel verbs to the same-manner action performed by a different actor when novel words carried sound symbolism than when the words did not have any sound-meaning relation.

### 4.1. Method

#### 4.1.1. Participants

Thirty-four 3-year-olds (15 boys and 19 girls, range = 37–48 months,  $M = 42.5$  months) were randomly assigned to either the *sound-symbolic mimetic verb* condition or the *non-sound-symbolic verb* condition. The children's demographic properties were the same as those of the children who had participated in Experiment 2. Four other children were tested but excluded from the final sample because of a position bias in the response (3) and failure to cooperate (1). The criterion for the position bias was the same as that used in Experiment 2.

#### 4.1.2. Materials and procedure

As in Experiments 1b and 2, six sets of visual stimuli were presented in PowerPoint slides. However, this time, each set consisted of two slides, with the first page showing a training event and the second page showing two test events. The action that sound-symbolically matched the target mimetic word served as the training event. In the same-action test event, the action was the same as the training event but the actor changed. In the same-actor event, the actor was the same but the action changed. The two test events were the same as those used in Experiments 1b and 2.

<sup>2</sup> As described in Footnote 1, the 3-year-olds' data here did not meet the normality assumption for  $t$ -tests. This was because all of the 3-year-olds (17 children) in this experiment selected the "correct" action either four or five out of the six trials. In this case, however, there is no doubt that 3-year-olds selected the correct sound-symbolic match significantly above chance (50%) even in the face of violation of the normality assumption. (It should also be significantly above chance by binomial criterion.)

<sup>3</sup> Golinkoff et al. (1996) reported that English-speaking 3-year-olds were able to extend a novel verb to the same-action done by a different actor. However, their stimuli showing the actions were still pictures, which might have made it easier to separate the action from the object and extend the verb to the same action.

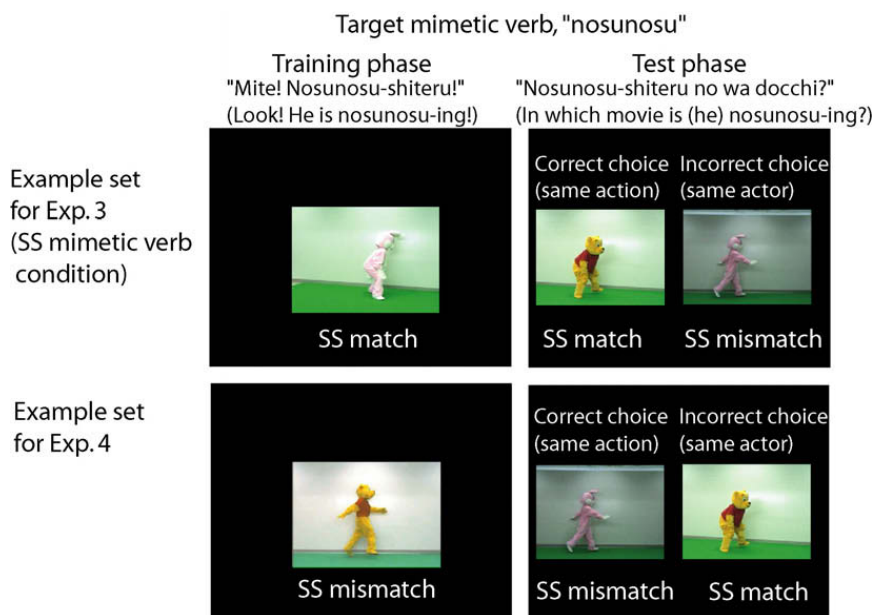
As in Experiment 1, children were tested individually by a female native speaker of Japanese at their preschool. Children received four practice trials prior to test trials, to familiarize them with the pointing procedure. The practice trials here were the same as those used in Experiment 1. In both conditions, children were first shown the training video with the verb. Each training video lasted approximately 5 s, and was shown twice. In both condition, the target novel word was repeated twice. The experimenter said the instruction sentence in natural, child-directed speech. Care was taken, however, that novel mimetic verbs as well as novel non-sound-symbolic verbs were said at the onset of the movement of the actor and at the same speed. They were then shown the two test events, and were asked to indicate to which video the verb should be generalized (see Fig. 2). In the *sound-symbolic mimetic verb* condition, the six verbs were those used in Experiments 1 and 2 (*chokachoka*, *hyaihyai*, *tokutoku*, *batobato*, *nosunosu* and *yotoyoto*). See Fig. 2 for the sentence frames in which the novel mimetic verbs were used in the training and test phases. In the *non-sound-symbolic verb* condition, the novel non-sense verbs were ones that had been used in previous novel verb learning studies with Japanese children (Imai et al., 2005). These verbs were presented in the morpho-syntactic form of regular, non-sound-symbolic verbs with no reduplication and they had no detectable sound-symbolic link between the word and action. The novel words used were *chimoru*, *nuheru*, *rikoru*, *yachiru*, *nekeru*, and *hekuru*. They are introduced in the same sentence frame used in the *sound-symbolic mimetic verb* condition (see Fig. 2). Fourteen Japanese adults rated how well the sound of the novel non-sense verbs matched the actions in the test video clips, using the same procedure as in

Experiment 1a. The sound-meaning match score was equally low for the same-action (correct) test and the same-actor (incorrect) test videos (same-action:  $M = 3.4$ ,  $SD = 1.1$ ; same-object:  $M = 3.1$ ,  $SD = 1.1$ ;  $t(13) = 1.08$ ,  $p > .1$ ).

#### 4.2. Results and discussion

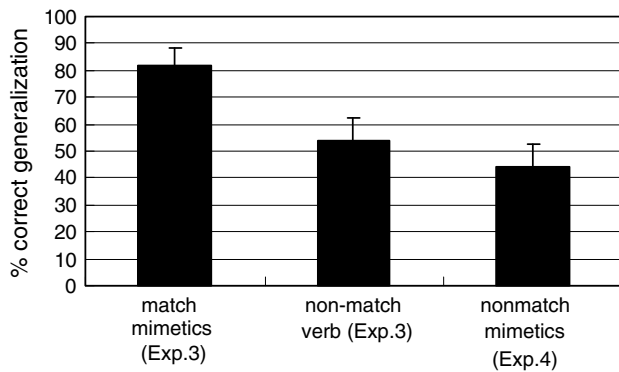
Supporting the sound-symbolism bootstrapping hypothesis, 3-year-olds were able to generalize the novel sound-symbolic verbs to the same-action test at significantly above chance level (82%,  $t(16) = 4.45$ ,  $p < .01$ ,  $d = 1.08$ ), but failed to do so when the verb did not carry sound-symbolic properties (54%,  $t(16) = .059$ ,  $p > .1$ , see Fig. 3). There was a significant difference across the two conditions,  $t(32) = 2.43$ ,  $p < .05$ ,  $d = 0.78$ .

The fact that 3-year-olds did not succeed in generalizing non-sound-symbolic verbs may not be so surprising, considering that 3- and 4-year-olds consistently failed to generalize verbs that were not sound-symbolic in the face of change in the actor or the theme object in previous studies (e.g., Imai, Haryu, Okada, Li, & Shigematsu, 2006; Imai et al., 2005; Kersten & Smith, 2002; Maguire et al., 2002). In this light, the fact that 3-year-olds were able to generalize the sound-symbolic verb at a rate over 80% is very impressive. However, there are two possibilities which may explain the children's above chance performance here. Children may have been able to extract the core component of the action event – the manner of the movement – by successfully separating the action from the actor. If this was the case, the sound-symbolism bootstrapping hypothesis is indeed supported. However, another possibility is that children selected the “correct” (i.e., the same-action) video simply because they were able to



**Fig. 2.** Example stimulus sets for the novel verb generalization experiments (Experiments 3 and 4). “SS” stands for “sound-symbolic”. In the test phase, the correct choice in the test phase comprised the same-action as in the training phase but with a different actor (i.e., “same-action test event”), and the incorrect choice comprised the same-actor but with a different action (i.e., “same-actor test event”). For Experiment 3, only the sound-symbolic mimetic verb condition is shown. The other condition (non-sound-symbolic verb condition) used the same visual stimuli, but with the following different sentences: the training phase = “Mite! X-tteiru! (Look, (he) is X-ing!)”, the test phase = “X-shiteru no wa docchi?” (In which movie is (he) X-ing?), where X stands for a novel non-mimetic verb such as “neke”.





**Fig. 3.** Percentage of the correct same-action event choice in 3-year-olds in Experiments 3 and 4). (The chance level is 50%.)

match the sound of the novel mimetic verb and the action at the test stage, without any consideration of which test event the verb learned in the training phase could be generalized to. Experiment 4 was conducted to rule out the second possibility.

## 5. Experiment 4

To rule out the possibility that 3-year-olds in Experiment 3 were simply matching the sound and the action during the test phase without undertaking the process of verb generalization, we conducted Experiment 4. This is also a verb learning experiment, similar to Experiment 3. Different from Experiment 3, in this experiment, the target mimetic word taught did not sound-symbolically match the action in the training event. Hence, in the training phase, the target mimetic word did not sound-symbolically match the “correct” (in light of verb generalization) choice (i.e., the same-action test event with a different actor from the training event) either. However, the target mimetic verb sound-symbolically *did* match the “incorrect” choice (i.e., the same-actor test event with a different action). (See Fig. 2 for how Experiment 4 differs from Experiment 3.) If the 3-year-olds in the sound-symbolic mimetic verb condition in Experiment 3 were simply sound-symbolically matching the word to the action during the test phase, the children in Experiment 4 should select the incorrect same-actor test event. Alternatively, if the 3-year-olds in Experiment 3 indeed learned the word better in the training phase due to sound symbolism, then the children in Experiment 4 should perform significantly worse than those in the sound-symbolic mimetic verb condition in Experiment 3, and their performance should be no better than the children in the non-sound-symbolic verb condition in Experiment 3, because they could not receive any scaffolding from sound symbolism here.

### 5.1. Method

#### 5.1.1. Participants

Fifteen monolingual Japanese-speaking 3-year-olds (range = 37–47 months;  $M = 43.1$  months, 7 boys and 8 girls) participated in this experiment. The children had the same demographic properties as those who participated in Experiments 2 and 3 but none had taken part in

those experiments. Two other children were tested but excluded from the final sample due to position bias in their response (1) and failure to cooperate (1).

#### 5.1.2. Materials

The stimuli for Experiment 4 were required to meet the following two constraints: (1) the target mimetic verb associated with the training event *did not sound-symbolically match* the training event and hence the correct test event (i.e., the same-action event with a different actor from the training event); (2) but it *sound-symbolically matched* the incorrect test event, (i.e., the same-actor event with a different action). To create such sets, 15 Japanese-speaking adults and 21 English-speaking adults rated all combinations of the 6 verbs and 12 videos used in Experiments 1–3 on the scale of 1 (the sound and action do *not* match) to 7 (the sound and action *match* well). Based on the results of the ratings from the two language groups, five sets were created. Five of the six novel mimetics used in Experiments 1b–3 were used: *batobato*, *chokachoka*, *hyaihyai*, *nosunosu*, and *tokutoku*. As in Experiment 3, the correct test event was the one with the same-action done by a different actor (see Fig. 2, for an example). The mean adult ratings for sound-symbolic match with the target mimetic were significantly higher for the incorrect (same-actor) test events than the training (as well as the same-action test events) for both Japanese speakers (training events and correct test events,  $M = 2.0$ ,  $SD = 0.64$ , incorrect test events,  $M = 5.7$ ,  $SD = 0.62$ ,  $t(14) = 16.88$ ,  $p < .001$ ,  $d = 4.36$ ) and for English speakers (training events and correct events,  $M = 3.7$ ,  $SD = 0.90$ , incorrect events,  $M = 4.4$ ,  $SD = 0.95$ ,  $t(20) = 3.49$ ,  $p < .01$ ,  $d = 0.76$ ).

#### 5.1.3. Procedure

The procedure was the same as that in Experiment 3.

### 5.2. Results and discussion

Unlike the 3-year-olds who were taught a sound-symbolically matching mimetic verb in Experiment 3, the 3-year-olds in this experiment failed to generalize the newly taught mimetic verb (one that did not sound-symbolically match the training action) to the same-action test event. Supporting the sound-symbolism bootstrapping hypothesis and ruling out the alternative account, the performance of the children in this experiment (44%) was significantly worse than that of the children who were taught matching mimetic verbs in Experiment 3 (82%),  $t(30) = 3.42$ ,  $p < .01$ ,  $d = 1.04$ . Their performance did not differ from the performance of the children in the *non-sound-symbolic verb* condition in Experiment 3,  $t(29) = 0.83$ ,  $p > 0.1$ , falling into the chance level,  $t(14) = -.61$ ,  $p > .1$ ). Thus, the children in this experiment did not simply sound-symbolically match the mimetic verb and the action in the test phase. If that had been the case, they would have chosen the incorrect same-actor test event at above chance level, as frequently as they chose the correct (sound-symbolically matching) event in Experiment 2 as well as in the *matching mimetic verb* condition in Experiment 3. Of course, caution is required to draw a conclusion here, as the conclusion depends on chance-level performance in Experiment 4.

However, 3-year-olds' chance level performance was systematically observed across different studies examining children's ability to generalize novel verbs in the face of a change of the object in action events (e.g., Imai et al., 2005; Imai et al., 2008; Kersten & Smith, 2002 as well as in the novel non-sound-symbolic verb condition in Experiment 3 in this research). Thus, it is most likely that the chance level performance in Experiment 4 reflects 3-year-olds' genuine difficulty in novel verb generalization rather than lack of attention or motivation. Taken together, the results indicate that sound-symbolic match between the verb and the action in the learning phase in Experiment 3 facilitated subsequent verb generalization.

## 6. General discussion

There are two major findings from this research. First, this research demonstrated the speakers of two very different languages both recognized the same sound symbolism in the domain of actions. The sound symbolism underlying novel mimetics referring to actions was detectable by adult native speakers of Japanese and adult native speakers of British English who had no knowledge of Japanese. Furthermore, the same sound symbolism was detected by Japanese children as young as 25 months of age who could not have been exposed to the novel mimetics used in the study. Previous research has mainly dealt with sound symbolism for shape (e.g., Maurer et al., 2006), and to our knowledge, our research is the first to empirically establish that there is a link between linguistic sound and action, which is shared – at least to some degree – across different languages (see also Iwasaki et al., 2007) and is also detected by children who have just had their second birthday.

Second, we provided evidence that sound symbolism plays a facilitative role in learning of action names in 3-year-old children (see also Yoshida & Smith, 2006, for related results). In a number of studies, novel verb generalization (in the face of a change in the theme object or the actor) has been found to be difficult for 3-year-old or younger children across different languages (Imai et al., 2005; Imai et al., 2008; Kersten & Smith, 2002; Maguire et al., 2002). In this study, we replicated these results with both novel plain verbs and novel mimetic verbs that did *not* sound-symbolically match the referent action (the non-sound-symbolic verb condition in Experiments 3 and 4, respectively). However, when novel verbs sound-symbolically matched the action, then 3-year-old children *were* able to make this generalization.

The children's good performance with sound-symbolic mimetic verbs in Experiment 3 cannot simply be attributed to the morphological (reduplication) or syntactic properties (a light verb construction involving a generic verb, *suru*, “do”) of mimetic words. If those had been the crucial factors, children should have performed equally well in the sound-symbolic mimetic condition in Experiments 3 and 4 because in both conditions the target words were mimetic words. The fact that children in fact performed significantly better in the former than the latter indicates that it was the sound-symbolic properties of the mimetic words

which facilitated verb generalization, not their morphological or syntactic properties.

In what ways did sound symbolism help 3-year-olds generalizing novel action names in our research? Actions, which verbs typically refer to, unfold over time and are ephemeral, while objects, which nouns typically refer to, are stable over time and perceptually individuated (Gentner & Boroditsky, 2001). The sound symbolism of the mimetic verbs may help children isolate the action out of the various components of an event, and highlight it. This allows children to overcome the “grip” of objects in word learning, and focus on the action alone as the invariance relevant for verb meaning.

The effects of sound symbolism are inconsistent with formal theories of linguistics in the tradition of de Saussure (1916) that regard language as an encapsulated system which is functionally separated from other cognitive functions. However, researchers in other areas regard sound symbolism to be much less problematic, especially when considered from the neurological perspective (e.g., Maurer & Mondloch, 2006; Ramachandran & Hubbard, 2001; Westbury, 2004). The neural substrate of the phenomena of sound symbolism is still at a stage of speculation. Ramachandran and Hubbard (2001) conjectured that sound symbolism may involve two cross-domain mappings. The first mapping is between sound contours and motor patterns in or close to Broca's area (possibly mediated by mirror neurons). For example, words referring to small things (or actions) such as *little* and *teeny* often contain high vowels in which lips and the tongue form a narrow constricted space (see also Hamano, 1986; Oda, 2000; Sapir, 1929 for the same hypothesis that sound symbolism is mediated by articulatory gestures). The second mapping is between hand gestures and articulatory gestures in the motor area. For example, the articulatory gestures for words such as *little* and *teeny* may mimic small pincer grip gestures made by the opposing thumb and index finger (Ramachandran & Hubbard, 2001, p. 20). This hypothesized link between sound symbolism and manual gestures is supported by the finding that when Japanese speakers produced mimetics in narrative, they almost always spontaneously produced an iconic hand gesture at the same time (Kita, 1993; Kita, 1997; Kita, 2001).

If sound symbolism is based on specific mappings between different brain areas, and these brain mappings are shared by all humans, then certain aspects of sound symbolism should be universal. Such an idea is compatible with the findings in this study that Japanese children as early as 25-month-old could map novel mimetics to novel actions in the same way as Japanese- and English-speaking adults, as well as with other findings in the literature (Davis, 1961; Maurer et al., 2006).

Of course, this does not entail that all aspects of sound symbolism are universal, nor does it imply that all languages should have a specialized word class of sound-symbolic words. Although adult speakers of English and Japanese both rated the fit between a novel mimetic word to the matching action significantly higher than the fit between the word and the non-matching actions, the difference was smaller for English speakers than for Japanese speakers. Likewise, in the forced-choice matching task,

although adult English speakers and Japanese 25-month-olds both matched a novel mimetic word to the matching actions at above chance levels, the effect size for Japanese 25-month-olds was larger than that for adult English speakers when compared against chance. Thus, sensitivity to sound-meaning matching increases with learning, and some aspects of sound symbolism are most likely to be language-specific. As reviewed earlier, Iwasaki et al. (2007) found that adult English speakers' judgments of conventional Japanese mimetic words for laughing and walking tended to converge with those of Japanese speakers on semantic dimensions concerning the magnitude (of size, sound), while they were quite different on evaluative dimensions (e.g., beauty, pleasantness), supporting the idea that some aspects of sound symbolism are universal, while others are language-specific.

Seen this way, the learning mechanism of mimetics is theoretically interesting and important in its own light. As discussed above, mimetics seem to contain aspects of sound symbolism that are biologically grounded and are recognized by speakers of across different languages. Mimetics are heavily used by care-takers in infant directed speech in Japanese, and they are a large part of the early vocabulary of Japanese children (Fernald & Morikawa, 1993; Ogura, 2001). One might then think that mimetics would also be easier to learn for adult second learners of Japanese compared to other conventional types of words such as verbs or adjectives, especially since the sound symbolism involved in Japanese mimetics could be detected by adult English speakers. Yet, mimetics are one of the hardest types of words for adult second language learners (Iwasaki et al., 2007). To acquire a native speaker's sensitivity and productive competence – to be able to comprehend even novel ones and to use conventional and novel mimetics productively and creatively – may require massive exposure to mimetics used in real contexts. This in turn suggests that, even though some aspects of language learning may be biologically grounded, it is crucial to have intensive exposure to a specific language in early stages of development. Through statistical learning (Saffran, Aslin, & Newport, 1996), young children may be able to extract patterns of form-meaning co-occurrences in the words they learn and abstract out language-specific aspects of sound symbolism. In this process, children may pay special attention to words or word classes that already have universal sound-symbolic properties, such as Japanese mimetics, resulting in sound-symbolic words that have both universal and language-specific components.

In any case, our findings endorse the view that sound symbolism is *not* a peripheral or trivial phenomenon in language, as sound symbolism facilitates one of the most important tasks for children in language development, namely, the learning of novel verbs. Furthermore, the investigation of the neural and psychological mechanisms underlying sound symbolism leads to important questions about the nature and origin of language, including how language is linked to non-linguistic visual, auditory, tactile, and motion perceptions, and how iconicity in multi-sensory mappings bootstraps children to break the initial barrier for language learning (Maurer & Mondloch, 2006; Ramachandran and Hubbard 2001).

The results of this research also have opened the door to a number of other interesting questions for future research. For example, do children universally come to word learning with an expectation that the sound of words and their referents have some meaningful relation? And if they do, does this expectation change developmentally, and to what extent is the change of this expectation influenced by the nature of the language they are learning (e.g., whether their language has a productive word class such as mimetics in Japanese)? Another important question that needs to be addressed is how children learn words that are *not* sound-symbolic and yet make use of sound symbolism when and only when the word carries sound-symbolic properties. It is possible that, through experience in language learning, children quickly learn that words are not always sound-symbolic and are willing to form word-referent associations even when they do not detect sound symbolism between the word and the referent, especially for object names. However, when children do detect sound symbolism in learning a novel word, they take advantage of it, and this additional cue is especially helpful for the learning of action names (for the reasons discussed above). The same facilitative effect may also extend to names of properties (adjectives), as learning a property name involves mapping a word to a single property of an object that necessarily have multiple properties (size, texture, color, weight, etc.), which also poses a challenge for young children (e.g., Waxman & Klibanoff, 2000).

## 7. Conclusion

This research demonstrated that Japanese adults and children as young as 25-months-old as well as adult English speakers were sensitive to the sound-symbolic relations between novel words and novel actions. Furthermore, it demonstrated that the sound symbolism facilitated one of the key steps in language development, i.e., learning the names of actions, which are known to be difficult both in terms of word-reference mapping and generalization. These findings, along with others in the literature, suggest that certain aspects of sound symbolism may be shared universally and biologically grounded. Future investigation of the neural and psychological mechanisms underlying sound symbolism may shed new light on important questions about the nature of language.

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