

Sound Symbolism Represented in Jazz Lyrics

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1. Introduction

1-1. Definition

Sound symbolism: An idea that vocal sounds or phonemes carry meanings in themselves

➤ **Size-phoneme symbolism**

/ɑ/ -/ɪ/ (Sapir, 1929; Newman, 1933)

➤ **Shape-phoneme symbolism**

“Maluma (baluba)-takete” (Köhler, 1929),

“Booba – kiki” (Ramachandran & Hubbard, 2001)

➤ **Emotion (Facial Expression)**

The Facial Feedback Hypothesis 

(Strack, Martin, & Stepper, 1988; Rummer, Schweppe, Schlegelivilch, & Grice, 2014)

Shape-phoneme symbolism

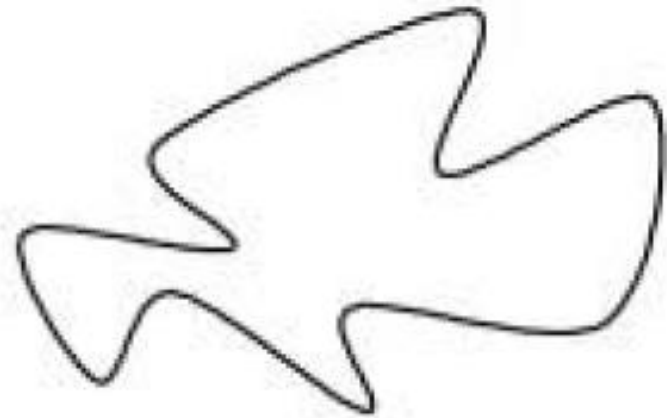
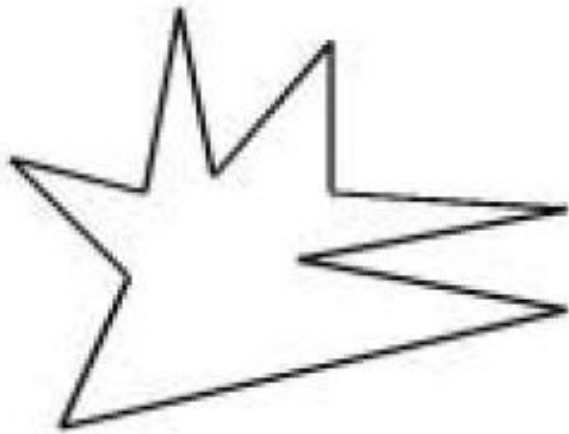
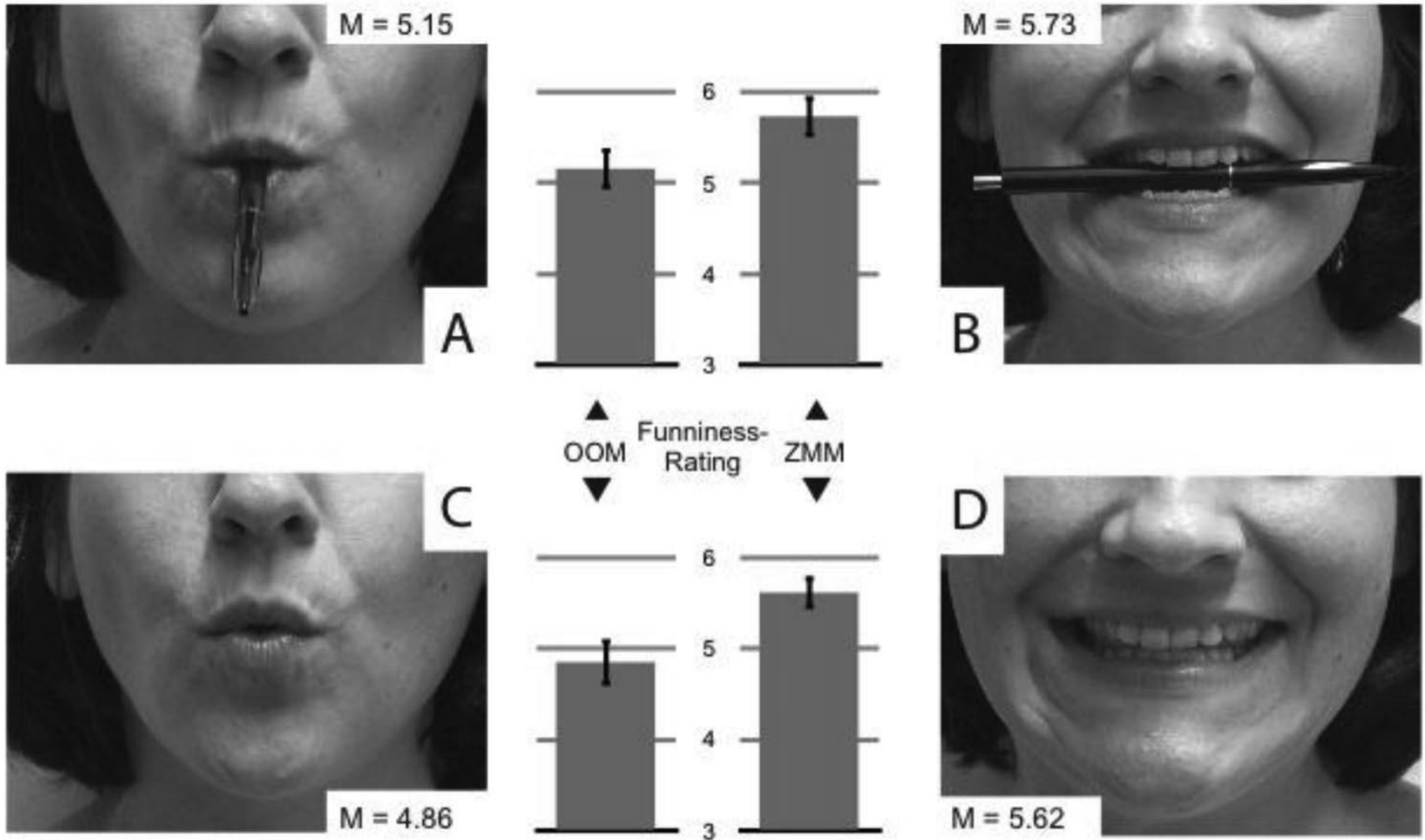


Figure 7. Demonstration of kiki and bouba. Because of the sharp inflection of the visual shape, subjects tend to map the name kiki onto the figure on the left, while the rounded contours of the figure on the right make it more like the rounded auditory inflection of bouba.

The Facial Feedback Hypothesis



Rummer, Schweppe, Schlegelivilch, & Grice (2014, p. 247)

James-Lange Theory of Emotion

...we feel sorry because we cry,
angry because we strike,
afraid because we tremble,
and not that we cry, strike, or tremble,
because we are sorry, angry, or fearful,
as the case may be.

(James, 1884)

→ We feel funny because we smile?

1-2. Research Questions

RQ1: Do people associate phonemes in non-words with particular images?

- Three dimensional approach
using SD method (Osgood, 1952)

1-3. Semantic Differential method

- **Osgood (1969, p. 194)**

... ordinarily measures certain affective features of total meaning, closely related to the dimensions of emotion or feeling... .

- **Universal features of human semantic systems**

- Evaluation (E)

- Potency (P)

- Activity (A)

- **A scale between two bipolar adjectives**

(例) PACIFIST: Kind : : : : : cruel

Osgood (1952, p. 226)

1-2. Research Questions

RQ1: Do people associate phonemes in non-words with particular images?

- Three dimensional approach using SD method (Osgood, 1952)

RQ2: Do these images match the result from Nakanishi & Nakagawa (2012),

- Analysis of phonemes in 100 jazz lyrics and Nakanishi (2013)?

- Musicians' & students' impression on 10 jazz standards

1-3. Nakanishi & Nakagawa (2012)

曲	① Front Vowels	② Back Vowels	③ Mid Vowels	④ Diphthongs	⑤ R-colored Vowels	⑥ Vt. Plosives & Affricates	⑦ Vd. Plosives & Affricates	⑧ Vt. Fricatives	⑨ Vd. Fricatives	⑩ Nasal, Lateral, Approximant
① Cheek to Cheek	16.83	0.97	11.8	7.54	7.93	16.63	6.58	9.48	6.77	15.47
② Someone to ...	14.41	5.08	9.11	8.26	8.69	10.59	6.78	10.17	7.63	19.28
③ Love for Sale	9.07	3.47	12.55	9.65	10.04	10.81	4.44	10.81	11.39	17.76
④ Sweet Georgia ...	11.44	4.01	6.54	9.81	11.59	11.14	11.89	12.18	6.98	14.41
⑤ Cry me a River	12.73	7.58	7.88	10.3	23.03	7.58	5.15	3.64	7.27	14.85
⑥ Route 66	15.34	5.82	6.88	7.41	11.64	18.25	5.29	11.38	3.97	14.02
⑦ Bye Bye Blackbird	9.09	5.61	5.61	10.64	13.54	8.7	17.41	7.16	4.45	17.79
⑧ Mack the Knife	13.59	3.18	9.55	7.22	10.19	12.53	9.55	11.46	8.49	14.23
⑨ Love is a Many ...	15.36	1.87	11.61	4.87	8.99	10.49	6.74	8.61	9.74	21.72
⑩ When You're ...	12.68	5.48	7.49	8.36	15.85	8.93	4.61	9.8	4.03	22.77

1-3. Nakanishi (2013)

曲	分類(イメージ)	学習者アンケートから抽出されたイメージ
①	前舌母音 (笑顔, 陽気)	楽しい(16), 明るい(10), 幸せ(7), 可愛い(4), 美しい(3), 嬉しい(3), 落ち着いた(3), ゆっくり(3)
②	後舌母音 (甘えん坊, 畏怖)	悲しい(10), ゆっくり(9), 美しい(7), 暗い(6), 寂しい(5)
③	中舌母音 (でしゃばらない, 献身的)	楽しい(7), 明るい(6), 美しい(5), 強い(4), 速い(4)
④	二重母音 (遊び心, 複雑)	かっこいい(10), 楽しい(10), 明るい(7), 暖かい(3), 暗い(2), 元気(2), 強い(2), リズムがよい(2)
⑤	r母音半母音 (重い, 暗い)	悲しい(13), 寂しい(7), 暗い(6), ゆっくり(6), きれい(5), 優しい(5)
⑥	無声閉鎖破擦音 (軽やか, 前進)	楽しい(12), 明るい(7), かっこいい(3), 速い(3), 軽い(2), 元気(2), 心地良い(2), 幸せ(2), 優しい(2)
⑦	有声閉鎖破擦音 (心残り, 停滞)	明るい(4), 落ち着いた(4), 楽しい(4), 暖かい(3), 悲しい(3), きれい(3)
⑧	無声摩擦音 (密やか, 静けさ)	楽しい(11), 明るい(8), かっこいい(5), 美しい(3), 静か(3), 強い(3)
⑨	有声摩擦音 (重厚, 壮大)	美しい(6), ゆっくり(6), 落ち着いた(5), 優しい(4), きれい(3), 静か(3), 優雅な(3)
⑩	鼻音側面接接近 (優しい, 柔らかい)	楽しい(8), ゆっくり(6), 明るい(5), 美しい(4), きれい(4)

2. Method (Sound symbolism in non-words)

2-1. Stimuli

- 84 “CVCV” synthesized stimuli composed of 7 consonants × 6 vowels × (male, female)
- 22 extracted as non-words in Eng., Jpn., & Chn.

2-2. bipolar adjectives

- 18 pairs of adjectives representing E, P, A from the factor analyses in Osgood (1964); Di Vesta (1965).

2-3. Web questionnaire

- For English, Japanese, & Chinese NSs.
- Showed the non-words in random order.

2-1. Stimuli ①

- Combination of 7 Cs and 6 Vs.

THE INTERNATIONAL PHONETIC ALPHABET

CONSONANTS (PULMONIC)

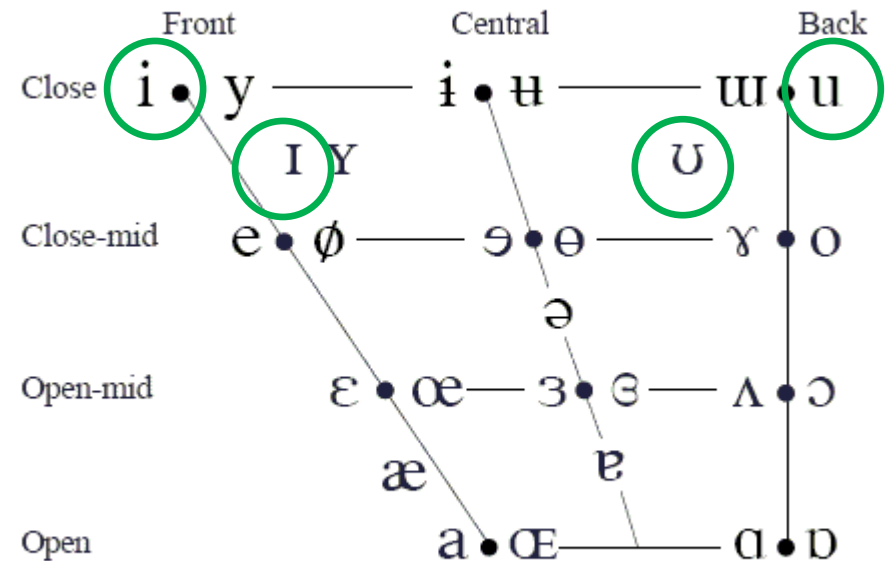
	Bilabial	Labiodental	Dental	Alveolar	Postalveolar													
Plosive	p b			t d														
Nasal	m	n ŋ		ɳ														
Trill	ʙ			r														
Tap or Flap				ɾ														
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ							
Lateral fricative				ɬ ɮ														
Approximant		ʋ		ɹ			ɻ	j	ɰ									
Lateral approximant				ɭ			ʎ	ʟ										

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.



Voiced labial-velar approximant

VOWELS



2-1. Stimuli ②

- Non-words extracted by NS of Eng. ($n=5$), Jpn. ($n=5$), Chn. ($n=5$)

合成音声・無意味語調査（日本語）			
この調査は、科学研究費助成事業（科研）助成金の交付を受けて行うものです。 本調査から得られた個人情報を研究以外の目的で使用することはありません。			
<回答者情報>			
★性別（当てはまらないものを削除してください） 男性 女性			
★年代（当てはまらないものを削除してください） 20代 30代 40代 50代 60代 70代			
1~42の男女それぞれの音声を聞いて、			
 ★日本語の単語のように聞こえたものは、その単語を記入 ★日本語の単語のように聞こえなければ「？」印を記入 ★人間が出した声のように聞こえなければ「×」印を記入 してください。			
No.	女性音	男性音	左の回答をした理由や、条件・前提など、 お気づきの点ご記入ください。
1			
2			
3			
4			

2-1. Stimuli ③

- Non-words in English, Japanese, & Chinese.
- As many minimal pairs as possible.
- Sounds natural as human voice.

	iː	i	uː	u	ɪə	ʊə
p	piːpiː	pipi	puːpuː	pupu	piəpiə	puəpuə
b	biːbiː	bibi	buːbuː	bubu	biəbiə	buəbuə
f	fiːfiː	fifi	fuːfuː	fufu	fiəfiə	fuəfuə
v	viːviː	vivi	vuːvuː	vuvu	viəviə	vuəvuə
m	miːmiː	mimi	muːmuː	mumu	miəmiə	muəmuə
l	liːliː	lili	luːluː	lulu	liəliə	luəluə
w	wiːwiː	wiwi	wuːwuː	wuwu	wiəwiə	wuəwuə

2-2. bipolar adjectives

- 18 pairs of adjectives Representing E, P, A

本調査で使した形容詞対				
順序	英語	日本語	中国語	因子
2	good - bad	良い - 悪い	好 - 坏	評価性
6	pleasant - unpleasant	快適な - 不快な	舒服 - 不快	評価性
9	happy - sad	嬉しい - 悲しい	高兴 - 悲伤	評価性
11	beautiful - ugly	美しい - 醜い	好看 - 难看	評価性
16	soft - rough	なめらかな - ざらざらした	光滑 - 粗糙	評価性
18	sweet - sour	甘い - 酸っぱい	甜 - 酸	評価性
1	strong - weak	強い - 弱い	强 - 弱	力量性
4	long - short	長い - 短い	长 - 短	力量性
5	big - little	大きい - 小さい	大 - 小	力量性
13	heavy - light	重い - 軽い	重 - 轻	力量性
15	thick - thin	厚い - 薄い	厚 - 薄	力量性
17	deep - shallow	深い - 浅い	深 - 浅	力量性
3	fast - slow	速い - 遅い	快 - 慢	活動性
7	young - old	若い - 老いた	年轻 - 年长	活動性
8	sturdy - delicate	たくましい - 繊細な	健壮 - 纤细	活動性
10	active - passive	積極的な - 消極的な	积极的 - 消极的	活動性
12	noisy - quiet	騒がしい - 静かな	吵闹 - 安静	活動性
14	sharp - dull	鋭い - 鈍い	锋利 - 钝	活動性

2-3. Web questionnaire ①

- For English, Japanese, & Chinese NSs.

Sound Image Survey

This survey is for exploring what kind of image certain sounds in human language give to people with different language backgrounds.

A USD 5.00 / JPY 500 / CNY 30 worth of
an Amazon Gift Card will be sent to
the respondents of this survey.

Survey period:

Aug. 1, 2014 to the middle of September

The expiry date is subject to change, according to the number of respondents.
This survey is a part of a project supported by Grants-in-Aid for Scientific Research (KAKENHI).
Information gained through this questionnaire will be used only for academic purposes.
Normally this questionnaire takes about half an hour to complete.

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Instruction

- Please listen to the sounds, and then, by intuition, indicate what image each sound gives you.
- First, click the speaker icon below, and make sure that you can hear the sound properly.



- Starting from the next page, each time you click the speaker icon, you will hear **a word that is NOT English**.
- Each word is read by a woman, and then a man.

For example, in English,
when you hear a sound "pop",
does it give you an image closer to "sudden", or "gradual"?

If you feel it's **"sudden"**

If you feel it's **"sudden" rather than "gradual"**

If you feel it's **neither "sudden" nor "gradual"**

If you feel it's **"gradual" rather than "sudden"**

If you feel it's **"gradual"**

1 2 3 4 5

sudden ☐ ☐ ☐ ☐ ☐ gradual

Click one of the buttons as shown above.

Go on to the Questionnaire

2-3. Web questionnaire ③

Sound Image Survey

0% 100%

Finally, please answer the questions below.

(All data collected will be held in strict confidence and will only be used for data analysis.)

* Sex

☐ Female ☐ Male

* Age

Choose one of the following answers

* The country you lived in for the longest time so far

* Area(s) you have stayed at over a year

Check any that apply

☐ Europe
☐ Asia
☐ Africa
☐ Oceania
☐ North America
☐ South America
☐ None

Survey period:
Aug. 2-24, 2014.

* Language(s) you have studied for more than half a year

Check any that apply

☐ None

☐ Japanese

☐ Chinese

☐ Other:

* Gift Card request

Choose one of the following answers

Submit

3. Results

3-1. Valid response

- Responses that took no shorter than 15 min. to answer all the questions ($n = 322 / 541$).

3-2. Reliability analysis

- Cronbach α for Evaluation, Potency, Activity

3-3. Tendency of images of each phoneme

- SD analysis

3-4. Comparisons among the phoneme groups

- T -test, One-way ANOVA
 - Multiple comparison (Bonferroni)

3-1. Valid response(*n*)

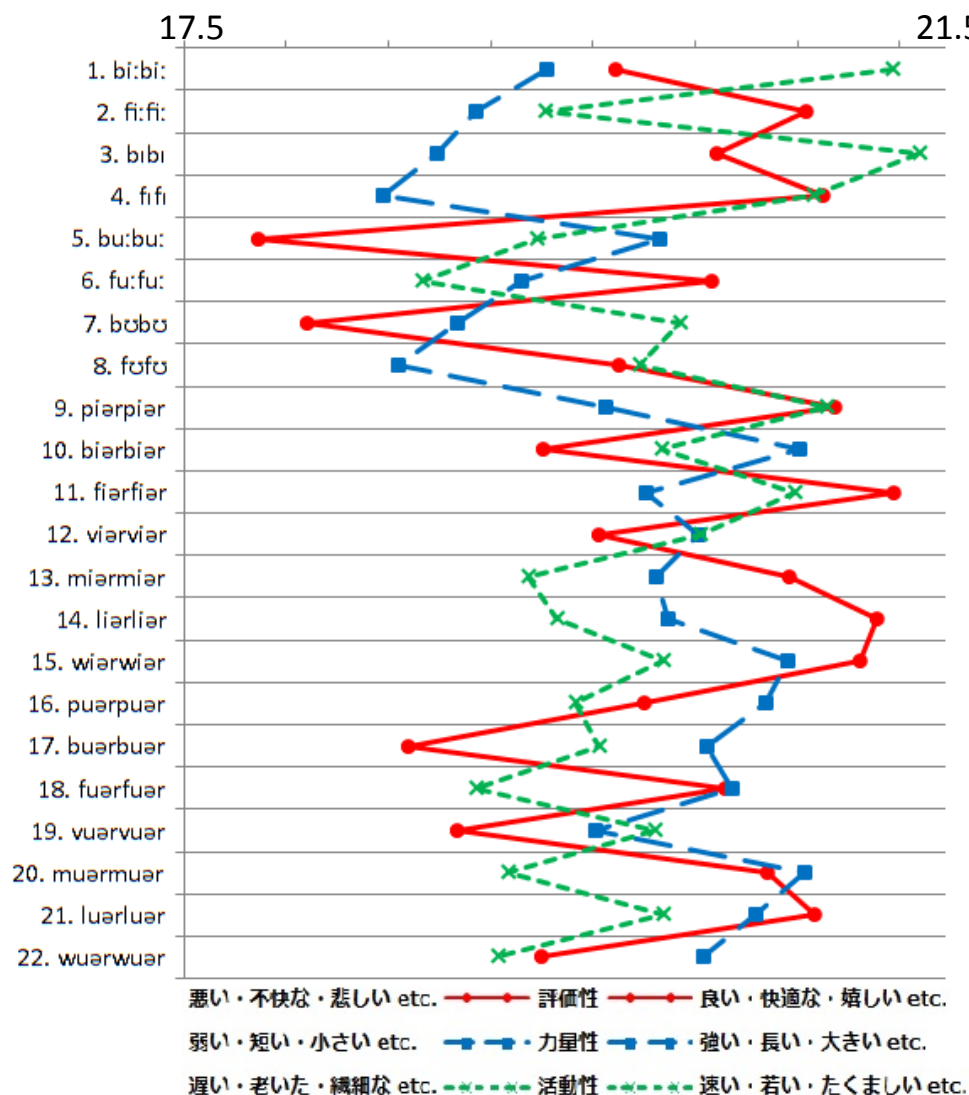
Lang.	sex	20-	30-	40-	50-	60-	70-	80-	total
Eng.	m	9	23	26	5	0	2	1	66
	f	16	31	13	5	1	3	0	69
Jpn.	m	13	7	10	6	3	1	0	40
	f	20	13	17	6	0	0	0	56
Chn.	m	11	17	12	3	2	0	0	45
	f	21	15	7	2	1	0	0	46
	total	90	106	85	27	7	6	1	322

- Duration $M = 45\text{min. } 12\text{sec.}$ ($SD = 66\text{min. } 57\text{sec.}$)
- The country or areas stayed the longest:
Eng.- Eng. 76%, Jpn.-Jpn. 93%, Chn.-chn. 90%

3-2. Reliability analysis

	Evaluation	Potency	Activity
1. bi:bi:	0.74	0.60	0.59
2. fi:fi:	0.69	0.60	0.66
3. biɪ	0.70	0.64	0.64
4. fiɪ	0.66	0.66	0.59
5. bu:bu:	0.79	0.63	0.62
6. fu:fu:	0.62	0.56	0.69
7. bʊbʊ	0.79	0.60	0.67
8. fʊfʊ	0.70	0.68	0.66
9. piəpiə	0.69	0.54	0.61
10. biəbiə	0.70	0.56	0.60
11. fiəfiə	0.72	0.56	0.61
12. viəviə	0.72	0.67	0.69
13. miəmiə	0.60	0.64	0.74
14. liəliə	0.71	0.66	0.70
15. wiəwiə	0.70	0.54	0.66
16. pʊəpʊə	0.73	0.54	0.69
17. bʊəbʊə	0.77	0.64	0.64
18. fʊəfʊə	0.69	0.59	0.68
19. vʊəvʊə	0.75	0.56	0.66
20. mʊəmʊə	0.68	0.58	0.74
21. lʊəlʊə	0.72	0.58	0.66
22. wʊəwʊə	0.72	0.62	0.69

3-3. Tendency of images of each phoneme



Evaluation

Potency

Activity

⇒ 3 scales to measure the images.

Phoneme groups were determined according to the tendency.

⇒ Front V. vs. Back V.

Tense V. vs. Lax V. vs. R-colored V.

Consonants

3-4. Comparisons ① (Front V. vs Back V.)

Mean scores of the stimuli in each phoneme group ($n=322$)

Group	Stimuli	Evaluation		Potency		Activity	
		<i>M</i>	<i>sd</i>	<i>M</i>	<i>sd</i>	<i>M</i>	<i>sd</i>
Front V	1. bi:bi:, 2. fi:fi:, 3. biɒi, 4. fiɒi, 9. piəpiə, 10. biəbiə, 11. fiəfiə, 12. viəviə, 13. miəmiə, 14. liəliə, 15. wiəwiə	3.39	0.51	3.26	0.52	3.35	0.50
Back V.	5. bu:bu:, 6. fu:fu:, 7. bʊbʊ, 8. fʊfʊ, 16. pʊəpʊə, 17. bʊəbʊə, 18. fʊəfʊə, 19. vʊəvʊə, 20. mʊəmʊə, 21. lʊəlʊə, 22. wʊəwʊə	3.23	0.56	3.29	0.50	3.23	0.53

Comparison of Front ▪ Back (*T*-test)

	Evaluation	Potency	Activity
Front /i:, ɪ, iə/ - Back /u:, ʊ, ʊə/	> ***	< **	> ***

*** $p < .001$, ** $p < .01$.

Front V. > Back V. associated with the following images:

(Evaluation) good, comfortable, happy, beautiful, soft, & sweet

(Potency) weak, short, small, light, thin, & shallow

(Activity) fast, young, sturdy, active, noisy, & sharp

3-4. Comparisons ② (Tense vs Lax vs R-colored)

Mean scores of the stimuli in each phoneme group ($n=322$)

Group	Stimuli	Evaluation		Potency		Activity	
		<i>M</i>	<i>sd</i>	<i>M</i>	<i>sd</i>	<i>M</i>	<i>sd</i>
Tense	1. bi:bi:, 2. fi:fi:, 5. bu:bu:, 6. fu:fu:	3.25	0.58	3.22	0.56	3.26	0.54
Lax	3. biɪ, 4. fiɪ, 7. bʊbʊ, 8. fʊfʊ	3.27	0.58	3.11	0.65	3.39	0.55
R-color	10. biəbiə, 11. fiəfiə, 17. bʊəbʊə, 18. fʊəfʊə	3.29	0.58	3.35	0.52	3.28	0.54

Comparison of Tense – Lax – R-color (One-way ANOVA + multiple comparison)

	Evaluation	Potency	Activity
Tense /i:, u:/ - Lax /ɪ, ʊ/	<i>n.s.</i>	> ***	< ***
Tense /i:, u:/ - R-color /ɪə, ʊə/	<i>n.s.</i>	< ***	<i>n.s.</i>
Lax /ɪ, ʊ/ - R-color /ɪə, ʊə/	<i>n.s.</i>	< ***	> ***

*** $p < .001$.

(Evaluation) *n.s.* difference among Tense, Lax & R-color

(Potency) “strong, long, big, heave, thick, & deep” image: R-color > Tense > Lax

(Activity) “fast, young, sturdy, active, noisy, & sharp” image: Lax > Tense & R-color

3-4. Comparisons ③ (Consonants)

Mean scores of the stimuli in each phoneme group ($n=322$)

Group	Stimuli	Evaluation		Potency		Activity	
		<i>M</i>	<i>sd</i>	<i>M</i>	<i>sd</i>	<i>M</i>	<i>sd</i>
VI. Plo.	9. piəpiə, 16. pʊəpʊə	3.37	0.63	3.33	0.55	3.34	0.60
Vd. Plo.	10. biəbiə, 17. bʊəbʊə	3.16	0.69	3.38	0.57	3.28	0.59
VI. Fric.	11. fiəfiə, 18. fʊəfʊə	3.43	0.62	3.33	0.56	3.28	0.59
Vd. Fric.	12. viəviə, 19. vʊəvʊə	3.20	0.69	3.29	0.60	3.32	0.62
Nasal	13. miəmiə, 20. mʊəmʊə	3.40	0.60	3.36	0.58	3.19	0.69
Lateral	14. liəliə, 21. lʊəlʊə	3.46	0.66	3.35	0.59	3.26	0.63
Approx.	15. wiəwiə, 22. wʊəwʊə	3.34	0.63	3.37	0.56	3.24	0.63

3-4. Comparisons ③ (Consonants)

Results of one-way ANOVA with multiple comparison (Bonferroni)

Consonants	Evaluation	Potency	Activity
VI. Plo. /p/ - Vd. Plo. /b/	> ***	<i>n.s.</i>	<i>n.s.</i>
VI. Plo. /p/ - Vd. Fric. /v/	> ***	<i>n.s.</i>	<i>n.s.</i>
VI. Fric. /f/ - Vd. Fric. /v/	> ***	<i>n.s.</i>	<i>n.s.</i>
VI. Fric. /f/ - Vd. Plo. /b/	> ***	<i>n.s.</i>	<i>n.s.</i>
Vd. Plo. /b/- Vd. Fric. /v/	<i>n.s.</i>	> **	<i>n.s.</i>
VI. Plo. /p/ - Nasal /m/	<i>n.s.</i>	<i>n.s.</i>	> ***
VI. Plo. /p/ - Approx. /w/	<i>n.s.</i>	<i>n.s.</i>	> *
VI. Fric. /f/ - Nasal /m/	<i>n.s.</i>	<i>n.s.</i>	> **
VI. Fric. /f/ - Approx. /w/	> **	<i>n.s.</i>	<i>n.s.</i>
Vd. Plo. /b/ - Nasal /m/	< ***	<i>n.s.</i>	<i>n.s.</i>
Vd. Plo. /b/ - Lateral /l/	< ***	<i>n.s.</i>	<i>n.s.</i>
Vd. Plo. /b/ - Approx. /w/	< ***	<i>n.s.</i>	<i>n.s.</i>
Vd. Fric. /v/ - Nasal /m/	< ***	<i>n.s.</i>	> **
Vd. Fric. /v/ - Lateral /l/	< ***	<i>n.s.</i>	<i>n.s.</i>
Vd. Fric. /v/ - Approx. /w/	< ***	< *	<i>n.s.</i>
Lateral /l/ - Approx. /w/	> **	<i>n.s.</i>	<i>n.s.</i>
VI. Plo. /p/ - Vd. Plo. /b/	> ***	<i>n.s.</i>	<i>n.s.</i>

*** $p < .001$, ** $p < .01$, * $p < .05$.

3-4. Comparisons ③ (Consonants)

(Evaluation)

/p/ ▪ /f/ > /b/ ▪ /v/

/m/ ▪ /l/ ▪ /w / > / b/ ▪ /v/

“good, pleasant, happy, beautiful, soft, & sweet” images

(Potency)

/v/ associated with

“strong, long, big, heavy, thick & deep” images?

(Activity)

/p/ associated with

“fast, young, sturdy, active, noisy & sharp” images?

/m/ associated with

“slow, old, delicate, passive, quiet & dull” images?

3-4. Comparisons (Overview)

Evaluation	Potency	Activity
good - bad	strong - weak	fast - slow
pleasant - unpleasant	long - short	young - old
happy - sad	big - little	sturdy - delicate
beautiful - ugly	heavy - light	active - passive
soft - rough	thick - thin	noisy - quiet
sweet - sour	deep - shallow	sharp - dull

Vowels

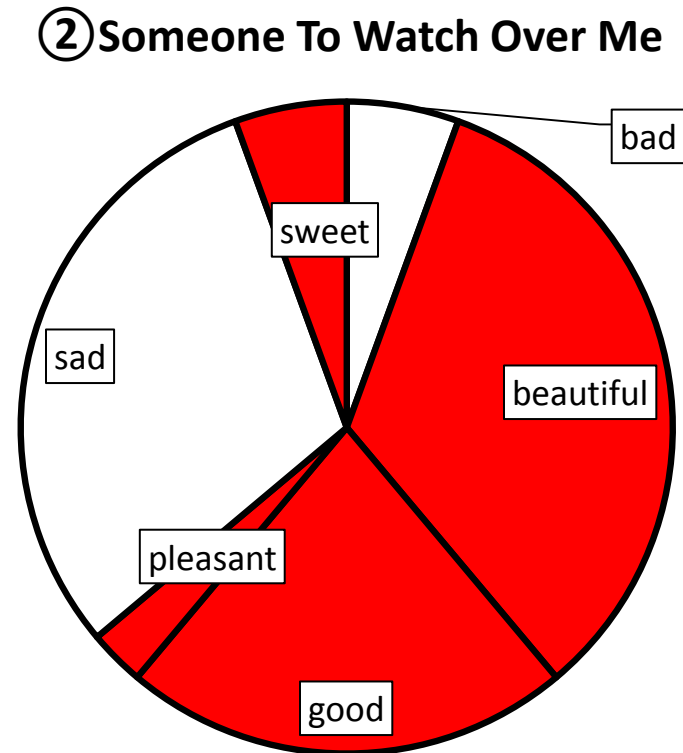
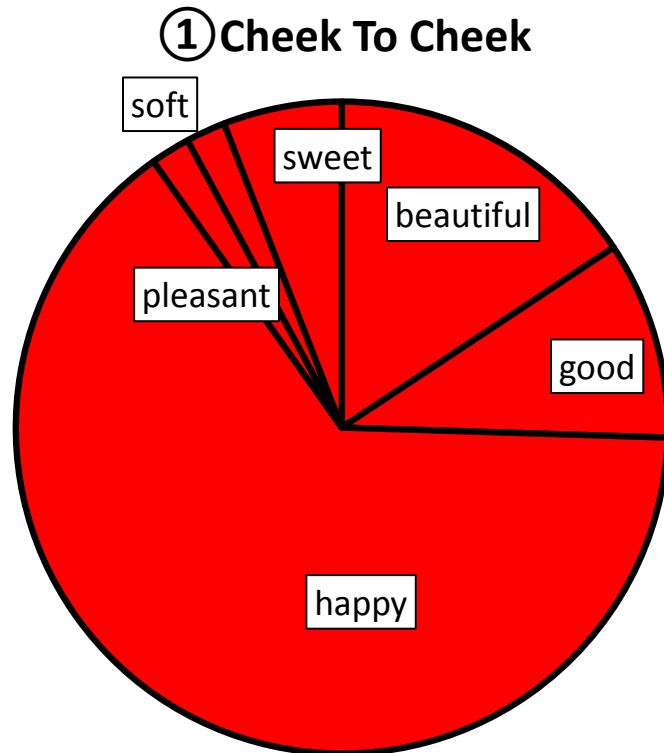
Front > Back	Back > Front	Front > Back
	R-color > Tense > Lax	Lax > Tense, R-color

Consonants

/p/, /m/ > /b, v/	/b/, /w/ > /v/	/p/, /f/, /v/ > /m/ > /w/
/f/, /l/ > /w/ > /b, v/		

3-5. Comparison with Nakanishi (2013)

➤ **Evaluation** “good, pleasant, happy, beautiful, soft, & sweet”

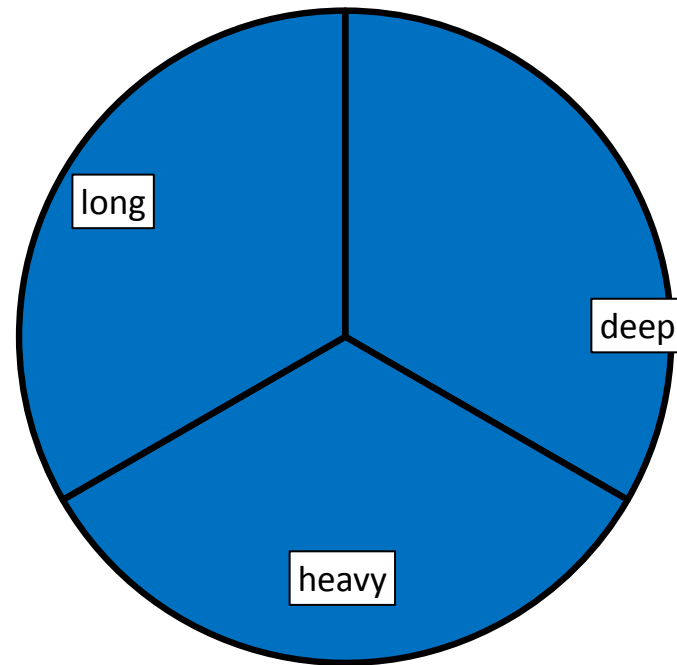


Translated & revised from Nakanishi (2013)

3-5. Comparison with Nakanishi (2013)

➤ **Potency** “strong, long, big, heavy, thick & deep”

② Someone To Watch Over Me

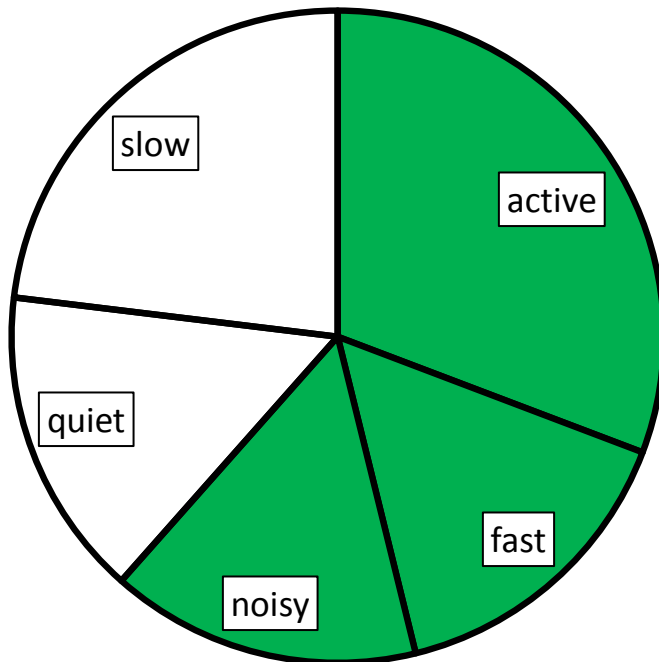


Translated & revised from Nakanishi (2013)

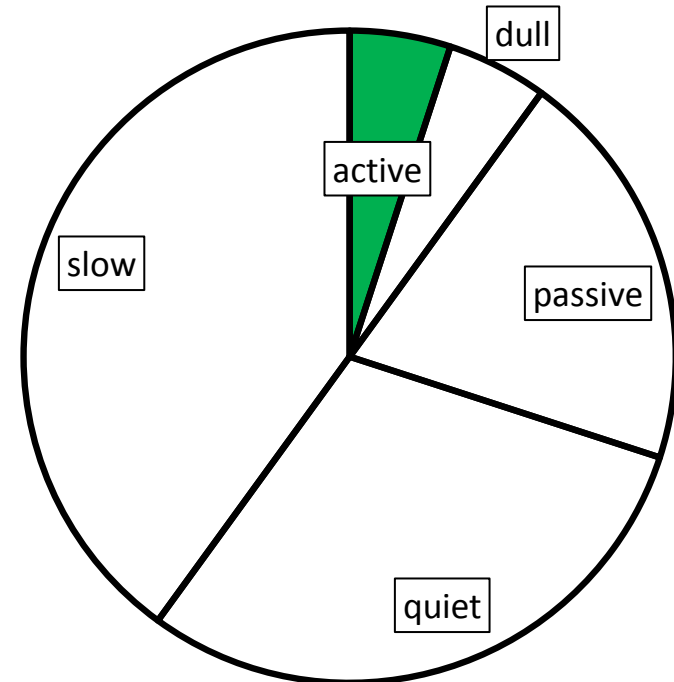
3-5. Comparison with Nakanishi (2013)

➤ **Activity** “fast, young, sturdy, active, noisy & sharp”

① Cheek To Cheek



② Someone To Watch Over Me



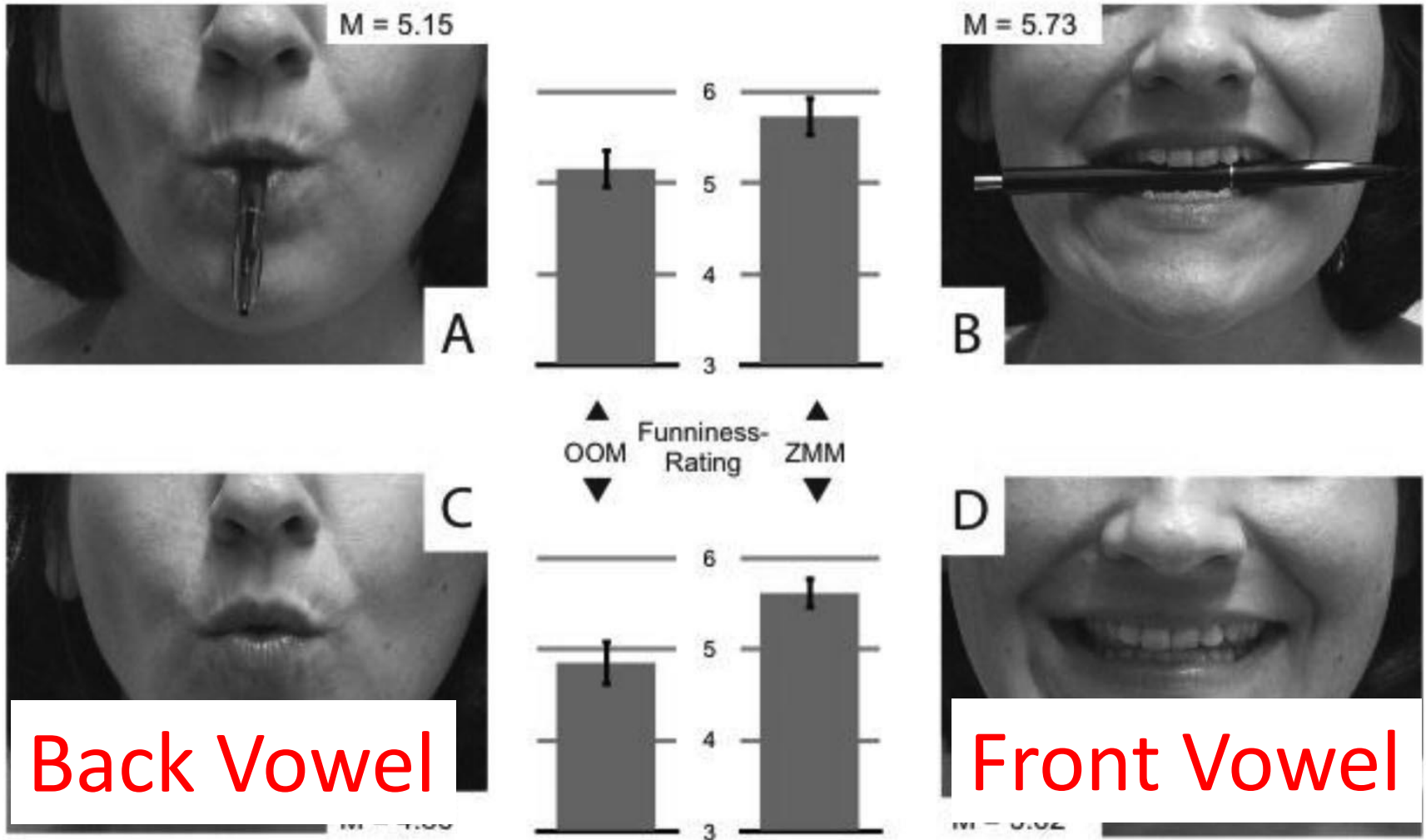
Translated & revised from Nakanishi (2013)

4. Discussion

In both experiments (non-word & jazz lyrics),

- **Front V is likely to be associated with**
“good, pleasant, happy, beautiful, soft, & sweet” images
- **Back V is likely to be associated with**
“strong, long, big, heavy, thick & deep” images
- **Front V is likely to be associated with**
“fast, young, sturdy, active, noisy & sharp” images

The Facial Feedback Hypothesis



Rummer, Schweppe, Schlegelivilch, & Grice (2014, p. 247)

The acoustic origin of the smile

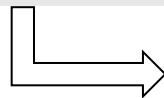


Redrawn from Schenkel, 1947.



Redrawn from van Hooff, 1962.

Resonances	higher	lower
mouth corners	retraced	brought forward
expression	submission	aggression



smile 😊

Ohala (1980)

4-1. Other ways to explain the phenomena

- **Neuroscience**: “(I)n a sense, perhaps we are all closet synesthetes.” (Ramachandran & Hubbard, 2003, p. 58)
- **Anatomy**: “Subjects in a positive mood produced more words containing /i:/, a vowel involving the same muscle that is used in smiling—the zygomaticus major muscle (ZMM).” Rummer, Schweppe, Schlegelivilch, & Grice, 2014, p. 247)
- **Rhetoric (onomatopoeia)**: 「私たちの言葉が、私たちの身体的感覚に接地する瞬間を、その地平を、とらえようと挑む研究者たちの努力」(篠原・宇野, 2013, p. 1)
- **Cognitive semantics**: 人の身体的な経験に基づく修辞のメカニズム (山梨, 2012, p. 111-8)
- **Acoustics**: The Frequency Code Hypothesis (Ohala, 1980)
- **Phonetics**: 円唇- 非円唇 (Nielsen & Rendall, 2011)

4-2. Theory into practice

- **Development of artificial intelligence**
- **Marketing**
- **Research into the origin of the speech**
- **Implication to language education :**
 - Imai, M., Kita, S., Nagumo, M., & Okada, H. (2008). Sound symbolism facilitates early verb learning. *Cognition*, 109(1), 54-65.
 - Pronunciation teaching: choosing words that are “good, comfortable, happy” for practicing front vowels, and “bad, uncomfortable, & sad” for practicing back vowels.
(subliminal effect?)
 - Showing the IPA chart in color to represent images (cf. Caleb Gattegno’s sound-color chart)

5. Limitations and further studies

5-1. Variation in the stimuli

- Images of other phonemes
- Images of the sounds in real world (rather than non-words)

5-2. Variation in the adjective pairs

- Scales rather than the 18 pairs of adjectives
- Connotations of the adjectives in each language

5-3. Variation in respondents

- Any influence of their native language?
- Any difference among regions?
- Any gender / age differences?

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