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Phonetic influences in the perception and production of interdental fricatives

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Observation: Learners of L2 English substitute different sounds in place of the interdental fricatives depending on their L1 (= differential substitution (Weinberger 1988)).

Common substitutes = [t,d] or [s,z] or [f,v]

Differential substitution occurs despite the various L1s having these segments in their phonemic inventories.

This Study

- Languages investigated: Japanese (JA), Russian (RU), European French (EF), Québec French (QF)
- [s,z] substitute: **JA & EF** (e.g. Hancin-Bhatt 1994 (JA), Berger 1951 (EF))
- [t,d] substitute: **RU & QF** (e.g. Weinberger 1988 (RU), Gatbonton 1978 (QF))

Previous Studies

• Weinberger (1988) Radical Underspecification. L2 data informs L1 underlying representations.

• Hancin-Bhatt (1994) Feature Competition Model. Features used to make most contrasts are most heavily weighted.

• Brown (1998) Feature Geometry. Non-contrastive features cannot be acquired.

• LaCharité & Prévost (1999) Feature Geometry. Terminal features easier to acquire than organizational nodes.

• Lombardi (2003) Optimality Theory. L1 affrication causes re-ranking from initial unmarked state so that IDENT CONTINUANT is highly ranked.

Hypotheses of Present Research

1. Differential substitution is due to transfer from the L1.

2. Transfer in production is caused by transfer in perception.

3. Transfer of non-contrastive, phonetic features is involved in substitution.

- Choice of substitute depends on a comparison of the phonetic properties of the target segment with phonetic properties of segments in the L1 sound system.

4. Features are subject to enhancement (e.g. Stevens, Keyser, Kawasaki 1989).

Phonetic Distance Scale

-2 -1 0 +1 +2

Mismatch region | Target region

Intake {θ,ð}			
salient	COR	+2
	CONT	+1
	MELL	+1
	DENT	+1
	LAM	+1

Feature	Inherent Weight	Enhanced Weight
Labial, Coronal, Dorsal	2	n/a
Stop, Continuant	1	Mellow enhances stop → 2
Strident, Mellow	1	Strident enhances Continuant → 2
Lip, Dental, Alveolar, Post-Alv	1	Alv, Post-Alv enhance Strident → 2
Laminal, Apical	1	n/a
Round, Unround	1	n/a

Phonetic detail: EF [s̪] "weak" (muted) STRIDENT vs. QF [s] "strong" (enhanced) STRIDENT

EF Predictions

Potential Substitute	Mismatches			Distance	Total Distance
☞ [s̪,z̪]	*enhanced*	CONT	+2	1	3
		STRID	-1	2	
[f,v]	*salient*	LAB	-2	4	4
[t̪,d̪]	*enhanced*	STOP	-2	3	5
		AP	-1	2	

QF Predictions

Potential Substitute	Mismatches			Distance	Total Distance
☞ [t̪,d̪]	*enhanced*	STOP	-2	3	3
[f,v]	*salient*	LAB	-2	4	4
[s,z]	*enhanced*	CONT	+2	1	6
		ALV	-1	2	
	enhanced	STRID	-2	3	

Phonetic detail: RU EF [s̪] "weak" STRIDENT vs. JA [s̪] no STRIDENT

RU Predictions

Potential Substitute	Mismatches			Distance	Total Distance
☞ [s̪,z̪]	*enhanced*	CONT	+2	1	3
		STRID	-1	2	
☞ [t̪,d̪]	*enhanced*	STOP	-2	3	3
[f,v]	*salient*	LAB	-2	4	4

JA Predictions

Potential Substitute	Mismatches			Distance	Total Distance
☞ [s̪,z̪]				0	0
☞ [ɸ]	*salient*	LAB	-2	4	4
[t,d]	*salient*	LAB	-2	4	4

Methodology

- **Perception**:

- ***AXB Discrimination***. *Participants:* 2 proficiencies: Low vs. High. Low N = EF 8, QF 10, JA 10, RU 10; High N = EF 12, QF 13, JA 7; English controls N = 9. *Other Factors. Vowel:* High Front (HF), High Back (HB), Non-High (NH). *Wordhood:* ±Word. *Task*: Two Interstimulus intervals (ISI) – phonetic (250ms) vs. phonological (1500ms). Different carrier phrases, different talkers. 1:1 Test:Filler ratio. Participant indicates whether AX or XB are the same.

You hear **th**ought…I learn **t**aught…You hear **t**aught.

-***Picture Identification* (PicID).** *Participants:* 2 proficiencies: Low vs. High. Low N = EF 11, QF 9, JA 8, RU 8; High N = EF 9, QF 11, JA 8; English controls N = 9. *Other Factors: Vowel:* HF, HB, NH. *Position:* Onset vs. Coda. *Voicing:* ±VOICE. *Task:* Three pictures (minimal pair, 1 foil). Participant selects the one s/he hears.

- *Statistical analysis*: Mixed ANOVA and Non-Parametrics.

- **Production**:

- ***Word Production****: Participants:* Low proficiency only. N = EF 5, QF 7, JA 5, RU 8. 3:1 Test:Filler ratio. Test word pairs – "th" target in same position. Participant pronounces the word in the largest font.

thing **th**ink

Predictions for AXB

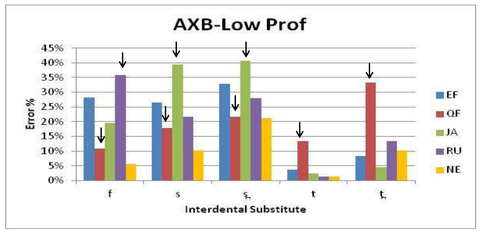
Phonetic Distance & Perceptual Assimilation Model (Best 1995)

Two-Category Assimilation (TC)	*Category-Goodness Assimilation (CG)*	*Single-Category Assimilation (SC)*
Intake {x} {y}	Intake {x} {z}	Intake {x} {w}
↓ ↓	↓ ↓	↓ ↓
Distance 2 3	Distance 2 0	Distance 2 2
↓ ↓	↘ ↙	↘ ↙
L1 categories [a] [b]	L1 category [a]	L1 category [a]
Good Discrimination	**Moderate Discrimination**	**Poor Discrimination**

Contrast	ISI	EF	QF	JA	RU	NE
f-θ	Short (Phonetic)	TC	TC	TC	TC	**TC**
	Long (Phonological)	TC	TC	CG	CG	**TC**
s-θ	Short (Phonetic)	CG	TC	CG	**CG**	**TC**
	Long (Phonological)	SC	SC	SC	**CG**	**TC**
t-θ	Short (Phonetic)	**TC**	CG	**TC**	**CG**	**TC**
	Long (Phonological)	**TC**	TC	**TC**	**CG**	**TC**

(Red = Confirmed by Results where Short ≠ Long predictions)

Results AXB (Graph: Real Words; ISI, Vowels collapsed)



PAM Results	EF	QF	JA	RU	NE
f	CG	CG	CG	SC	TC
s	CG	CG	SC	CG	TC
s̪	CG	CG	SC	CG	CG
t	TC	CG	TC	TC	TC
t̪	TC	CG	TC	CG	TC

SC 35% ↑ CG 11-34% TC 10% ↓

- **ISI**: Main effect, no interactions; therefore, phonetic level only.
- **Contrast** [s/s̪] vs. [θ]: JA (no strident) > EF,RU (muted strident) > QF,NE (enhanced strident). RU: low error rate on [t/t̪] vs. [θ].
- **Vowel x Language:** [s/s̪] vs. [θ]: **JA** most errors before HF (45% error) vs. other vowels (35%); **QF** least errors before HF (10%) vs. other vowels (25%) ($p = .001$).
- **Wordhood:** [f-θ]: Words (5% error) easier than Non-Words (45%) ($p < .001$); [t-θ] for **QF** – Words easier (10% error) than Non-Words (25%) ($p < .001$).

Predictions for PicID if only contrastive features available

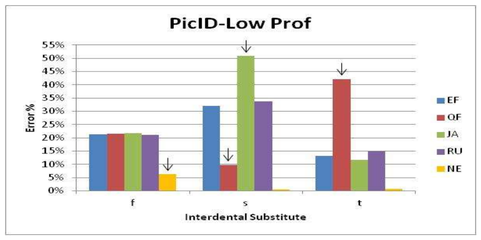
EF, QF, JA:

Intake {θ}	CONTINUANT CORONAL	
Potential Substitute	**Mismatches**	**Featural Conflicts**
☞ /s/		0
/t/	STOP	1
/f/	LABIAL	1

RU:

Intake {θ}	CONTINUANT CORONAL MELLOW	
Potential Substitute	**Mismatches**	**Featural Conflicts**
☞ /f/	LABIAL	1
☞ /t/	STOP	1
☞ /s/	STRIDENT	1

Results PicID (Graph: Voiceless Onset; Vowels collapsed)

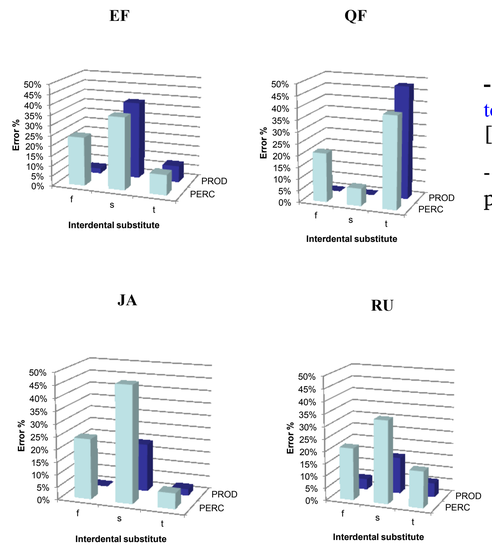


EF, JA, RU ☞ /s/
QF ☞ /t/

- Contrast /s-θ/:
JA > EF,RU > QF,NE same as AXB; suggests non-contrastive features playing a role at phonological level.

-**Vowel x Position:** /f-θ/ easier before NH (5% error) vs. HF (35%) in Onset; opposite in Coda: NH (45%), HF (25%) ($p < .001$).
- **Voicing x Language** (Coda only): For **QF** /d-ð/ easier (25% error) than /t-θ/ (35%); for **JA** /z-ð/ (35%) easier than /s-θ/ (45%) ($p < .001$).

Results Production vs. Perception (Voiceless Onset; Vowels collapsed)



$\tau = .438(27)$, $p < .01$

- Production errors correspond to perception errors, except for [f].

- more variation in production for EF, JA, RU

Differential substitution is shown to have a perceptual basis.

The non-contrastive feature STRIDENT plays an important role in the perception of the English interdental fricatives.

Results indicate cross-linguistic differences in the representation of STRIDENT (Brannen 2011).

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