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

Mutsumi Imai

Keio University

In collaboration with Sotaro Kita, Miho Nagumo, Hiroyuki Okada, Mamiko Arata, Katerina Kantartzis, Kimi Akita, Tetsuya Matsuda & Guillaume Thierry

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(decend)”

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?

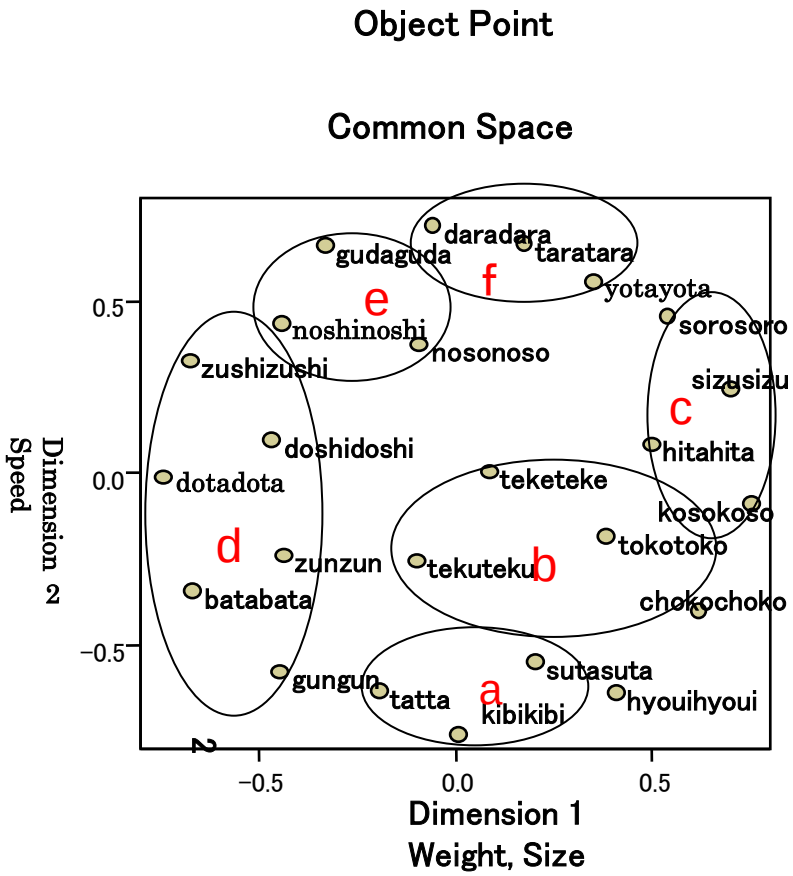
Test of the sound symbolism bootstrapping hypothesis

- 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: Step2

- 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)

	conventional	novel
1	noshinoshi	nosunosu
2	tokotoko	Tokutoku
3	batabata	batobato
4	yotayota	yotoyoto
5	hyoihyoi	hyaihyai
6	chokochoko	chokachoka

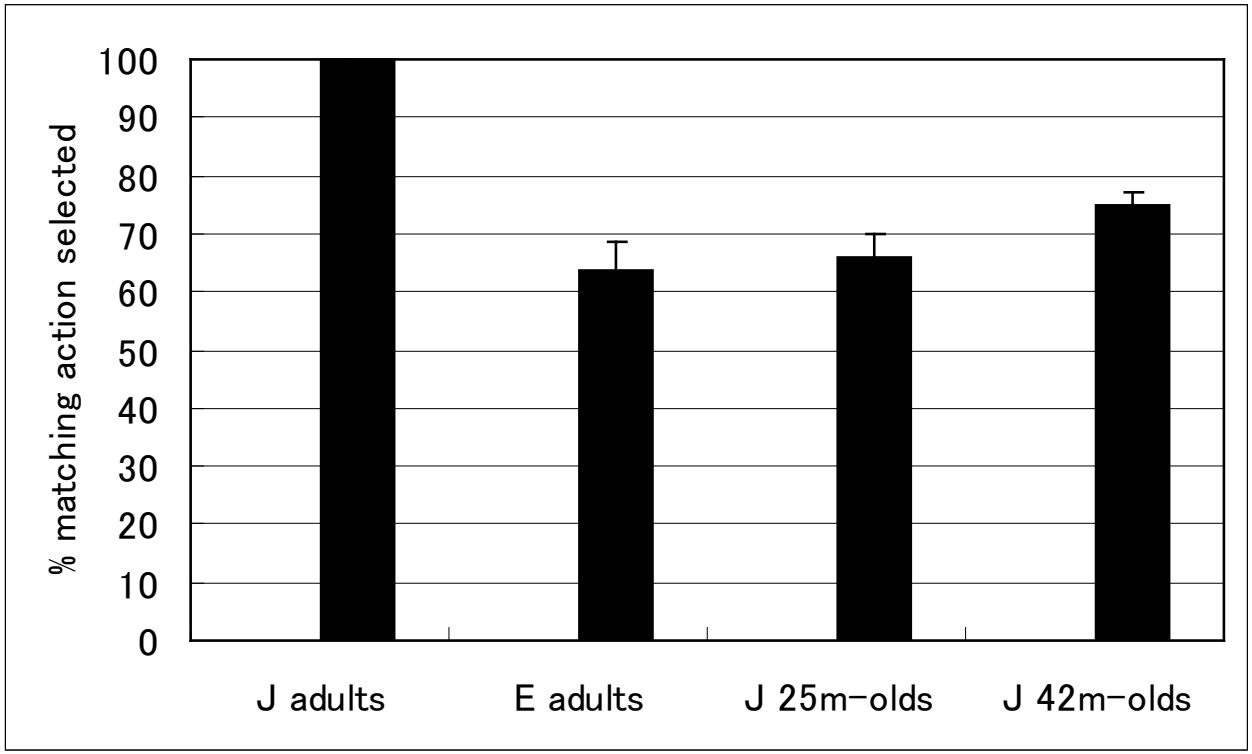
Preparation of the stimuli:Step3

- 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!"

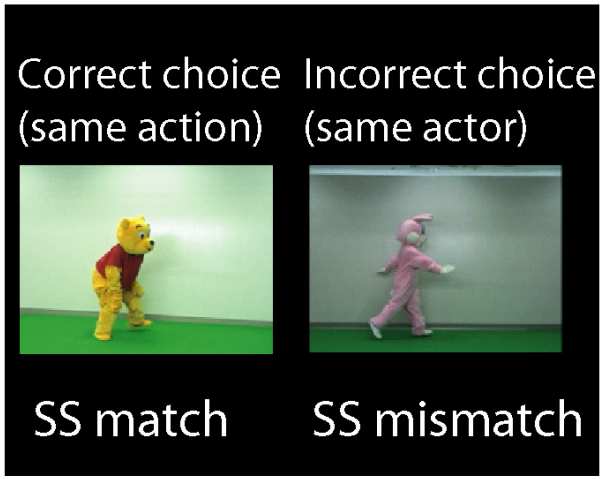
(Look! He is nosunosu-ing!)

Test phase

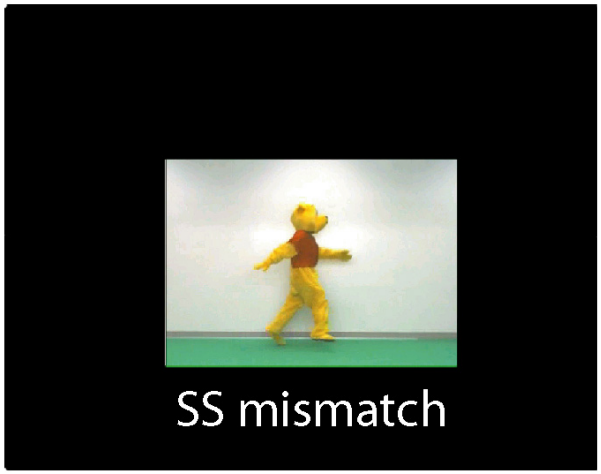
"Nosunosu-shiteru no wa docchi?"

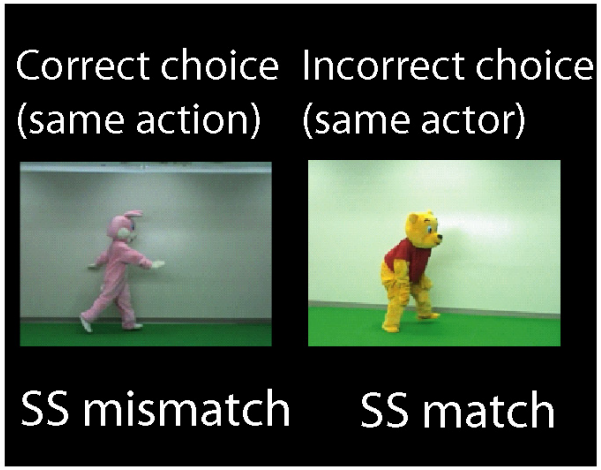
(In which movie is (he) nosunosu-ing?)

Sound Symbolically Matching Mimetic Condition

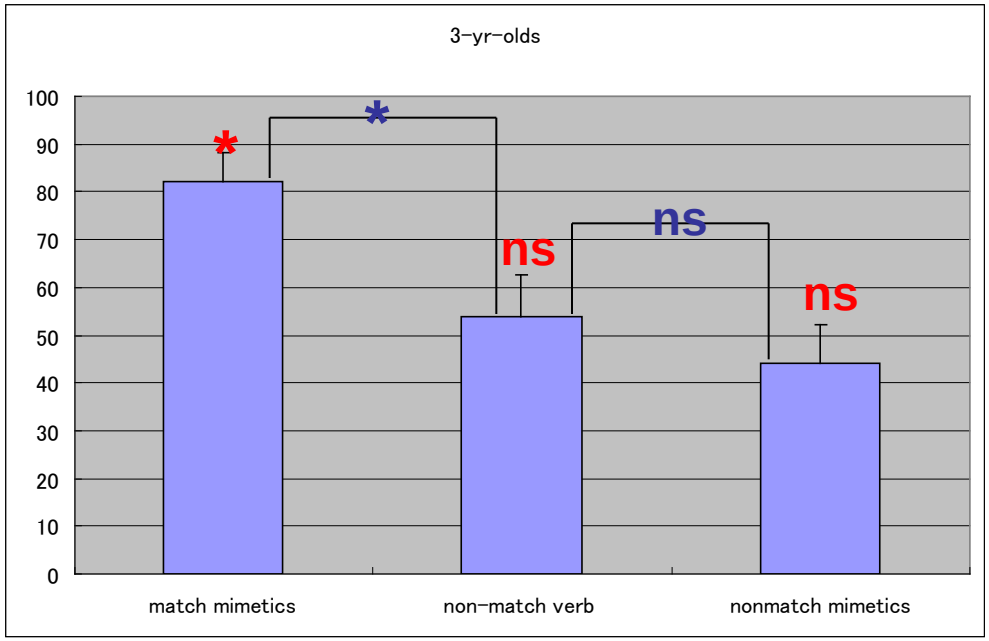


Control (Sound Symbolically Mismatching Mimetic Condition)



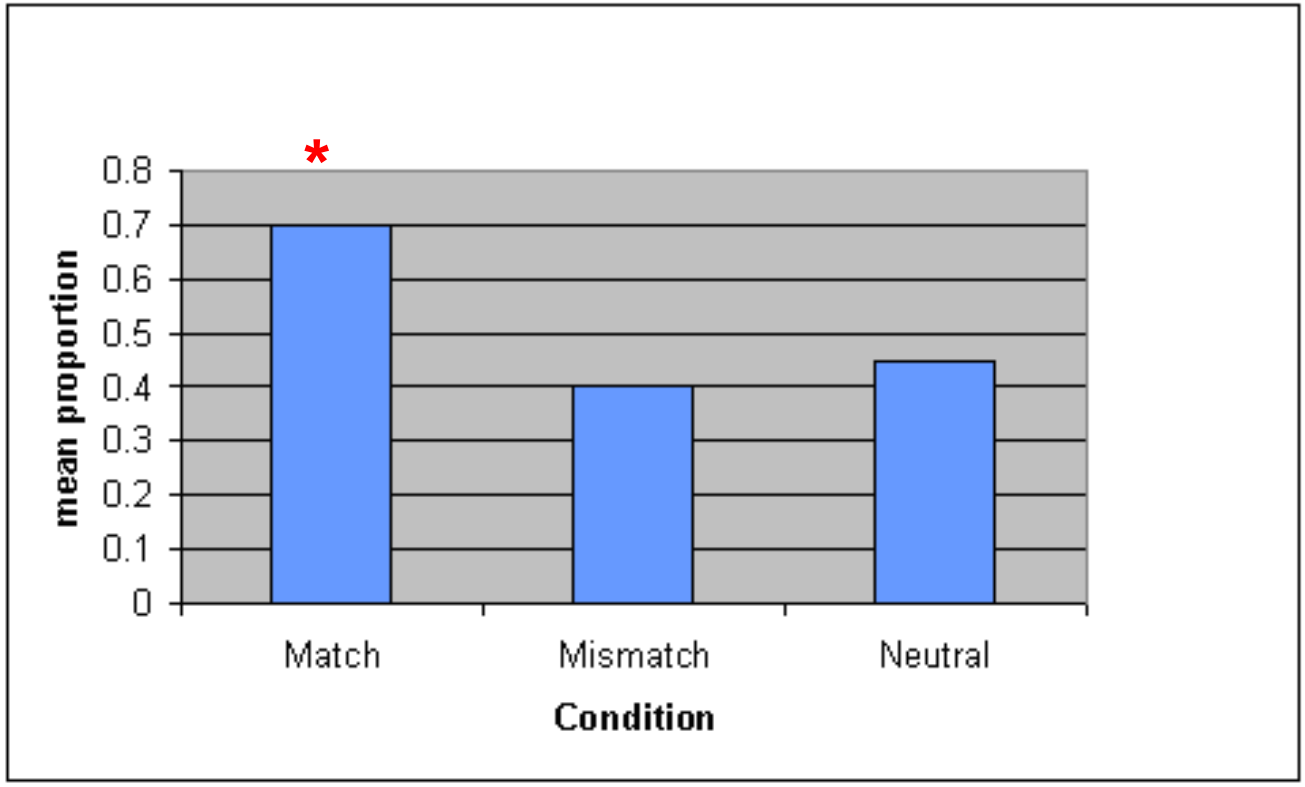


Results of Study 2 (verb generalization)



- Sound symbolism bootstrapping effect found

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/distasteful ness) from 1 to 7
- Production task: Ps produced mimetics that best matched the tactile sense for each stimulus


tupi


kupu


gaji


gode


furi


moni


mohu


zaza


sura

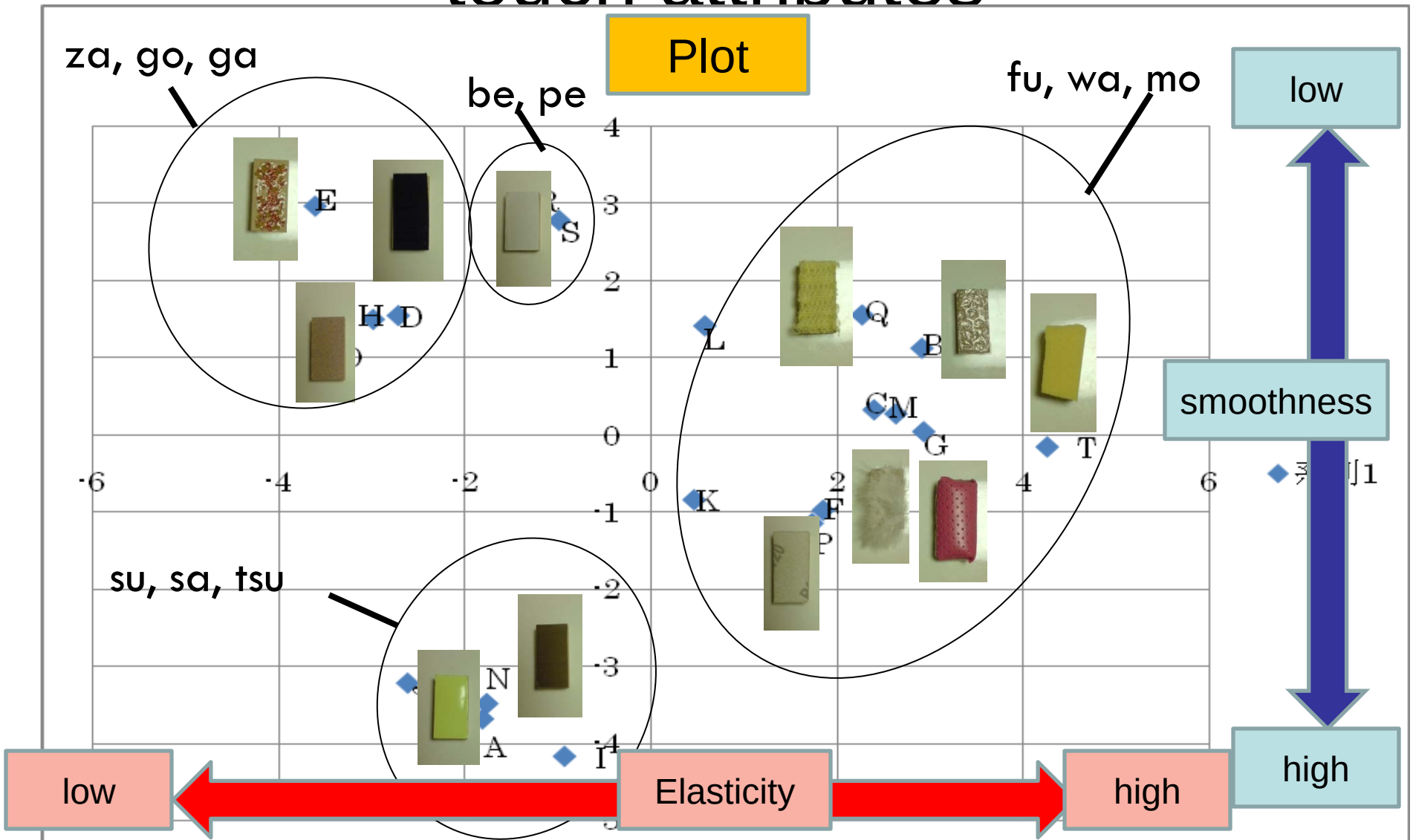

mohi


bete

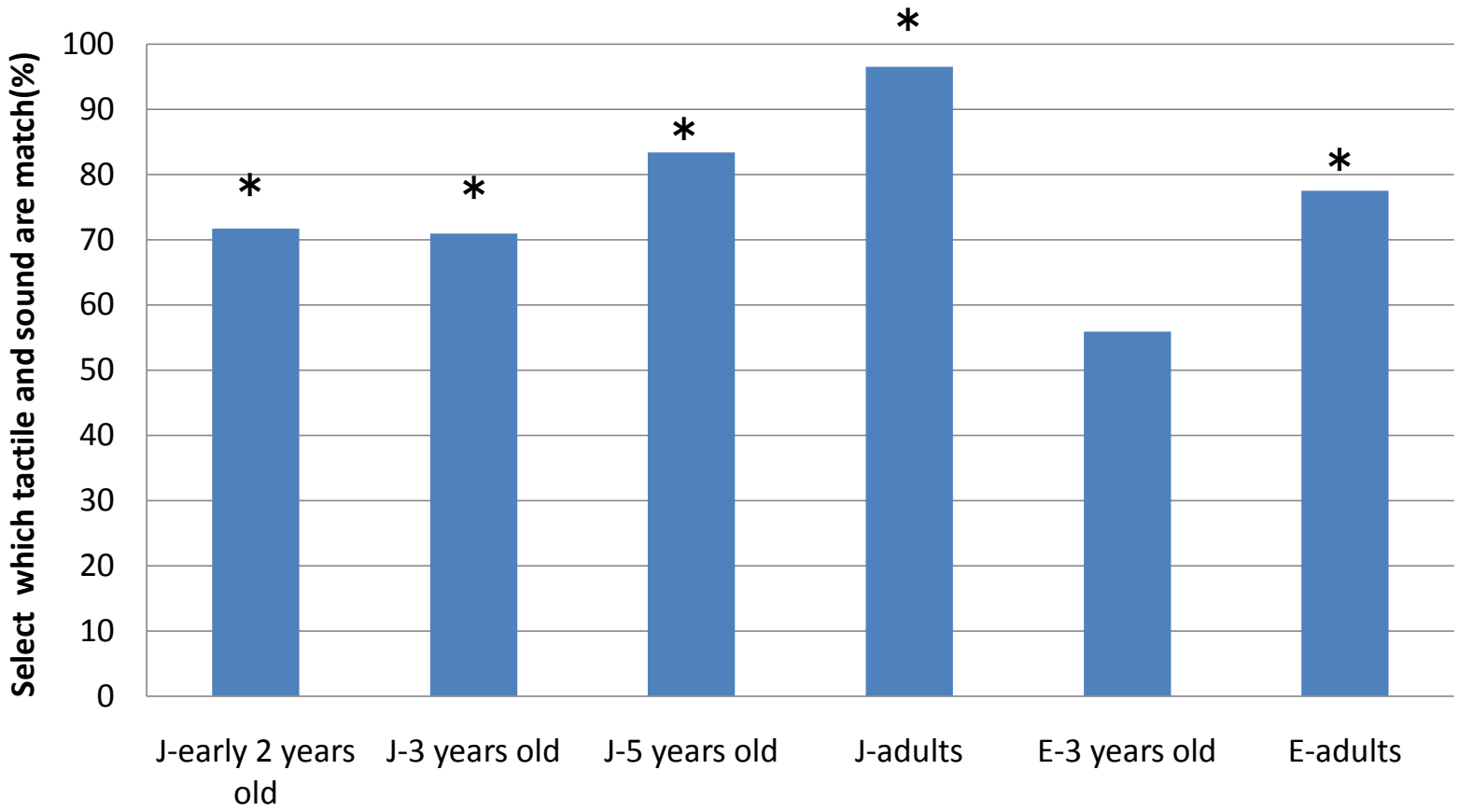

pohu

- From the rating task and the production task, we selected 12 stimuli and the name of each stimulus

Relation between sound sand touch attributes



Experiment1-result



*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

Complex

Standard item

Shape item

Material item

Simple

Standard item

Shape item

Material item

procedure

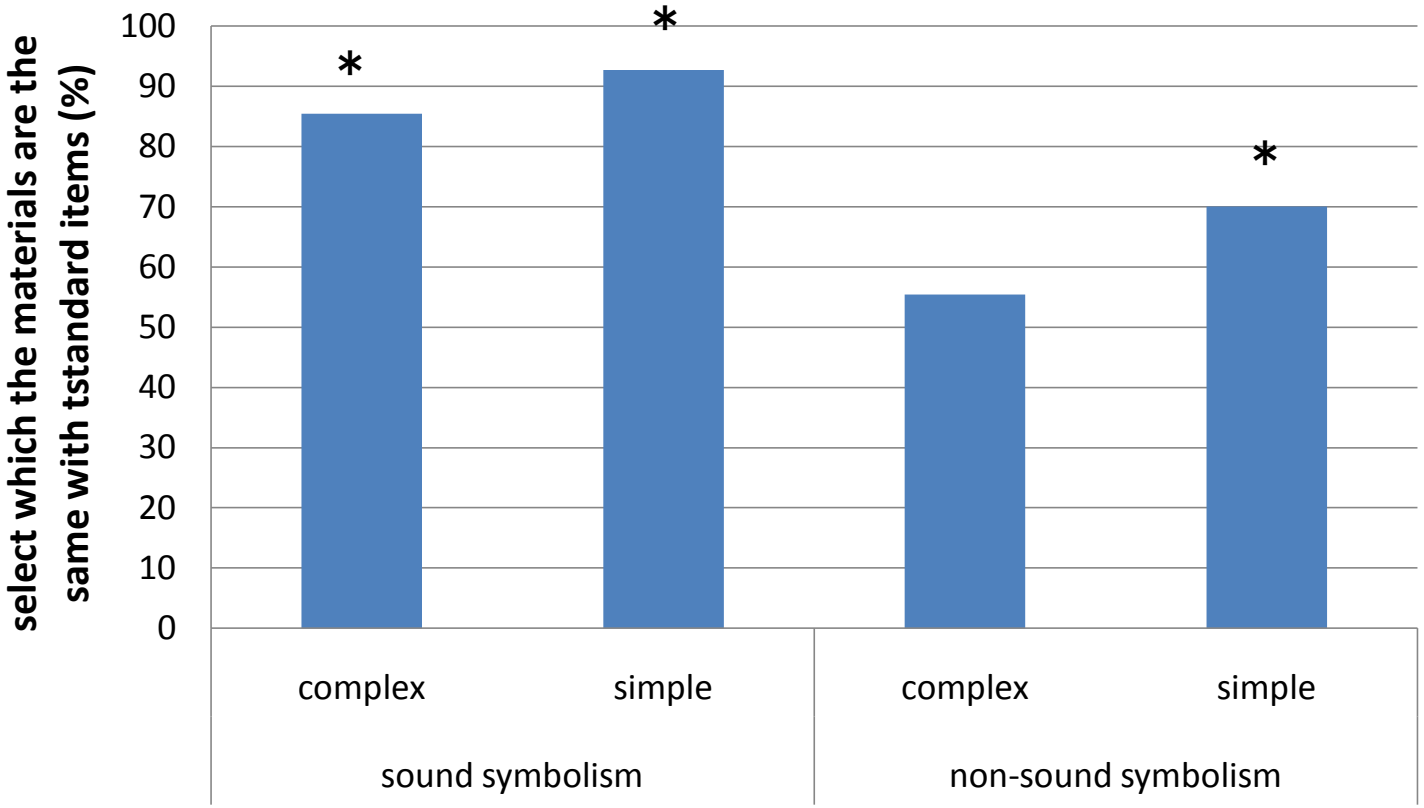
Ex) Kore wa ZAZA yo

“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?”

Experiment2-result



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)

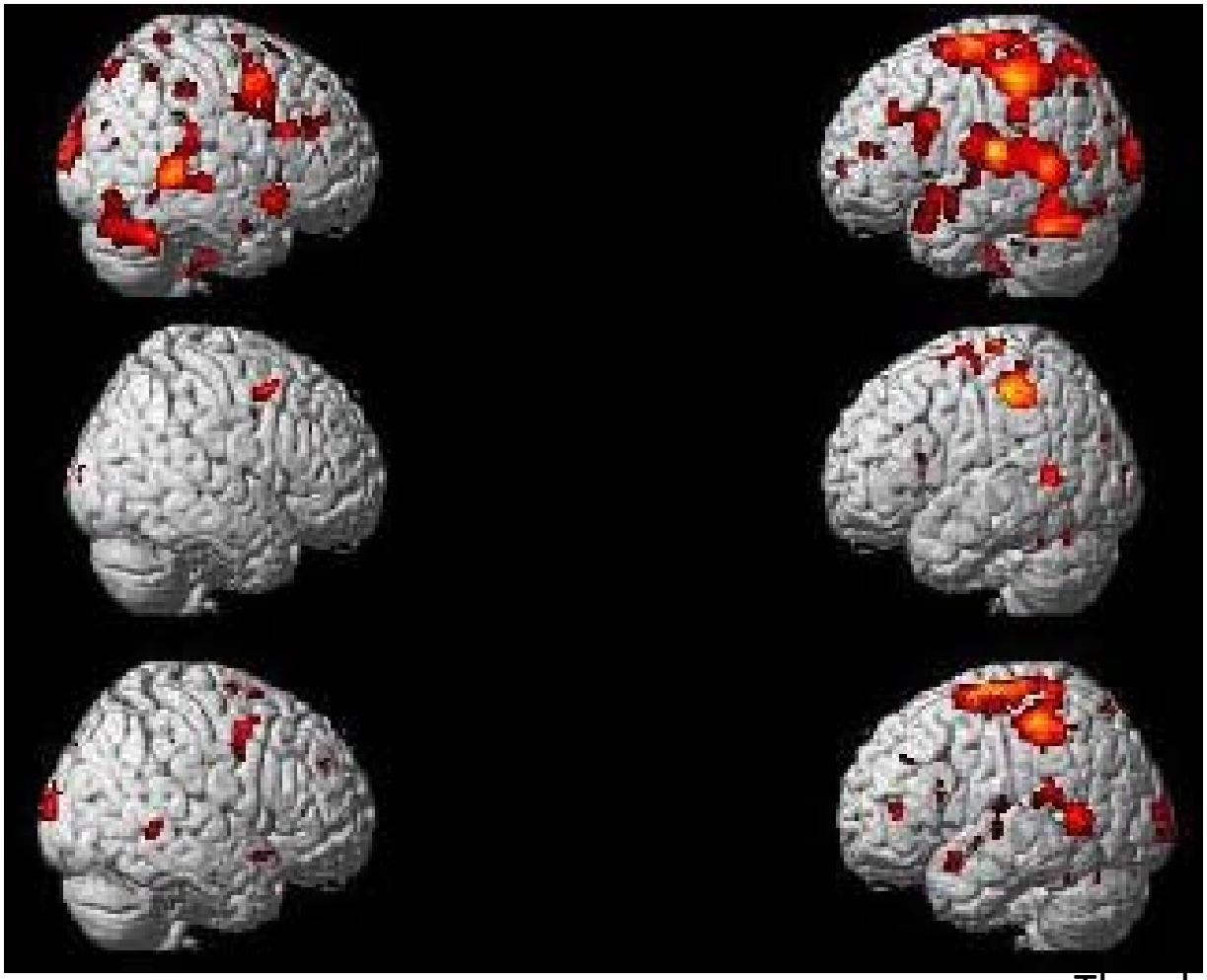
Participants rated how well the word matched the action in the video by pressing a bottom (1-5)

Activated areas of each word class —baseline

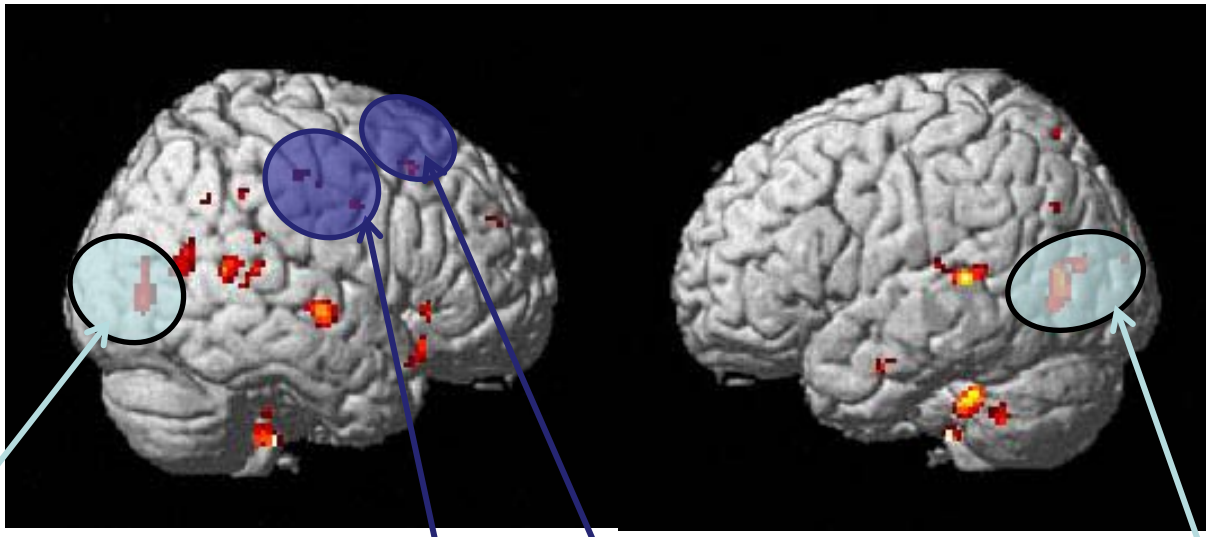
mimetics

verb

adverb



Threshold:0.001
Extent threshold:0



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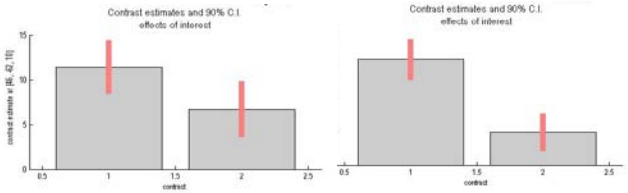
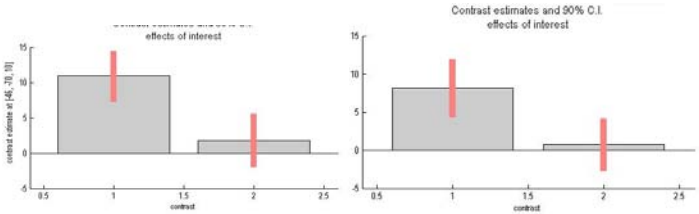
Extent threshold:0

MT



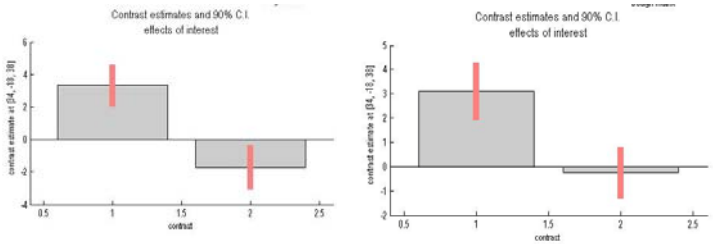
mimeticsadverb mimeticsverb

MT



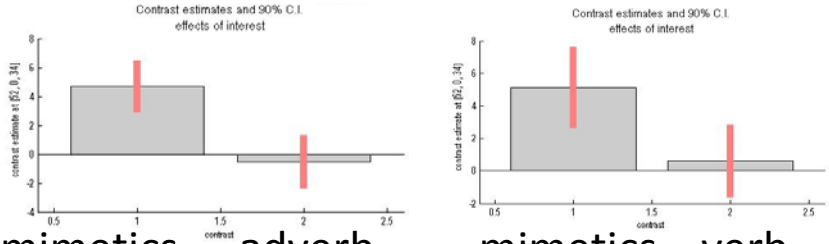
mimetics adverb mimetics verb

Motor area

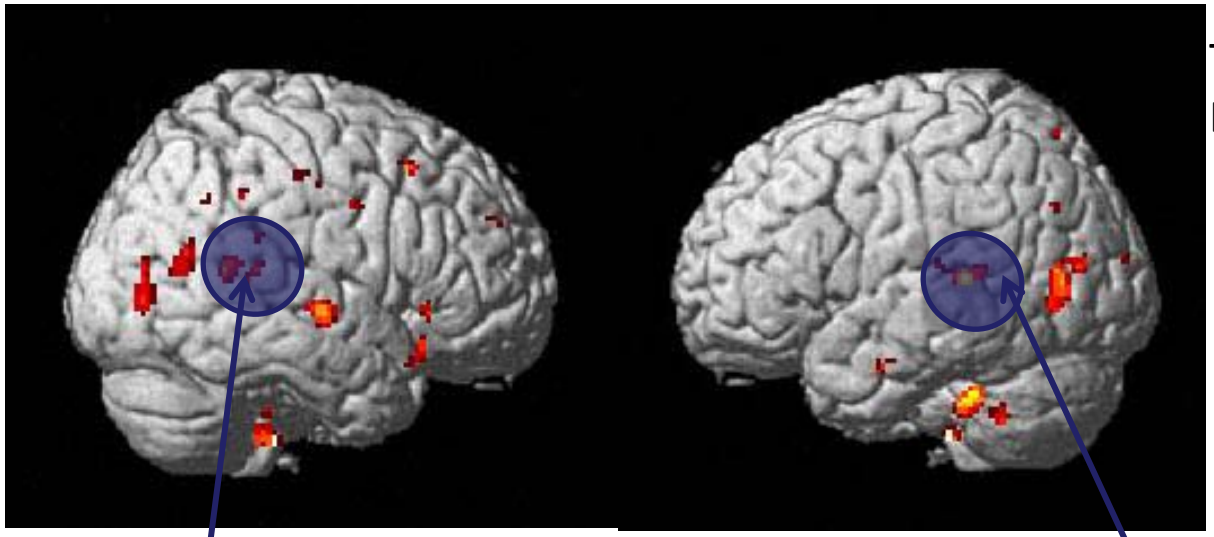


mimetics adverb mimetics verb

Pre-motor area

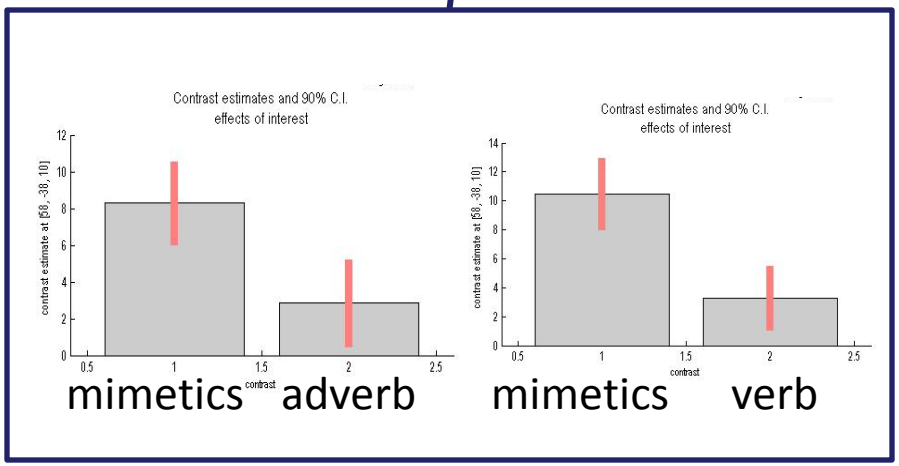


mimetics adverb mimetics verb

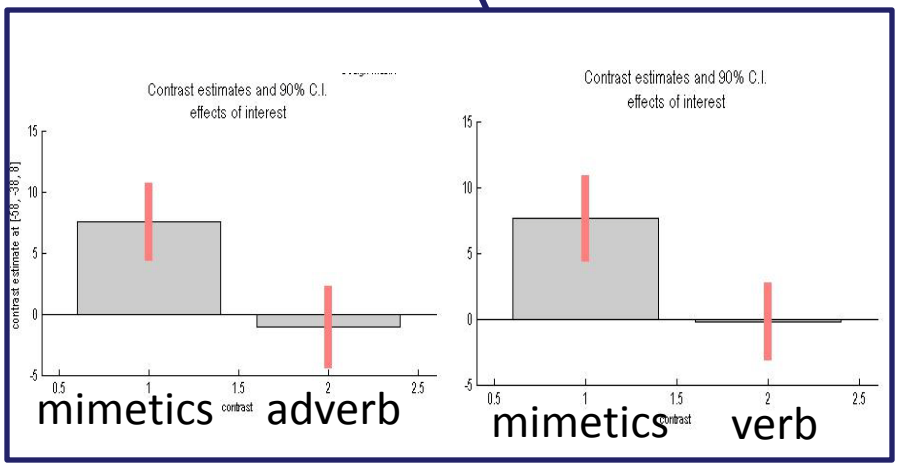


Threshold:0.001
Extent threshold:0

Superior temporal sulcus



Superior temporal sulcus

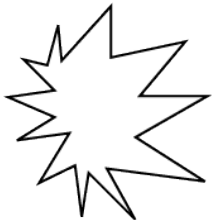
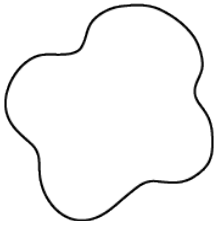
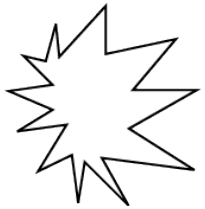
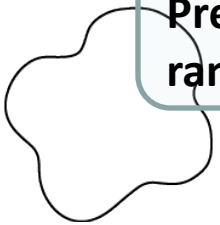


How early do infants detect sound symbolism?

- Can ERP reveal infants’ sensitivity to sound symbolism?

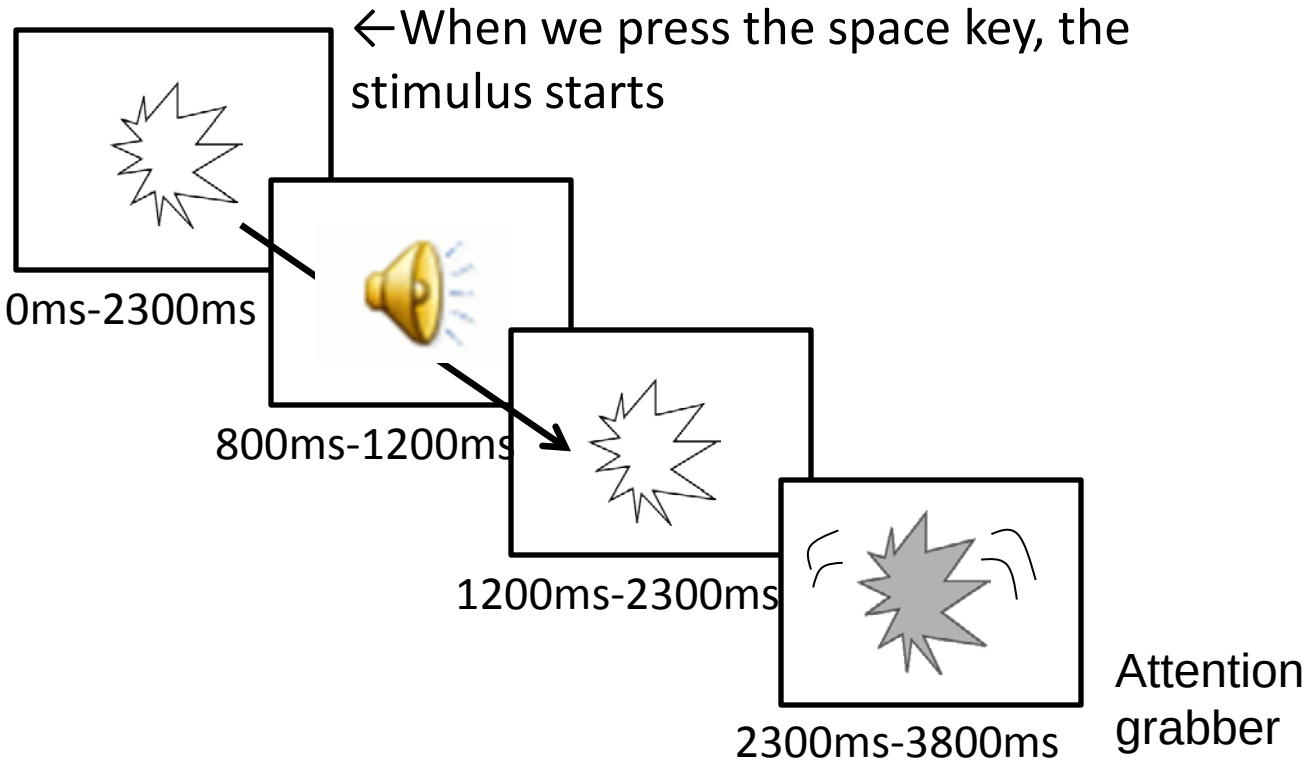
Experiment-2(infants' study)
Stimuli

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

Example figures				
Sound	KIPI	KIPI	MOMA	MOMA
Condition	Match	Mismatch	Mismatch	Match
Number of trials	40 (20figures×2times)	40	40	40

160trials Presented randomly

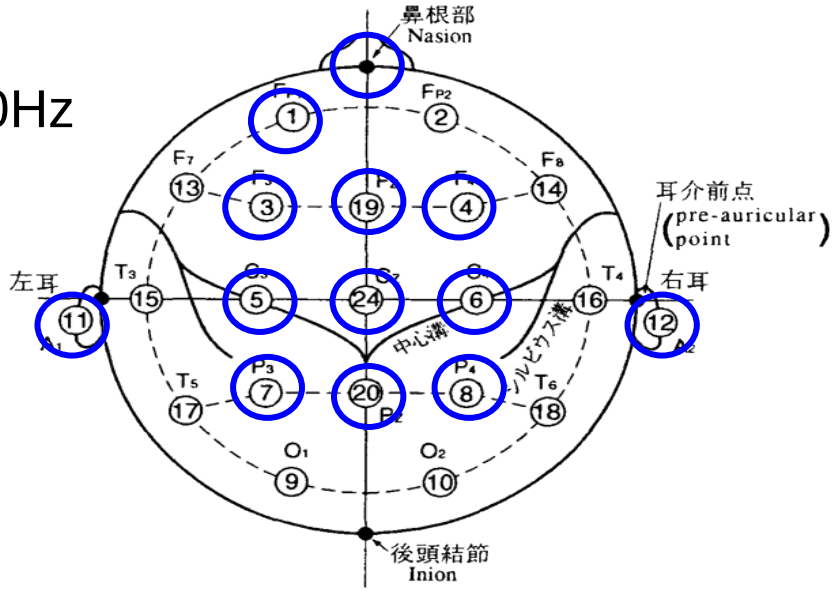
Design


←When we press the space key, the stimulus starts
0ms-2300ms
800ms-1200ms
1200ms-2300ms
2300ms-3800ms
Attention grabber

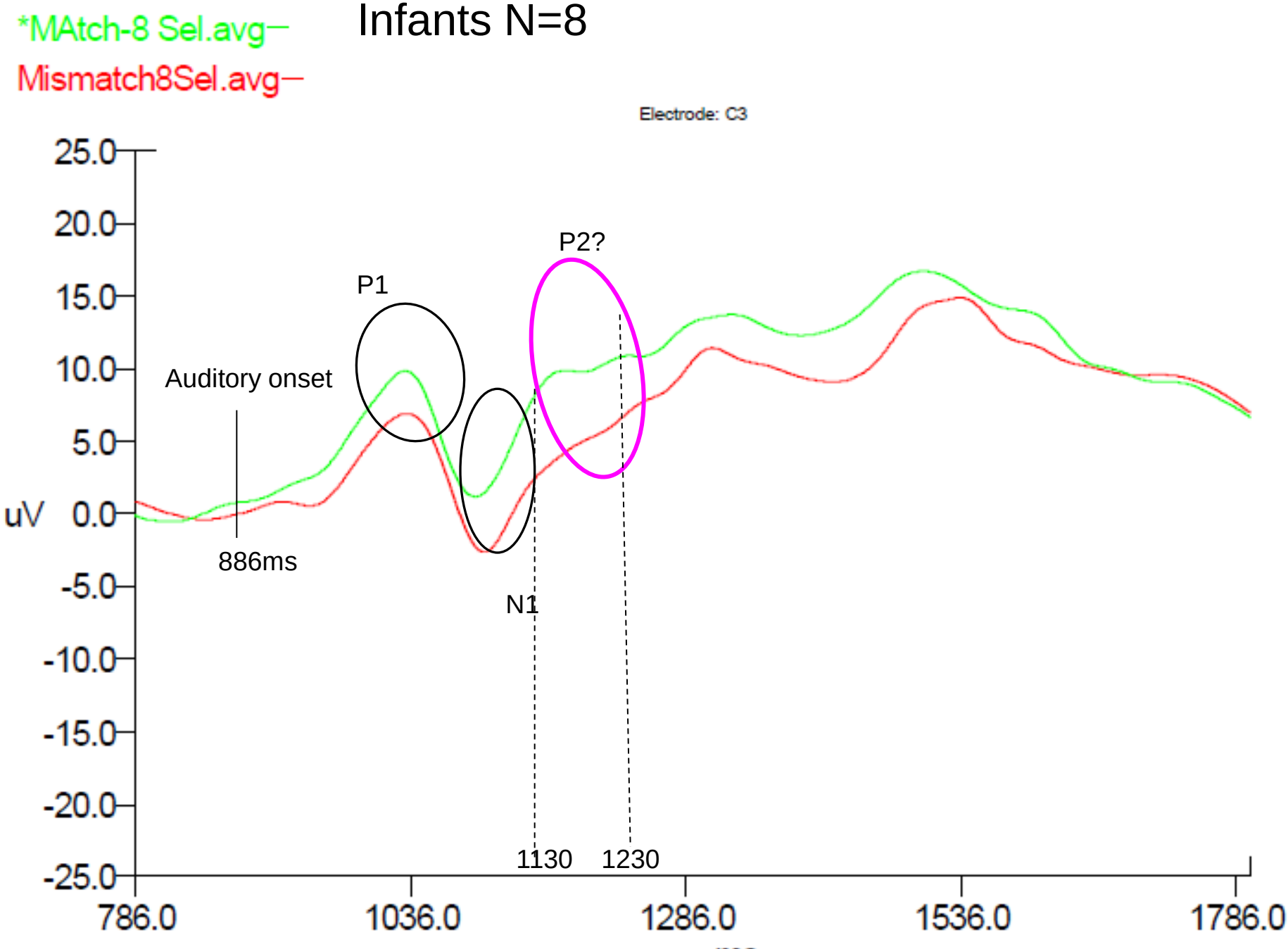
Subjects&Analysis

- **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
25.0
20.0
15.0
10.0
5.0
uV 0.0
-5.0
-10.0
-15.0
-20.0
-25.0
786.0
1036.0
1286.0
1536.0
1786.0
P1
P2?
Auditory onset
886ms
N1
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.