Breaking the initial barrier of language: Children’s use of sound-symbolism

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Japanese children love onomatopoeia and mimetic words

• Children’s books contain more onomatopoeia and mimetic words than any other genre (Oda, 2000)

• Fernald & Morikawa (1993)
  – Japanese mothers frequently used onomatopoeic labels when referring to objects (e.g., buubuu for ‘car’; wanwan for ‘dog’).
Picture book reading study (Okada et al. in prep)

- Showed mothers a book containing pictures of simple, everyday actions
- The mother talked to her child and an adult experimenter about the pictures
• Mother to child: Mimetic words were used 58.1% of action reference
  “pyon(mim)-shiteru (do-ing)”
• Mother to adult: Mimetic words were used only 11.8% when they referred to actions.
  “tobi(jump)-oriru(descend)”
Sound symbolism bootstrapping hypothesis

- Sound symbolism helps children learn words
How do I test the hypothesis?

• Do very young children (24 months olds) detect sound symbolism?

• Do children use sound symbolism for inference of word meanings
  – Motion
  – Tactile

• Are sound symbolic words processed differently in the brain?

• How early do infants get sensitive to sound symbolism? In what form?
Test of the sound symbolism bootstrapping hypothesis

• Novel mimetic verbs should be better learned than novel verbs that do not have sound symbolic properties.
Our research

• Tested whether Japanese 25-month-olds and 3-year-olds, Japanese adults and British adults (who do not know Japanese) are able to match novel mimetic words to the matching action (Study 1)

• Tested whether Japanese 2.5- and 3-year-olds learn novel mimetic verbs better than non-iconic novel verbs (Study 2)
Categorization of existing mimetic motion words

- Consonant is more important than vowels. (c.f., Hamano, 1986)
- Cluster a: "t" "s": lightness, small size; alveolar
- Cluster b: also "t" "s"; alveolar
- Cluster c: "s" "h": quietness, weakness, softness fricative
- Cluster d, f: "b" "d" "z": heaviness, big size, roughness, voicedness
- Cluster e: "n": slowness nasal
Preparation of the stimuli: Step 2

- Selected 12 mimetic action words from a large pool of conventional action mimetic words.
- Created videos matching the selected action words.
- Showed the videos to 15 Japanese adults, and had them produce matching mimetic words.
- The mimetic word most frequently produced for the video → conventional matching mimetic word.
- Transformed the conventional mimetic words to novel mimetic words following Hamano’s (1986) analysis.
Transformation of conventional mimetics to novel ones

- Based on Hamano (1986)
  - C1V1C2V2
  - Both C1C2 retained
  - Changed either V1 or V2 to another vowel (except for e)

<table>
<thead>
<tr>
<th></th>
<th>conventional</th>
<th>novel</th>
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<tbody>
<tr>
<td>1</td>
<td>noshinoshi</td>
<td>nosunosu</td>
</tr>
<tr>
<td>2</td>
<td>tokotoko</td>
<td>Tokutoku</td>
</tr>
<tr>
<td>3</td>
<td>batabata</td>
<td>batobato</td>
</tr>
<tr>
<td>4</td>
<td>yotayota</td>
<td>yotoyoto</td>
</tr>
<tr>
<td>5</td>
<td>hyoihyoi</td>
<td>hyaihyai</td>
</tr>
<tr>
<td>6</td>
<td>chokochoko</td>
<td>chokachoka</td>
</tr>
</tbody>
</table>
Preparation of the stimuli: Step 3

- Different group of adults rated the degree of match between each of the videos and novel mimetic words.
- Novel mimetic words rated highest for the video: matching mimetic words.
- Novel mimetic words rated lowest for the video: non-matching mimetic words.
Study 1: Matching task

- Select the matching novel mimetic verb
- Nosunosu-shiteiru no wa docchi？ (Where is (it) doing nosu-nosu?)
Results of the action-mimetic words matching study

Significantly above chance in all groups
Action words are difficult to learn

• At 14 months, children are able to establish a word-object association (Werker, Cohen et al., 1998), but they cannot establish a word-action association until 18 months (Cassasola and Cohen, 2000)

• Generalization of verbs is even more difficult (Imai, Haryu & Okada, 2005; Imai et al., 2008)
  – 3-year-olds were unable to map and generalize a novel verb in the face of a change of the agent or the theme object.
novel verb generalization

• Participants: Japanese 3-year-olds (16 children in each age/condition)

• Conditions:
  - Novel mimetic verb condition (Novel mimetic verb matching to the target action)
  - Novel verb (non-sound symbolic) condition
  - Control (Novel mimetic verb non-matching to the target action and matching to the distractor)
Target mimetic verb, "nosunosu"

Training phase
"Mite! Nosunosu-shiteru!"
(Look! He is nosunosu-ing!)

Test phase
"Nosunosu-shiteru no wa docchi?"
(In which movie is (he) nosunosu-ing?)

Sound Symbolically Matching Mimetic Condition

Correct choice (same action)  Incorrect choice (same actor)

SS match  SS mismatch

Control (Sound Symbolically Mismatching Mimetic Condition)

Correct choice (same action)  Incorrect choice (same actor)

SS mismatch  SS match
Results of Study 2 (verb generalization)

- Sound symbolism bootstrapping effect found

![Bar chart showing results for 3-year-olds with significant differences marked with asterisks and non-significant differences marked with 'ns'.]
What about English-speaking children?

Kantartzis, Kita, & Imai, in prep.
Sound symbolism in the sense of touch

• Do children and adults also detect symbolism between sound and touch?
Can children and adults detect sound symbolism in touch sense?

<The rating task and the production task with adults>

• Rating task: Ps rated all 20 stimuli of 7 items (hardness/smoothness/lightness/regularity/elasticity/intensity/distastefulness) from 1 to 7

• Production task: Ps produced mimetics that best matched the tactile sense for each stimulus

• From the rating task and the production task, we selected 12 stimuli and the name of each stimulus
Relation between sound sand touch attributes

Relation between sound sand touch attributes

Elasticity

high

low

smoothness

low

high

za, go, ga

be, pe

fu, wa, mo

su, sa, tsu
Experiment 1-result

Select which tactile and sound are match (%)

* p < 0.001
E-3 years old; p = 0.053
Do sound symbolism modify a shape bias in novel word learning?

• It is widely known that young children are biased to assume that novel word is generalized by shape, but not by color or texture (Imai, Gentner & Uchida, 1994, Landau, Smith & Jones, 1988)
Can children map new word to texture?

- **Stimuli Type:** Complex shape trials (5) and Simple shape trials (5)
- **Condition:** Sound symbolic match/mismatch
- **Participants** 44 5-year-olds
procedure

Ex) Kore wa ZAZA yo

“Look at this ZAZA.

Ex) ZAZA wa docchi?

“Which one do you think is the ZAZA? Could you hand me the tray that also has the ZAZA on it?”
Experiment 2 Result

Select which the materials are the same with standard items (%)

<table>
<thead>
<tr>
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<th>complex</th>
<th>simple</th>
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<th>simple</th>
</tr>
</thead>
<tbody>
<tr>
<td>sound symbolism</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>non-sound symbolism</td>
<td></td>
<td>*</td>
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Discussion

• Young children are sensitive to sound symbolism in the domains of motion and touch and use it for the inference of the meaning of novel words
  → support for the sound symbolism bootstrapping hypothesis
Why do mimetics foster word learning?

- Mimetic words are more directly grounded to sensory experience than non-sound symbolic words (verb, adverb)
- Mimetic words help children map the world to abstract linguistic symbols by its sound-meaning correlates
Support for sensory-grounding iconicity in mimetics: Brain imaging data

• 11 Japanese adults were shown videos of walking on various manners (overlapping with videos for the verb learning study with children) together with a word
  – Mimetics (e.g., choko-choko)
  – Verb (e.g., aruku ‘walk’)
  – Adverb (e.g., yukkuri ‘slowly’)

ちょこちょこ (choko-choko)
Participants rated how well the word matched the action in the video by pressing a bottom (1-5)
Activated areas of each word class — baseline

mimetics

verb

adverb

Threshold: 0.001
Extent threshold: 0
How early do infants detect sound symbolism?

• Can ERP reveal infants’ sensitivity to sound symbolism?
Experiment-2 (infants’ study)

Stimuli

We are using the same visual and auditory stimuli of adults’ experiments

<table>
<thead>
<tr>
<th>Example figures</th>
<th>Sound</th>
<th>Condition</th>
<th>Number of trials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KIPI</td>
<td>Match</td>
<td>40 (20figures × 2times)</td>
</tr>
<tr>
<td></td>
<td>KIPI</td>
<td>Mismatch</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>MOMA</td>
<td>Mismatch</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>MOMA</td>
<td>Match</td>
<td>40</td>
</tr>
</tbody>
</table>

160 trials presented randomly
When we press the space key, the stimulus starts.

- 0ms-2300ms
- 800ms-1200ms
- 1200ms-2300ms
- 2300ms-3800ms

Attention grabber
Subjects & Analysis

• **Subjects & System**
  - Japanese-speaking infants (N=8, range=11-12 month, mean age=11.7)
  - Electrode arrangement (based on the 10-20 system, 13 electrodes)

• **Analysis**
  - Re-reference: A1+A2
  - Filter: Bandpass (zero phase shift) 1-30Hz
  - Epoch file: -100~2300ms
  - Baseline correction: 700-800ms
  - Artifact rejection: ±150µV
Infants N=8

*Match-8 Sel.avg*
*Mismatch8Sel.avg*

Electrode: C3

- **Auditory onset** at 886 ms
- **P1**
- **N1**
- **P2?**
- **1130 1230**
Take-home messages

• Sound symbolism is present in language
• Some (but not all) aspects of sound symbolism may be biologically grounded and universally detected
• Children are able to detect sound-meaning correlates from early (possibly at the onset of language learning).
• This sensitivity helps children to break the initial barrier of language by bridging the sensory experience and abstract linguistic symbols.