Patterns and scales of expressive palatalization: Typological and experimental evidence

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Abstract
This paper argues for a distinct treatment of expressive palatalization – an apparently phonologically unmotivated process that applies in babytalk registers, diminutive constructions, and sound symbolism. As evidence we present results of a cross-linguistic survey of expressive palatalization and of two experiments testing native speakers' intuitions about alternations in Japanese mimetic vocabulary and the babytalk specialized register. Both typological and experimental results point to the same scale of palatalizability, with coronal sibilants being the most optimal targets and outputs of expressive palatalization. The source of this scale, we argue, is in relative acoustic salience of palatal(ized) consonants and their ability to function iconically – as phonological correlates of 'smallness' and 'childishness' (cf. Ohala 1994). We further provide an Output-Output Correspondence analysis of Japanese babytalk and mimetic palatalization that employs a set of register-specific EPAL ICONICITY constraints referring to the scale of perceptual salience of palatal(ized) consonants.

Keywords:
palatalization, phonetic scales, cross-linguistic, Japanese, expressive registers/vocabulary

1. Introduction

Palatalization – a process by which consonants acquire secondary palatal articulation or shift to coronal place under the influence of front vowels or glides (e.g. $p \rightarrow p^j$/_i, t → ʧ/_j) – is among the most cross-linguistically common phonological processes (Chen, M. 1973; Bhat 1978). The ubiquity of palatalization is not surprising, given its primary phonetic source – consonant-to-vowel coarticulation characteristic of human speech in general. As a typical 'natural' phonological process, palatalization has played a prominent role in the development and testing of phonological theories – from early generative rule-based work (Chomsky & Halle 1968; Kenstowicz & Kissertberth 1977), to various models of featural and gestural representations (Sagey 1990; Hume 1992; Calabrese 1995; Zsiga 1995), to constraint interactions in standard Optimality Theory (Chen, S.-I 1996; Rose 1997; Rubach 2000) and various alternative phonetically-based approaches (Guion 1996; Flemming 2002; Padgett 2003; Bateman 2007).

Perhaps less known is another type of palatalization that is not phonologically conditioned, but has a specific iconic function, being associated with smallness, childishness, or affection (Ferguson 1977; Nichols 1971; Ohala 1994). Expressive palatalization is used cross-linguistically in sound symbolism, diminutive morphology, hypochoristics, and in babytalk – conventionalized adults' speech directed to small children. For example, in Basque and Japanese, palatalization of consonants adds the meaning of smallness or childishness in sound symbolic manner vocabulary (1a). In Huave and Island Lake Ojibwa, palatalization is used as a marker of diminutive constructions (1b). In Quechua and Russian, truncating hypocoristics are formed by palatalization of consonants (1c). In Japanese and Warlpiri, certain consonants are consistently palatalized in babytalk (1d).

(1)	a.	Sound symbolism		
		Basque	[**t**aka-**t**aka] 'toddling'	Ibarretxe-Antuñano
			[**c**aka-**c**aka] 'walking taking baby steps'	(2006)
		Japanese	[**t**oko-**t**oko] 'trotting'	Hamano (1986/1998)
			[**ʧ**oko-**ʧ**oko] 'moving like a small child'	
	b.	Diminutives		
		Huave	[**s**o**n**o^{ŋ}g] 'pile up'	Kim (2008)
			[**ʃ**u**ɲ**u^{ŋ}g] 'pile up', diminutive	
		Island Lake Ojibwa	[kih**t**ikan] 'garden'	Shrofel (1981)
			[kih**ʧ**ikan] 'little garden'	
	c.	Hypocoristics		
		Quechua	[ab**s**alon] → [ab**ʃ**a] *Absalón*, familiar	de Reuse (1986)
		Russian	[v^{j}i**t**al^{j}ij] → [v^{j}i**t**$^{\mathbf{j}}$-a] *Vitaly*, familiar	Soglasnova (2003)
	d.	Babytalk		
		Japanese	[**s**ora paipai oiʃiː-oiʃiː jo] →	Chew (1969)
			[**ʧ**ora paipai oi**ʧ**iː-oi**ʧ**iː jo]	
			'Here's baby's milk. It's yummy!	
		Warlpiri	[wi**t**a ca**ɾ**a pa**l**a ja**l**i-**ɭ**a maɲu-ka**ɾ**i-ja] →	Laughren (1984)
			[wi**c**a ca**j**a pa**ʎ**a ja**ʎ**i-**ʎ**a maɲu-ka**j**i-ja]	
			'You two little ones, play over there!'	

Phonological accounts of expressive palatalization of this kind often assume that it is essentially a phonological phenomenon, governed by the same general principles as phonological palatalization, albeit unique in some of its characteristics. This assumption, for example, underlies Hualde's (1991) approach to Basque 'affective palatalization' (which applies to diminutives and babytalk), and most treatments of Japanese mimetic palatalization (e.g. Mester & Itô 1989; Chen S.-I 1996; Akinlabi 1996; Zoll 1997; Kurisu 2009, among others). The fact that expressive palatalization processes do not have an overt phonological trigger, and the fact that they often target a set of segments different from those targeted by phonological palatalization (as e.g. palatalization next to [i] or [j] in Basque and Japanese) have been attributed to special structural and lexical properties of expressive palatalization. Formal analyses of some of these cases have made important theoretical contributions, for example, providing insights into the nature of phonological representations (e.g. underspecification and feature geometry representations: Mester & Itô 1989; Chen S.-I 1996) and markedness constraint hierarchies (e.g. featural compatibility: Akinlabi 1996; Kurisu 2009). However, as we argue in this paper, any analysis that views cases of expressive palatalization as part of the general typology of phonological palatalization runs the risk of missing certain unique properties of the former process, potentially leading to incorrect generalizations about palatalization processes in general.

Our main proposal is that expressive palatalization (E-Pal) has a set of properties that distinguish it from phonological palatalization (P-Pal). Among the properties that characterize E-Pal are a near-exclusive preference for coronals as targets and outputs of the process, a stronger avoidance of palatalized rhotics, and well-defined manner-specific restrictions on targets and outputs. Evidence for this comes from a cross-linguistic survey of patterns of E-Pal and from our experimental investigation of well-known cases of Japanese mimetic and babytalk palatalization. The established differences between E-Pal and P-Pal, we argue, suggest that the two phenomena are governed by different underlying principles. Specifically, E-Pal is rooted in the iconic relation between 'smallness' or 'childishness' and acoustic frequency, exploiting speakers' knowledge of phonetic salience and patterns of phonological acquisition. The mechanism of E-Pal is therefore better captured by an output-output correspondence model akin to those used in analyses of ludlings and language games (Itô, Kitagawa, & Mester 1996). This is in contrast to P-Pal, which is governed mainly by feature spreading and featural compatibility constraints rooted in articulatory effort minimization. The proposed treatment E-Pal as a distinct, partly extra-grammatical phenomenon has an important theoretical consequence – it leads to a stronger and more predictive theory of P-Pal.

The paper is organized as follows. In section 2 we present results of a cross-linguistic survey of patterns of expressive palatalization and compare these with previous findings on patterns of phonological palatalization. In sections 3 and 4 we re-examine the patterns of Japanese mimetic and babytalk palatalization, showing that these present typical cases of E-Pal. These sections include two experiments with 35 native speakers of Japanese, probing their intuitions about the two cases of palatalization. Finally, in section 5 we examine phonetic sources of E-Pal and explore directions towards a formal account of the phenomenon.

2. Cross-linguistic patterns of expressive palatalization

2.1 The survey

To identify cross-linguistic patterns of expressive palatalization (E-Pal), we conducted a survey of literature on babytalk registers, diminutive morphological constructions, and diminutive sound symbolism in a variety of languages. For our purposes, E-Pal was defined as a phonologically unmotivated (having no overt trigger) use of palatalized and (mainly posterior) coronal consonants within the above-mentioned registers or grammatical/lexical classes. The survey documents 37 distinct cases (including 9 cases of 'tonality' diminutive shifts' previously reported by Nichols 1971). These cases come from 35 languages/dialects belonging to 26 genera and 19 language families (based on WALS classification). (These cases do not include Japanese mimetic and babytalk palatalization, which will be examined in detail in section 3 and 4.)

All the cases are briefly summarized in Table 1 (which is split up into three parts, A, B, and C), with respect to the patterns of segments targeted by palatalization – *targets*, and segments resulting from palatalization – *outputs*. As we will see further, a clear distinction between targets and outputs is important for the analysis of E-pal. For expository reasons, the cases are arranged in terms of classes of segments targeted by palatalization:

- cases 1.1-1.4 target both non-coronals and coronals;
- cases 2.1-2.9 target coronals only, both sonorants and obstruents;
- cases 3.1-3.4 target coronal obstruents only, both sibilants and non-sibilants;

- cases 4.1-5.5 target coronal non-sibilant obstruents only;
- cases 5.1-5.12 target coronal sibilant obstruents only.

The heading at the top divides the processes into those resulting in a simple addition of secondary palatal articulation or a shift in place or manner of articulation. These are further subdivided by place and manner of consonant targets (non-coronal/coronal, sonorant, obstruent, etc.), and sibilancy of consonant outputs. Due to space limitations, some feature differences are compressed, specifically manner differences in non-coronals (i.e. P and K referring to labial and velar consonants in general) and laryngeal differences in coronal obstruents (i.e. t, s, ʧ, etc. including voiceless, voiced, ejective, etc. consonants). Note that a given language may exhibit more than one pattern involving the same target consonants, as the processes of interest often result in variable outputs.

While quite diverse, the identified cases show some striking similarities in patterns of preferred targets and outputs of E-Pal. These observations will be briefly described below.

Table 1, Part A. Cross-linguistic patterns of expressive palatalization, organized by types of processes, consonant targets and outputs, and specific changes (SS = (diminutive) sound-symbolism, D = diminutive morphological constructions, BT = babytalk, HC = hypocoristics). See the text for explanation.

Language and type			Addition of secondary palatalization							
			non-cor		cor: rhotics, sonorants, stops, fricatives					
									sib	sib
			P→Pj	K→Kj	$r \rightarrow r^j$	$l \rightarrow l^j$	$n \rightarrow n^j$	$t \rightarrow t^j$	$s \rightarrow s^j$	$\theta \rightarrow s^j$
1.1	Saami, Kildin	D	x	x	x	x	x	x	x	
1.2	Estonian, S.	BT	x	x	x	x	x	x	x	
1.3	Georgian	D								
1.4	Basque, W.	D								
2.1	Warlpiri	BT								
2.2.1	Basque, E.	D, BT								
2.2.2	Basque	SS								
2.3	Huave	D								
2.4.1	Quechua	D, HC								
2.5	Latvian	BT			(x)					
2.6	Russian	HC			x	x	x	x	x	
2.7	Cahuilla	D								
2.8	Cupeño	D								
2.9	Koryak	D								
3.1	Ojibwa, Island Lake	D								
3.2.1	Cree, Moose, E. Swampy	D								
3.2.2	Cree, Eastern	BT								
3.3	Wiyot	D								
3.4.1	Greek	BT						x	x	x
3.4.2	Greek	D								
4.1	Cree, Plains, W. Swampy	D								
4.2	Yurok	D								
4.3	Karok	D								
4.4	Jaqaru	D								
4.5	Chukchi	D								
5.1	Chumash, Ventureño	D								
5.2	Nuuchahnulth	D								
5.3	Paiute, N.	D								
5.4	Kannada, Havyaka	BT								
5.5	Persian	BT								
5.6	Dakota	BT								
5.7	Miwok, S. Sierra	D								
5.8	Quechua, Wanka	BT								
5.9	Spanish	BT								
5.10	Korean	BT								
5.11	Thai	BT								
5.12	Nez Perce	D								

Table 1, Part B

	Place/manner-changing shifts 1												
	non-cor: various manner			rhotics				cor son					
	sib	sib	sib				sib					sib	sib
	P→ʧ	K→ʧ	K→ʦ	r→j	r→ʎ	ɹ→j	r→ʧ	l→ʎ	ɭ→ʎ	n→ɲ	ɳ→ɲ	n→ʧ	l→ʧ
1.1													
1.2		x	x										
1.3		x	x				x					x	
1.4	x	x					x					x	x
2.1				x		x		x	x	x	x		
2.2.1				x	x			x		x			
2.2.2										(x)			
2.3								x		x			
2.4.1								x		x			
2.5								(x)		(x)			
2.6													
2.7								x		x			
2.8								x		x			
2.9								x		x			
3.1													
3.2.1													
3.2.2													
3.3													
3.4.1													
3.4.2													
4.1													
4.2													
4.3													
4.4													
4.5													
5.1													
5.2													
5.3													
5.4													
5.5													
5.6													
5.7													
5.8													
5.9													
5.10													
5.11													
5.12													

Table 1, Part C

	Place/manner-changing shifts 2													
	cor obs nonsib: various lar						cor obs sib: various lar							
			sib	sib	sib	sib	sib	sib	sib	sib	sib	sib	sib	sib
	t→c	ʈ→c	t→ʧ	t→ʦ	θ→ʧ	ɬ→ʧ	ʦ→ʧ	ʦ→sj	ʈʂ→ʧ	s→ʃ	s→ʧ	s→ʦ	ʃ→ʧ	ʂ→ʃ
1.1														
1.2				x								x		
1.3			x	x										
1.4			x								x			
2.1	x	x												
2.2.1	x						x			x				
2.2.2	(x)		(x)				(x)			(x)				
2.3	x						x			x				
2.4.1										x				
2.5			x				x			x	x	x		
2.6														
2.7										x				
2.8										x				
2.9	x													
3.1			x							x			x	
3.2.1			x							x				
3.2.2			x							x				
3.3				x						x				
3.4.1								x		x				
3.4.2				(x)								(x)		
4.1				x										
4.2			x											
4.3					x									
4.4	x													
4.5						x								
5.1							x			x				
5.2							x			x				
5.3												x		
5.4											x			
5.5										x				
5.6										x				
5.7											x			
5.8									x					x
5.9											x			
5.10											x			
5.11											x			
5.12												x		

2.1.1 The coronal/non-coronal asymmetry

Starting with the most general observation, non-coronals are relatively uncommon targets of E-Pal processes, compared to coronals. Only 5 cases show palatalization of non-coronals: diminutives in Kildin Saami, Georgian, and Western Basque, and babytalk in Southern Estonian. Interestingly, all these languages also exhibit palatalization of coronals. Moreover, in some languages, palatalization of non-coronals is more limited in extent than palatalization of coronals. For example, palatalized non-coronals in South Estonian babytalk can occur only before /i/ and word-finally, while palatalized coronals can also occur before back vowels – a context where palatalized consonants do not occur in adult speech (2a). This shows that palatalization of non-coronals in our data consistently implies palatalization of coronals.

Another observation is that E-Pal relatively rarely involves the addition of secondary articulation, as opposed to the shift to the coronal place of articulation (either posterior or anterior). There are only 4 cases that show secondary palatalization. In two of these cases, Southern Estonian and Greek, some coronal consonants may either acquire secondary palatalization or shift to posterior coronal place (e.g. Greek (2b)). In languages like Western Basque (2c) and Georgian (2d), non-coronals do not acquire secondary palatalization, but shift to coronal place, in both cases to sibilant affricates. This suggests that consonants with primary coronal place of articulation (and particularly posterior sibilant coronals, as will be discussed below) are the preferred outputs of E-Pal, rather than consonants with secondary coronal (palatal) articulation.

(2) a. South Estonian babytalk-specific lexical items (Pajusalu 2001)
[**p**ii**m**] → [**p**ʲi**pp**ʲ] ‘milk’
[lu**tt**] → [lu**tt**ʲu] ‘dummy’
[**t**i**ll**okano] → [**ʦ**ʲi**ll**ʲo] ‘tiny’

b. Greek babytalk (Pareskevas-Shepard 1985)
[lulu**ð**i] → [lulu**z**i]~[lulu**ʒ**] ‘flower’

c. Western Basque diminutives (Hualde & Urbina 2003)
[**p**ispildu] → [**ʧ**ispildu] ‘become happy after drinking, PRF’

d. Georgian diminutives (Neisser 1953)
[**k**un**k**uri] → [**ʧ**un**ʧ**uri] ‘Beschälung’

2.1.2 The manner asymmetries in coronals

With respect to the manner of articulation of coronals, sonorants in our data are targeted by E-Pal only if obstruents are targeted too. There are 11 cases that support this implicational relation, and no cases exhibit the opposite pattern. Further, while sonorants targeted by palatalization usually preserve their manner, they occasionally shift to obstruents (affricates), as, for example, in diminutives in Georgian (3a). The opposite types of changes – palatalizing shifts of obstruents to sonorants – are found in none of the surveyed languages.

Another robust asymmetry is between sibilant and non-sibilant obstruents. Strident posterior coronals (fricatives and affricates) are the most common targets of E-Pal. In many cases, palatalization of coronal stops implies palatalization of coronal fricatives; the opposite, however, does not hold. Sibilants, and particularly sibilant affricates, are also by far the most common outputs of palatalization. In fact, they can result from palatalization of consonants of any place and manner of articulation (as in Chukchi (3b), and Georgian, Western Basque examples above). Note that affricates resulting from E-Pal can be either posterior ([ʧ ʤ]) or, less commonly, anterior ([ʦ ʣ]). In many such cases the change [t d] → [ʦ ʣ] co-occurs with other palatalizing changes, as for example, to [s] → [ʃ] in Wiyot diminutives (3c).

It is worth noting that the same manner asymmetries can be realized gradiently in cases which do not show categorical differences between sonorants and obstruents or non-sibilants and sibilants. For example, in some varieties of Eastern Basque, palatalization of obstruents in diminutives is obligatory, while palatalization of sonorants is optional (e.g. (3d)). In Santiago del Estero Quechua, the pattern of palatalization found in hypocoristics with sonorants and obstruents, has been extended to adjectival diminutives and reduplicative sound-symbolic items, however, only to those with sibilant fricatives (3e). Southern Estonian and Latvian specialized babytalk vocabularies, and Basque sound symbolism are characterized by a considerably higher incidence of palatal(ized) sibilants, compared to other palatal(ized) consonants, as well as compared to adult speech in general (Pajusalu 2001, Rūķe-Draviņa 1977, Ibarretxe-Antuñano 2006). Sibilant affricates (/ʦ/ and /ʣ/) are also used extensively in Greek sound symbolic items, diminutive affixes, hypocoristics, and specialized babytalk-related lexical items (3f), while occurring very rarely in the regular (non-expressive) lexicon.

(3) a. Georgian diminutives (Neisser 1953)
[k’be**n**a] ‘beißen’ → [na-k’be**ʧ**a] ‘bebeißen, anbeißen’
b. Chukchi diminutive/momentary action verbs (Bogoras 1922)
[**ɬ**eivu] ‘to walk’ → [**ʧ**eivu] ‘to walk for a little while’
c. Wiyot diminutives (Teeter 1959)
[**t**awiːpaʔliɬ] ‘he sings’ + [-oːʦ] dimin. → [**ʦ**awiːpaʔroɬ-oːʦ] ‘twine’
[loli**s**w-iɬ] ‘he sings’ + [-oːʦ] dimin. → [rori**ʃ**w-oːʦ-iɬ] ‘he hums’
d. Eastern Basque diminutives (Hualde & Urbina 2003)
[e**d̪**eɾ] → [e**ɟ**eɾ] ‘beautiful’
[**l**abuɾ] → [**ʎ**abuɾ~**l**abuɾ] ‘short’
e. Santiago del Estero Quechua sound symbolism (Reuse 1986)
[a**s**i-] ‘to laugh’, [a**ʃ**i-ku] ‘smiling’
[ku**s**i] ‘happy’, [ku**ʃ**i-ku**ʃ**i] ‘a happily-running little spider’

f. Greek expressive vocabulary (Joseph 1994)
[**ts**ita-**ts**ita] 'just barely'(said of a tight fit)
[ɣlik-os] 'sweet', [ɣlik-u**ts**ik-os] 'cute' (with a diminutive suffix)
*Ðimi**t**rios* → [mi**ts**os] 'Dimitrios' (name, familiar)
[**ts**is(i)a]~[**dz**is(i)a] 'peepee' (babytalk-specific)

In sum, the patterns of E-Pal are indicative of greater preference of obstruents over sonorants and of sibilants over non-sibilants.

2.1.3 The continuancy asymmetry in sibilants

The preference for affricates as outputs of E-Pal noted above also holds when targets are fricatives. Fricatives shift to affricates in a number of cases, among them in Havyaka Kannada and Spanish babytalk, Southern Sierra Miwok and Southern Paiute diminutives (4). The opposite, however, a shift of affricates to fricatives, is rarely found (the only example in our data is the [dz] → [z^j] change in Greek babytalk, see Pareskevas-Shepard 1985).

(4) a. Havyaka Kannada babytalk (S. Bhat 1967)
[glaː**s**u] → [ga**tʃ**u] 'glass'
b. Spanish babytalk (Ferguson 1964)
[be**s**o] → [be**tʃ**o] 'kiss'
c. Southern Sierra Miwok diminutives (Broadbent 1964)
[ʔe**s**elːɨ] 'child' → [ʔe**tʃ**elːɨ] 'baby'
d. Northern Paiute diminutives (Nichols 1971)
[**s**ɨ**z**ɨʔa] 'big girls, teenagers' → [**ts**ɨ**dz**ɨʔa] 'little girls'

These and other above-noted examples (e.g. (3)) suggest that sibilant affricates or sibilants in general are not only associated with smallness, childishness, or affection, but also serve as markers of the babytalk register and/or related lexical classes (cf. Ferguson 1977).

2.1.4 The rhotic/non-rhotic asymmetry

The final observation concerns palatalization of rhotics, as opposed to other sonorants or coronals in general. Rhotics with secondary palatal articulation are attested along other palatalized sonorants in Kildin Saami diminutives (5a), Latvian babytalk (5b), South Estonian babytalk, and Russian hypocoristics – notably all areally close, if not genetically related, languages. In some other cases, rhotics are palatalized to posterior coronals of a different manner, as for example in Warlpiri (5c) and Eastern Basque (the tap only, (5d)).

In most cases, however, rhotics remain unaffected, even if other coronal sonorants are targeted by palatalization, as for example, the trill in Eastern Basque and both the trill and the tap in Huave (5e). In Russian hypocoristics, palatalized rhotics often depalatalize, while other coronals remain unaffected (5f). Overall, these patterns suggest that avoidance of palatalized rhotics in E-Pal is a strong cross-linguistic tendency. [1]

(5) a. Kildin Saami diminutives (Kert 1971)
[mu**rr**] → [mu**r**^{j}-a] 'tree', diminutive
b. Latvian babytalk-specific vocabulary (Rūķe-Draviņa 1977)
[**r**^{j}uk-**r**^{j}uk] 'little pig'
c. Warlpiri babytalk (Laughren 1984)
[**ɻ**ama**ɾ**a] → [**j**ama**j**a] 'ribs'
d. Eastern Basque diminutives (Hualde & Urbina 2003)
[be**ɾ**o] → [be**ʎ**o~be**j**o] 'hot'
e. Huave diminutives (Kim 2008)
[-po**r**os] → [-pu**ɾ**uʃ] 'crunching sound', diminutive
cf. [**l**oh**c**] → [**ʎ**uh**c**] 'pierce', diminutive
f. Russian hypocoristics (Soglasnova 2003)
[ju**r**^{j}ij] → [ju**r**-a] 'Yury' (name, familiar)
cf. [v^{j}e**n**^{j}iam^{j}in] → [v^{j}e**n**^{j}-a] 'Veniamin' (name, familiar)

To summarize, the results of the survey of 37 distinct cases of babytalk, diminutive morphology and sound symbolism show a number of asymmetries in terms place and manner of targets and outputs of E-Pal (6). These asymmetries can be also viewed as a series of scales of expressive palatalization, capturing more and less likely targets and outputs of the process.

(6) Asymmetries in targets/outputs of expressive palatalization (more likely > less likely):
a. The coronal/non-coronal asymmetry (targets and outputs)
coronals > non-coronals
b. The manner asymmetry in coronals (targets and outputs)
i. coronals: obstruents > sonorants
ii. coronal obstruents: sibilants > non-sibilants
c. The continuancy asymmetry in sibilants (outputs)
coronal sibilant obstruents: affricates > fricatives
d. The rhotic/non-rhotic asymmetry (targets)
non-rhotics > rhotics

[1] It should be noted that plain rhotics are also often avoided in babytalk, shifting to either coronal stops, [l], or glides, as, for example, in Gilyak, Comanche, Hidatsa, Berber, Cocopa, and English (Ferguson 1977: 217). This suggests that the avoidance of palatalized rhotics may be related to the avoidance of rhotics in expressive registers in general.

It is interesting to note that various types of expressive vocabulary show quite similar, and sometimes identical, patterns. As we can see in Table 1, there are cases of both babytalk and diminutives exhibiting the 'coronal preference' for palatalization (e.g. Warlpiri babytalk and Huave diminutives), the 'obstruent preference' (e.g. Island Ojibwa diminutives and Greek babytalk), the 'affricate preference' (e.g. Southern Sierra Miwok diminutives and Havyaka Kannada babytalk), and the 'rhotic avoidance' of palatalization (e.g. Basque diminutives/babytalk and Huave diminutives). This suggests that all these cases of palatalization belong to one general type, expressive palatalization.

At the same time, there appear to be some differences among the register/vocabulary types in preferred targets and outputs. For example, all but one case of babytalk in our sample show palatalization of sibilants. (The only exception is Warlpiri, an Australian language that does not have phonemic or allophonic sibilants; see Laughren 1984) Among these cases, non-sibilant consonants can be targeted only when sibilant fricatives are targeted too (e.g. Southern Estonian, Eastern Basque, and Greek). While this preference for sibilants as targets is also obvious in many examples of other types of expressive vocabulary (e.g. categorically in Nuuchahnulth and Southern Paiute diminutives (4d)), and gradiently in Basque and Quechua sound symbolism (3e)), there are some cases of diminutives where sibilants are not targets (e.g. Georgian (2d, 3b), Chukchi (3a), and Karok (Bright 1956)).

Further, while most cases of E-Pal processes in our sample are structure-preserving – producing segments that are phonemic in a given language (albeit possibly marginal, as in Greek (3f)) and occurring in phonotactically possible contexts, they sometimes produce novel segments, or phonemic segments in phonotactically illegal contexts. This appears to be characteristic to a greater extent of babytalk registers (e.g. Southern Estonian (2a); Greek, and Eastern Cree babytalk, Pareskevas-Shepard 1985; Jones 1988; see also Ferguson 1977) than of the other register/vocabulary types (but see Nuuchahnulth diminutives and Santiago del Estero Quechua sound symbolism; Sapir [1915] 1949; Reuse 1986).

Finally, there are also some notable differences in whether a given process affects a single consonant or all palatalizable consonants within a stem or a word. Most babytalk processes favour exhaustive palatalization, affecting all eligible consonants, as, for example, in Warlpiri and Eastern Basque. The same is true of many morphological diminutive constructions, as for example, in Huave diminutives (within a root, Kim 2008) and in Island Lake Ojibwa diminutives (within a prosodic word, Melnychuk 2003). Some diminutive construction, hypocoristics, and sound symbolism, however, may target a single consonant, as, for example, Kildin Saami diminutives (the rightmost consonant in a stem (5a)) or Western Basque (the leftmost consonant in a word (2c)).

We believe that all these differences are indicative of a continuum from "more expressive" to "less expressive" vocabulary/register types, and correspondingly less and more conforming to regular phonological patterns. Overall, E-Pal patterns characteristic of babytalk appear to be "more expressive", more phonologically deviant – involving a more restricted set of palatalizable consonants, exhaustive, and possibly non-structure-preserving. In contrast, many patterns characteristic of diminutive morphology, sound symbolism, and hypocoristic are in this sense intermediate between expressive and regular phonology. Although these differences between the types of expressive vocabulary/registers are clearly worth exploring, this question is beyond the scope of the paper. We will not therefore make further distinctions between various types of expressive vocabulary, treating them as a single general category, at least with respect to E-Pal.

Now we will turn to the question how the patterns of E-Pal differ from those commonly observed for phonological palatalization.

2.2 Expressive palatalization vs. phonological palatalization

Cross-linguistic preference for phonological palatalization of coronals over non-coronals has been long-observed and well-documented in the literature (Bhat 1978; Hume 1992; Kochetov 2002, in press; Bateman 2007, among others). The same can be said about the avoidance of palatalized rhotics compared to palatalized non-rhotics (Bhat 1978; Hall 2000). However, as we will show, these preference/avoidance tendencies are not as robust and consistent as those exhibited by patterns of E-Pal. In addition to showing clearer coronal/non-coronal and rhotic/non-rhotic asymmetries, patterns of E-Pal also exhibit manner and continuancy asymmetries, something that is rarely, if ever, observed in purely phonologically motivated palatalization processes. To clarify these observations, let us review some results of Bateman's (2007) cross-linguistic survey of phonological palatalization processes, and compare them to similar changes in our data.

Bateman (2007) defines palatalization as a phonologically or morpho-phonologically conditioned change where a consonant acquires a secondary palatal articulation ('secondary palatalization') or shifts its place to "palatal-like" ('full palatalization'), usually next to a front vowel or a glide (p. 5). Her survey identified 58 languages that exhibit such process, out of a sample of 117 languages. Among the palatalizing languages, 32 show secondary palatalization of at least some consonants (55%), and 45 (78%) show full palatalization (with some showing both types involving different consonants). This is quite different from the patterns of E-Pal described above. While both P-Pal and E-Pal show preference for its full realization (primary place coronals as outputs), this tendency is almost absolute in E-Pal, with cases of full palatalization accounting for 95% of the sample (Table 2).

Table 2. Secondary vs. full palatalization, based on Bateman (2007: 44-51) and our data

	Secondary palatalization		Full palatalization	
P-Pal (58 cases)	32	*55%*	45	*78%*
E-pal (37 cases)	5	*14%*	35	*95%*

Further, most common targets of both secondary and full P-Pal are coronals and dorsals, shown in bold in Table 3a. These can occur independently or together in a given language. Palatalization of labials is much less frequent, and is implied by palatalization of coronals or dorsals. Again, this is partly in contrast with E-Pal, where coronals, but not dorsals, are the main targets. Palatalization of dorsals and labials is very infrequent, and in those cases it always implies palatalization of coronals (shown in bold in Table 3b). This shows that the coronal/non-coronal asymmetry is absolute in E-Pal, but a tendency in P-Pal.

Table 3. Coronal vs. non-coronal asymmetry, based on Bateman (2007: 44-51) and our data

a. Secondary palatalization

	lab only	cor only	dor only	lab&cor	lab&dor	cor&dor	lab,cor,&dor
a. P-Pal (32 cases)	0 *0%*	**7** ***16%***	**9** ***20%***	4 *9%*	2 *4%*	3 *7%*	**10** ***22%***
b. E-pal (5 cases)	0 *0%*	**3** ***60%***	0 *0%*	0 *0%*	0 *0%*	0 *0%*	**2** ***40%***

b. Full palatalization

	lab only	cor only	dor only	lab&cor	lab&dor	cor&dor	lab,cor,&dor
P-Pal (45 cases)	0 *0%*	**27** ***60%***	**9** ***20%***	0 *0%*	0 *0%*	**12** ***27%***	2 *4%*
E-pal (35 cases)	0 *0%*	**32** ***91%***	0 *0%*	0 *0%*	0 *0%*	2 *6%*	1 *3%*

Turning to more specific palatalization changes, rhotics are relatively common targets of P-Pal, at least as part of secondary palatalization (Table 4). In fact, as targets of palatalization they are as common as laterals, and both classes are less likely targets than nasals. In E-Pal, however, the main difference is between rhotics and the other sonorants, with the instances of the rhotics accounting for about half of either laterals or nasals. This clearly shows a strong tendency for the avoidance of palatalized rhotics, which can be satisfied by either non-palatalization or place/manner-changing shifts. Another peculiar characteristic of E-Pal are the manner-changing shifts of both rhotics and non-rhotic sonorants (as [r]/[l]/[n] → [ʧ]), something that is not reported for P-Pal processes.

Table 4. Rhotic vs. non-rhotic asymmetry, based on Bateman (2007: 313-316) and our data

	Rhotics					Non-rhotic coronal sonorants							
	r→r^j	r→j	r→ʎ	r→ʧ	*r total*	l→l^j	l→ʎ	l→ʧ	*l total*	n→n^j	n→ɲ	n→ʧ	*n total*
P-Pal	10	0	0	0	*10 20%*	5	4	0	*9 18%*	12	18	0	*30 61%*
E-pal	3	2	1	1	*7 23%*	3	7	1	*12 35%*	3	8	2	*13 42%*

Finally, P-Pal processes do not show a clear difference between sonorants and obstruents as targets of palatalization. While Bateman mentions that obstruents as targets are most common in her sample (p. 56), this could be simply because languages usually have a higher number of obstruent phonemes, as opposed to sonorants. A comparison of specific changes in Table 5 shows that nasals are about as frequently targeted by P-Pal as voiceless stops, and both nasals and stops are targeted somewhat less commonly than voiceless sibilant fricatives. The difference between nasals and stops, and between these two classes and the fricatives is much more defined in E-Pal, with nasals being the least likely targets, and fricatives being the most likely targets. This suggests that manner asymmetry is characteristic of E-Pal, but not of P-Pal. Moreover, the two are also different in some specific changes, as, for example, the shifts of fricatives to affricates are specific to E-Pal.

Table 5. Manner asymmetry in coronals, based on Bateman (2007: 313-316) and our data

	Coronal nasals			Coronal stops				Coronal fricatives			
	n→ɲ	n→ʧ	*n total*	t→c	t→ʧ	t→ʦ	*t total*	s→ʃ	s→ʧ	s→ʦ	*s total*
P-Pal	18	0	*18* 29%	3	18	-	*21* 33%	23	0	-	*23* 37%
E-pal	9	2	*11* 19%	6	8	5	*19* 33%	15	7	5	*27* 47%

In sum, E-Pal has a set of properties that distinguishes it from P-Pal. Among these properties is the absolute implicational relation between coronals and non-coronals as targets and outputs of palatalization, the greater avoidance of palatalized rhotics, and the manner asymmetries – sonorant/obstruent and stop/fricative asymmetries in targets and the fricative/affricate asymmetry in sibilants. The finding that E-Pal has special properties different from P-Pal are not at all surprising, as the choice of segments in the former is constrained by factors that are beyond the regular phonology – selection of segments that are better associated with the meanings of smallness, childishness, or affection, or simply serve to identify the expressive register or lexical/grammatical class (Ferguson 1977; see section 5.1 below). In contrast, none of these constraints apply in P-Pal, which is presumably markedness-based (involving feature spreading and feature compatibility (Akinlabi 1996; Chen S.-I. 1996; Bateman 2007, among others), being ultimately rooted in phonetic coarticulation.

In the next two sections we turn to two specific palatalization processes – those applying in Japanese mimetic lexicon and in Japanese babytalk palatalization. We argue that that both processes are typical cases of E-Pal, as evident in the patterns of preferred targets and outputs, as well as in native speakers' intuitions about these processes.

3. Japanese mimetic palatalization as a case of E-Pal

3.1 Patterns

Japanese mimetic palatalization has received considerable attention in phonological literature (Mester & Itô 1989; Archangeli & Pulleyblank 1994; Chen, S.-I. 1996; Akinlabi 1996; Zoll 1997; Kurisu 2009, among others), and was often explicitly or implicitly considered as a case of phonological palatalization. The mimetic (sound-symbolic) lexicon is an extensive lexical network characterized by associations between certain phonological features or classes of segments and specific semantic attributes. Palatal(ized) consonants are, for example, known to signal a set of meanings including ‘childishness’, ‘immaturity’, ‘instability’, ‘unreliability’, etc. (see Hamano 1986/1998 for details). This is evident when comparing mimetic words that differ solely in palatalization, as in (7). As seen in the examples, only one consonant within a root (which is usually CVCV or CV(N)) can be palatalized. The choice of this target consonant is subject to certain segmental restrictions, the nature of which is directly relevant to the question at hand.

Below, we will briefly describe the patterns of mimetic palatalization, as re-evaluated in Alderete & Kochetov (2009) based on a list of 101 mimetic items with (phonetically unconditioned) palatalization compiled from various published sources (supplemented by additional items elicited from native speakers of Japanese, as discussed below).

(7) Examples of mimetic palatalization (from Kakehi, Tamori, & Schourup 1996)

a.	[**ʧ**oro-**ʧ**oro]	the manner in which a small object makes short, rapid movements
	cf. [**t**oro-**t**oro]	the manner of a vehicle moving too slowly
b.	[ba**ʃ**a-ba**ʃ**a]	a repeated splashing sound involving much spray
	cf. [ba**s**a-ba**s**a]	a flapping or rustling sound made when thin, dry materials fall or brush together
	[**p**^{j}oko-**p**^{j}oko]	the manner of jumping or hopping along in small leaps, or walking with a waddling gait
	cf. [**p**oko-**p**oko]	the manner of things appearing unexpectedly one after another

The patterns of mimetic palatalization with respect to targets and outputs are summarized in Table 6. The two most common patterns are those involving of palatalization of a coronal in roots where it follows or precedes a non-coronal, as shown in (a) and (b) (e.g. [baʃa-baʃa] and [ʤabu-ʤabu]). There is only one exception to palatalization of coronals ([k^{j}oto-k^{j}oto], which also has a counterpart with coronal palatalization, [koʧo-koʧo]). Another relatively common pattern is one where a coronal is palatalized when co-occurring with a rhotic (c) (e.g. [ʧoro-ʧoro]; there are no roots with initial rhotics). Altogether, these three patterns account for 88% of all instances of mimetic palatalization, thus clearly exemplifying a near-absolute preference for palatalization of non-rhotic coronals compared to non-coronals and rhotics (i.e. the coronal/non-coronal and rhotic/non-rhotic asymmetries). It is interesting, however, that among coronal consonants, nasals are considerably less common targets of palatalization (n=11) relative to any of the obstruents (n=38, 14, and 30). This suggests that there is a gradient preference for palatalization of obstruents over sonorants, reminiscent of similar gradient cases in Southern Estonian and Latvian babytalk, and Basque sound symbolism (see section 2).

Table 6. Patterns of mimetic palatalization (based on Alderete & Kochetov 2009)

Combination	Target and change								Total
	non-coronal			rhotic	cor sonorant	cor obstruent			
	$P \rightarrow P^j$	$K \rightarrow K^j$	$h \rightarrow h^j$	$r \rightarrow r^j$	n→ɲ	t→ʧ	d/z→ʤ	s→ʃ	
a. noncor-cor (e.g. baʃa-baʃa)	0	1	0		7	20	5	20	*53*
b. cor-noncor (e.g. ʤabu- ʤabu)	0	0	0		1	12	6	5	*24*
c. cor-r (e.g. ʧoro-ʧoro)				0	3	4	3	3	*13*
d. noncor-r (e.g. g^joro-g^joro)	0	3	2	0					*5*
e. cor-cor (e.g. doʃa-doʃa)					0	2	0	2	*4*
f. noncor-noncor (e.g. p^joko-p^joko)	1	0	1						*2*
Total	*1*	*4*	*3*	*0*	*11*	*38*	*14*	*30*	***101***

The other three palatalization patterns are not as clear and uncontroversial, and thus require a more detailed discussion. First, the pattern showing palatalization of non-coronals next to rhotics (d) (e.g. g^joro-g^joro) has often been interpreted as evidence for the greater susceptibility of non-coronals to palatalization relative to rhotics, which avoid palatalization altogether (e.g. Mester & Itô 1989; Zoll 1997). However, there are only 5 items exemplifying the pattern (with no examples of labials) – a surprisingly small number compared to the sizable class of non-coronal + rhotic items without palatalization (n = 68; Alderete & Kochetov 2009: p. 377). Moreover, it appears that avoidance of rhotic palatalization next to non-coronals is far from absolute. As Hamano (1986/1998: 148-149) notes, /r/ can shift to [j] when expressing 'childishness' or 'haziness' in newly created mimetic items: thus the standard form [goro-goro] denoting an adult's spirited drumming can be modified to [gojo-gojo] referring to a child's immature drumming. This suggests that palatalization of /r/ in mimetics is possible, and can result in [j], rather than in [r^j], which is in fact supported by a number of paired mimetic items with [r] and [j], e.g. [mura-mura] vs. [muja-muja], [kara-kara] vs. [kaja-kaja], etc. Recall that such alternations are not uncommon in expressive palatalization, being attested in Basque diminutives and Warlpiri babytalk (see (5cd)).

Second, palatalization in roots with two coronals and two non-coronals has been claimed as evidence for the 'default-to-opposite' (DTO) generalization (or 'conflicting directionality': Zoll 1997), as rightmost palatalization was observed in the former roots and leftmost palatalization in the latter. This putative generalization is important for the treatment of mimetic palatalization as a phonological process, since similar default-to-opposite edge effects have been observed for some unquestionably phonological phenomena such as stress (Zoll 1997). The interpretation of the data that led to this generalization, however, is not unproblematic, as the rightmost palatalization of coronals is exhibited unambiguously by only one item ([doʃa-doʃa], with another item [ʃana(ri)-

ʃana(ri)] showing the opposite pattern). Similarly, the leftmost palatalization of non-coronals is exhibited by only two items ([pʲoko-pʲoko] and [hʲoko-hʲoko]). The small number of examples, as we argue in Alderete & Kochetov (2009), is insufficient to support the default-to-opposite generalization. Additional mimetic items with two coronals and two non-coronals elicited from six speakers of Japanese showed no clear preference for rightmost or leftmost palatalization (see Alderete & Kochetov 2009 for details). What appears to affect the choice of palatalized consonants in coronal-coronal items, however, is the manner of articulation of these consonants. Among the 13 elicited items, 11 showed palatalization of sibilant obstruents [ʧ], [ʃ], or [ʤ], and only 2 showed palatalization of the sonorant [ɲ] (of all possible combinations of plain and palatalized coronal consonants). This is indicative of the manner asymmetry, where obstruents are more likely targets of E-Pal than sonorants, the pattern widely attested in our cross-linguistic sample (see section 2).

In sum, the patterns of Japanese mimetic palatalization reflect many of the asymmetries characteristic of E-Pal, either categorically or gradiently: the coronal/non-coronal asymmetry, the rhotic/non-rhotic asymmetry, and the obstruent/sonorant manner asymmetry (see (6)). It is worth noting that none of these asymmetries characterize phonological palatalization processes in Japanese, where all consonants (except the glides), regardless of the place and manner of articulation, are palatalized before /i/ (McCawley 1968; Vance 1987; Ito & Mester 2003). This suggests that mimetic palatalization is a phenomenon completely distinct from phonological palatalization. An alternative interpretation of the same data, however, argues for the phonological status of mimetic palatalization, citing as evidence the putative default-to-opposite edge effects, which are also characteristic of other phonological phenomena (Zoll 1997).

The experiment below addresses the question of which generalizations are correct and consistent with native speakers' intuitions about patterns of mimetic vocabulary, and ultimately reflecting properties of either expressive or phonological palatalization.

3.2 Speakers' intuitions: Experiment 1

The goal of this experiment is to test speakers' preference for palatalization of coronals over non-coronals and rhotics (the coronal/non-coronal and rhotic/non-rhotic hypotheses) and preference for palatalization of coronal obstruents over coronal sonorants (the obstruent/sonorant manner hypothesis), while at the same time evaluating the alternative interpretation of some of the patterns – the rightmost palatalization of coronals and leftmost palatalization of non-coronals (the default-to-opposite hypothesis, consistent with the P-Pal treatment of mimetic palatalization).

A commonly used method to probe native speakers' intuitions about morphologically productive sound patterns is a wug test – asking speakers to apply familiar morphological rules to novel forms (Berko 1958). Since much of the prior work assumes that Japanese mimetic palatalization is essentially morphological (i.e., attachment of a featural affix: Hamano 1986/1998; Mester & Itô 1989; Zoll 1997; but see

Schourup & Tamori 1992), a wug test would have been an appropriate method to test Japanese speakers' intuitions about palatalization. Our pilot investigation, however, led us to believe that this was not a possible strategy: the four speakers we tested were not apparently able to clearly relate palatalized and non-palatalized pairs morphologically. This is not entirely surprising, given the frequent lack of clear semantic correspondence between actual mimetic words with and without palatalization.

Another possible way of tapping into speakers' intuitions about 'grammatical' and 'ungrammatical' forms is a word-likeness study. Such a study of Japanese mimetic palatalization was in fact conducted in Nagao & McCall (1999), who asked Japanese speakers to rank and rate a number of nonce palatalized mimetic forms in terms of acceptability. Most of their items contained coronal-coronal combinations, with each having three versions: with double palatalization (e.g. ʧoɲa-ʧoɲa), with the leftmost consonant palatalization (e.g. ʧona-ʧona), and with the rightmost consonant palatalization (e.g. toɲa-toɲa). The results were similar for both tasks and showed a clear disfavor of double palatalization. The choice between the leftmost and the rightmost palatalization, however, was far less clear. Some coronal-coronal items appeared to show the expected preference for the rightmost palatalization (e.g. nVʃV), while others – for the leftmost palatalization (e.g. ʃVnV). The authors proposed that subjects' responses were sensitive to the manner of articulation of consonants involved, rather than reflecting intuitions about default-to-opposite palatalization. However, given the relatively small scale of the study and the lack of some important controls, the noted manner effects could not be fully verified. This suggests that the manner asymmetry hypothesis and the default-to-opposite palatalization hypothesis require further and a more rigorous testing, as provided by the following experimental study.

3.2.1 Method

Test materials used in the experiment consisted of nonce mimetic C1VC2V-C1VC2V word pairs with either C1 or C2 palatalized, for example, ʧaro-ʧaro or tar^{j}o-tar^{j}o. Two sets of stimuli were created. The first set (Table 7a) was designed to test three general hypotheses: the coronal/non-coronal asymmetry, the rhotic/non-rhotic asymmetry, and the conflicting directionality in non-coronals and coronals. The second set (Table 7b) was designed to further investigate coronal-coronal combinations by examining palatalization in combinations of coronals of different manners. The goal was to compare the predictions of the conflicting directionality hypothesis for coronals and the manner (obstruent/sonorant and sibilant/non-sibilant) asymmetry hypothesis.

To ensure that subjects' responses reflected generalizations about consonant combinations rather than particular test items, all consonant combinations were placed in five different back vowel contexts. Two of the contexts included the vowels /a/ and /o/ in either order (a-o and o-a); two contexts included the vowels /a/ and /u/ in either order (a-u and u-a); and one context included two identical vowels /o/ (o-o). Pairs containing actual mimetic words (ʧupa-ʧupa, poʧa-poʧa, ʧoro-ʧoro, and ɲoro-ɲoro, marked with X in the table) were excluded from the set to minimize lexical interference. This resulted in a total of 22 pairs of stimuli for Set 1 and 38 pairs for Set 2.

Table 7. Stimuli: Pairs of nonce mimetic C1VC2V-C1VC2V words with different place and manner consonant combination types; X = pairs omitted from the set.

		C1-C2		a-o		o-a	a-u	u-a	o-o
	Place	input	output	C1=pal	C2=pal	…	…	…	…
a.	cor-noncor	t-p	ʧ-p/t-pʲ	ʧapo-ʧapo	tapʲo-tapʲo	…	…	X	…
	noncor-cor	p-t	pʲ-t/p- ʧ	pʲato-pʲato	paʧo-paʧo	X	…	…	…
	cor-r	t-r	ʧ-r/t-rʲ	ʧaro-ʧaro	tarʲo-tarʲo	…	…	…	X
	noncor-noncor	g-b	gʲ-b/g-bʲ	gʲabo-gʲabo	gabʲo-gabʲo	…	…	…	…
	cor-cor	t-d	ʧ-d/t-ʤ	ʧado-ʧado	taʤo-taʤo	…	…	…	…
b.	nas/fric	n-s	ɲ-s/n-ʃ	ɲaso-ɲaso	naʃo-naʃo	…	…	…	…
		s-n	ʃ-n/s-ɲ	ʃano-ʃano	saɲo-saɲo	…	…	…	…
	nas/stop	n-t	ɲ-t/n-ʧ	ɲato-ɲato	naʧo-naʧo	…	…	…	…
		t-n	ʧ-n/t-ɲ	ʧano-ʧano	taɲo-taɲo	…	…	…	…
	stop/fric	t-s	ʧ-s/t-ʃ	ʧaso-ʧaso	taʃo-taʃo	…	…	…	…
		s-t	ʃ-t/s-ʧ	ʃato-ʃato	saʧo-saʧo	…	…	…	…

Word pairs from both sets were randomized and presented together in two blocks, together with other pairs of nonce words with and without palatalization. In the first block, the first word in each pair had C1 palatalized and the second word had C2 palatalized (ɲaso-ɲaso vs. naʃo-naʃo). In the second block, the order was reversed: the first word in each pair had C2 palatalized and the second word had C1 palatalized (naʃo-naʃo vs. ɲaso-ɲaso). The use of these two blocks was necessary to control for any general bias towards subjects' choosing either the first or the second word throughout the experiment. Both blocks of stimuli, printed in the Hiragana script, were presented to each subject once, thus giving two responses for each stimulus pair.[2] The order of presentation (Block 1-Block 2 or Block 2-Block 1) was alternated among the subjects.

The subjects were 35 native speakers of Japanese residing in the Vancouver area, British Columbia, Canada. They were college or university level ESL students who were on average 28 years old and had lived in Canada for less than 2 years. The subjects were told that they would be presented with pairs of made-up words, which were similar in shape to actual Japanese sound symbolic words. Their task was to go through the list at a

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[2] Japanese orthography clearly marks palatalization and employs the same palatalization symbols for all consonants regardless of their place and manner of articulation (e.g. Hiragana ゃ '(C)ʲa', ゅ '(C)ʲu', ょ '(C)ʲo').

comfortable pace selecting one item from each pair which was "more acceptable, sounded more like a Japanese word". They were also told that the purpose of the study was to learn about the use of sounds in Japanese sound-symbolic vocabulary, and therefore native speakers' judgments of nonce words were crucial to this purpose. All instructions were given in Japanese.

The task used in the experiment was thus similar to the well-formedness/wordlikeness ranking task employed in Nagao & McCall's (1999) study of Japanese mimetic palatalization (see also the studies of Hebrew gemination by Berent & Shimron 1997 and English root place restrictions by Coetzee 2009 using a similar method). Note that Nagao & McCall used both ranking and rating (well-formedness on a 5-point scale) tasks, and found that the results for both tasks were similar.

Collected data were analyzed the following way. Each response was assigned 1 if the leftmost consonant (C1) palatalization was preferred to the rightmost consonant (C2) palatalization (i.e. ɲaso-ɲaso > naʃo-naʃo) or 0 if the rightmost consonant palatalization was preferred to the leftmost consonant palatalization (i.e. naʃo-naʃo > ɲaso-ɲaso). This measure will be referred to as 'C1 pal ratio'. Each subject's responses were averaged over 2 repetitions for each stimulus pair (in two different orders), and then further averaged over the vowel contexts, resulting in 35 data points for each combination pair.

3.2.2 Predictions

In Set 1, the *coronal preference hypothesis* predicted that the subjects would select palatalized coronals regardless of their order, C1 or C2, resulting in a high C1 pal ratio for t-p pairs (i.e. ʧapo-ʧapo > tap^{j}o-tap^{j}o) and a low C1 pal ratio for p-t pairs (i.e. paʧo-paʧo > p^{j}ato-p^{j}ato). The *rhotic avoidance hypothesis* predicted that palatalization of rhotics would be avoided, resulting in a high C1 pal ratio (i.e. ʧaro-ʧaro > tar^{j}o-tar^{j}o). The *default-to-opposite hypothesis* for the non-coronal pair g-b predicted a high C1 ratio (leftmost palatalization, g^{j}abo-g^{j}abo > gab^{j}o-gab^{j}o), comparable to the t-p and t-r pairs. In contrast, the same hypothesis for the coronal pair t-d predicted a low C1 pal ratio (rightmost palatalization, ʧado-ʧado > taʤo-taʤo), comparable to the p-t pair. In Set 2, the default-to-opposite hypothesis for all coronal pairs predicted consistently low C1 ratios (rightmost palatalization, naʃo-naʃo > ɲaso-ɲaso, saɲo-saɲo > ʃano-ʃano, etc.). In contrast, the *manner asymmetry hypothesis* predicted that palatalization would be attracted to obstruents in sonorant/obstruent combinations (*obstruent preference*), resulting in a higher C1 ratio in s-n than in n-s and in t-n than in n-t (e.g. ʃano-ʃano > saɲo-saɲo and naʃo-naʃo > ɲaso-ɲaso). It also predicted the attraction of palatalization to sibilants as compared to stops (*sibilant preference*), resulting in a higher C1 ratio in s-t than in t-s (i.e. taʃo-taʃo > ʧaso-ʧaso and ʃato-ʃato > saʧo-saʧo).

3.2.3 Results and discussion

Figure 1 plots overall means of C1 pal ratio responses for each consonant combination type in Set 1. As we can see, the highest and the lowest C1 pal ratio values were obtained for t-p and p-t combinations respectively, in full agreement with the coronal preference hypothesis. Responses for the two combinations were highly significantly different ($t(34) = 15.901$, $p < .001$). The overall high C1 pal ratio for t-r combination was indicative of the palatalization avoidance by /r/, thus providing support for the rhotic avoidance hypothesis. However, the overall values for t-r were significantly lower than for t-p ($t(34) = 5.545$, $p < .001$), suggesting that the rhotic/non-rhotic asymmetry was somewhat weaker, more gradient than the coronal/non-coronal asymmetry. Of particular interest was the finding that C1 pal ratio values for combinations with two non-coronals (g-b) and two coronals (t-d) were similar, being both around 0.5, which was the chance level. The values for the two pairs were not significantly different from each other ($t(34) = -.633$, $p = .531$), while being significantly different from the respective controls (g-b vs. t-p: $t(34) = 10.560$, $p < .001$; g-b vs. t-r: $t(34) = 6.371$, $p < .001$; t-d vs. p-t: $t(34) = 5.726$, $p < .001$). This shows that unlike with coronal/non-coronal and rhotic/non-rhotic pairs, the subjects had no clear intuitions about the palatalization of two non-coronals and two coronals of the same manner. The results thus fail to support the default-to-opposite hypothesis, for both coronals and non-coronals.

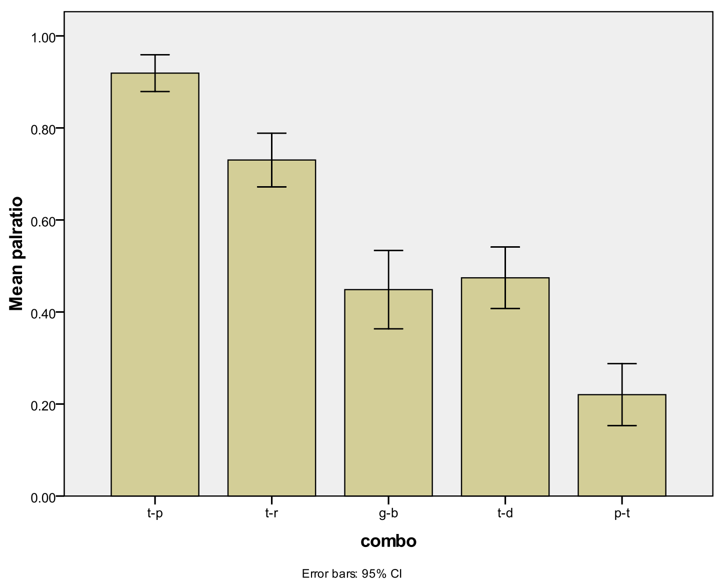


Figure 1. Overall means of C1 pal ratio responses for each consonant combination type, Set 1

Overall means of C1 pal ratio responses for each consonant combination of Set 2 are plotted in Figure 2. As was found with the t-d pair in Set 1, none of the coronal-coronal pairs showed any clear preference for the rightmost palatalization, contrary to the conflicting directionality hypothesis. At the same time, the results showed that C1 pal ratio values were affected by the manner of articulation of C1 and C2. Specifically, in obstruent/nasal pairs, C1 pal ratio was significantly higher when C1 was obstruent, as opposed to when C1 was sonorant (s-n vs. n-s: $t(34) = 2.493$, $p < .05$; t-n vs. n-t: $t(34) = 5.226$, $p < .001$). Further, in obstruent/obstruent pairs, C1 pal ratio was significantly higher when (the input) C1 was a sibilant fricative, as opposed to a stop (t-s vs. s-t: $t(34) = -6.015$, $p < .001$). Although these differences were not as robust as, for example, the differences in coronal/non-coronal pairs in Set 1, they were clearly indicative of a gradient preference for palatalization of obstruents over sonorants, and sibilant fricatives over stops. These findings thus support the manner asymmetry hypothesis for coronal-coronal items.

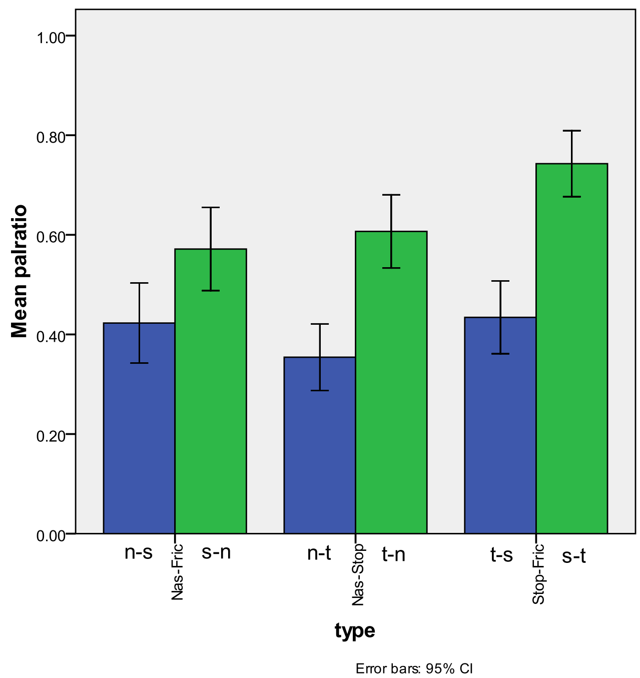


Figure 2. Overall means of C1 pal ratio responses in coronal/coronal items where C1 and C2 differ in manner and order, Set 2

In sum, the results of the experiment revealed that native speakers of Japanese show overwhelming preference for palatalized coronals over palatalized non-coronals and, to a lesser extent, palatalized rhotics. The most interesting result is that speakers' responses show clear, albeit gradient, preference for palatalized (sibilant) coronal obstruents over sonorant coronals. This indicates that the choice of target consonants in coronal-coronal roots is strongly influenced by manner of articulation of the consonants (as was suggested by Nagao & McCall's 1999 results). All these findings are, consistent with our hypotheses based on the observed patterns and tendencies in the Japanese mimetic lexicon and on the general asymmetries found in cross-linguistic patterns of E-Pal. No evidence was found for the default-to-opposite hypothesis (conflicting directionality: Zoll

1997), as neither leftmost nor rightmost palatalization was consistently favoured in items with two coronals or two non-coronals. Overall, these findings – a strong coronal preference, rhotic avoidance, the scale of manner preferences, and the lack of default-to-opposite edge effects – further support the view of Japanese mimetic palatalization as a typical case of expressive palatalization, rather than a case of phonological palatalization.

The results of this experiment, however, do not allow us to tease apart two possible kinds of speakers' intuitions about the data – their implicit knowledge of the actual scales of expressive palatalization (as in (6)) as grammatical generalizations, and their lexical knowledge of mimetic vocabulary – relative frequency of palatalized consonants in the mimetics. In other words, certain segmental preferences we have observed could be attributed either to the speakers' knowledge of the scale of E-Pal or to their knowledge of mimetic vocabulary. To explore this question further, we turn to Japanese babytalk, which is known to exhibit a similar, but apparently more productive kind of palatalization.

4. Japanese babytalk palatalization as E-Pal

4.1 Patterns

Previous analyses of Japanese mimetic palatalization explicitly linked the process with palatalization in Japanese babytalk – a specialized register used by adults communicating with small children. Specifically, it was noted that the two processes share preference for palatalization of coronals over non-coronals (Hamano 1986/1998: 186-187; Mester & Itô 1989: 268, fn. 21). The two processes are also expected to share some characteristics, given the fact that mimetic vocabulary is used very frequently in child-directed speech (about 5 times higher than with adults: Imai et al. 2008) and given the high incidence of (non-mimetic) reduplication in babytalk (Chew 1969). To our knowledge, however, no attempts have been made to explicitly compare mimetic and babytalk palatalization processes or to provide a phonological analysis of the latter.

Chew (1969), who examined the use of Japanese babytalk by several mothers, notes that the register is characterized by a set of well-defined structural properties, including patterns of certain phoneme "substitutions and distortions". These changes, according to his examples, all target sibilant coronals and result in palatal affricates: [s ʦ ʃ] → [ʧ], [z] → [ʤ] (with [ʦ] being an allophone of /t/ before /u/). These are illustrated in (8) in child-directed speech utterances ((a), repeated from (1d)) and in specialized babytalk lexical items (b). The change [s] → [ʃ] (with no affrication) is also attested, as shown in (c). Based on these examples, the targets of babytalk palatalization are neither coronals in general, nor coronal obstruents as a class, but exclusively sibilant fricatives and affricates. Notably, coronal stops (other than /t/ before /u/, [ʦ]), nasal /n/, and non-coronals appear to be unaffected by babytalk palatalization (e.g. *[ʧabema**s**uka], *[ɲominasai], *[p^{j}aip^{j}ai]). Nor is palatalized the rhotic (*[osar^{j}u]).[3] The palatalization process appears to be exhaustive, with more than one palatalizable sibilants affected within a word or a phrase (e.g. [oʧaruʧan]; but see [nominasai]).

(8) Japanese babytalk ((a) and (b) adapted from Chew 1969: 5, 9; (c) from Hamano 1986/1998: 186-187)

a. [**s**ora paipai oiʃiː-oiʃiː jo] → [**ʧ**ora paipai oiʧiː-oiʧiː jo]
'Here's baby's milk. It's yummy!
[omi**z**u nominasai] → [omi**ʤ**u nominasai] 'Drink your water!

b. [go**ts**uN] (/gotuN/) 'thump' + [ko] 'child' → [goʧːuNko] (suru) 'bump (the head)
[o**s**aru] 'monkey' + [**s**an] 'Mr.' → [oʧaruʧan] 'Mr. Monkey'

c. [tabema**s**uka] → [tabemaʃuka] ~ [tabemaʧuka] 'Will you eat?'
[ʤuː**s**u] → [ʤuːʃu] 'juice'

As palatalization in babytalk is seemingly more productive than in mimetic vocabulary, an experimental study of the former is likely to provide a clearer indication of speakers' knowledge of relative scales of expressive palatalization.

4.2 Speakers' intuitions: Experiment 2

As with the first experiment, the goal here is to test speakers' knowledge of the coronal/non-coronal, rhotic/non-rhotic, and manner asymmetries, while also comparing the pattern of babytalk palatalization to that in mimetics.

4.2.1 Method

The experiment materials included a list of 14 utterances the following potentially palatalizeable consonants: sibilants [s z ts] (and [ʃ]), nonsibilant coronals [t n d r], and noncoronals [b m k h], as shown in Table 8 (with potential target consonants indicated in bold). These utterances, written in the Japanese orthography, were selected as representative of adult-child interactions.

The subjects were the same 35 native speakers of Japanese as in Experiment 1 (with none of them being parents of small children). (Experiment 2 was conducted immediately after Experiment 1.) The subjects were provided with the list of utterances written in Japanese orthography and were asked to reproduce the sentences using the *Hiragana* script (which consistently renders palatalized consonants, see footnote 2) as if

[3] Chew (1969) mentions, however, that /r/ can shift to [j] or deleted before front vowels: [kire-kire] → [kie-kie] 'clean'.

they were speaking to a small child. No examples of baby talk were provided, in order not to bias the subjects in favor of any particular responses.

Table 8. Utterances used in the experiment

Utterance	*Gloss*
ʤuːsu o nomu?	'Have some juice, would you?'
kutsuʃita o haku?	'Put on your socks, would you?'
seːtaː wa doko?	'Where's the sweater?'
samui?	'(Are you) cold?'
tsumetai?	'(Is it) cold?'
ojasumi	'Good night.'
onaka suita?	'(Are you) hungry?'
zembu taberu?	'Will you eat all?'
ʤoːzu desu ne!	'Good girl/boy!'
ʧiːzu wa oiʃiː	'The cheese is yummy.'
natːoː wa suki?	'Do you like fermented beans?'
zetːai dame!	'Don't do that!'
zoː wa kawaiː	'The (toy) elephant is cute.'
buranko de asobu?	'(Do you) want to do the swing?'

4.2.2 Predictions

Assuming that previous descriptive accounts of Japanese babytalk were correct, and consistent with the scales of expressive palatalization, it was expected that palatalization would target sibilants [s ts z] (and [ʃ]) to the exclusion of coronal stops [t d], sonorant [n], rhotic [r], and non-coronals [b m k h]. Note that evidence for [ts] (an allophone of /t/ before /u/) being a target of palatalization to the exclusion of [t] (an allophone of /t/ before non-high vowels) would be important, as it would show whether palatalization applies to surface or lexical representations.

4.2.2 Results and discussion

The results showed that 27 out of 35 subjects made at least some consonant changes resulting in palatal or palatalized consonants. On average, these substitutions were made at least once per phrase (i.e. 14 per speaker), ranging from 3 to 22 for the whole list (out of 43 potentially palatalizeable consonants). As shown in Table 9, non-coronals were very rarely targeted by palatalization ([k m] → [k^j m^j]; 2 subjects), or not targeted at all ([b h]). Almost equally rarely were targeted the rhotic [r], the coronal nasal [n], and the coronal stops [t d]. In contrast, sibilant coronals – the fricatives [s z ʃ] and the affricate [ʦ] – were targeted by most subjects. Specifically, all 27 subjects palatalized [s] (to [ʧ] or [ʃ]), 22 of them palatalized [ʦ] (to [ʧ]), and 16 palatalized [z] to [ʤ]. The few subjects who targeted non-coronals or non-sibilant coronals also targeted sibilants, indicative of an implicational relation between sibilants and non-sibilants as targets.

The other 8 subjects who did not show consonant substitutions often used babytalk-specific lexical items or mimetics (e.g. [buru-buru] for [samui], [hija-hija] for [ʦumetai], and [peko-peko] for [suita]), adding particles indicating emphatic statements or questions ([ne], [da jo], [kana], [no]), dropping certain particles ([o], [wa]), or lengthening vowels ([kanaː], [daːme]). All these are known as additional devices of Japanese babytalk (Chew 1969). We will not, however, discuss these results further, restricting our focus to consonant substitutions produced by the other 27 subjects.

Table 9. Targets and outputs of consonant substitutions in responses, with numbers representing numbers of speakers (out of 27) who employed a particular change.

Target	Output								
	C^j	j	ɲ	ʤ	ʃ	ʃ~ʧ	ʧ	other	no change
k	2								25
m	2								25
b, h									27
r	1	1						1 ([d])	24
n			1						26
d									27
t							2		25
ʦ							22		5
z				16					11
s					3	10	14		0
ʃ							21		6

As seen in the table, outputs of palatalization generally preserved the manner and voicing of target consonants, except for sibilant fricatives which tended to shift to affricates. For most subjects, this process also involved both alveolar and palatal fricatives. The variation between [ʃ] and [ʧ] as outputs of palatalization appears to denote different degrees of 'babyishness' or degrees of intensity of affection (cf. the [ʃ-ʧ] distinction in Island Lake Ojibwa diminutives; Melnychuk 2003). As one of the subjects noted after the experiment, both variants [ʧuki] and [ʃuki] (for [suki]) were acceptable to her, although the first one "sound[ed] cuter".

Some examples of the most common changes are shown in (9) – those targeting [s] (a), [ʦ] (b), [z] (c), and [ʃ] (d). Numbers of responses for each output are given in parentheses.

(9) a. [suita] → [ʧuita] (n=16), [ʃuita] (n=3)
[samui] → [ʧamui] (n=9), [ʃamui] (n=3)
[ʤuːsu] → [ʤuːʧu] (n=10)
[suki] → [ʧuki] (n=13), [ʃuki] (n=4)
[seːtaː] → [ʧeːtaː] (n=3), [ʃeːtaː] (n=1)
b. [kuʦuʃita] → [kuʧuʃita] (n=13), [kuʧuʧita] (n=1)
c. [ʤoːzu] → [ʤoːʤu] (n=10)
[ʧiːzu] → [ʧiːʤu] (n=6)
[zoː] → [ʤoː(saN/ʧaN)] (n=6)
[zembu] → [ʤembu] (n=9)
d. [oiʃiː] → [oiʧiː] (n=22)

It is interesting to note that the palatalization process is fairly productive and not limited to any particular lexical strata, as evident in the changes affecting recent loanwords (e.g. [ʧiːʤu] from [ʧiːzu] ‘cheese’). It is also not fully structure preserving, as it can produce palatalized consonants in a context where these are not generally permitted (Vance 1987) – before /e/ (e.g. [ʧeːtaː] and [ʤembu] from [seːtaː] and [zembu]).

In addition to the segmental substitutions in target utterances discussed above, many subjects (n=21) had similar substitutions in auxiliaries or suffixes that they had added to the utterances: [deʧu] (from [desu]), [-imaʧu] (from [-imasu]), and [-imaʧo] (from [-imaʃo]). For example, the target utterances [ʦumetai] and [kuʦuʃita o haku] were changed to [ʦumetai/ʧumetai **deʧu ka**] and [kuʦuʃita/kuʧuʃita o hak**imaʧu**] respectively. The modified forms represent a more formal register, which is also commonly observed in Japanese babytalk (Chew 1969). At the same time, these forms provide additional material for palatalization changes, with [deʧu] and [-imaʧu] serving as salient, possibly lexicalized, markers of babytalk.

In sum, the results of the experiment revealed that Japanese babytalk is a highly productive process that targets and outputs almost exclusively palatalized sibilants. This confirms the earlier description of the babytalk register by Chew (1969), while also being indicative of the (surface) sibilant/non-sibilant distinction within coronals. In terms of its targets, the process is more restrictive than mimetic palatalization, which in addition to sibilants targets coronal stops and sonorant /n/, and under some conditions, non-coronals. Recall, however, than mimetic palatalization also shows a gradient manner asymmetry in the same direction. The two processes taken together thus exemplify an implicational relation typical of the typology of E-Pal in general: palatalization of non-coronals implies palatalization of coronals, palatalized sonorants imply palatalized obstruents, and palatalized stops imply palatalized fricatives. Unlike mimetic palatalization, which limits the number of palatalized consonants, babytalk is exhaustive, potentially affecting all palatalizable sibilants, similar to many cases of babytalk in our typology. The results thus clearly support the view that both Japanese mimetic and babytalk palatalization are typical cases of E-Pal. As such, the two processes require an analysis different from analysis of phonological palatalization.

5. General discussion

In the previous sections we presented evidence for expressive palatalization processes (including Japanese mimetic and babytalk palatalization) having a set of properties that distinguish it from phonological palatalization. These include the more robust coronal/non-coronal and rhotic/non-rhotic asymmetries, and several manner asymmetries in coronals, which together result in a series of scales of more and less preferred targets and outputs of E-Pal. What are the functional sources of these scales? How do these scales possibly interact with the 'regular' phonology, resulting in cross-linguistic patterns of E-Pal? These questions will be explored in the next section.

5.1 Scales of expressive palatalization

5.1.1 Acoustic frequency and salience

The use of palatalized consonants, and particularly of palatalized coronals, as a marker of smallness/childishness is part of a more general sound-symbolic correspondence, also known as Ohala's 'frequency code' (1984, 1994). As Ohala (1994: 335) notes, "words denoting or connoting SMALL or SMALLNESS (and related notions) tend to exhibit a disproportionate incidence of vowels and/or consonants characterized by high acoustic frequency." The high acoustic frequency sounds, according to Ohala, include non-low front vowels [i ɪ y e] (high F2), palatalized consonants (high F2 formant transitions), alveolar and palatal coronals (higher frequency bursts, frication noise and/or formant transitions), voiceless obstruents and ejectives (higher frequency due to the higher velocity of the airflow), as well as – at the suprasegmental level – high tone. These sounds are presumably associated with smallness because small objects tend to emit sounds that are high in resonance frequency, as opposed to large objects emitting low resonance frequency sounds (Ohala 1994). This association appears to be universal, as has been shown in many psycholinguistic experiments with participants of various language backgrounds (see Ohala 1994 for details; see also Masuda 2004).

If acoustic frequency is indeed a factor, we would expect that the associative relation between smallness and palatalization is better rendered by some palatalized consonants rather than others. Specifically, the relation should be rendered best by consonants on which palatalization is realized acoustically most saliently. This scale of acoustic salience of palatalization is shown in (10). Palatals (or more precisely laminal posterior coronals, (b)) are more salient than palatalized non-coronals (a) as they tend to have higher vowel-to-consonant and consonant-to-vowel F2 transitions. In addition, the former have more robust segment-internal high frequency cues to palatalization (bursts and frication, discussed below; Fant 1960: 198). Among the palatals, obstruents are more salient than sonorants, because the former are characterized by high frequency noise – at the release of stops and affricates, and throughout the constriction of fricatives (c). This noise has the highest intensity in sibilants – strident affricates and fricatives, thus making these segments more salient than palatal stops or non-strident fricatives (d). Finally, the strident noise in affricates has an abrupt onset preceded by silence, thus presumably having the maximum impact on the auditory nerve, and as a result making affricates the most salient high frequency sounds (e) (Stevens 1998). Other differences, such as between voiceless or ejective obstruents and their voiced counterparts are also expected, but will not be crucial to the discussion.

(10) Frequency-based acoustic salience scale of SMALLNESS (from the least salient in (a), to the most salient in (e))

a. palatal(ized) consonants (V- or C-Place [coronal, -ant])
high F2 transitions
b. palatal (laminal posterior coronal) consonants (C-Place [coronal, -ant, +dist])
higher F2 transitions, internal cues for some consonants
c. palatal obstruents ([-son] & C-Place [coronal, -ant, +dist])
higher F2 transitions, high frequency bursts/frication
d. palatal sibilants ([-son, +strid] & C-Place [coronal, -ant, +dist])
higher F2 transitions, high frequency & high intensity frication
e. palatal sibilant affricates ([-son, +strid, -cont] & C-Place [coronal, -ant, +dist])
higher F2 transitions, high frequency & high intensity frication, abrupt onset of frication

To make some of these differences more concrete, Figure 3 presents spectrograms of (nonsense) words with nasals that differ in terms palatalization and primary place – [ama], [am^{j}a], [ana], [aɲa], produced by a female native speaker of Japanese. It can be seen that palatal(ized) consonants [m^j] and [ɲ] are characterized by higher F2 compared to their non-palatalized counterparts [m] and [n]. However, there is a clear difference between the two palatalized consonants: [ɲ] is cued by high F2 on both the preceding and the following vowels, while [m^j] is cued mainly by high F2 of the following vowel (with lower F2 cuing the primary labial place). Moreover, F2 next to the non-palatalized coronal [n] is also relatively high, higher than before the palatalized labial. This shows that palatalized coronals are characterized by higher acoustic frequency than non-palatalized coronals (illustrating (10ab)). Also, plain coronals are characterized by higher frequency than plain non-coronals, and to some extent, palatalized non-coronals. Given these differences, it is not surprising that palatalized coronals are identified by listeners better than palatalized non-coronals, as was found in a perceptual experiment in

Kochetov (2004) with Russian plain and palatalized coronal and labial stops presented to Russian and Japanese listeners. Among the labials, palatalized consonants were often confused with their plain counterparts, while among the coronals, plain consonants were often confused with the palatalized ones. This shows that identification of consonants as palatalized or plain depends on how high or low F2 is next to the consonants.

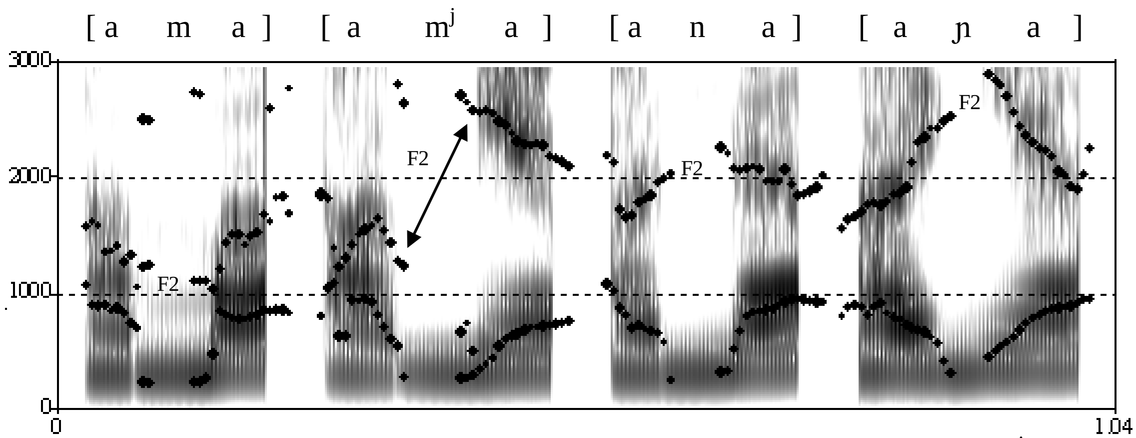


Figure 3. Spectrograms illustrating spectral properties of consonants [m], [mʲ], [n], and [ɲ] in the range 0-3 kHz, produced by a Japanese female speaker

Turning to acoustic differences within coronals, Figure 4 presents words with [aɲa], [aʃa], and [atʃa], produced by the same speaker. The frequency range is extended here to 20 kHz. While all three consonants are characterized by contextual cues – high F2 of the preceding and the following vowel, the sibilants [ʃ] and [tʃ] are also characterized by robust internal cues – high-intensity strident noise extending from about 4 kHz all the way up to 20 kHz, resulting from extreme turbulence at the point of articulation (Stevens 1971; Shadle 1985). The onset of this noise is gradual in fricatives, while being abrupt and preceded by a period of silence in affricates. The high-intensity high-frequency strident noise makes sibilants more acoustically salient in general, and with respect to palatalization (cf. (10d)). The abrupt onset of noise (Raphael 2008) presumably makes affricates more auditorily salient than fricatives (cf. (10e)). The relative psycho-acoustic salience of sibilants as a class, as well as the salience of the contrasts within this class (anterior vs. posterior and fricative vs. affricate), have been confirmed in a number of perceptual studies (Singh et al. 1972; Klatt 1968; Wang & Bilger 1973; Redford & Diehl 1999, among others). In this respect, coronal sibilants that differ in place and/or continuancy are among the consonants that, according to Nichols (1971: 833), are most appropriate for diminutive alternations, being acoustically salient and "psychologically equivalent at some level of abstraction" (cf. Ferguson 1977 on babytalk).

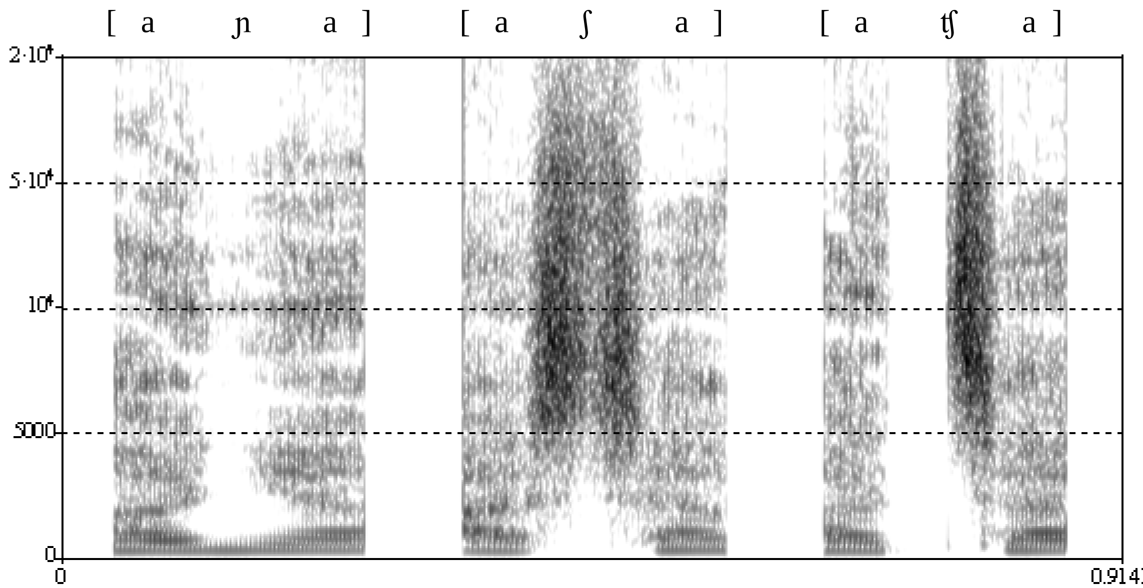


Figure 4. Spectrograms illustrating spectral properties of palatal nasal [ɲ] and post-alveolars [ʃ] and [ʧ] in the range 0-20 kHz, produced by a Japanese female speaker

5.1.2 Front cavity size and articulatory compatibility

While acoustic frequency appears to be the main source of the symbolic relation between smallness and palatalized consonants (and front vowels), articulatory properties of these consonants may also be a factor (see Masuda 2004 for discussion). These consonants, as we know, are produced with a considerably smaller front oral cavity (which in fact results in higher F2) than their non-palatalized/non-coronal consonant counterparts or back vowels. The front cavity is even smaller for palatal(ized) coronals than for palatalized non-coronals. This can be seen in Figure 5, which presents electropalatographic (EPG) data from a speaker of Japanese (from the University of xxx multilingual EPG corpus). Given the approximant-like palatal articulation of [p^j], the consonant shows considerably less linguopalatal contact at the point of acoustic release of [p^j], compared to the release of [ʧ] (palatal vs. post-alveolar). Also, as expected, the constriction for the former is more back than for the latter consonant. Similarly, the constriction for the non-sibilant palatal [ç] (/h^j/) is more back than for the sibilant fricative [ʃ] (palatal/front velar vs. post-alveolar). These differences show that [p^j] and [ç] are produced with a larger front cavity compared to [ʧ] and [ʃ]. Assuming that front cavity size can serve as an additional basis of associative phonological iconicity (see Maeda 2007), these differences would be expected to further enhance the perceived difference between the two classes of palatalized consonants, and their greater or smaller degrees of contrast with non-palatalzied consonants.

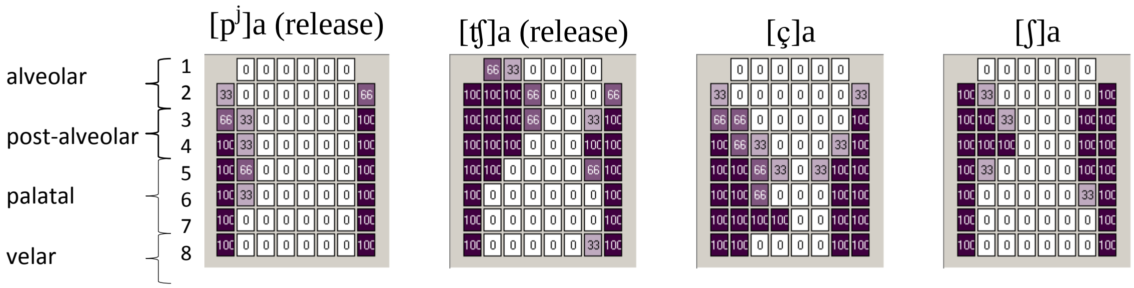


Figure 5. Mean linguopalatal contact profiles for selected palatalized consonants (before [a]) produced by a female Japanese speaker (measured at the point of maximum contact; averaged over 3 tokens; black (100%) = contact in all tokens, white (0%) = no contact at all).

The class of palatalized rhotics, as opposed to other palatalized coronals and non-coronals, seems to be defined solely in articulatory terms: rhotics, which usually involve an apical (the tongue tip up) articulatory gesture are poorly compatible with the laminal (the tongue tip down) gesture of palatalization (Ladefoged & Maddieson 1996; Hamann 2003). In languages where these sounds are phonemic, their production involves additional adjustments, different from other palatal(ized) coronals, such as a shift of the primary constriction from (post-)alveolar to dental and/or a greater lag between the two gestures, as for example in Russian (Kochetov 2005). The same is evident in our data for Japanese rhotic flaps: Figure 6 shows that the primary constriction for plain [r] is in the post-alveolar/palatal region, while the constriction for its palatalized counterpart is considerably more front, alveolar. Note that the fronting of the primary constriction for [rʲ] is the opposite of what we observe with non-rhotic coronals, whose constriction is always backed to the post-alveolar/palatal region.

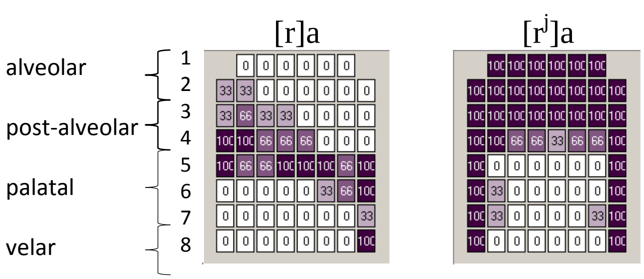


Figure 6. Mean linguopalatal contact profiles for [r] and [rʲ] (before [a]) produced by the same Japanese speaker.

The articulatory incompatibility of rhotics with palatalization is a general property of palatalization, not specific to E-Pal. What makes this asymmetry (and the other asymmetries discussed above) more robust in E-Pal is that it appears to be reinforced by speakers' internalized observations of small children's speech patterns.

5.1.3 Limitations of child speech

Speech produced by small children is often noted to have an overall 'palatal quality', which arises due the small size and the morphology of their vocal tract, where the tongue is relatively large in relation to the oral cavity and having little room for vertical movement (Vihman 1996: 104). This effect is also due to not fully mastered tongue motor control, resulting in excessive vowel-to-consonant coarticulation – particularly raising and fronting of vowels next to coronal consonants (Zharkova 2004). In languages where the palatal(ized) consonants are contrastive, palatalized coronals are noted to be acquired relatively early, prior to some non-palatal(ized) consonants and prior to palatalized non-coronals and /r^j/ (see Zharkova on Russian; Yasuda 1970, Tsurutani 2004 on Japanese). Tsurutani (2004), who investigated the acquisition of palatal(ized) consonants by Japanese children of the age of 2:3 to 3:9 (years : months), found that errors involving palatal affricates /ʧ ʤ/ were the least common (less than 10%), followed by errors with palatalized non-coronal stops /k^j g^j/ (between 30 and 40%), palatalized fricative /ʃ/ (approximately 40%), and – at a considerable distance – with the palatalized rhotic (approximately 80% errors). Interestingly, palatalized affricates and [j] were the most frequent outputs of errors with palatalized non-coronals (k^j → ʧ, g^j → j), palatalized fricatives (ʃ → ʧ), and /r^j/ (→ j). This suggests that affricates and /j/ are the first palatal(ized) consonants acquired by Japanese children. In addition, alveolar fricatives /s/ and /z/ were often substituted by affricates [ʧ] and [ʤ], or fricative [ʃ] (for /s/), indicative of a relatively late acquisition of alveolar fricatives (cf. Beckman et al. 2003; Li et al. 2009). The latter can be attributed to the considerable articulatory precision required in the production of these consonants. Notably, even for the Japanese children who have acquired the /s/ vs. /ʃ/ contrast, its realization is often highly variable and not sufficiently differentiated acoustically, and therefore still resulting in the common adults' perception of children's /s/ and /ʃ/ as [ʃ] (Tsurutani 2004; cf. Li et al. 2009; see also Zharkova 2004 on the Russian plain/palatalized contrast). Finally, the acquisition data show that Japanese palatalized /r^j/ is the latest-acquired palatalized consonant, together with its plain counterpart (cf. Vihman 1996: 219, 239, among others on the late acquisition of English /r/).

In sum, studies of acquisition of palatalized consonants show that certain palatalized sounds are easier or harder to acquire, and (at least for Japanese) this scale of acquisition difficulty in many respects overlaps with the scales based on acoustic and articulatory factors. Adult's knowledge of the acquisition scale would therefore further reinforce certain feature asymmetries – specifically those involving the distinctions between coronals and non-coronals, non-rhotics and rhotics, and non-continuant sibilants and their continuant counterparts. The resulting scale is shown in (11), closely corresponding to the asymmetries observed in patterns of E-Pal (6). Specifically, the scale shows that coronals are more likely targets and outputs of the process than non-coronals (a); among coronals, obstruents are more likely targets and outputs than sonorants (b), sibilants are more likely targets and outputs than coronal obstruents (c), affricates are more likely outputs than affricates (d), and non-rhotics are more likely targets of the process compared to rhotics (e).

(11) The place and manner scales of E-Pal

a. coronals > non-coronals (targets and outputs)
|
b. obstruents > sonorants (targets and outputs)
|
c. sibilants > non-sibilants (targets and outputs)
|
d. affricates > fricatives (outputs)

e. non-rhotics > rhotics (targets)

How does this scale interact with the core phonology of a language, resulting in commonly observed patterns of E-Pal? In the next section we explore some directions towards a formal account of E-Pal focusing on Japanese babytalk and mimetic palatalization.

5.2 A preliminary account of expressive palatalization

5.2.1 Generalizations and assumptions

Based on the results of Experiment 2 and consistent with previous literature, Japanese babytalk is characterized by a set of structural properties that are summarized in (12).

(12) Properties of Japanese babytalk

a. Systematicity: applies to all words of the lexicon, including loanwords;
b. Target selection: coronal sibilants;
c. Output change: targets changed to palato-alveolar affricates (/s/ to [ʧ] via [ʃ]);
d. Context-free application: neighboring segments don't seem to condition the change;
e. Faithfulness to manner and voicing: manner and voicing are unchanged;
f. Non-structure preserving application: may produce palatalized consonants that are generally not permitted in the language e.g., before /e/ in [ʧeːtaː]
g. Exhaustivity: may apply to more than one sibilant; often all eligible targets changed
h. Surface orientation: systematically changes surface segments, not lexical segments; lexical /t/ changes to [ʦ], which subsequently changes to [ʧ], but surface [t] remains unaffected.

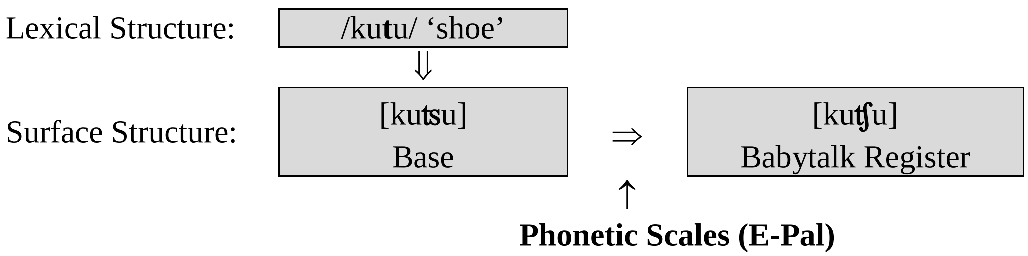
These properties are shared by many other cases of expressive palatalization, including babytalk registers, diminutive constructions and sound symbolism (see section 2). At the same time, there are some differences between Japanese babytalk and certain cases of E-Pal, including Japanese mimetic palatalization. For example, unlike Japanese babytalk, some cases of E-Pal limit the scope of palatalization to certain lexical strata (e.g. sound symbolism) or constructions (diminutives) and may not apply in a context-free fashion, for example targeting stem-initial or root-final consonants. They can also differ in target selection, affecting a wider range of consonants, given the E-Pal target eligibility hierarchy (see above). Further, they can differ in faithfulness to manner and continuancy features, for example, allowing changes of sonorants to obstruents or stops to affricates, or disallowing changes of fricatives to affricates.

We propose that the scope of E-Pal can be relativized if we define constraint triggering the process using correspondent segments. In this way, entire mappings (as in babytalk) can be achieved with Output-Output correspondence; specific strata (as sound symbolism) can be handled with level-specific correspondence (see Itô & Mester 1999 on lexical stratification), and constructions can be accounted for with subclasses of OO-correspondence (see Benua 2000 for affix classes).

What are the possibilities for capturing all these properties, and differences among different kinds of E-Pal? One possible approach is probabilistic linguistics (Pierrehumbert 2003). It is known that speakers have fine-grained intuitions about gradient phonotactic patterns. Perhaps some E-Pal patterns could be the result of such intuitions. For example, as noted in section 3.1, over 90% of Japanese mimetic items involve palatalization of coronals, predominantly coronal obstruents. Recall that very similar gradient differences have been reported for specialized babytalk vocabularies in Southern Estonian and Latvian, and Basque and Quechua sound symbolism, among other cases (see section 2). The preference for palatalization of coronals over non-coronals, and obstruents over sonorants could be predicted by the fact that these are the dominant patterns in the language.

Another possible approach is the one that have been previously used in analyses of ludlings and language games. This approach is attractive because of its systematicity, surface orientation, and lack of context sensitivity. It seems particularly appropriate for the more categorical patterns of E-Pal. This way, the systematic palatalizing changes can be treated as the result of phonological changes caused by well-formedness constraints' that are in effect in the mapping from normal surface words to babytalk surface words, as has been done in Itô et al.'s (1996) analysis of a Japanese reversing argot. We can adopt this general analysis assuming that the mapping from surface words to babytalk words is mediated by the scales of E-Pal. This approach to E-Pal is summarized in (13), with mappings shown between lexical and surface representations (Input-Output relations in the regular grammar), and between base and babytalk register representations (Output-Output relations specific to babytalk).

(13) An expressive register correspondence model (with an example from Japanese babytalk)



We think that both approaches are fruitful ways of approaching E-Pal, but we will focus here on formalizing the Output-Output correspondence approach because if its systematicity and surface orientation of Japanese babytalk.

5.2.2 A language game based analysis of babytalk

One important property of a language game based analysis is the integration of the process with faithfulness. In Japanese babytalk, the palatalization process involves some systematic substitutions, but faithfulness to manner and voicing preempts certain other substitutions. As we know, however, languages differ in how much faithfulness restricts the targeted segment. This suggests that manner and voicing faithfulness interacts with some constraints to restrict the set of targets of E-Pal.

Another question is what triggers the substitution in E-Pal. The trigger must be fully general in the sense that it can have different domains of application: constructions, lexical strata, whole mapping domains (babytalk). Output-Output correspondence is a plausible way of accounting for the different domains, as different correspondence relations can characterize different constructions (Benua 2000, Alderete 2001), different lexical strata (Itô & Mester 1999), and entire mapping domains, like Itô et al.'s (1996) base-argot faithfulness. Furthermore, the restrictions on mappings made possible by a constraint on correspondence segments makes it possible to account for nonstructure-perserving mappings. The limited scope made possible by such a constraint makes it possible to rank it above the markedness constraints responsible for phonotactic restrictions, predicting phonotactically illicit structures in the babytalk register only. Finally, the triggering mechanism must be a set of different constraints, to allow for collapsing of a set of conditions in target selection, as in Japanese babytalk.

We propose to formalize the triggering constraints as constraints that require the palatal feature structure implied by the scales as an output change, and capture the hierarchical structure of the phonetic scales with stringent constraint relations (Prince 1997), or special-general relationships among our constraints. The EPAL ICONICITY constraints in (14) establish an iconic relationship between phonological structure and the meanings of smallness, childishness, or affection (a). The constraints below have special-general relationships in that each refers to a subset of the feature structure referred to by the next, capturing the hierarchical structure of the E-Pal scale in (11).

(14) EPAL ICONICITY Constraints, EPALICON (natural class) for short

a. Constraint template

- For mappings from $String_1$ to $String_2$, i.e., $String_1 \mathit{R}_{small} String_2$ in which an iconic relationship between phonological structure and denotations of smallness/childishness is established, and for segments a $\in$ $String_1$ and segments b $\in$ $String_2$, if aR_{small}b, then b $\in$ [specified natural class]

b. Constraint set, in stringency relation (no fixed ordering)

- EPALICON(AFFRIC): If aR_{small}b, then b $\in$ [CPlace/cor, -ant, -son, +strid, -cont]
- EPALICON(SIB): If aR_{small}b, then b $\in$ [CPlace/cor, -ant, -son, +strid]
- EPALICON(PAL): If aR_{small}b, then b $\in$ [CPlace/cor, -ant, -son] (i.e., primary palatal coronal or secondary palatalization)
- EPALICON(COR): If aR_{small}b, then b $\in$ [CPlace/cor]

The scope of the correspondence constraint can be relativized to the mapping domain required by the analysis. The E-Pal eligibility hierarchy is built into the stringency relationship explicit in the specification of natural classes. Interspersing these constraints with a standard set of faithfulness constraints will account for both target selection and output change, and at the same time will allow for nonstructure-preserving mappings. Given this analysis, E-Pal is crucially different from P-Pal, because the former is defined on correspondence relations rather than markedness.

Let us now turn to the specifics of the analysis of Japanese babytalk. The tableau in (15) gives a simplified illustration of how the analysis works. The input is a nonce syllable [ʦu], which itself is an output of a regular phonology, being derived from the string /tu/ (through an interaction of markedness and IO-faithfulness constraints). Note that EPALICON constraints are interspersed with Output-Output (OO) faithfulness constraints specific to the babytalk register. Among the latter, IDENT-OO constraints on the features (major) [Place], [±sonorant], [±voice], and [±strident] are ranked higher, while IDENT-OO constraints on [±continuous] and [±anterior] are ranked lower than some of the EPALICON constraints. For ease of exposition, we only count violations of EPALICON constraints in consonants, because the focus here is on consonant phonology. Correspondent vowels that lack palatal feature structure in the output also violate EPALICON, but we assume, like with other consonant classes, high-ranking faithfulness precludes palatalization. Candidate (a) that is identical to the input, violates all EPALICON constraints and therefore fails. Candidate (b) involves palatalization of [ʦ] to [ʧ] thus satisfying all EPALICON constraints and violating only the lower ranked constraint IDENT-OO[ANTERIOR]. Candidate (c) shows palatalization, but to a fricative, not an affricate, and therefore violating the highly ranked EPALICON(AFFRICATE) constraint. It also violates a lower ranked constraint IDENT-OO[CONTINUOUS]. The other three candidates (d, e, f) fail because they violate highly ranked OO-faithfulness constraints, as they involve changes in voicing, primary place, and stridency.

(15) Japanese babytalk: A sample evaluation

SR [t͡su] (from UR /tu/)	**ID-OO [PLACE] [SON] [STRID] [VOI]**	**EPALICON (AFFRIC)**	**EPALICON (SIB)**	**ID-OO [CONT]**	**ID-OO [ANT]**	**EPALICON (COR)**	**EPALICON (PAL)**
a. **t͡s**u		*!	*			*	*
b. > **t͡ʃ**u					*		
c. **ʃ**u		*!		*	*		
d. **d͡ʒ**u	*! (voi)				*		
e. **kʲ**u	*! (Place)	*	*		*	*	
f. **t**u	*! (strid)	*	*			*	*

Now we can examine how this ranking would work with an actual babytalk example – the utterance [onaka suita] 'hungry(?)' in the tableau in (16). It contains four consonants: a non-coronal, a coronal nasal, a coronal stop, and a coronal sibilant fricative. As we would expect, the winning candidate is (b), [onaka t͡ʃuita] – one that palatalizes only the sibilant having an affricate as an output, with the other coronals and non-coronals being unaffected. All the other candidates fail because they either do not involve palatalization (a), or produce palatalized consonants that are lower on the scale of E-Pal (i.e. less acoustically salient) (c, f), or violate higher ranked OO-faithfulness constraints (d, e). Recall that the output [ʃuita] instead of [t͡ʃuita] was also possible at least for some speakers in Experiment 2 (seemingly denoting a smaller degree of childishness; see section 4.2.2). This optionality is produced by an optional ranking of Ident-OO[continuous] with respect to EPALICON(AFFRIC) and EPALICON(SIB) constraints.

(16) Japanese babytalk: Sibilant fricatives changed to affricates, while non-sibilant coronals and non-coronals remain unaffected

[onaka suita]	**ID-OO [PLACE] [SON] [STRID] [VOI]**	**EPALICON (AFFRIC)**	**EPALICON (SIB)**	**ID-OO [CONT]**	**ID-OO [ANT]**	**EPALICON (COR)**	**EPALICON (PAL)**
a. o**n**a**k**a **s**ui**t**a		****!	****			****	****

[onaka suita]	ID-OO [PLACE] [SON] [STRID] [VOI]	EPALICON (AFFRIC)	EPALICON (SIB)	ID-OO [CONT]	ID-OO [ANT]	EPALICON (COR)	EPALICON (PAL)
b. > o**n**a**k**a ʧui**t**a		***	***	*	*	***	***
c. oɲa**k**a ʧui**t**a		***	***	*	**!	**	**
d. oɲa**k**ʲa ʧuiʧa	*!	**	**	*	****	*	
e. oʧaʧa ʧuiʧa	***!			*	****		
f. o**n**a**k**a ʃui**t**a		****!	***		*	***	***

In sum, this ranking of EPAL ICONICITY and Output-Output faithfulness constraints restricts palatalization to surface sibilant consonants [s z ʦ ʃ], the exact set of targets of Japanese babytalk, as observed in our Experiment 2. This ranking also makes it possible for palatalization to apply exhaustively (e.g. [zoːsaN] → [ʤoːʧaN]) and in a nonstructure-preserving way (e.g. [seːtaː] → [ʧeːtaː]).

Note that the analysis makes certain predictions about other possible patterns of E-Pal. For example, a lower ranking of IDENT-OO[STRIDENT] would produce palatalization of coronal stops (as, for example, in Island Lake Ojibwa), and a lower ranking of IDENT-OO[PLACE] would result in a shift of non-coronals to palatal coronals (as in Western Basque). A still lower ranking of IDENT-OO[ANTERIOR] would make possible consonants with secondary articulation as outputs (as, for example, in Southern Estonian). Pursuing some of these options would also account for some of the patterns of Japanese mimetic palatalization, as outlined below.

5.2.3 An extension of the analysis to mimetics

Recall that mimetic palatalization is different from babytalk palatalization in that it is restricted to the sound-symbolic stratum (non-systematic) and is limited to a single consonant per root (non-exhaustive). It targets a wider range of consonants – not only sibilants, but also coronal stops and nasals, as well as non-coronals (and optionally rhotics; see section 3.1). Unlike babytalk, mimetic palatalization is structure preserving. Following Mester & Itô (1989), the palatalized mimetics can be assumed to be the output of a morphological process, being derived from corresponding plain mimetic forms (e.g. [tapo-tapo] → [ʧapo-ʧapo]; but see section 3.1). Given this, mimetic palatalization can be, in principle, handled by the same type of OO-faithfulness and EPAL ICONICITY constraints, together with some constraints specific to the mimetic stratum, such as *2PAL, limiting the number of palatalized segments to a single consonant. (Note that this restriction is not unique to Japanese, as some cases of E-Pal similarly restrict the process to a single consonant; see section 2). An alternative to the use of OO-faithfulness would be to employ stratum-specific faithfulness constraints (Itô & Mester 1999). Here, however, we will explore the first option, making the analysis of mimetic palatalization more comparable to that of babytalk.

The ranking of correspondence constraints vis a vis EPALICON constraints also needs to be somewhat different. Specifically, ranking of IDENT-OO[STRIDENT] and IDENT-OO[ANTERIOR] below EPAL ICON(PAL) would ensure that palatalization of coronal stops, nasals, and non-coronals is possible. The analysis is illustrated in tableaux in (17), (18), and (19) – showing preferred patterns of palatalization in nonce roots with a coronal and a non-coronal, with two coronals, and with two non-coronals respectively. Starting with the analysis of the least controversial pattern (see section 3.1) in (17), the dominance of coronals palatalization falls out from the hierarchy of EPAL ICON constraints requiring a palatal as an output, with OO-Faithfulness constraints permitting only minimal changes (in anteriority and stridency).

(17) Japanese mimetics: Coronals are palatalized in coronal-noncoronal roots

[tapo]	***2PAL**	**ID-OO [PLACE] [SON] [CONT]**	**EPALICON (AFFRIC)**	**EPALICON (SIB)**	**EPALICON (COR)**	**EPALICON (PAL)**	**ID-OO [STRID]**	**ID-OO [ANT]**
a. tapo			**!	**	**	**		
b. > tʃapo			*	*	*	*	*	*
c. tapʲo			**!	**	**	*		*
d. tatʃo		*!	*	*	*	*	*	*
e. ʃapo		*!	**	*	*	*	*	*
f. tʃapʲo	*!		*	*	*		*	**

The tableau illustrating palatalization in coronal-coronal roots in (18) is of particular interest. Note that rightmost palatalization of [s] in (b) ([taso]→ [ta ʃo]) is simply a side-effect of preference for palatalization of sibilants over non-sibilant coronals. An input with the reverse order of the same consonants, [sato] would produce the output with leftmost palatalization, [ʃato], rather than [satʃo]. This is in contrast with all previous phonological analyses of mimetic palatalization (rightmost palatalization of coronals: Mester & Itô 1989; Zoll 1997; Kurisu 2009, among others), but consistent with the results of Experiment 1. Recall that our Japanese participants clearly favoured items with palatalized sibilants over non-sibilants (i.e. [taso] → [taʃo], rather than [ʧaso]; [sato] → [ʃato], rather than [satʃo]; see Figure 2).

(18) Japanese mimetics: Sibilants are palatalized in coronal-coronal stop-fricative roots

[taso]	*2PAL	ID-OO [PLACE] [SON] [CONT]	EPALICON (AFFRIC)	EPALICON (SIB)	EPALICON (COR)	EPALICON (PAL)	ID-OO [STRID]	ID-OO [ANT]
a. taso			**	**!	**	**		
b. >taʃo			**	*	*	*		*
c. tatʃo		*!	*	*	*	*		*
d. ʧaso		*!	*	*	*	*	*	*
e. ʧaʃo	*!		*				*	**

With respect to roots with two non-coronals (19), the analysis predicts that either of them can be palatalized (b, c). Again, this is in contrast with previous literature (the leftmost palatalization of non-coronals generalization), but consistent with our results, as the subjects in our Experiment 1 showed no clear preference for leftmost or rightmost palatalization in items intuitions about (i.e. [gabo] → [g^{j}abo] or [gab^{j}o]; see Figure 1).

(19) Japanese mimetics: Non-coronals are palatalized in noncoronal-noncoronal roots

[gabo]	*2PAL	ID-OO [PLACE] [SON] [CONT]	EPALICON (AFFRIC)	EPALICON (SIB)	EPALICON (COR)	EPALICON (PAL)	ID-OO [STRID]	ID-OO [ANT]
a. gabo			**	**	**	**!		
b. > g^{j}abo			**	**	**	*		*
c. > gab^{j}o			**	**	**	*		*
d. ʤabo		*!	*	*	*	*	*	*
e. g^{j}ab^{j}o	*!		**	**	**			**

Thus, the ranking of EPALICON constraints against a set of Ident-OO imposes the restrictions on targets and outputs of the process, characteristic of the patterns of mimetic palatalization: stops are targeted only when there are no sibilant coronals in the same root, sonorants are targeted when there are no obstruents in the root, and non-coronals are targeted when there are no coronals in the root.

The final pattern of mimetic palatalization, avoidance of palatalization of /r/, can be captured by an additional constraint EPALICON(PALNONRHOT), which would favour non-rhotics as outputs of palatalization. This constraints is also based on the E-Pal scale in (11). A high ranking of EPALICON(PALNONRHOT), for example, given an input [paro] would output [p^jaro], and not [par^jo]. Note that under this account, a change of the rhotic to palatal glide – [pajo] (see section 3.1) – is also possible under (assuming a lower ranking of IDENT-OO[CONSONANTAL]).

5.2.4 Summary and discussion

In sum, the Output-Output correspondence approach originally proposed to account for ludlings and language games can be successfully extended to both Japanese babytalk and mimetic palatalization. When interfaced with the scale of E-Pal in (11), the analysis captures some key properties of these processes, most importantly the complex hierarchy of preferred targets and outputs. The analysis also makes some interesting predictions about possible and impossible patterns of E-Pal. How well this analysis would generalize to other the cases of E-Pal in our typology, and perhaps to other cases of phonological iconicity (e.g. the use of voicing in mimetics: Kawahara, Shinohara, & Ushimoto 2008) is an interesting question opening an avenue for future research.

Another question raised by the analysis pertains to the origin of the set of EPALICON constraints: Where do these constraints come from, how do they become part of speakers' phonological knowledge (albeit somewhat peripheral)? One obvious possibility is that the constraints could be given *a priori*, as assumed by many theories of Universal Grammar. This is also consistent with Ohala's (1994) view of 'frequency code' as an innate predisposition. Alternatively, one may speculate that these constraints can be learned through induction, perhaps building on speakers' knowledge of relative acoustic salience (cf. Hayes & Steriade 2004) and their awareness of acquisition patterns involving palatal(ized) consonants. The second possibility seems plausible and perhaps more compatible with the range of language-particular variation found in patterns of E-Pal. It also explains a close match between the patterns of Japanese babytalk and the patterns of acquisition of consonants by Japanese children (see section 5.1.3).

Finally, it is important to mention again that the Output-Output correspondence is more appropriate for productive, systematic E-Pal processes like Japanese babytalk. The approach is much less suitable to account for more gradient preferences that are also common in our typology of E-Pal, as well as evidenced by our experimental results. A probabilistic phonological approach, such as stochastic OT is clearly preferred here, and can capture the gradient trends observed in the data. For example, the fact that sibilant fricatives are more likely, but not absolute, targets of Japanese mimetic palatalization compared to coronal stops and nasals (as e.g. in (18)) can follow from a probabilistic ranking of OO[CONT] above EPALICON(AFFRIC), which can be reversed under low-probability scenarios. The difference between categorical and gradient effects would therefore depend on whether or not the tails of the probabilistic rankings overlap. In conclusion, it remains to be seen whether both approaches can be integrated providing a more comprehensive account of both categorical and gradient patterns of E-Pal.

6. Conclusion

The main goal of this paper was to make a distinction between *expressive palatalization (E-Pal)* that applies in babytalk registers, diminutive constructions, and sound symbolism on one hand, and *phonological palatalization (P-Pal)* on the other. Our survey of cross-linguistic cases of E-Pal revealed a set of properties that differentiate it from P-Pal in some very important respects. Among these properties is the absolute implicational relation between coronals and non-coronals as targets and outputs of palatalization, the greater avoidance of palatalized rhotics, and the manner asymmetries – sonorant/obstruent and stop/fricative asymmetries in targets and the fricative/affricate asymmetry in sibilants. Our examination of lexical patterns and an experimental investigation of speakers' intuitions about Japanese mimetic and babytalk palatalization – revealed that the two processes are fully representative of the typology of E-Pal. Moreover, both the experimental results and the typology of E-Pal point to the same scales of more or less preferred targets and outputs of the process. The main source of this scale, we argued, is in iconic associations between acoustic characteristics of palatalized consonants (and especially coronals), and the meanings of smallness, childishness, or affection (Ohala 1994). Given the distinct properties of E-Pal and their specific sources different from the sources of P-Pal, we argued that the two phenomena require different formal analyses. As a step in this direction, we outlined a preliminary analysis of Japanese babytalk and mimetic palatalization using an Output-Output correspondence approach. This account, as we showed, successfully captures some of the key properties of these two processes, having implications for formal analyses of E-Pal patterns in general. Another important consequence of the distinct formal treatment of E-Pal is a stronger and more predictive theory of P-Pal, and phonetically-motivated phonological processes in general.

While we believe that the distinction between E-Pal and P-Pal is largely clear-cut (see the discussion in section 2.2), there seem to be some cases of apparent overlap that deserve further investigation. Among such cases are long-distance palatalization in Ethio-Semitic languages (Rose 1997, 2004) and 'morphological' (word-level prosody) palatalization in Chadic languages (Hoskison 1975; Schuh 2002; Tsang 2007). Both processes appear to show some manner-specific preferences in targets of palatalization, and both are restricted to certain morphological constructions or lexical classes – thus somewhat reminiscent of palatalization in diminutive constructions and sound symbolic vocabulary. Interestingly, manner specific preferences are also exhibited consonant harmony processes, with sibilant harmony being by far the most common type of consonant harmony (Hansson 2001; Rose & Walker 2004). It seems possible that these highly morphologized or lexicalized palatalization and harmony processes also exploit acoustic salience scales, similar to the scale of E-Pal, yet used for different functional purposes. This predicts that some similarities between patterns of E-Pal and phonological processes that are psycho-acoustically motivated. Our better understanding of phonological patterns is therefore tightly tied to our understanding of the nature of phonetic scales and their interactions with phonological grammar.

References

Akinlabi, Akinbiyi. 1996. Featural affixation. *Journal of Linguistics* 32:239–289.

Alderete John. 2001. *Morphologically governed accent in Optimality Theory*. New York: Routledge.

Alderete John, and Alexei Kochetov. 2009. Japanese mimetic palatalization revisited: implications for conflicting directionality. *Phonology* 26:369–388.

Archangeli, Diana, and Douglas Pulleyblank. 1994. *Grounded phonology*. Cambridge, MA: MIT Press.

Bagemihl, Bruce. 1996. Language games and related areas. In *The handbook of phonological theory*, ed. John A. Goldsmith, 697–712. Cambridge: Blackwell Publishers.

Bateman, Nicoleta. 2007. A crosslinguistic investigation of palatalization. Doctoral dissertation, University of California, San Diego.

Benua, Laura. 2000. *Phonological relations between words*. New York: Routledge.

Berko, Jean. 1958. The child's learning of English morphology. *Word* 14:150–177.

Bhat, D. N. S. 1978. A general study of palatalization. In *Universals of human language*, Vol. 2: Phonology, ed. J. H. Greenberg, 47–92. Stanford: Stanford University Press.

Bhat, Shankara D. N. 1967. Lexical suppletion in baby talk. *Anthropological Linguistics* 9:33–36.

Berent, Iris, and Joseph Shimron. 1997. The representation of Hebrew words: Evidence from the obligatory contour principle. *Cognition* 64: 39–72.

Bogoras,Waldemar. 1922. Chukchee. In *Handbook of American Indian languages* (BAE-B 40:2), 631–903. Washington: Smithsonian Institution.

Bright, William. 1957. *The Karok language*. (UCPL, 13.) Berkeley & Los Angeles: University of California Press.

Broadbent, Sylvia. 1964. *The Southern Sierra Miwok language*. (UCPL, 38.) Berkeley & Los Angeles: University of California Press.

Calabrese, Andrea. 1995. A constraint-based theory of phonological markedness and simplification procedures. *Linguistic Inquiry* 26:373–463

Cerron-Palomino, Rodolfo Marcial. 1977. Huanca-Quechua Dialectology. Doctoral dissertation, University of Illinois at Urbana-Champaign.

Chen, Matthew. 1973. Predictive power in phonological description. *Lingua* 32:173–191.

Chen, Su-I. 1996. A theory of palatalization and segment implementation. Doctoral dissertation, State University of New York, Stony Brook.

Chew, John J., Jr. 1969. The structure of Japanese baby talk. *Journal-Newsletter of the Association of Teachers of Japanese* 6:4–17.

Chomsky, Noam, and Morris Halle. 1968. *The sound pattern of English*. Cambridge, MA: MIT Press.

Coetzee, Andries W. 2009. Grammar is both categorical and gradient. In *Phonological Argumentation*, ed. Steven Parker, 9–42. London: Equinox Publishers.

Fant, Gunnar. 1970. *Acoustic theory of speech production: With calculation based on X-ray studies of Russian articulations*, 2nd printing. The Hague: Mouton.

Ferguson, Charles A. 1964. Baby talk in six languages. *American Anthropologist, New Series*, 66:103–114.

Ferguson, Charles A. 1977. Baby talk as a simplified register. In *Talking to children: Language input and acquisition*, ed. Catharine E. Snow and Charles A. Ferguson, 209–235. Cambridge: Cambridge University Press.

Flemming, Edward S. 2002. *Auditory representations in phonology*. New York: Routledge. [1995. Los Angeles, CA: University of California doctoral dissertation.]

Guion, Susan Guignard. 1996. Velar palatalization: Coarticulation, perception, and sound change. Doctoral dissertation, University of Texas, Austin.

Hall, T. A. 2000. Typological generalizations concerning secondary palatalization. *Lingua* 110:1–25.

Hamano, Shoko. 1998. *The sound-symbolic system of Japanese*. Stanford, CA: CSLI Publications. [1986 PhD dissertation, University of Florida, Gainesville.)]

Hamann, Silke. 2003. *The phonetics and phonology of retroflexes*. Utrecht: LOT.

Hansson, Gunnar Ólafur. 2001. Theoretical and typological issues in consonant harmony. Doctoral dissertation, University of California, Berkeley.

Hayes, Bruce and Donca Steriade. 2004. Introduction: The phonetic bases of phonological markedness. In *Phonetically-based phonology,* ed. Bruce Hayes, Robert Kirchner, and Donca Steriade, 1–32. Cambridge: Cambridge University Press.

Hoskison, James. 1975. Notes on the phonology of Gude. Master's thesis, Ohio State University.

Hualde, José Ignacio. 1991. *Basque phonology*. London: Routledge.

Hualde, José Ignacio, and Jon Ortiz de Urbina. 2003. *A grammar of Basque*. Mouton de Gruyter.

Hume, Elizabeth. 1992. Front vowels, coronal consonants and their interaction in nonlinear phonology. Doctoral dissertation, Cornell University [Published in 1994 by Garland].

Ibarretxe-Antuñano, Iraide. 2006. *Sound symbolism and motion in Basque*. Munich: Lincom Europa.

Imai, Mutsumi, Sotaro Kita, Miho Nagumo, and Hiroyuki Okada. 2008. Sound symbolism facilitates early verb learning. *Cognition* 109:54–65.

Itô, Junko, and Mester, Armin. 1999. The structure of the phonological lexicon. In *The handbook of Japanese linguistics*, ed. Natsuko Tsujimura, 62-100. Malden, MA: Blackwell Publishers.

Ito, Junko, and Armin Mester. 2003. *Japanese morphophonemics: Markedness and word structure*. (Linguistic Inquiry Monograph 41.) Cambridge, MA: MIT Press.

Itô, Junko, Yoshihisa Kitagawa, and Armin Mester. 1996. Prosodic faithfulness and correspondence: Evidence from a Japanese argot. *Journal of East Asian Linguistics* 5:217–294.

Jones, Linda M. 1988. Cree baby talk and universal baby talk. Doctoral dissertation, McMaster University.

Joseph, Brian D. 1994. Modern Greek *ts*: beyond sound symbolism In *Sound symbolism*, ed. Leanne Hinton, Joanna Nichols, and John Ohala, 222–236. Cambridge: Cambridge University Press.

Kakehi, Hisao, Ikuhiro Tamori, and Lawrence Schourup, eds. 1996. *Dictionary of iconic expressions in Japanese*. Berlin: Mouton de Gruyter.

Kawahara, Shigeto, Kazuko Shinohara, and Yumi Uchimoto. 2008. A positional effect in sound symbolism: An experimental study. In *Proceedings of the 8th meeting of Japan Cognitive Linguistics Association*.

Kenstowicz, Michael, and Charles Kisseberth. 1977. *Topics in phonological theory*. New York: Academic Press.

Kert, G. M. 1971. *Saamskii iazyk (Kildinskii dialekt): Fonetika, morfologiia, sintaksis*. Moscow: Nauka.

Kim, Yuni. 2008 Topics in the phonology and morphology of San Francisco del Mar Huave. Doctoral dissertation, University of California, Berkeley.

Klatt, Dennis H. 1968. Structure of confusions in short-term memory between English consonants. *Journal of Acoustical Society of America* 44:401–407.

Kochetov, Alexei. 2002. *Production, perception, and emergent phonotactic patterns.* New York: Routledge.

Kochetov, Alexei. 2004. Perception of place and secondary articulation contrasts in different syllable positions: Language-particular and language-independent asymmetries. *Language and Speech* 47:351–382.

Kochetov, Alexei. 2005. Phonetic sources of phonological asymmetries: Russian laterals and rhotics. In *Proceedings of the 2005 Canadian Linguistics Association Annual Conference*, ed. Claire Gurski, 12 pp.

Kochetov, Alexei. (in press). Palatalisation. In: C. Ewen, B. Hume, M. van Oostendorp, & K. Rice (eds.) *Companion to Phonology*. Wiley Blackwell.

Kurisu, Kazutaka. 2009. Palatalisability via feature compatibility *Phonology* 26:437–475

Ladefoged, Peter, and Ian Maddieson. 1996. *The sounds of the world's languages*, Cambridge, MA: Blackwell.

Laughren, Mary. 1984. Warlpiri baby talk. *Australian Journal of Linguistics* 4:73–88.

Li, Fangfang, Jan Edwards, and Mary E. Beckman. 2009. Contrast and covert contrast: The phonetic development of voiceless sibilant fricatives in English and Japanese toddlers. *Journal of Phonetics* 37:111–124.

Masuda, Keiko. 2007. The physical basis for phonological iconicity. In *Insistent images*, ed. Elżbieta Tabakowska, Christina Ljundberg, and Olga Fischer, 57–71. Amsterdam/Philadelphia: John Benjamins.

McCawley, James D. 1968. *The phonological component of a grammar of Japanese*. The Hague: Mouton.

Melnychuk, Teresa D. 2003. Diminutive consonant harmony in several dialects of Cree. Master's thesis, University of Manitoba.
Mester, Armin, and Junko Itô. 1989. Feature predictability and underspecification: Palatal prosody in Japanese mimetics. *Language* 65:258–293.
Nagao, Kyoko, and McCall, Betsy. 1999. A perception-based account of mimetic palatalization in Japanese. A poster presented at the International Congress of Phonetic Sciences satellite meeting, The Role of Perception in Phonology, July 30, 1999. University of Indiana, Bloomington, ms.
Neisser, Friedrich. 1953. *Studien zur georgischen Wortbildung*. (Deutsche morgenlandische Gesellschaft, Abhandlungen, 31:2.) Wiesbaden: Steiner.
Nichols, Johanna. 1971. Diminutive consonant symbolism in Western North America. *Language* 47:826–848.
Ohala, John. 1984. An ethological perspective on common cross-language utilization of F0 in voice. *Phonetica* 41:1–16.
Ohala, John.1994. The frequency code underlies the sound-symbolic use of voice pitch. In *Sound symbolism*, ed. Leanne Hinton, Joanna Nichols, and John Ohala, 325–347. Cambridge: Cambridge University Press.
Padgett, Jaye. 2003. Contrast and post-velar fronting in Russian. *Natural Language & Linguistic Theory* 21:39–87.
Pajusalu, Karl. 2001. Baby talk as a sophisticated register: A phonological analysis of South Estonian. *Psychology of Language and Communication* 5:81–92.
Pareskevas-Shepard, Cornelia. 1985. One-way talking: My Greek motherese. *Kansas Working Papers in Linguistics* 10:24–32.
Pierrehumbert, Janet. 2003. Probabilistic phonology: Discrimination and robustness. In *Probabilistic linguistics*, ed. Bod Rens, Jennifer Hay, and Stefanie Jannedy, 177–228. Cambridge, MA: MIT Press.
Prince, Alan. 1997. Paninian relations. Lecture given at LSA Summer Institute, Cornell University.
Redford, M. A., and R. Diehl. 1999. The relative perceptual distinctiveness of initial and final consonants in CVC syllables. *Journal of Acoustic Society of America* 106:1555–1565.
Reuse, Willem J. de. 1986. The lexicalization of sound symbolism in Santiago del Estero Quechua. *International Journal of American Linguistics* 52:54–64.
Rose, Sharon. 1997. Theoretical issues in comparative Ethio-Semitic phonology and morphology. Doctoral dissertation, McGill University.
Rose, Sharon. 2004. Long distance vowel-consonant agreement in Harari. *Journal of African Languages and Linguistics* 25:41–87.
Rose, Sharon, and Rachel Walker. 2004. A typology of consonant agreement as correspondence. *Language* 80:475–531.
Rubach, Jerzy. 2000. Backness switch in Russian. *Phonology* 17:39–64.
Rūķe-Draviņa, Velta. 1977. Modifications of speech addressed to young children in Latvian. In *Talking to children: Language input and acquisition*, ed. C. Snow and C. A. Ferguson, 237–254. Cambridge: Cambridge University Press.

Sagey, Elizabeth, C. 1990. *The representation of features and relations in nonlinear phonology*. New York: Garland. [1986. Cambridge, MA: MIT doctoral dissertation.]
Sapir, Edward. [1915] 1949. Abnormal types of speech in Nootka. In *Canada Geological Survey* 62, Anthropological Series 5. Ottawa. Reprinted in Sapir 1949:179–96.
Schourup, Lawrence, and Ikuhiro Tamori. 1992. Palatalization in Japanese mimetics: Response to Mester and Itô. *Language* 68:139–148.
Schuh, Russell G. 2002. Palatalization in West Chadic. *Studies in African Linguistics* 31:97–128.
Shadle, C. H. 1985. The acoustics of fricative consonants. Doctoral dissertation, MIT.
Shrofel, Salina M. 1981. Island Lake Ojibwa morphophonemics. Doctoral dissertation, University of Toronto.
Singh, S., D. R. Woods, and A. Tishman. 1972. An alternative MD-SCAL analysis of the Graham and House data. *Journal of the Acoustical Society of America* 51:666–668.
Soglasnova, Svetlana. 2003. Russian hypocoristic formation: A quantitative approach. Doctoral dissertation, University of Chicago.
Stevens, Kenneth N. 1971. Airflow and turbulence noise for fricative and stop consonants: Static considerations, *Journal of the Acoustical Society of America* 50: 1180–1192.
Stevens, Kenneth N. 1998. *Acoustic phonetics*. Cambridge, MA: MIT Press.
Teeter, Karl V. 1959. Consonant harmony in Wiyot, with a note on Cree. *International Journal of American Linguistics* 25:41–43.
Tsang, Clinton Yin Hang. 2007. Palatalization in Gude. University of British Columbia ms.
Tsurutani, Chiharu. 2004. Acquisition of yo-on (Japanese contracted sounds) in L1 and L2 phonology in Japanese second language acquisition, *Journal of Second Language* 3:27–48.
Vance, Timothy. 1987. *An introduction to Japanese phonology*. New York: SUNY Press.
Vihman, M. M. 1996. *Phonological development: The origins of language in the child.* Cambridge, MA: Blackwell.
WALS: Haspelmath, M., D. Gil, B. Comrie, H.-J. Bibiko, and M. Dryer, eds. 2005. *The world atlas of language structures*. New York: Oxford University Press.
Wang, M. D., and R. C. Bilger. 1973. Consonant confusion in noise: A study of perceptual features. *Journal of the Acoustical Society of America* 54:1248–1266.
Zharkova, Natalia. 2004. Strategies in the acquisition of segments and syllables in Russian-speaking children. In *Developmental paths in phonological acquisition*, ed. Marina Tzakosta, Claartje Levelt, and Jeroen van de Weijer, 1574–4728.
Zoll, Cheryl. 1997. Conflicting directionality. *Phonology* 14:263–286.
Zsiga, Elizabeth C. 1995. An acoustic and electropalatographic study of lexical and post-lexical palatalization in American English. In *Papers in Laboratory Phonology IV: Phonology and phonetic evidence*, ed. B. Connell and A. Arvaniti (eds.), 282–302. Cambridge: Cambridge University Press.