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Patterns and scales of expressive palatalization: Experimental evidence from Japanese

ALEXEI KOCHETOV
University of Toronto
JOHN ALDERETE
Simon Fraser University

1. INTRODUCTION

The concept of phonetic scales — degrees of articulatory difficulty and perceptual salience — has been at the core of recent research on the role of phonetics in phonology. Yet there is little agreement among researchers on whether phonetic scales are part of speakers' linguistic knowledge, and if they are, whether this knowledge is innate or derived through linguistic experience (Archangeli and Pulleyblank 1994, Blevins 2004, Hayes and Steriade 2005, among others). In this article we suggest that one potentially revealing approach to understanding the relation between phonetic scales and grammatical hierarchies is through a systematic investigation of "marginal" linguistic systems such as simplified registers, sound symbolism, and language games (see Bagemihl 1996, Joseph 1997). Specifically, the aim of this article is to investigate scales and patterns of expressive palatalization — the process that exploits a sound–symbolic relation between the palatalized consonants and the meaning of smallness/childishness.

Palatalization — a process by which consonants acquire secondary palatal articulation or shift to coronal place — is among the most common phonological processes cross-linguistically (Bhat 1978). Palatalization is triggered by front vowels or a palatal glide and can target consonants of various places and manners of articulation. In Japanese, for example, all consonants are palatalized before the high front vowel *i*, as shown in (1). Labials, dorsals, and *r* acquire secondary articulation (1a), while anterior coronals shift in place to alveolo-palatals (1b) (Halle and Clements 1983, Vance 1987, Chen 1996).

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(1) *Japanese palatalization before* i:

	Volitional			*Present*
a.	/job-itai/	[jobʲitai]	'call'	[jobu]
	/wak-itai/	[wakʲitai]	'boil'	[waku]
	/kar-itai/	[karʲitai]	'shear'	[karu]
b.	/kat-itai/	[katʃitai]	'win'	[katsu]
	/kas-itai/	[kaʃitai]	'lend'	[kasu]
	/ʃin-itai/	[ʃiɲitai]	'die'	[ʃinu]

Palatalization of this kind is inherently assimilatory, as consonants become more similar in place of articulation to neighbouring vocoids. The phonetic motivation for palatalization is relatively uncontroversial: the phonological process can be viewed as an abstract, discrete instantiation of the concrete, gradient consonant-to-vowel coarticulation (Hyman 1975) and its perceptual miscategorization in phonetics (Guion 1996). As a common case of C–V interactions, palatalization has attracted considerable attention in the context of the development of theories of distinctive features (Chomsky and Halle 1968, Flemming 2002), autosegmental representations (Sagey 1990, Hume 1994, Calabrese 1995), and constraint interactions (Chen 1996, Rose 1997, Padgett 2003, Bateman 2007, among others; see Kochetov 2011 for a review).

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" (Nichols 1971, Ferguson 1977, Ohala 1994). Expressive palatalization of this kind is used cross-linguistically in sound symbolism, diminutive morphology, hypocoristics, and in "babytalk" — conventionalized adults' speech directed to small children. In Japanese, for example, palatalization is associated with "childishness", and "uncontrolledness" in sound–symbolic (mimetic) vocabulary (2a) (Hamano 1998). Palatalization of certain consonants also serves as a marker of the Japanese babytalk register (Chew 1969) (2b).

(2) a. *Palatalization in Japanese sound symbolism (mimetics)*:

[tʃoko-tʃoko]	'moving like a small child'
cf. [toko-toko]	'trotting'
[katʃa-katʃa]	'the sound of keys hitting against each other'
cf. [kata-kata]	'the sound of a hard object hitting the hard surface'
[pʲoko-pʲoko]	'hopping around in a childish bobbing motion'
cf. [poko-poko]	'making holes here and there'

b. *Palatalization in Japanese babytalk*:

[osarusan]	→ [otʃarutʃan]	'monkey (honorific)'
[kutsu]	→ [kutʃu]	'shoe'
[tabemasuka]	→ [tabematʃuka]	'Will you eat?'
[omizu nominasai]	→ [omidʒu nominatʃai]	'Drink your water!'

One key difference between the cases of phonologically conditioned palatalization presented earlier and the expressive palatalization in (2) is the presence or absence of an overt trigger of the process. In addition, the two kinds of palatalization are remarkably different in terms of which particular consonants are targets and/or outputs of the process (if such mappings exist). Thus, Japanese sound symbolic reduplicative forms exhibit restrictions on how many and which consonants can be palatalized. Specifically, only one consonant within the CVCV root is palatalized — one of the non-rhotic coronals (*t d s z n*), if present. Non-coronals can be palatalized only in the absence of the above-mentioned consonants, while the rhotic *r* is never palatalized (Hamano 1998). This pattern is in contrast to the "across-the-board" palatalization of all consonants before *i* — non-coronals and coronals including *r*. The restrictions on targets and outputs of expressive palatalization are not unique to Japanese, but are characteristic of many other cross-linguistic patterns of expressive palatalization, as will be examined in the next section. The functional sources of expressive palatalization are also distinctly different. It has little to do with coarticulation or misperception; instead, the process can be viewed as an abstract instantiation of iconic sound–meaning associations — mappings between certain acoustic (and possibly articulatory) properties of palatal(ized) consonants and the meaning of smallness or childishness (Ohala 1994).

Despite the striking differences between phonologically conditioned and expressive palatalization, previous phonological accounts assume that the latter is essentially a regular phonological phenomenon, governed by the same general principles as the former, albeit unique in some of its characteristics. This assumption, for example, underlies most treatments of Japanese mimetic palatalization (e.g., Mester and Itô 1989, Akinlabi 1996, Chen 1996, Zoll 1997, Kurisu 2009, among others; see Hualde 1991 on Basque diminutive and babytalk palatalization). The fact that expressive palatalization does not have an overt phonological trigger and the fact that it often targets a set of segments different from those targeted by phonological palatalization have been attributed to special structural characteristics (floating feature) and lexical properties (a specific lexical stratum) 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 and Itô 1989, Chen 1996) and markedness constraint hierarchies (e.g., featural compatibility: Akinlabi 1996, Kurisu 2009). In this article we argue that 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 and introducing unnecessary complexity into accounts of purely phonological palatalization processes.

Understanding differences between phonologically conditioned and expressive palatalization is important, as it provides the basis for empirically plausible formal accounts of palatalization phenomena in general. Equally important is our understanding of phonetic scales of expressive palatalization (preferences for certain segmental targets and outputs). Why do these scales arise and how do they relate to abstract phonological patterns? Answers to these questions would undoubtedly provide important insight into the mechanisms of phonetics–phonology interactions. The general goal of this article is thus to contribute to the ongoing debate on the role of phonetic factors in phonology.

The article is organized as follows. Section 2 provides motivation for distinguishing between expressive and phonological palatalization, while Section 3 presents some cross-linguistic generalizations about the two types. Sections 4 and 5 review the patterns of and report experimental results on Japanese mimetic and babytalk palatalization, respectively. Section 6 presents the discussion of the results.

2. Expressive palatalization: A proposal

We propose that phonological palatalization (P-Pal) and expressive palatalization (E-Pal) are inherently different phenomena and should be treated as such in phonological theory. This proposal is schematized in Figure 1. Apart from the different functional sources, P-Pal belongs to the "core" phonological grammar, representing a set of generalizations over the entire lexicon of the language. In contrast, E-Pal is more "marginal", specific to a relatively small set of lexical items or pragmatic situations (see Joseph 1997 on marginal linguistic phenomena).

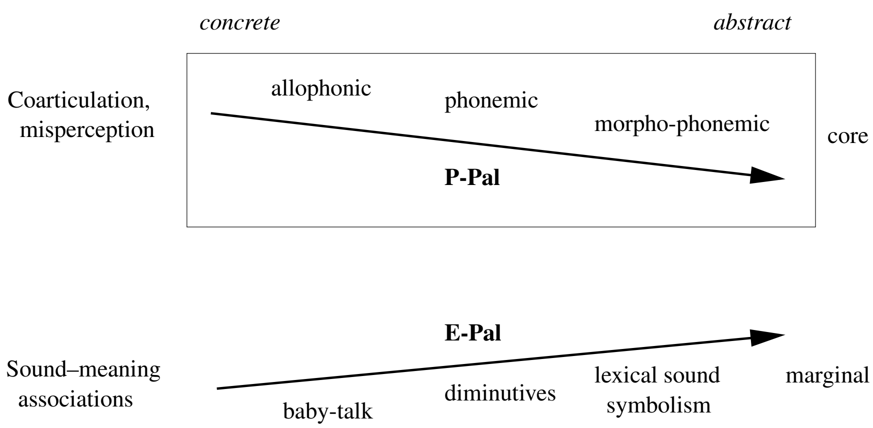

Figure 1: A schematic representation of phonologically conditioned palatalization (P-Pal) and expressive palatalization (E-Pal)

At the same time, P-Pal and E-Pal are similar in the sense that specific processes fall on a continuum from the more concrete to the more abstract. Processes that are more concrete are more "natural" (see Hyman 1975), clearly phonetically or psycho-acoustically motivated. This includes many allophonic and phonological P-Pal processes (e.g., Japanese *i*-palatalization). On the more concrete pole of the continuum are also the cases of babytalk and diminutive constructions that involve exhaustive and relatively unambiguous substitutions of consonants by those denoting childishness or smallness (e.g., Japanese babytalk in (2b)).[1] In contrast,

[1]The placement of diminutives and sound symbolism in Figure 1 is intended to show that the former displays more concrete associations between "smallness" and palatalization. Diminutive constructions, however, can be considered more abstract in the sense that they are more integrated with the core phonological/morphological patterns.

P-Pal processes that are highly morphologically conditioned and E-Pal cases with opaque sound–meaning correspondences and/or lexical conditioning are on the opposite pole of the concrete/abstract continuum. The former include the well-known cases of morpho-phonemic palatalization that lack overt triggers (e.g., Chaha: Rose 1997, Gude: Hoskison 1975), while the latter include Japanese mimetic palatalization in (2a), among other sound symbolic patterns (see Kochetov and Alderete 2011). The relative abstractness of these processes is in large part due to historical changes and analogical extension of the patterns to new phonological or semantic contexts (see also Regier 1998 on the extension of iconic meanings in reduplication). Justification for the direction of this semantic extension in E-Pal is given in section 6.1.

Highly abstract cases of P-Pal and E-Pal are of particular interest. Being superficially similar in some respects, these can be mistakenly taken as representing the same phonological patterns. Chen (1996), for example, equates the analysis of Japanese mimetic palatalization with that of Southern Bantu long-distance palatalization, as both are assumed to be triggered by a floating palatal feature affix (cf. Mester and Itô 1989, Hualde 1991). Likewise, Zoll (1997) draws parallels between Japanese mimetic palatalization and certain core phonological phenomena such as stress, as both putatively exhibit default-to-opposite edge effects. Also, Kurisu (2009) builds his feature compatibility analysis of Japanese mimetic palatalization on cross-linguistic observations about the typology of phonologically based palatalization and, in turn, argues that his analysis can be extended to palatalization processes in general.

In this article we argue, however, that it is necessary to treat E-Pal as a distinct, partly extra-grammatical phenomenon, on both empirical and theoretical grounds. As part of this, we explore the properties of and native speaker intuitions about the controversial phenomenon of Japanese mimetic palatalization. We hypothesize that patterns of mimetic palatalization represent an abstract phonological (and semantic) extension of E-Pal palatalization observed in Japanese babytalk. These patterns, in turn, are grounded in iconic correspondences between acoustic properties of palatalized consonants and the meanings of smallness and childishness. We test the hypothesis that E-Pal is different from P-Pal by reviewing previous generalizations on the patterns of mimetic palatalization and babytalk, probing native speaker intuitions about them, and examining phonetic sources of the relevant sound–meaning correspondences. We show that the results are fully consistent with our hypothesis. We also show that, although phonologically marginal, Japanese mimetic palatalization and E-Pal in general present an interesting test case for study of the relation between concrete physical properties of speech and abstract phonological generalizations, providing an important insight into the mechanisms of phonetics–phonology interactions.

3. Expressive palatalization vs. phonological palatalization: A survey

In this section we review some relevant results of previous cross-linguistic surveys of P-Pal (Bateman 2007; see also Bhat 1978 and Kochetov 2011) and E-Pal (Kochetov

Table 1: Scales of P-Pal and E-Pal: A comparison

	Preferences (more likely > less likely)	*P-Pal*	*E-Pal*
a.	Targets:		
	i. coronals, dorsals > labials	yes	no
	ii. coronals > non-coronals	yes (weaker)	yes (stronger)
	iii. obstruents > sonorants	no	yes
	iv. sibilants > non-sibilants	no	yes
	v. non-rhotics > rhotics	yes (weaker)	yes (stronger)
b.	Outputs:		
	i. coronals > non-coronals (secondary articulation)	yes (weaker)	yes (stronger)
	ii. obstruents > sonorants	no	yes
	iii. sibilants > non-sibilants	yes (stops only)	yes
	iv. affricates > fricatives	no	yes

and Alderete 2011, henceforth K&A). Bateman's survey consists of 58 languages with P-Pal, with selected languages being controlled for genetic affiliation. K&A is based on 37 languages (excluding Japanese), representing 27 *genera* and 20 language families, with various types of E-Pal — babytalk registers, diminutive morphological constructions, and diminutive/affective sound symbolism. Our focus here is on differences between P-Pal and E-Pal in terms of targets and outputs of palatalization. Targets are understood here as segments affected by the process, while outputs are segments resulting from palatalization. Considering both targets and outputs is important, as the relation between the two is not always straightforward, particularly in the more output-oriented E-Pal (see K&A).

Table 1 summarizes general preferences on targets and outputs typical of P-Pal and E-Pal. Starting with targets of palatalization, P-Pal has been observed to target almost exclusively coronals and dorsals, while labials are rarely targets of the process. That is, labials are palatalized in a given language only if coronals and dorsals are also palatalized (Bateman 2007:44–51). No such implicational relation is found between coronals and dorsals (although palatalization of coronals is statistically more common): there are languages where targets are coronals only, both coronals and dorsals, or dorsals only. Interestingly, the last group (dorsal-only palatalization) is well established and represented by various genetically and geographically diverse languages including Luganda (Niger-Congo), Roviana (Austronesian), Dakota (Siouan), and Somali (Afro-Asiatic) (Bateman 2007:305; see also Kenstowicz and Kisseberth 1979, Hume 1994 for multiple examples of velar palatalization). In contrast, E-Pal almost exclusively targets coronals. There are only three cases where non-coronals are palatalized, and in all of them palatalization of dorsals and labials is more limited than and/or implies palatalization of coronals. This is illustrated in Table 2, which presents percentages of cases of "full" (place-changing) palatalization in P-Pal (based on 50 cases of phonological and morpho-phonemic palatalization from Bateman 2007:44-51) and E-Pal (based on 35 cases of E-Pal from K&A). Note that over 50% of all P-Pal cases involve dorsals (on their own or together with

Table 2: Target place in full palatalization: P-Pal vs. E-Pal

	lab	cor	dor	lab + cor	lab + dor	cor + dor	lab + cor + dor
P-Pal (50 cases)	0%	60%	20%	0%	0%	27%	4%
E-Pal (35 cases)	0%	91%	0%	0%	0%	6%	3%

coronals). In contrast, dorsals are targeted in only 9% of E-Pal cases, and always together with coronals.

Furthermore, there are no consistent manner differences in targets of P-Pal: some languages palatalize obstruents, others palatalize non-rhotic sonorants, or both (Bateman 2007:313–316). In contrast, E-Pal shows clear manner effects: palatalization of sonorants implies palatalization of obstruents. Within the latter class, sibilants are more likely targets than non-sibilants (stops). In fact, almost half of the surveyed E-Pal cases target the sibilant fricatives *s* and *z*, often to the exclusion of all other consonants. Both types of processes tend to avoid palatalizing rhotics (Hall 2000, Bateman 2007 on P-Pal), yet this tendency appears to be stronger in E-Pal (see, for example, the Japanese examples in (2)).

Turning to the outputs of palatalization, P-Pal processes commonly result in consonants with secondary articulation (mainly from non-coronal targets) or posterior coronals (mainly from anterior coronals and dorsals; Bateman 2007, Kochetov 2011). Outputs of E-Pal are overwhelmingly coronals. While this is not unexpected given that the targets of the process are mostly coronals, there are cases where a consonant of any place or manner is converted to a coronal affricate. Consider, for example, Western Basque diminutives which convert any word-initial consonant to *ʧ:<u>p</u>ispildu* → *<u>ʧ</u>ispildu* 'become happy after drinking (perfective)' (Hualde and Urbina 2003:39). A process as powerful as this is completely unheard of in the context of P-Pal and is at the least highly untypical of regular phonological processes in general.

This brings us to another important property of E-Pal — the strong preference for sibilants, and particularly affricates, as outputs. While affrication is also common in P-Pal (Bhat 1978), it is always limited to stop targets (e.g., *t d k g* → *ʧ ʤ*). Importantly, coronal fricatives are never affricated (**s z* → *ʧ ʤ*). In E-Pal, affrication (if derived) can affect stops (19 cases out of 35), fricatives (12 cases), and even sonorants (2 cases). Overall, E-Pal is considerably more restrictive than P-Pal in the choice of outputs of palatalization. It also differs from P-Pal by the presence or absence of certain implicational relations.

A relevant illustration of the place and manner difference between P-Pal and E-Pal is Standard Modern Greek. In this language, P-Pal targets dorsals (before *e* and *i*) and coronal sonorants *n* and *l* (before *i*), as shown in (3a). The outputs are palatals of the same manner of articulation as the targets. Notably, coronal obstruents (as well as *r* and labials) are not affected (Bateman 2007, citing Arvaniti 1999). This pattern is indicative of a target scale *coronals, dorsals* > *labials* (leaving aside the manner distinction within coronals), which is typical of P-Pal (see Table 1a). The process does not show any preference for coronal obstruents or sibilants. In fact, it shows the opposite: a preference for coronal sonorants to the exclusion of coronal obstruents. This language-particular scale of palatalizability is generally consistent with the patterns of P-Pal, but is almost the reverse of what is expected for E-Pal (apart from the lack of rhotic palatalization). Interestingly, Standard Modern Greek also exhibits a strikingly different lexical pattern which can be classified as E-Pal in our terms. As Joseph (1994) notes, Greek diminutives, hypocoristics, and babytalk lexical items show an abundance of sibilant affricates [ts] and [ʣ] (the language does not have [ʧ] and [ʤ]), which are otherwise infrequent in Greek (3b). This largely lexicalized pattern clearly manifests a strong preference for affricates as outputs, which is fully consistent with the scale of E-Pal.

(3) a. *Greek P-Pal: velars and coronal sonorants as targets (and outputs)*:

/kerasa/	[cerasa]	'I treated (to a drink)'	
/tongerasa/	[toŋɟerasa]	'I treated him (to a drink)'	
/xeri/	[çeri]	'hand, arm'	
/ɣeros/	[ʝeros]	'strong, robust'	
/tsakizo/	[tsacizo]	'I snap'	
/xioni/	[çoni]	'snow'	
/betoniera/	[betoɲera]	'cement-mixer'	
/jali/	[jaʎi]	'glass'	(Bateman 2007:226)

b. *Greek E-Pal (sound symbolism, diminutives, and baby-talk lexical items): sibilant affricates as outputs*:

[tsita-tsita]	'just barely'(said of a tight fit)
[tsiros]	'thin person'/'dried mackerel'
[ʣuʣes]	'dwarf'
[-itsa], [-itsi], [-utsikos], [-ʣikos]	'affective diminutive for adjectives', e.g., [ɣlik-os] 'sweet', [ɣlik-utsikos] 'cute'
Đimitrios → [mitsos]	
Konstandinos → [kotsos]	
[tsitsi]	'meat'
[tsis(i)a] ∼ [ʣis(i)a]	'peepee'
[pitsipitsi]	'(act of) washing'

(Joseph 1994:224–231)

There are other differences between P-Pal and E-Pal that are relevant to the current discussion. Many cases of E-Pal are exhaustive — affecting all segments within a word or a phrase (e.g., Japanese babytalk (2b)). The same is uncharacteristic of P-Pal (but reminiscent of consonant harmony: Hansson 2001, Rose and Walker 2004). Further, there are many cases of E-Pal that can be characterized as non-structure-preserving (introducing segments that are not part of the inventory) and violating phonotactic constraints of the language. Among P-Pal cases, only allophonic palatalization can be classified as non-structure-preserving, and P-Pal processes rarely, if ever, violate language phonotactics (see Kenstowicz and Kisseberth 1979). We elaborate this argument in section 6.3.

In sum, E-Pal has a set of properties that distinguishes it from P-Pal. This finding is not at all surprising, as the targeted segments and outputs of E-Pal are constrained by factors that are beyond the regular phonology. The output segments 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, Ohala 1994; see section 6). In contrast, none of these constraints apply in P-Pal, which is rooted in phonetic coarticulation and miscategorization of coarticulated segments (Hyman 1975, Guion 1996). Place and manner scales of E-Pal are expected to be discernable in a detailed examination of patterns of Japanese mimetic palatalization, as well as in native speaker intuitions about the patterns. These questions are addressed in the next section.

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

The contrast between plain, that is non-palatalized, and palatal(ized) consonants plays an important part in Japanese phonology. As shown in (4), all consonants belong to one class or the other class and are paired with respect to palatalization (Vance 1987, Itô and Mester 2003). The contrast is maintained before back vowels and neutralized before front vowels, where plain consonants occur before *e* and palatalized ones occur before *i*. The latter restriction is also manifested in alternations, as shown at the beginning of section 1.

(4) *The Japanese consonant inventory*:

plain			*palatal(ized)*		
p b	t d	k ɡ	p^j b^j	ʧ ʤ	k^j ɡ^j
	s z	h		ʃ	h^j
m	n		m^j	ɲ	
	r			r^j	
w				j	

Notes: [a]/t/ and /h/ are realized as [ʦ] and [ɸ] before /u/;
[b]/r/ is a flap [ɾ];
[c]/h^j/ is realized as palatal [ç]

The plain–palatalized contrast also plays a prominent role in the Japanese sound–symbolic (mimetic) lexicon (Hamano 1998). Mimetic palatalization has received significant attention in the phonological literature (Mester and Itô 1989, Archangeli and Pulleyblank 1994, Akinlabi 1996, Chen 1996, Zoll 1997, Kurisu 2009, among others), and has often been explicitly or implicitly considered a regular phonological phenomenon on a par with other palatalization processes. Mimetics 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, uncoordinated movement, diversity, excessive energy, noisiness, lack of elegance, cheapness, and lack of restraint (Hamano 1998:238). This is evident when comparing mimetic words that differ solely in palatalization, as shown earlier in (2a). (Not all palatalized forms have plain counterparts and vice versa; see

Schourup and Tamori 1992.) Recall that 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.

4.1 Lexical evidence

In this section, we will briefly describe the patterns of mimetic palatalization, as re-evaluated in Alderete and Kochetov (2009) based on a list of 101 mimetic reduplicative CVCV roots[2] with (phonetically unconditioned) palatalization, compiled from various published sources (and supplemented by additional items elicited from native speakers of Japanese, as discussed below). The patterns of mimetic palatalization with respect to targets and outputs are summarized in Table 3.

Table 3: Patterns of mimetic palatalization in reduplicative CVCV roots (based on Alderete and Kochetov 2009)

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

Note: P and K stand for all labials and all velars, respectively.

The two most common patterns are those involving palatalization of a coronal in roots where it follows or precedes a non-coronal (e.g., *baʃa-baʃa* and *ʤabu-ʤabu*).[3] There is only one exception to palatalization of coronals (*k^joto-k^joto*, which also has

[2]Reduplicative CVCV roots have been the focus of almost all previous studies of mimetic palatalization (Mester and Itô 1989, Hamano 1998). Palatalization, however, is also observed in other mimetic constructions (see Kakehi, Tamori, and Schourup 1996 and Kurisu 2009 for details).

[3]Glosses for these and other mimetic examples are available in the online supplement to Alderete and Kochetov (2009).

a counterpart with coronal palatalization, *kotʃo-kotʃo*; see Hamano 1998:178, n. 4). Another relatively common pattern is one where a coronal is palatalized when co-occurring with a rhotic (c) (e.g., *tʃoro-tʃoro*; 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 (coronal/non-coronal and rhotic/non-rhotic asymmetries). It is interesting that among coronal consonants, nasals are less common targets of palatalization (n = 11) than any of the obstruents (n = 38, 14, and 30). This can be in part attributed to the overall higher incidence of obstruents compared to nasals and other sonorants in the mimetic lexicon, suggesting a gradient preference for the former consistent with the typology of E-Pal (see Table 1).

The other three palatalization patterns are not as clear empirically. First, the pattern showing avoidance of rhotic palatalization in roots with non-coronals (d) (e.g., *gʲoro-gʲoro*) 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 and Itô 1989, Zoll 1997). There are only 5 items exemplifying the pattern, which is a surprisingly small number compared to the sizable class of non-coronal + rhotic items without palatalization (n = 68; Alderete and Kochetov 2009:377). It also appears that avoidance of rhotic palatalization next to non-coronals is not absolute. As Hamano (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 at least marginally possible, and can result in *j* rather than *rʲ* (which is common in the typology of E-Pal, e.g., Warlpiri babytalk *ɻamaɻa* → *ɟamaɟa* ‘ribs’; Laughren 1984:74–80).

Second, palatalization in roots with two coronals and two non-coronals has been claimed to be evidence for the “default-to-opposite” (DTO) generalization (or “conflicting directionality”; Zoll 1997), as rightmost palatalization was observed in the former type of roots and leftmost palatalization in the latter. This putative generalization is important for the traditional treatment of mimetic palatalization as a regular phonological process, since similar DTO 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 problematic, as the rightmost palatalization of coronals is exhibited unambiguously by a single item *doʃa-doʃa*, with another item *ʃana(ri)-ʃana(ri)* showing the opposite pattern. (In the other two coronal–coronal items, palatalization is positionally restricted by the presence of a front vowel in one of the syllables.) Similarly, the leftmost palatalization of non-coronals is exhibited by only two items (*pʲoko-pʲoko* and *hʲoko-hʲoko*), which are phono-semantically related. The small number of examples, as we argue in Alderete and Kochetov (2009), is insufficient to support the DTO 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. 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 (to ʧ, ʃ, or ʤ), and only 2 showed palatalization of the nasal (to 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, which is again the pattern widely attested in our cross-linguistic sample (see section 3).

In sum, the patterns of Japanese mimetic palatalization reflect asymmetries characteristic of E-Pal, either categorically or gradiently: the strong preference for coronals and obstruents as targets and outputs, compared to non-coronals, rhotics, and other sonorants (see Table 1). These asymmetries are not characteristic of Japanese phonological palatalization, where essentially all consonants are palatalized before *i* (Halle and Clements 1983, Vance 1987, Chen 1996, Itô and Mester 2003). Overall, this shows that mimetic palatalization is a phenomenon completely distinct from phonological palatalization. An alternative interpretation of the same data, however, argues for the regular phonological status of mimetic palatalization, citing as evidence the putative DTO 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, ultimately reflecting properties of either expressive or phonological palatalization.

4.2 Experimental evidence

An experiment involving Japanese speakers' intuitions regarding palatalization in Japanese mimetic vocabulary was conducted. The goal was to test speakers' preference for palatalization of coronals over non-coronals and rhotics (the Coronal Preference and Rhotic Avoidance Hypotheses) and their preference for palatalization of coronal obstruents over coronal sonorants (the Manner Asymmetry Hypothesis). A second goal was to evaluate the alternative interpretation of some of the patterns — rightmost palatalization of coronals and leftmost palatalization of non-coronals (the DTO Hypothesis, which would be 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: Mester and Itô 1989, Zoll 1997, Hamano 1998), 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 workable 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 (Schourup and Tamori 1992).

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 and 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: double palatalization (e.g., *ʧoɲa-ʧoɲa*), leftmost consonant palatalization (e.g., *ʧona-ʧona*), and rightmost consonant palatalization (e.g., *toɲa-toɲa*). The results were similar for both tasks and showed a clear disfavouring of double palatalization. The choice between leftmost and the rightmost palatalization, however, was far less clear. Some coronal–coronal items appeared to show the expected preference for rightmost palatalization (e.g., *nVʃV*), while others showed preference for 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 DTO palatalization. However, given the lack of certain important controls,[4] the noted manner effects could not be fully verified. This suggests that the Manner Asymmetry Hypothesis and the DTO Hypothesis require further and a more rigorous testing, as provided by the experimental study described here.

4.2.1 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, as described in Table 4. The first set (a) was designed to test three general hypotheses: the Coronal Preference Hypothesis (coronal vs. non-coronal), the Rhotic Avoidance Hypothesis (*r* vs. any consonant), and the DTO Hypothesis in palatalization (leftmost for non-coronals and rightmost for coronals). The second set (b) was designed to further investigate coronal–coronal combinations by examining palatalization in combinations of coronals of different manners. The goal here was to compare the predictions of the DTO Hypothesis and the Manner Asymmetry Hypothesis (obstruent/sonorant and sibilant/non-sibilant) for coronals.

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, as identified by a native speaker consultant (*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.

[4]While Nagao and McCall's set of stimuli was relatively large (45 items consisting of 25 consonant pairs), it was not balanced for vowel context and did not include non-coronal/coronal combinations.

Table 4: Stimuli of the Japanese mimetic palatalization experiment: Pairs of nonce mimetic C1VC2V–C1VC2V words with different place and manner consonant combination types

	C1–C2		a–o		o–a	a–u	u–a	o–o
Place	*input*	*output*	*C1 = pal*	*C2 = pal*	…	…	…	…
a. Set 1								
cor–non-cor	t-p	ʧ-p/t-p^{j}	ʧapo-ʧapo	tap^{j}o-tap^{j}o	…	…	X	…
non-cor–cor	p-t	p^{j}-t/p-ʧ	p^{j}ato-p^{j}ato	paʧo-paʧo	X	…	…	…
cor–rhotic	t-r	ʧ-r/t-r^{j}	ʧaro-ʧaro	tar^{j}o-tar^{j}o	…	…	…	X
non-cor–non-cor	ɡ-b	ɡ^{j}-b/ɡ-b^{j}	ɡ^{j}abo-ɡ^{j}abo	ɡab^{j}o-ɡab^{j}o	…	…	…	…
cor–cor	t-d	ʧ-d/t-ʤ	ʧado-ʧado	taʤo-taʤo	…	…	…	…
b. Set 2								
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	…	…	…	…

Notes: [a] X = pairs omitted from the set
[b] … = pairs of forms with the same consonant combinations as in *a–o* column, but in different vowel contexts

Word pairs from both sets were randomized and presented together in two blocks, along 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 choosing either the first or the second word throughout the experiment. Both blocks of stimuli, printed in the *hiragana* script,[5] were presented to each subject once, thus resulting in two responses for each stimulus pair. 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 comfortable pace selecting one item from each pair which was "more acceptable, sounded more like a Japanese word". They were also told

[5] Japanese uses either *hiragana* or *katakana* to render mimetic forms (Kakehi et al. 1996). We chose *hiragana*, to be consistent with Nagao and McCall (1999). Japanese orthography clearly marks palatalization and employs the same palatalization symbols for all consonants regardless of their place and manner of articulation.

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

Collected data were analyzed in the following way. Each response was assigned 1 if leftmost consonant (C1) palatalization was preferred to rightmost consonant (C2) palatalization (i.e., *ɲaso-ɲaso* > *naʃo-naʃo*) or 0 if rightmost consonant palatalization was preferred to 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 two 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. Since our interest is in specific comparisons between consonant combinations (see below), we used paired-samples t-tests with subject-specific C1 pal ratios (averaged over the order of presentation and vowel context) as data points. In addition, we ran t-tests on vowel contexts with subject-specific C1 pal ratios averaged over the order and consonant combination. The significance value was set to 0.1.

4.2.2 Predictions

In Set 1, the Coronal Preference Hypothesis predicts 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* > *tapʲo-tapʲo*) and a low C1 pal ratio for *p–t* pairs (i.e., *paʧo-paʧo* > *pʲato-pʲato*). The Rhotic Avoidance Hypothesis predicts that palatalization of rhotics would be avoided, resulting in a high C1 pal ratio (i.e., *ʧaro-ʧaro* > *tarʲo-tarʲo*). (The only pairs were *t–r*.) The DTO Hypothesis for the non-coronal pair *g–b* predicts a high C1 ratio (leftmost palatalization, *gʲabo-gʲabo gabʲo-gabʲo*), comparable to the *t–p* and *t–r* pairs. In contrast, the same hypothesis for the coronal pair *t–d* predicts a low C1 pal ratio (rightmost palatalization, *ʧado-ʧado* > *taʤo-taʤo*), comparable to the *p–t* pair.

In Set 2, the DTO Hypothesis for all coronal pairs predicts consistently low C1 ratios (rightmost palatalization, *naʃo-naʃo* > *ɲaso-ɲaso*, *saɲo-saɲo* > *ʃano-ʃano*, etc.). In contrast, the Manner Asymmetry Hypothesis predicts 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 predicts 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*).

4.2.3 Results and discussion

Figure 2 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 significantly different ($t(34) = 15.901$, $p < .001$). The overall high C1 pal ratio for the *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, both around 0.5, 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, at least for stops. The results thus fail to support the DTO Hypothesis, for both coronals and non-coronals.

Detailed results by consonant combination and vowel context are presented in Table A in the Appendix. That table shows considerable variation across vowel contexts within given consonant combinations. None of the vowel context differences, however, were significant.

Overall means of C1 pal ratio responses for each consonant combination of Set 2 are plotted in Figure 3 (see Table B in the Appendix for detailed results). 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 DTO 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, the 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 are 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.

In summary, the results of the experiment reveal 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 a clear, albeit gradient, preference for palatalized (sibilant) coronal

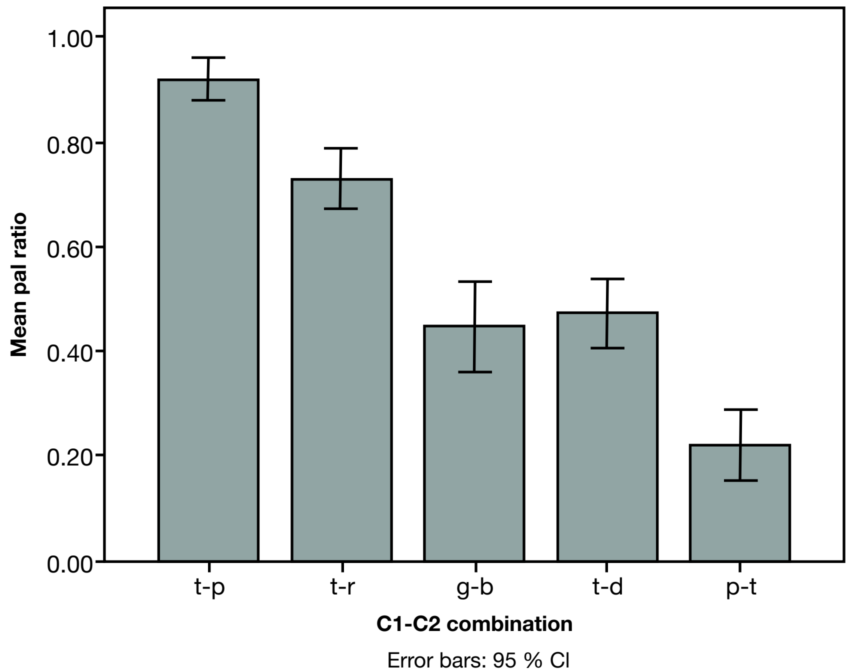

Figure 2: Overall means of C1 pal ratio responses for each consonant combination type, Set 1

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 and 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 DTO Hypothesis, 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 DTO edge effects — further support the view of Japanese mimetic palatalization as a typical case of expressive palatalization, rather than a case of phonological palatalization.[6] There are, in fact, remarkable similarities between the patterns of Japanese mimetics and E-Pal in sound–symbolic systems of other languages. As seen in (5), the same preference for coronal obstruents, and particularly sibilants, as targets is exhibited by E-Pal cases from Basque, Quechua, and Greek, among other languages.

[6]Note that the experimental results do not allow us to separate speakers' intuitions about the general scales of E-Pal from language-specific generalizations about the mimetic lexicon of Japanese. Further work and different experimental methodologies would be necessary to examine the relative contributions of both kinds of implicit knowledge in phonological processing.

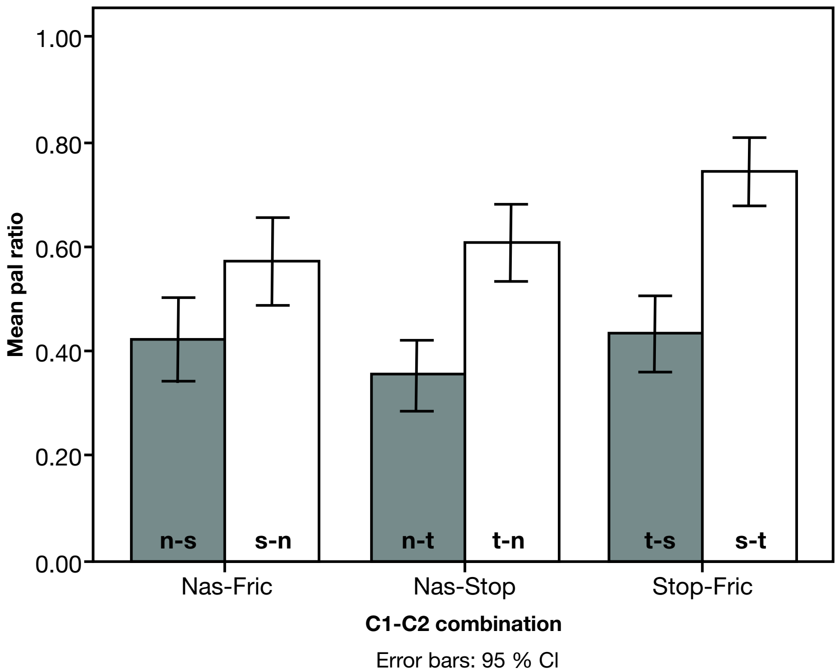

Figure 3: Overall means of C1 pal ratio responses for each consonant combination type, Set 2: coronal/coronal items where C1 and C2 differ in manner and order

(5) a. *Basque sound symbolism*:

[c̠aka-c̠aka] ‘walking taking baby steps’
cf. [t̠aka-t̠aka] ‘toddling’
[ʃ̠abu-ʃ̠abuka] ‘swinging, rocking’
cf. [s̪̠abu-s̪̠abu] ‘teetering, tottering’

(Ibarretxe-Antuñano 2006:66–77)

b. *Santiago del Estero Quechua sound symbolism*:

[kuʃ̠i-kuʃ̠i] ‘a small ground spider that seems to run around as if it were happy’
cf. [kus̠i] ‘happy’
[ʃ̠ira-ʃ̠ira] ‘a solitary kind of wasp that builds nests under roofs’
cf. [s̠era] ‘to sew’ (de Reuse 1986:57–61)

c. *Greek sound symbolism*:

[t̠s̠ima-t̠s̠ima] ‘right up to the edge, close’
[d̠ʑ̠ingu-d̠ʑ̠ingu] ‘drop-by-drop’ (West Crete dialect)

(Joseph 1994:224–231)

To further confirm the status of mimetic palatalization as E-Pal we will examine the patterns of Japanese babytalk, whose expressive, marginally grammatical phonological status is relatively uncontroversial.

5. Japanese babytalk vs. mimetic palatalization

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 a preference for palatalization of coronals over non-coronals (Mester and Itô 1989:268, fn. 21; Hamano 1998:186–187). The two processes are also expected to share some characteristics, given the fact that mimetic vocabulary is used very frequently in child-directed speech (at a rate about five times higher than with adults; Imai, Kita, Nagumo and Okada 2008) and given the high incidence of (non-mimetic) reduplication in babytalk (Chew 1969; cf. Mazuka, Kondo, and Hayashi 2008). To our knowledge, however, no attempt has been made to explicitly compare mimetic and babytalk palatalization processes or to provide a phonological analysis of the latter.

5.1 Patterns

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" (p. 5). While he does not explicitly define the set of segments undergoing the process, all changes in his examples appear to involve sibilants and result in palatal affricates: *s*, *ʦ*, *ʃ* → *ʧ*, *z* → *ʤ* (with *ʦ* being an allophone of *t* before *u*). These are illustrated in (6) in child-directed speech utterances (6a) and in specialized babytalk lexical items (6b).[7] Note that coronal stops (other than *t* before *u*: *ʦ*), nasal *n*, and non-coronals appear to be unaffected by babytalk palatalization (e.g., **ʧabemasuka*, **ɲominasai*, **pʲaipʲai*). The rhotic is not palatalized either (**osarʲu*).[8] The palatalization process also appears to be exhaustive, with more than one palatalizable sibilant affected within a word or a phrase (e.g., *oʧaruʧan*). Hamano (1998) also reports the change *s* → *ʃ* with no affrication (6c). She considers the shifts involving sibilants as part of a more general propensity of coronals to palatalization: "Coronals are easier to palatalize, and palatalized coronals are directly tied to the meaning of childishness" (p. 187; cf. Mester and Itô 1989:268, fn. 21). Given this, it is not clear whether babytalk palatalization targets all coronals as a class or coronal sibilants exclusively.

(6) *Japanese babytalk*:

a. [sora paipai oiʃiː-oiʃiːjo] → [ʧora paipai oiʧiː-oiʧiːjo]
   'Here's baby's milk. It's yummy!'
   [omizu nominasai] → [omiʤu nominaʧai]
   'Drink your water!' (adapted from Chew 1969:5)

b. [goʦuN] (/gotuN/) 'thump' + [ko] 'child' → [goʧːuŋko] (suru)
   'bump (the head)'

[7] *N* stands for a word-final nasal, which is phonologically placeless, while phonetically velar or uvular (Vance 1987).

[8] Chew (1969) mentions, however, that *r* optionally shifts to *j* or is deleted before front vowels: *kire–kire* → *kie–kie* 'clean'.

[o<u>s</u>aru] 'monkey' + [<u>s</u>an] 'Mr.' → [otʃarutʃan]
'Mr. Monkey' (adapted from Chew 1969:9)

c. [tabema<u>s</u>uka] → [tabemaʃuka] ∼ [tabematʃuka]
'Will you eat?'
[ʤuː<u>s</u>u] → [ʤuːʃu]
'juice'
[<u>s</u>ugoi] → [ʃugoi]
'wonderful' (adapted from Hamano 1998:186–187)

5.2 Experimental evidence

An experiment involving Japanese speaker intuitions regarding Japanese babytalk was conducted. The goal was to further test the Coronal Preference Hypothesis, the Rhotic Avoidance Hypothesis, and the Manner Asymmetry Hypothesis. A second goal was to compare the pattern of palatalization in Japanese babytalk to that of Japanese mimetics. The experiment was designed as a follow-up to the mimetic palatalization experiment and was exploratory in nature.

5.2.1 Method

The experiment materials included a list of 14 utterances with the following potentially palatalizable consonants: sibilants *s z ʦ* (and *ʃ*), nonsibilant coronals *t n d r*, and non-coronals *b m k h*, as shown in Table 5. (In the table, potential target consonants are underlined.) These utterances, written in Japanese orthography, were selected as representative for adult–child interactions. No attempt was made to control for the number of target consonants, given the exploratory nature of the experiment.

The subjects were the same 35 native speakers of Japanese as in the first experiment (which was conducted immediately prior to the current experiment.) 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 5) as if they were speaking to a small child. No examples of baby talk were provided, in order not to bias the subjects in favour of any particular responses. The questionnaires revealed that none of the participants were parents of small children. This was in fact desirable, as it allowed us to test the status of babytalk as a conventionalized speech register beyond the immediate context of parent–child interactions.

5.2.2 Predictions

Assuming that Chew's (1969) descriptive account of Japanese babytalk is correct and, consistent with the scales of expressive palatalization, it was expected that palatalization would target sibilants *s ʦ 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 *ʦ* (an allophone of *t* before *u*) being a target of palatalization to the exclusion of [t] (an allophone of /t/ before non-high vowels) is important, as it can show whether palatalization applies to surface or lexical representations. Alternatively, assuming the general palatalizability

Table 5: Utterances used in the Japanese babytalk 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?'
ʦumetai?	'(Is it) cold?'
ojasumi	'Good night.'
onaka suita?	'(Are you) hungry?'
zembu taberu?	'Will you eat it 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!'
zoːwa kawaiː	'The (toy) elephant is cute.'
buranko de asobu?	'(Do you) want to do the swing?'

of coronals as a class (Hamano 1998), we would expect the process to target both sibilants *s z* and non-sibilants *t d n*, changing them to *ʃ ʤ* and *ʧ ʤ ɲ*, respectively.

5.2.3 *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 subject), ranging from 3 to 22 substitutions per subject for the whole list (out of 43 potentially palatalizable consonants). As shown in Table 6, non-coronals were very rarely targeted by palatalization (*k m* → *kʲ mʲ*; 2 subjects), or not targeted at all (*b h*). Almost equally rarely targeted were the rhotic *r* (3 subjects), the coronal nasal *n* (1 subject), and the coronal stops *t d* (2 subjects). In contrast, sibilant coronals (the boxed region in the table) — 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. It should be kept in mind that some consonants occurred more frequently in the stimuli than others, before both back and front vowels (as indicated in the second column in Table 6). Nevertheless, a comparison of consonants that have similar frequency, for example *t* and *s* (7 instances of each before back vowels) or *n* and *z* (3 instances of each before back vowels), shows a clear split between sibilants and non-sibilants, rather than between coronals and non-coronals.

The other eight subjects who did not show consonant substitutions often used babytalk-specific lexical items or mimetics (e.g., *buru-buru* for *samui* 'cold', *hija-hija* for *ʦumetai* '(something is) cold', and *peko-peko* for *suita* 'hungry'), adding particles indicating emphatic statements or questions (*ne*, *da jo*, *kana*, *no*), dropping certain particles (*o*, *wa*), or lengthening vowels (*kanaː* 'isn't it?', *daːme* 'don't (do it)!'). All these are known as additional devices of Japanese babytalk (Chew 1969).

Table 6: Targets and outputs of consonant substitutions in responses and numbers of speakers (out of 27) who employed a particular change in any of the items

Target	*Occurrence*	*Output*								
	(_V_{bk} + _V_{fr})	Cʲ	j	ɲ	ʤ	ʃ	ʃ~ ʧ	ʧ	other	no change
k	(n = 6 + 1)	2								25
m	(n = 2 + 3)	2								25
b	(n = 3 + 1)									27
h	(n = 1)									27
r	(n = 2 + 1)	1	1						1 ([d])	24
n	(n = 3)			1						26
d	(n = 2 + 2)									27
t	(n = 7)							2		25
ʦ	(n = 2)							22		5
z	(n = 3 + 2)				16					11
s	(n = 7 + 1)					3	10	14		0
ʃ	(n = 0 + 2)							21		6

Note: Shaded cells correspond to logically impossible outputs.

We will not discuss these results further, restricting our focus to consonant substitutions produced by the other 27 subjects.

As seen in Table 6, outputs of palatalization generally preserved the manner and voicing of target consonants, apart from sibilant fricatives which tended to shift to affricates. For most subjects who palatalized, this process targeted both alveolar and palatal fricatives. Some qualitative data also suggests that the variation between *ʃ* and *ʧ* as outputs of palatalization denotes different degrees of "babyishness" or degrees of intensity of affection. One subject noted after the experiment that both variants *ʧuki* and *ʃuki* (for *suki* 'to like') were acceptable to her, although the first one "sounds cuter".

Examples of the most common changes are shown in (7): those targeting *s* (7a), *ʦ* (7b), *z* (7c), and *ʃ* (7d). Numbers of responses for each output are given in parentheses.

(7)	a.	[suita]	→	[ʧuita]	(n = 16)
			→	[ʃuita]	(n = 3)
		[samui]	→	[ʧamui]	(n = 9)
			→	[ʃamui]	(n = 3)
		[ojasumi]	→	[ojaʧumi]	(n = 19)
			→	[ojaʃumi]	(n = 3)
		[ʤuːsu]	→	[ʤuːʧu]	(n = 10)
		[suki]	→	[ʧuki]	(n = 13)
			→	[ʃuki]	(n = 4)
		[asobu]	→	[aʃobu]	(n = 7)
			→	[aʧobu]	(n = 5)
		[seːtaː]	→	[ʧeːtaː]	(n = 3)
			→	[ʃeːtaː]	(n = 1)

b.	[tsumetai]	→	[tʃumetai]	(n = 20)
	[kutsuʃita]	→	[kutʃuʃita]	(n = 13)
		→	[kutʃutʃita]	(n = 1)
c.	[dʒoːzu]	→	[dʒoːdʒu]	(n = 10)
	[tʃiːzu]	→	[tʃiːdʒu]	(n = 6)
	[zoː]	→	[dʒoː(saN/tʃaN)]	(n = 6)
	[zembu]	→	[dʒembu]	(n = 9)
	[zetːai]	→	[dʒetːai]	(n = 6)
d.	[oiʃiː]	→	[oitʃiː]	(n = 22)

It is interesting to note that the palatalization process is fairly productive and participants are remarkably consistent in their responses. This, together with the fact that none of the participants were parents of small children, shows that babytalk is a highly conventionalized speech register that is part of Japanese speakers' linguistic repertoire. It is hard to imagine what would have been responses of native English speakers to a similar task, in the absence of a similarly clearly-defined babytalk register in English.

Examining the data in (7) further, note that babytalk is not limited to any particular lexical strata, as evident in the changes affecting recent loanwords (e.g., *tʃiːdʒu* from *tʃiːzu* '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., *tʃeːtaː* and *dʒembu* from *seːtaː* 'sweater' and *zembu* 'all').

In contrast to the frequent substitutions of sibilant fricatives, changes involving non-coronals or non-sibilant coronals were very infrequent, as shown in (8a) and (8b), respectively.[9] Note that all these substitutions were produced by the same four speakers, and thus can be attributed to idiolect differences or task effects.

(8)	a.	[nomu]	→	[nom^{j}u]	(n = 2)
		[samui]	→	[sam^{j}ui]	(n = 1)
		[kutsuʃita]	→	[k^{j}utsuʃita]	(n = 1)
		[haku]	→	[hak^{j}u]	(n = 1)
		[onaka]	→	[onak^{j}a]	(n = 1)
	b.	[taberu]	→	[tʃaberu]	(n = 1)
			→	[taber^{j}u]	(n = 1)
			→	[tabeju]	(n = 1)
		[zetːai]	→	[zetʃːai]	(n = 1)
		[nomu]	→	[ɲomu]	(n = 1)
		[natːoː]	→	[ɲatːoː]	(n = 1)

In addition to the segmental substitutions in target utterances discussed above, many subjects (n = 21) had similar substitutions in auxiliaries or suffixes that they

[9] An anonymous reviewer notes the common occurrence of the palatalized form *k^{j}awaiː* (from *kawaiː* 'cute') on the Internet. None of our subjects, however, produced that substitution in this word; instead, the answers were either *kawaiː* (n = 19) or *kawaiː detʃu* (n = 8).

had added to the utterances: *deʧu* (from *desu*), *-maʧu* (from *-masu*), and *-maʧo* (from *-maʃo*). For example, the target utterances *ʦumetai* 'cold' and *kuʦuʃita o haku* 'put on the socks' were changed to *ʦumetai/ʧumetai* <u>*deʧu ka*</u> and *kuʦuʃita/kuʧuʃita o hak*<u>*imaʧu*</u>, 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 *-maʧu* 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 palatalized sibilants almost exclusively. This confirms the earlier description of the babytalk register by Chew (1969) and shows that the key distinction in the process is between sibilant coronals and all other consonants, rather than between (non-rhotic) coronals and non-coronals (contra Hamano 1998). This is fully consistent with the patterns of babytalk E-Pal in other languages. Like in Japanese, anterior sibilant fricatives shift to affricates in the babytalk register in languages as diverse as Spanish, Thai, Estonian, Cree, and Kannada (among others), as shown in (9).

(9) a. *Spanish babytalk*:
[beso] → [beʧo] 'kiss' (Ferguson 1964: 105–106)

b. *Thai babytalk*:
[sǒŋsǎan] → [ʧǒŋʧǎan] 'pity' (Nattaya Piriyawiboon, p.c. 01/20/2008)

c. *Southern Estonian babytalk*:
[sysar] → [ʦʲiʦʲæ] 'sister' (Pajusalu 2001:86–92)

d. *Cree babytalk*:
[suzæn] → [ʤuʤæn] 'Suzan' (Jones 1988:141–148)

e. *Havyaka Kannada babytalk*:
[glaːsu] → [gaʧu] 'glass' (Bhat 1967:36)

6. General discussion and conclusion

The experiments presented in the previous sections have established some interesting similarities and differences between Japanese mimetic palatalization and babytalk. The comparison of the two patterns, their phonetic sources, and theoretical implications of the findings are discussed in the following sections.

6.1 Mimetic and babytalk palatalization as E-Pal

As we have seen, both mimetic palatalization and babytalk palatalization in Japanese convey a set of meanings related to smallness and/or childishness. Both phenomena show the primacy of coronal obstruents as targets and sibilants as outputs, which is manifested as a gradient tendency in mimetics and as a categorical restriction in babytalk. At the same time, the two patterns are different from each other in several respects. While mimetic palatalization shares the basic meaning of "childishness" with babytalk, it has additional meanings that can be considered as semantic extensions of this: "immaturity, instability, unreliability, uncoordinated movement, diversity, excessive energy, noisiness, lack of elegance, cheapness, lack of restraint" (Hamano 1998:238; see also Regier 1998 on the extension of iconic meanings in reduplication). Phonologically, mimetics are less restrictive in target selection (all non-approximant consonants, with non-rhotic coronals being preferred) and more faithful to the input, permitting only the palatalizing change (addition of secondary articulation or a shift in place for coronals). In contrast, babytalk restricts targets to strident coronals and modifies not only place, but also continuancy. In this respect both patterns are highly characteristic of the typology of E-Pal, with mimetic palatalization representing a phonological extension of patterns of babytalk to new classes of targets and regularization of segmental changes. Further, mimetic palatalization is largely lexicalized, forming a part of the more general sound–symbolic lexical network, with some palatalized forms having no non-palatalized counterparts and vice versa. It is structure-preserving, and the occurrence of palatalization is highly restricted (a single palatalized consonant per root). In contrast, babytalk is highly productive, applying to all forms regardless of their lexical stratum affiliation (e.g., Yamato, Sino-Japanese, and recent English loans), and exhaustive, potentially applying to all eligible targets within a word or a phrase. Taken together, the two processes exemplify two points on the concrete-to-abstract semantic/phonological continuum of E-Pal illustrated earlier in Figure 1. Mimetic palatalization is a more abstract, more lexically and grammatically integrated instantiation of iconic sound–symbolic associations, compared to the more concrete and phonologically/semantically transparent babytalk register. The greater abstractness of mimetic palatalization makes it superficially similar to some genuine phonological palatalization patterns. Yet the two kinds of patterns can never be expected to exhibit an identical set of properties, given their inherently different sources and underlying mechanisms (see Figure 1).

6.2 Frequency code and E-Pal

While we have mentioned that E-Pal as a phenomenon is grounded in iconic sound–symbolic correspondences, questions remain about what these correspondences actually are and how they arise. Here we build on Ohala's (1994) "frequency code" hypothesis. Ohala observes (p. 335) that "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, which emit 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 2007 and Shinohara and Kawahara, to appear). The associative relation between smallness and palatalization is arguably better rendered by some palatalized consonants rather than others. Alveolo-palatal sibilants (fricatives and affricates) are more acoustically salient than (alveolo-)palatal sonorants (nasals and liquids), as well as palatalized non-coronals, as they are characterized by both high F2 transitions and high-intensity strident fricative noise (Fant 1970, Stevens 1998).[10] The onset of this noise is more abrupt, and thus psycho-acoustically more salient, in affricates than in fricatives, making the former ideal for iconic sound–symbolic marking (cf. Nichols 1971:833). The symbolic relation between palatalization and smallness is likely further strengthened by articulatory properties of palatalized consonants (the smaller vocal tract and incompatibility of apical rhotics with the tongue body fronting; see e.g., Masuda 2007, Iskarous and Kavitskaya 2010), as well as speakers' observations of patterns of child language acquisition (the general "palatal quality" and fricative stopping or affrication: Tsurutani 2004; see Kochetov and Alderete 2011 for a review). In sum, the place and manner scales of E-Pal are firmly grounded in the acoustics of palatalized consonants and are reinforced by observations about their articulation and patterns of acquisition.

6.3 Theoretical implications

So far we have argued largely on empirical grounds for the distinction between E-Pal and P-Pal. We also believe there is strong theoretical motivation for treating the two as distinct phonological phenomena. As space limitations preclude us from explicating this in sufficient detail, we will only briefly touch on some of the consequences of an undifferentiated approach to palatalization. In order to make the discussion explicit, let's take Japanese babytalk as a representative example of E-Pal and compare it to three cases of P-Pal: Japanese phonological palatalization, a typical case of P-Pal with an overt *i* trigger (see ex. (1)), and two less common cases of morpho-phonemic palatalization triggered by an apparent floating feature morpheme, Zoque and Chaha (Akinlabi 1996, Zoll 1996, Kurisu 2009; but see Rose 1997 for an analysis of Chaha involving an underlying suffix -*i*). The last two cases are particularly interesting, as they have been considered to be structurally similar to Japanese mimetic palatalization (Akinlabi 1996, Zoll 1996, Kurisu 2009).

The properties of the four palatalization processes are summarized in Table 7 (following the literature mentioned above) and will be discussed in turn.

First, Japanese babytalk (BT-Pal) applies in a context-free fashion; that is, neighbouring segments do not condition the change. This is obviously in contrast to most known phonological palatalization processes, including Japanese palatalization before *i* (*i*-Pal). P-Pal processes are inherently assimilatory, being triggered by overt, usually immediately adjacent triggers. BT-Pal, however, is similar in this respect to morpho-phonemic palatalization in Zoque and Chaha (MP-Pal). The synchronic lack

[10] Noise frequency in sibilants (higher for alveolars than alveolo-palatals) does not seem to correlate with smallness to the same extent as the frequency of vowel transitions (higher for alveolo-palatals than alveolars). According to Nichols (1971), languages of Western North America vary in whether the diminutive meanings are signaled by "hissing" (alveolar) or "hushing" (alveolo-palatal) sibilants.

Table 7: A comparison of Japanese babytalk palatalization and three cases of P-Pal

	Parameters	*Japanese BT-Pal*	*Japanese i-Pal*	*Zoque MP-Pal*	*Chaha MP-Pal*
a.	Context-free application	yes	no	yes, left	yes, right
b.	Exhaustivity	yes	no	no	no
c.	Systematicity	yes	no	yes	yes?
d.	Structure preservation	no	yes	yes	yes
e.	Surface orientation	yes	no	no	no
f.	Target selection	[+cons COR +strid]	[+cons]	[+cons]	[+cons COR DOR −rhot]
g.	Output change	[−cont −ant]	[−ant]	[−ant]	[−ant]
h.	Input feature faithfulness	all except [ant, cont]	all except [ant]	all except [ant]	all except [ant]

Abbreviations used in this table:

ant	anterior	COR	Coronal	rhot	rhotic
CONS	consonantal	DOR	Dorsal	strid	strident
CONT	continuant				

of an overt trigger in the latter two, however, is due to a historical loss of the prefix *j*- or suffix -*i*, as is evident from a related word-medial palatalization (for Zoque, see Sagey 1990) or from the same process in related languages (for Chaha, see Rose 1997). It is unlikely that such a morpheme has ever been present in BT-Pal. Also the two MP-Pal processes exhibit clear edge effects (left in Zoque and right in Chaha, corresponding to the original affix location), while this is not the case for BT-Pal.

Second, BT-Pal is exhaustive, applying to more than one sibilant and often to all eligible targets. This is hardly ever the case with P-Pal processes, where a single, usually immediately adjacent segment is the target of the process. In a handful of cases of P-Pal that seem to exhibit multiple targets, these effects are subject to various other restrictions (Harari: Rose 1997, 2004; Gude: Hoskison 1975) making the processes more typologically similar to consonant harmony rather than to P-Pal (see Hansson 2001, and Rose and Walker 2004 on consonant harmony).

Third, BT-Pal is systematic in the sense that it applies to all words of the lexicon, including recent loanwords, and regardless of morphological boundaries. Although MP-Pal processes in Zoque and Chaha also appear to be systematic, as they are inflectional processes that tend to apply across the board, this is not the case for the seemingly automatic Japanese *i*-Pal, which is reported to fail to apply to coronal stops *t d* in the loanword stratum of the lexicon (Itô and Mester 1999).

Fourth, in contrast to P-Pal, BT-Pal is non-structure-preserving, as it can violate phonotactic constraints of the language (e.g., $*C^je$). It is also surface-oriented, systematically applying to surface segments rather than to lexical segments (e.g., the allophone *ts* rather than the underlying *t*). None of the examined P-Pal processes do that. In fact, it is hard to imagine that morpho-phonemic palatalization like in Zoque or Chaha could exhibit such behaviour. If anything, BT-Pal can be compared to relatively "late" allophonic or post-lexical palatalization processes, which can also produce novel segments. This property of BT-Pal, however, is hard to reconcile with the lack of overt triggers, which is more typical of the highly abstract morphologically conditioned processes. Interestingly, the surface orientation and the lack of triggers render BT-Pal more similar to other marginally linguistic phenomena such as language games (Bagemihl 1996, Itô et al. 1996), and thus profoundly different from core phonological phenomena.

Finally, BT-Pal differs from the three P-Pal cases in targets, outputs, and the change involved in the process. Its set of targets is highly restricted (sibilants only), while the classes targeted by P-Pal are relatively general (all consonants or all non-labial non-rhotic consonants). The modification of input segments in the P-Pal cases is minimal — palatalization itself (which can be assumed to involve an addition V-Place[ant] or a change from [+ant] to [−ant]; cf. Zoll 1997). In BT-Pal, palatalization per se is accompanied by affrication, which is a change in continuancy of the input segment. Recall that this kind of change is highly typical of E-Pal, yet it is virtually unknown in the typology of P-Pal. In fact, the feature [continuant] is hardly ever involved in assimilatory processes, either on its own or together with other features (McCarthy 1988). In many languages E-Pal affrication of fricatives or other consonants is accompanied by other continuancy changes, such as changes of liquids to coronal nasals or stops or velar fricatives to velar stops (so called "hardness shifts" in various indigenous languages of Western North America; Nichols 1971). Like fricative affrication, these processes have no parallels in the regular phonology of corresponding languages (Nichols 1971:838).

In sum, expressive and phonologically conditioned palatalization processes are profoundly different in most if not all structural parameters. Therefore, any generalizations about E-Pal cannot be safely extended to P-Pal, and vice versa, without missing some important properties of each. Moreover, any phonological analyses that attempt to capture both by using the same mechanisms run the risk of making incorrect predictions or adding unnecessary complexity to either system. In contrast, treatment of 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.

To conclude, although linguistically marginal, patterns of expressive palatalization provide many case studies relevant to our understanding of phonetics–phonology interaction. Our investigation of phonetic sources of E-Pal and speakers' intuitions about patterns of Japanese mimetic and babytalk palatalization has established a clear link between phonetic scales and language-particular patterns, suggesting that such scales are an important part of synchronic phonological grammars. Arguably, similar results would be more difficult to obtain when dealing with "core" phonological phenomena (cf. Hayes and Steriade 2004). Thus, further systematic typological and experimental investigations of marginal phonological phenomena will undoubtedly provide important insights into the mechanism of phonetics–phonology interactions, serving as a testing ground for phonological theories (see Bagemihl 1996, Itô et al. 1996, Joseph 1997).

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APPENDIX

Table A: C1 pal ratio results for Set 1 of Japanese mimetic experiment (see section 4.2.3)

Place	C1–C2	a–o	o–a	a–u	u–a	o–o	Mean
non-coronal–non-coronal	g–b	0.43	0.44	0.60	0.40	0.37	0.45
coronal–coronal	t–d	0.51	0.37	0.13	0.76	0.60	0.47
coronal–rhotic	t–r	0.87	0.31	0.74	0.99	X	0.73
coronal–non-coronal	t–p	1.00	0.80	0.96	X	0.91	0.92
non-coronal–coronal	p–t	0.36	X	0.11	0.21	0.19	0.22
	Mean	0.63	0.44	0.46	0.59	0.55	0.54

Note: X = pairs omitted from the set

Table B: C1 pal ratio results for Set 2 of Japanese mimetic experiment (see section 4.2.3)

Place	C1–C2	a–o	o–a	a–u	u–a	o–o	Mean
coronal–coronal, nasal/fricative	n–s	0.37	0.24	0.53	0.36	0.61	0.42
	s–n	0.66	0.66	0.53	0.56	0.46	0.57
coronal–coronal, nasal/stop	n–t	0.13	0.67	0.27	0.17	0.53	0.35
	t–n	0.58	0.71	0.50	0.81	0.44	0.61
coronal–coronal, stop/fricative	t–s	0.41	0.36	0.43	0.69	0.29	0.43
	s–t	0.77	0.74	0.66	0.67	0.87	0.74
	Mean	0.49	0.56	0.49	0.54	0.53	0.52