Integrating sound symbolism with core grammar: The case of expressive palatalization

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ABSTRACT. Fifty cases of sound-symbolic expressive palatalization were collected in a typological survey of babytalk registers, diminutive constructions, and other sound symbolic systems. Analysis of the typological trends and language-particular examples reveals important differences between expressive palatalization and phonologically motivated palatalization. To account for expressive palatalization, we propose a novel set of EXPRESS(X) constraints in Optimality Theory. The integration of the EXPRESS(X) constraints with the rest of phonology is shown to explain the typological differences between expressive and phonological palatalization, account for the phonological extension of expressive palatalization, and constitute a general theoretical framework for sound symbolic phonological patterns.[*]

KEY WORDS: sound symbolism, palatalization, expressive phonology, typology, Optimality Theory

1. INTRODUCTION

Some of the most robust patterns in phonology are found in sound symbolic systems. The fixed sound sequences in PHONESTHEMES, like English *gl* 'vision, light' (1a), have been found in several genetically and geographically distinct languages, and indeed in all languages where one has endeavoured to look (Bergen 2004; Hinton et al. 1994b). BABYTALK registers, or the specialized registers used with small children, are equally common and exhibit a host of recurring phonological patterns, including shape canons, cluster resolution, reduplication, and characteristic segmental alternations (Ferguson 1964; Ferguson 1977). IDEOPHONES and other kinds of sound symbolic vocabularies may not be as prevalent in Indo-European languages, but they are tremendously important linguistic structures in the languages of Asia, Africa, and the Americas (Voeltz & Kilian Hatz 2001). The phonology of ideophones overlaps considerably with the patterns observed in babytalk registers. Japanese ideophones, for example, exhibit a pattern of palatalization (1c) that compares with similar types of sound-symbolic or expressive palatalization patterns found in babytalk (1b), diminutive constructions, and onomatopoeia (Kochetov & Alderete 2011; Nichols 1971). Cross-linguistic investigation of these phonological patterns rivals that of any typological domain and has documented a number of typological trends in sound symbolism of considerable interest (see e.g. Dingemanse (2012); Haynie et al. (2014); Ultan (1978)).

(1) Phonological patterns in sound symbolism

a. Phonesthemes: *gl* 'light, vision', *gleam, glisten, glow* (English)

b. Babytalk registers: /ɻamaɾa/ → *[j]ama[j]a* 'ribs' (Warlpiri, Laughren 1984)

c. Ideophones: *[tʃ]oko-[tʃ]oko* 'moving like a small child', cf. *toko-toko* 'trotting' (Japanese, Hamano 1986/1998)

Despite its prevalence, it is fair to say that sound symbolism has never found a natural place in generative grammar. The reason for this state of affairs is many-fold, but we believe that one of the main

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obstacles is a kind of 'all-or-nothing' mentality that has guided its treatment. On the one hand, sound symbolism runs counter to several deeply held beliefs in linguistics, leading many to either exclude it from analysis or relegate it to the margins of grammar. Conventional and imitative sound symbolism like the patterns in 1 exhibit non-arbitrary relationships between sound and meaning, running contrary to the prevailing view of the arbitrariness of the sign (Saussure 1959). These structures also challenge the principle of compositionality, because the abstract semantic features of phonesthemes and ideophones cannot be easily isolated and combined together in coherent semantic representations (Bolinger 1950; Diffloth 1972; Kita 1993). Perhaps more problematic, the formal properties of sound symbolic systems seem exceptional in many ways, exhibiting phonologically aberrant structure, special paradigms and morpho-syntactic requirements, interspeaker variation, and imperfect control (Ferguson 1977; Kita 1997; Zwicky & Pullum 1987). Sound symbolism, from this perspective, is different in kind from productive phonology and morphology, and so its analysis must therefore be marginal in grammar.

A different perspective is emerging, supported by recent work in psycholinguistics, that sound symbolism is indeed suitable for analysis within generative grammar. Phonesthemes may be a problem for compositionality, but they seem to fit well within the view of the lexicon as a web of interconnected linguistic units, a position that has become dominant in psycholinguistics (see e.g. Dell (1986); Luce and Pisoni (1998)). Bybee (1988) shows how lexical networks can capture the relationship between the phoneme sequences and semantic features in phonesthemes, and this non-compositional analysis has been probed psycholinguistically and demonstrated to display priming effects similar to compositional morphology (Bergen 2004). Recent research has also uncovered non-trivial roles for sound symbolism in language acquisition, including the facilitation of word learning by iconic perceptuomotor analogies (Imai et al. 2008; Kelly et al. 2010; Nygaard et al. 2009) and aid in category learning through more abstract but systematic sound-meaning correspondences (Cassidy & Kelly 1991; Fitneva et al. 2009; Monaghan et al. 2012). If, as these results suggest, the sound-meaning associations of sound symbolism are psychologically real and provide important evidence in language learning, perhaps their marginal status in grammar should be reconsidered.

In this light, it is interesting to review phonological analyses that have bucked the usual trend outlined above and approached sound symbolism with standard tools of linguistic analysis. Since Ferguson (1977), the segmental processes of babytalk have been formalized using *SPE* rule notation (Chomsky & Halle 1968), which attests to ease with which expressive and regular phonology can be compared. In autosegmental approaches to sound symbolism, certain segmental alternations have been treated as featural morphemes subject to the same principles as those governing non-expressive phonology and morphology (Akinlabi 1996). Thus, Mester and Itô (1989) motivate association principles for docking a featural morpheme in Japanese mimetic palatalization (1c) and compare it directly to the analysis of non-expressive sequential voicing in Japanese; see also Hualde (1991) for a related approach to Basque. In a similar vein, Kurisu (2009) argues that the docking of palatal prosody in Japanese mimetics illustrates certain featural compatibility constraints that apply to both expressive and non-expressive phonology. In yet another example, Zoll (1997) likens the apparent conflicting directionality patterns in expressive grammar to similar patterns in default-to-opposite stress systems (cf., Alderete and Kochetov (2009)). While these parallels need to be investigated and validated in broader analysis, the recurring comparisons between phonological typology and the phonology of sound symbolism, across a variety of different frameworks, places a greater emphasis on the need to integrate sound symbolism with traditional grammar, a point that is often echoed by field researchers (Abbi & Victor 1997; Dixon 2010).

Our goal here is not to argue for one of these positions over the other, but instead show that an acceptable middle ground exists that preserves the insights of both positions. In particular, we focus on expressive palatalization, as illustrated above in 1b-c, and argue that its integration with a standard phonological grammar has a number of desirable consequences. First, we argue that expressive palatalization is indeed different in kind from phonologically motivated palatalization, and we defend this position with original typological evidence. Second, the typological differences are argued to stem from differences in the functional motivation for the two types: expressive palatalization is motivated by iconic sound-meaning associations that distinguish it from phonological palatalization. Third, this distinct motivation is formalized with a set of EXPRESS(X) constraints that require the existence of palatal feature structure in specialized lexical domains. We illustrate how the integration of these constraints within standard optimality theoretic grammars accounts for the typological differences between expressive and phonological palatalization. While we do not make the specific argument that system integration is only possible in Optimality Theory (OT), our results demonstrate how these typological differences can be accounted for as a natural consequence of core tenets of OT, namely that constraints are ranked and violable. The larger goal here is to provide explicit formal tools for the creative analysis of sound symbolism, and therefore break the impasse that exists in contemporary approaches to this important empirical phenomenon.

The rest of this article is organized as follows. The next section illustrates expressive and phonological palatalization and fleshes out a set of typological patterns that demonstrate fundamental differences between the two types. Section 3 provides the theoretical background for palatalization in general, and expressive palatalization in particular, including an original proposal for the EXPRESS(X) constraints. In section 4, we show how the typological differences between phonological and expressive palatalization can be captured in a standard OT grammatical architecture by presenting results of a detailed factorial typology. Section 5 goes on to show how the structural relationships formalized by the factorial typology support the phonological extension of expressive phonology, and that the generalization mechanisms also require integration of expressive grammar. The last section presents our conclusions and some further issues raised by the research.

2. PHONOLOGICAL PALATALIZATION VERSUS EXPRESSIVE PALATALIZATION

To establish the typological facts, we must first give a general characterization of the two types of palatalization we wish to investigate. PHONOLOGICAL PALATALIZATION[1] is an assimilatory process in which consonants acquire either a secondary palatal articulation or a shift in coronal place, usually triggered by front vowels or palatal glides (Bateman 2007; Bhat 1978). It is inherently assimilatory and its motivation is relatively uncontroversial: it is generally viewed as the phonologization of gradient consonant-to-vowel co-articulation (Hyman 1975) and the miscategorization of this C-V structure in the phonetics (Guion 1996). In Japanese, for example, phonological palatalization affects all consonants before *i* and replaces a plain consonant with its palatal counterpart (Vance 1987, Chen 1996, Labrune 2012). This is illustrated below with secondary palatalization of non-coronals and rhotics (2a) and shifts in alveolar coronals (2b).

(2) Phonological palatalization in Japanese before *i*

a.	/job-itai/	jo[b^j]itai	'call'
	/wak-itai/	wa[k^j]itai	'boil'
	/kar-itai/	ka[r^j]itai	'shear'
b.	/kat-itai/	ka[tʃ]itai	'win'
	/kas-itai/	ka[ʃ]itai	'lead'
	/ʃin-itai/	ʃi[ɲ]itai	'die'

[1] We follow Kochetov & Alderete's (2011) use of this term, essentially as a contrast to expressive palatalization, but it is a misnomer because expressive palatalization also involves phonological structure and phonological palatalization does not always exhibit synchronic evidence of assimilation. In invoking Kochetov and Alderete's terminology, we are focusing on the key functional differences between assimilatory (phonological) and iconic (expressive) palatalization.

EXPRESSIVE PALATALIZATION, on the other hand, is not typically assimilatory or phonologically conditioned. Rather, it is a fact of a register or a lexical domain in which it serves an iconic function. Expressive palatalization is commonly found in sound symbolic systems like mimetic vocabularies, hypocoristics, and diminutive morphology, as well as specialized BABYTALK registers used by care-givers when speaking with small children.[2] In these circumscribed domains, palatalization carries the sound-symbolic function of denoting smallness, child-like behavior, or, in the case of babytalk registers, it embodies a kind of phonological mimcry of small children (Ferguson 1977; Nichols 1971; Ohala 1994). In Japanese babytalk, for example, coronal fricatives and *ts* are systematically replaced with *tʃ/dʒ* (Chew 1969, Kochetov and Alderete 2011, Sawada 2013) as illustrated below.

(3) Expressive palatalization in Japanese babytalk

Source phrase	Babytalk form	Gloss
onaka suita	onaka [tʃ]uita	'(Are you) hungry'
tsumetai	[tʃ]umetai	'(Is it) cold?'
kutsuʃita o haku	ku[tʃ]u[tʃ]ita o haku	'Put on your socks, would you?'
se:ta: wa doko	[tʃ]e:ta: wa doko	'Where's the sweater?'
tʃi:zu wa oiʃi:	tʃi:[dʒ]u wa oi[tʃ]i:	'The cheese is yummy'

As this example demonstrates, expressive palatalization is not assimilatory in nature. The affricates are inserted before all vowels, even before the mid front vowel *e*, as in *tʃe:ta:*, creating a *tʃe* sequence that is otherwise outlawed in Japanese (Itô & Mester 1995; McCawley 1968).

These differences in the motivation for expressive and phonological palatalization correlate with a set of cross-linguistic differences in the patterning of palatalization (Kochetov & Alderete 2011). In a sense, the main goal of this work is to explain these correlations. Kochetov and Alderete (2011) compiled a dataset of 37 cases of expressive palatalization, including examples from babytalk registers, diminutive morphology, and other sound symbolic vocabularies. They established certain typological differences between the two types of palatalization by contrasting the typological trends in expressive palatalization with the patterns documented in Bateman's (2007) typological survey of phonological palatalization. We review these findings below, and build on the original sample by contributing 13 additional examples. The 50 cases of expressive palatalization come from 43 different languages (or dialects), belonging to 31 different genera and 22 language families. While not suitable for statistical analysis, every effort has been made to support our typological generalizations with a broad sample of languages. A factbook with full references and a spreadsheet file for exploring these systems further are available from the authors' webpages.

To give a sense of the patterns in our dataset, consider the mappings schematized in (4-7), where column headers represent the inputs from an entire natural class (i.e. k = non-coronal stop, n = sonorant, t = coronal stop, s = coronal fricative) and cells show the observed output pattern. The last column lists the language examples by type (BT = babytalk register, DIM = diminutive construction, SS = sound symbolic vocabulary). Like phonological palatalization, expressive palatalization may involve the insertion of secondary palatalization (4a-c), a shift of place articulation (5), or some combination of the two (4d-e). Cases also differ in the scope of palatalization, with some cases, like 4a, affecting the entire consonant system, and others palatalizing a smaller subset, for example 4c or 5g. These schematic snapshots standardize the affected segments to either palatals (*c ɲ*), post-alveolars (*ʃ tʃ*), or secondary

[2] A number of terms in the psycholinguistic literature have been used recently to describe the speech of adults in similar situations, see for example Shockey & Bond (1980), including 'motherese' and infant-directed speech. By employing Ferguson's term, more often used in the ethnography of speaking literature, we wish to emphasize the conventionalized nature of the lexicon and phonological patterns. For example, Kochetov & Alderete (2011) asked 35 university age Japanese adults to speak in babytalk and found considerably uniformity in eliciting the patterns shown in 3.

palatalizations (*k*ʲ), and are intended to apply to the entire natural class, which reflects the majority of cases. However, palatalization in some languages produces alveolo-palatals, as in Jaqaru, and in few cases, palatalization does not apply to the entire class. For example, rhotics are often exceptional, and in some cases, like Bengali babytalk and Latvian diminutives, default coronals fail to palatalize, a typical kind of coronal exceptionality (Paradis & Prunet 1991).[3]

(4) Secondary palatalization (7 cases, 5 distinct patterns)

	k	n	t	s	
a.	kʲ	nʲ	tʲ	sʲ	Estonian (Southern) BT, Saami (Kildin) DIM
b.	k	nʲ	tʲ	sʲ	Russian DIM
c.	k	n	tʲ	sʲ	Greek BT
d.	kʲ	ɲ	tʃ	ʃ	Japanese SS, Polish DIM
e.	k	ɲ	tʲ	ʃ	Marathi BT

(5) Place shifts, typically coronals (24 cases, 9 patterns)

	k	n	t	s	
a.	k	ɲ	c	ʃ	Arandic BT, Basque (Eastern) BT/DIM, Gurindji Kriol BT, Huave DIM, Koryak DIM, Warlpiri BT
b.	k	ɲ	tʃ	ʃ	Basque SS, Mapuche SS
c.	k	ɲ	t	ʃ	Cahuilla DIM, Cupeño DIM, Quechua DIM
d.	k	ɲ	tʃ	tʃ	Latvian BT
e.	k	n	tʃ	ʃ	Cree BT, Cree (Moose, E. Swampy) DIM, Ojibwa (Island Lake) DIM
f.	tʃ	n	tʃ	ʃ	Latvian DIM
g.	k	n	t	ʃ	Dakota BT, Nuuchahnulth DIM, Persian BT, Quechua (Santiago del Estero) SS, Quechua (Wanca) BT
h.	k	n	c		Jaqaru DIM
i.	k	n	ts	ʃ	Wiyot DIM

A substantial number of cases also have a single output segment, namely one of the affricates shown in 6 and 7. These substitution patterns also differ in scope and the specific place and manner classes affected.

[3] These details can be explored further in the associated factbook, but certain facts should be made clear here. Arandic, Gurindji Kriol, and Warlpiri pattern with the other languages in 5a, but they lack fricative palatalization because they either lack phonemic fricatives or there is insufficient evidence in the babytalk data. Also, fricative palatalization is difficult to determine in Jaqaru, Georgian, and Yurok, due to lack of evidence. Input *s* in Chukchi denotes a lateral fricative. Finally, dorsals and labials generally pattern together as a class of non-coronals (represented here as "k"), but diminutives in Georgian and Latvian palatalize dorsals but not labials, and Polish diminutives palatalize labials but not dorsals.

(6) Affrication I: tʃ (15 cases, 5 patterns)

	k	n	t	s	
a.	tʃ	tʃ	tʃ	tʃ	Basque (Western) DIM
b.	tʃ	tʃ	tʃ		Georgian DIM
c.	k	n	tʃ	s	Osage DIM, Yurok DIM
d.	k	n	t	tʃ	Chukchi DIM, Chumash (Ventureño) DIM, Japanese BT, Kannada (Havyaka) BT, Karok DIM, Korean BT, Miwok (S. Sierra) DIM, Spanish BT, Thai BT, Bengali BT
e	k	n	tʃ	tʃ	Chilean Spanish DIM

(7) Affrication II: ts (4 cases, 3 patterns)

	k	n	t	s	
a.	k	n	ts	ts	Greek SS
b.	k	n	ts	s	Cree (Plains, W. Swampy) DIM
c.	k	n	t	ts	Nez Perce DIM, Paiute (Northern) DIM

One salient distinction emerging from this dataset, when compared with phonological palatalization, concerns the different motivations for affrication. In phonological palatalization, obstruents sometimes become affricates because affricates pattern with stops, or the language simply lacks a corresponding palatal stop, as in Japanese phonological palatalization (2). Affrication in these cases can be seen as a kind of structure preservation (Kiparsky 1985), where the palatal affricate is the closest stop-like sound to a palatal stop. In expressive palatalization, on the other hand, affricates arise because of sound-symbolic associations between their acoustic structures (high F2 and high intensity strident noise) and the concept of smallness (Kochetov & Alderete 2011; Ohala 1994). These associations account for the single output systems in 6-7, including certain cases of rampant palatalization that seem entirely unnatural from the point of view of assimilatory palatalization. For example, Georgian diminutives are formed by shifting coronal and velar stops, as well as coronal sonorants, to alveolar and post-alveolar affricates (8). Such an aggressive pattern of neutralization, targeting multiple manner and place classes, is completely unattested in phonological typologies of palatalization.

(8) Aggressive affrication in Georgian diminutives (Neisser 1953)

	base form	diminutive	
a.	toto	tʃotʃori	Tierjunges (cub)
	pit'i	pitʃ'i	Honigscheibe (honeycomb)
b.	k'bena	na-k'betʃa	bebeißen, anbeißen (to bite into)
	puri	putʃina	Kälbchen (calf, babytalk)
c.	nak'uk'i	natʃ'utʃ'i	Schale (shell, skin)
	kunkuri	tʃuntʃuri	Beschälung (covering)

An examination of the affrication patterns in 6 and 7 reveals another important typological difference between expressive and phonological palatalization. While phonological palatalization may produce an affricate to avoid a marked palatal stop or sonorant, it never changes fricatives to affricates (Bhat 1978). However, in expressive palatalization, 15 of the 19 affrication systems do precisely this: 6a, 6d, 6e, 7a and 7c; see also 5d. Our dataset also includes many examples in which palatal fricatives become affricates, as in *oiʃi:* → *oitʃi:* 'yummy' in Japanese babytalk. But again, affrication of palatal fricatives is entirely unattested in phonological palatalization. Concerning the insertion of alveolar affricates in 7, phonological palatalization is sometimes grouped with cases of assibilation that involve similar mappings to *ts* (Telfer (2006), cf. Bateman (2007)), as in Japanese *t* → *ts* /__*u*. However, no cases of assibilation that we are aware of map fricatives to *ts*. Expressive palatalization, on the other hand, has three examples of this type: 7a and 7c. Clearly, affrication is a mechanism intrinsic to expressive palatalization that works rather differently than affrication in phonological palatalization.

Another salient fact is that expressive palatalization exhibits a place asymmetry not found in phonological palatalization. As shown below, both types can target specific places of articulation, like the common limitation to coronal consonants. In expressive palatalization, however, this coronals-only palatalization is found almost all the time (86%), and when non-coronals are palatalized, so too are corresponding coronals. Thus, of the seven cases with non-coronal expressive palatalization, four palatalize all place classes, two cases, Georgian and Latvian, palatalizes specifically coronals and dorsals, and Polish palatalizes coronals and labials.

Table 1. Place of articulation targets: phonological vs. expressive palatalization

	cor	dor	cor+dor	cor+lab	lab+cor+dor
Phonological (*n*=50)	30	10	8	0	2
Expressive (*n*=50)	43	0	2	1	4

While exclusive palatalization of coronals is still the most common type of system in Bateman's dataset, it is much less frequent (60%) and non-coronal palatalization does not imply coronal palatalization. Indeed, dorsals-only phonological palatalization is well established cross-linguistically and represented by genetically and geographically diverse languages, including Luganda (Niger-Congo), Roviana (Austronesian), Dakota (Siouan), and Somali (Afro-asiatic); see Bateman 2007: 305 and Hume (1994) for additional examples. These data collections are not suitable for statistical analysis because the examples were not collected in a way that ensured the independence of cases. However, the contrast between the two types for dorsals-only palatalization is striking: in phonological palatalization, dorsals-only palatalization accounts for half of the 20 non-coronal cases. In expressive palatalization, none of the seven non-coronal cases meet this description, which we believe calls for interpretation. To summarize, dorsal palatalization implies coronal palatalization in expressive phonology, but this is not the case in phonological palatalization.

Another set of differences between expressive and phonological palatalization concerns manner of articulation. Expressive palatalization always targets obstruents, and sometimes also targets sonorants. In our sample, 29 out of 50 cases palatalize only obstruents and another 21 cases palatalize both obstruents and sonorants. Thus, the pattern of sonorants-only expressive palatalization is unattested in our dataset. Obstruents are also more frequently targeted in phonological palatalization, a fact that Bateman (2011) attributes to the larger number of obstruents in sound inventories. However, as shown in Bateman's collection of examples, phonological palatalization does not have the same implicational relation. Some languages palatalize obstruents only, others palatalize non-rhotic sonorants exclusively, and still others palatalize both manner classes. As with dorsal palatalization, exclusive sonorant palatalization is attested in several unrelated languages, including Basque (isolate), Tohono O'odham (Uto-Aztecan), Eastern Mari (Uralic), Greek, and Lahu (Sino-Tibetan).

Another difference concerning manner is that obstruents are preferred outputs of expressive palatalization, so much so that sonorants can be changed to post-alveolar affricates in two systems mentioned above, Western Basque (6a) and Georgian (6b). Phonological palatalization, on the other hand, has no cases with such a drastic change. Like the place asymmetry, expressive palatalization exhibits a manner asymmetry in which sonorant palatalization implies obstruent palatalization, but this implicational relation does not hold in phonological palatalization.

3. THEORETICAL ASSUMPTIONS

3.1 PHONOLOGICAL PALATALIZATION

Starting with our representational assumptions, we assume that the featural make-up of the inputs and outputs of both types of palatalization are essentially the same. In particular, the phonological representations of alveolar and post-alveolar affricates are identical in both expressive and phonological palatalization, as are the manner and place classes that serve as input to these processes. We also assume, following standard practice (Hume 1994; Lombardi 1990; Sagey 1986), that affricates have complex manner. That is, they have both [-continuant] and [+continuant] specifications. Concerning place specification, we adopt the analysis of Jacobs (1989) and Jacobs and van de Weijer (1992) (see also Halle (2005) and Telfer (2006) for related ideas), that palatals and post-alveolars have complex place, with both a coronal and dorsal component, and that the [dorsal] specification has a [-back] dependent. Beyond the advantages it has for the phonetics of palatals (Keating 1988), we feel the complex place approach represents a good CONSENSUS MODEL of palatalization because it captures shifts to a posterior place as a consequence of autosegmental spreading, and secondary palatalization as a linking to the dorsal component of the vowel. However, alternative models (Bateman 2007; Hume 1994; Lahiri & Evers 1991) could be adopted with similar results. Our goal is not to argue for one theory of palatalization over another, but to show that a sensible model of the feature representation of palatals and post-alveolars can be used for both expressive and phonological palatalization.

We employ a set of markedness and faithfulness constraints in Optimality Theory (Prince & Smolensky 1993/2004) to implement this model. Following prior research in OT (Fukazawa 1999; Lombardi 2001; McCarthy & Prince 1995), we make a distinction between features that act as autosegments, and features that seem to behave as integral parts of segments. Autosegmental features are governed by the MAX/DEP[FEATURE] constraints, and the rest are governed by IDENT[FEATURE] constraints, as shown below. The feature [continuant] is treated as an autosegmental feature because the complex manner of affricates requires insertion of either [+continuant] or [-continuant]. The facts of both expressive and phonological palatalization indicate that faithfulness to [continuant] must distinguish stop → affricate from fricative → affricate mappings; see (6-7) above and Bhat (1978) on phonological palatalization. Consequently, we must split DEP[CONT] into two separate constraints.

(9) Faithfulness

IDENT[SON]	Corresponding segments agree in [sonorant].
IDENT[BACK]	Corresponding segments agree in [back].
MAX[CONT]	No deletion of [continuant].
DEP[+CONT/-CONT]	No insertion of [+cont], No insertion of [-cont].
DEP[PLACE]	No insertion of place features.
MAX[PLACE]	No deletion of place features.

The markedness constraints that motivate phonological palatalization are given below in 10. The first four constraints account for the context-sensitive nature of phonological palatalization by banning different natural classes before high front vocoids. These constraints are admittedly descriptive, but they are in fairly widespread use (Hall & Hamann 2003; Itô & Mester 1999; Telfer 2006), and they accomplish the task at hand. These constraints work in tandem with the last four constraints to structure the output of palatalization by penalizing secondary palatalization, alveolar affricates, palatals in general, and non-strident palatals. *C^j, *Ts, and *PALATAL are motivated typologically in that they ban marked segments, and their occurrence in an inventory implies the existence of their less marked counterparts (Maddieson 1984). These segment classes are also more complex featurally, with either secondary place, complex manner (affricates), or complex place (palatals), which fits formally with the contention that complex structures are more marked. PALSTRIDENCY has been motivated on phonetic grounds (Calabrase 2005), stemming from the difficulty in producing palatals without a period of airstream turbulence, and all four of these constraints have been employed in prior analyses of palatalization and assibiliation (Chen 1996; Telfer 2006), providing evidence from alternations.

(10) Markedness

*KI	No sequence of non-coronal stop followed by a high front voicoid.
*NI	No sequence of a sonorant coronal followed by a high front voicoid.
*TI	No sequence of a coronal stop followed by a high front voicoid.
*SI	No sequence of a coronal fricative following by a high front voicoid.
*C^j	No consonants with secondary palatalization.
*Ts	No *ts dz*.
*PALATAL	No palatal consonants (bans *c ɟ*, *ʃ ʒ*, *ɲ*, and *tʃ dʒ*)
PALSTRIDENCY	Palatals must be strident (bans *c ɟ* and *ɲ*, but not *ʃ ʒ* or *tʃ dʒ*).

Again, while we believe Jacobs and van de Weijer's complex place model is explanatory, our goal here is not specifically to explore consequences of that model on palatalization in OT. Rather, our focus is on implementing an established model of palatalization that accounts for the context-sensitive nature of phonological palatalization. We do this here with context-sensitive markedness constraints, following many before us.

To illustrate these assumptions, phonological palatalization involves spreading of the complex Place of *i* to the neighboring consonant. The double [coronal] + [dorsal/-back] specification results in a post-alveolar stop or affricate (Jacobs & van de Weijer 1992), as shown in Figure 1 on the left below. We assume, following Jacobs and van de Wiejer, that different classes of coronals arise from [anterior] and [distributed] specifications. The majority of cases discussed below are post-alveolars, and are therefore specified [+ant, -distr]. But some cases involve prepalatal blade articulations, and thus [-ant, +distr]. Secondary palatalization also involves a [dorsal/-back] specification, but to formalize its secondary status, it is spread to a VPlace node, shown on the right. Alternatively, a Sageyan (1986) 'pointer' device could be used to indicate secondary status.

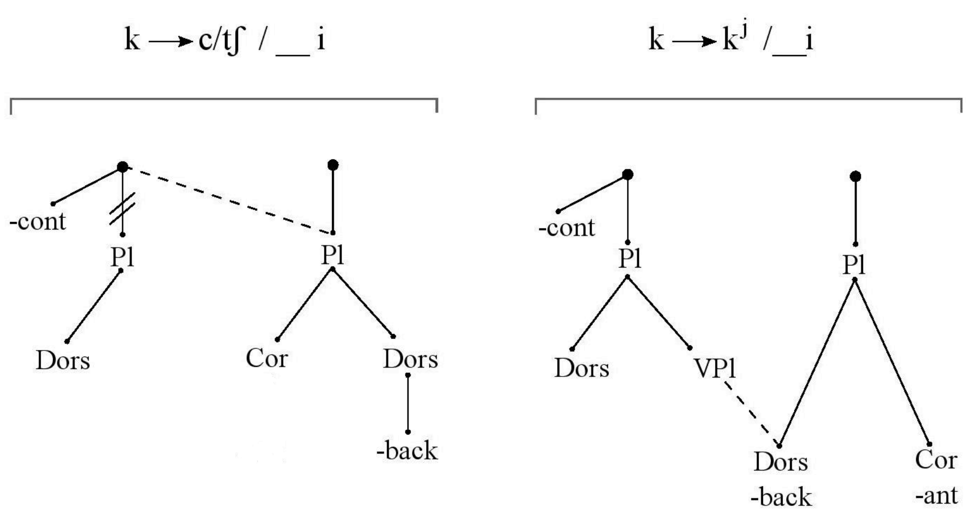

Figure 1. Context-sensitive phonological palatalization

In our implementation of the consensus model, place-shifting palatalization comes about by ranking both context-sensitive and general markedness constraints above MAX[PLACE], as shown in 11 for /ki/ → *tʃi*. Thus, top-ranked *KI prohibits the faithful mapping, and *C^j and *PALSTRIDENCY shape the output by prohibiting marked secondary palatalization and palatal stops. Secondary palatalization, on the other hand, involves the domination of *C^j by either Max[Place] or Dep[+cont], as shown in 12.[4]

(11) Phonological palatalization: change of place palatalization

/ki/	*KI	*C^j	*PalStrid	DepPlace	MaxPlace	*Dep(+cont)
ki	*!					
ci			*!		*	
→ tʃi					*	*
k^{j}i		*!				

(12) Phonological palatalization: secondary palatalization

/ki/	*KI	*PalStrid	MaxPlace	DepPlace	*C^j	*Dep(+cont)
ki	*!					
ci		*!	*			
tʃi			*!			*
→ k^{j}i					*	

The consensus model thus accounts for phonological palatalization as the result of assimilation via feature deletion and modification of association lines, driven by context-sensitive markedness.

3.2 Expressive palatalization

Expressive palatalization is not assimilatory, and as a result, the autosegmental operations that underlie it are different from phonological palatalization. Rather than spreading complex place from a neighboring vowel, expressive palatalization involves more autosegmental action, as shown below for a velar input. Thus, mapping a velar to a coronal involves both inserting a primary Cor specification and the flipping of the [+back] specification in the velar to [-back] in the post-alveolar. Secondary palatalization likewise involves feature insertion, in particular, a Dors/[-back] specification under the VPlace node to account for the palatal off-glide. Comparing Figure 2 with Figure 1, expressive palatalization has Dep[Place] and Ident[back] violations not found in phonological palatalization because its non-assimilatory nature requires both feature insertions and feature value switches.[5]

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[4] We assume that insertion of a VPlace node in secondary palatalization has no faithfulness cost, essentially because it is unclear if this structural assumption is necessary, given the Sageyan pointer device mentioned above. This assumption does not impact our argument, as it is not at the heart of the difference between expressive and phonological palatalization.

[5] A plausible alternative to this approach would involve deletion of the velar's dorsal component, and insertions of both primary Cor and Dors/[-back] specifications to account for the complex Place of the post-alveolar. We have examined both options and opt for the proposed account, which retains the velar's Dors specification and flips its [+back] dependent to [-back], because it is actually a more generous account of palatalization for the purpose of an argument laid out below, and it appears to be more in the spirit of the Jacobs and van de Weijer's original proposal.

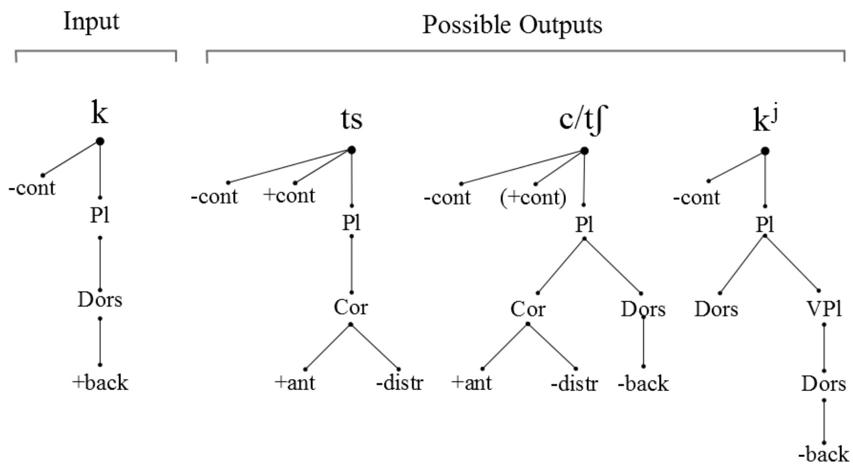

Figure 2. Context-free expressive palatalization

What kinds of constraints could motivate such drastic autosegmental actions as these? They cannot be based on phonologically natural assimilations because the sound substitutions are not context sensitive. Instead, we require a set of constraints that formalize the iconic function of palatals and affricates in circumscribed domains, namely specific registers, lexical levels or strata. To capture this iconic function, as well as the typological facts discussed above, we propose the set of EXPRESS(X) constraints below.

(13) EXPRESS(X) constraints

EXPRESS[PAL]: All segments must be palatal (i.e. have a Cor & Dors/[-back] specification).

EXPRESS[AFFRIC]: All segments must be affricates (i.e. have both [-cont] and [+cont]).

These constraints are context-free because they require palatal and affricate structure in all segments. Which segments actually get affected is a matter of ranking the EXPRESS(X) constraints relative to other markedness and faithfulness constraints in the usual fashion of OT grammars. For concreteness, these constraints adopt specific featural assumptions, namely that post-alveolars are complex segments with coronal and dorsal components, and the relatively standard assumption that affricates have both [-continuant] and [+continuant] specifications (see above).

The EXPRESS(X) constraints above are designed to implement the frequency code hypothesis of Ohala (1994) in an OT system, as well as the iconic motivation for expressive palatalization given in Nichols (1971) and Dressler and Barbaresi (1994). In particular, they capture the two basic forces in Nichols' (1971) study of diminutive consonant symbolism, namely HIGHER TONALITY (an attribute from Jakobson et al. (1952), i.e. acute and sharp consonants and vowels) and INCREASED HARSHNESS (affrication). Acute consonants are anterior coronals characterized by raised F2 and a smaller front oral cavity, when compared with labials and velars, and sharp consonants are palatalized consonants with even higher formants resulting from the smaller front oral cavity. Affricates are produced with an abrupt onset of high intensity strident noise. Both the raised F2 and the noise onset are auditorily salient properties that can be associated with ideas of childishness and smallness. The EXPRESS(X) constraints formalize these two separate forces as separate rankable constraints, and we argue below that these two forces must be separate in our typology. Both Nichols (1971) and Ohala (1994) discuss additional segmental changes, including stopping, glottalization, and certain fronting processes. However, because palatalization and affrication are central to the systems we examine here, we will focus on them. Further investigation of expressive phonology may lead us to extend the EXPRESS(X) constraints to these additional structures (see section 6).

The EXPRESS(X) constraints also find support in the grammar of reduplication, whose iconic nature has been noted in many studies (Haiman 1980; Kiyomi 1995; Regier 1988). In Yip's (1998) theory of reduplication and repetition avoidance, doubled forms (both morphological and prosodic categories) are created by the constraint REPEAT(X). Thus, our EXPRESS(X) constraints and Yip's REPEAT(X) constraint create specific output targets in iconic constructions. The EXPRESS(X) and REPEAT(X) constraints can therefore be understood as part of a larger family of iconic constraints in OT that set specific output targets, a parallel we return to below in connection with phonological extension.

Putting these ideas into action, the role of the EXPRESS(X) constraints is shown below for *k* → *tʃ* palatalization. Compare these candidates with their feature representations in Figure 2. Outputs *co, tʃo,* and *tso* all insert a primary Cor specification, and so receive a DEP[PLACE] violation each. Output *kʲo* also gets a DEP[PLACE] violation because it inserts a Dors/[-back] specification for its palatal off-glide. IDENT[BACK] violations are assigned to *co* and *tʃo* because these post-alveolars retain the Dors specifications of the velar input, but switch the dependent [back] specification. The other outputs either lack a Dors specification (*ts*) or do not change the corresponding Dors (*kʲo*), and so they do not violate this constraint. The two affricate outputs, *tʃo* and *tso*, receive an inserted [+cont], and thus violate *DEP[+CONT]. These violations are caused by the higher-ranking EXPRESS(X) constraints, which favor *ko* → *tʃo*, because it inserts palatal feature structure and results in an affricate.

(14) Expressive palatalization: context-insensitive segment substitution

/ko/	EXPR[PAL]	EXPR[AFF]	*Cʲ	*PALSTRID	ID[BACK]	DEP[PL]	MAX[PL]	*DEP[+CONT]
ko	*!	*						
co		*!		*	*	*		
→ tʃo					*	*		*
tso	*!					*	*	*
kʲo		*!	*			*		

The larger point is that expressive palatalization is non-assimilatory, and so it is governed by constraints that are different from those required for phonological palatalization. The EXPRESS(X) constraints shown above account for their non-assimilatory iconic nature.

What kind of constraints are the EXPRESS(X) constraints in Optimality Theory? Several options seem plausible. The fact that many babytalk registers work on existing words suggests an output-to-output constraint similar to those employed for language games (Itô et al. 1996), perhaps achieving the insertion of the palatal feature structure using the negation of DEP-type constraints in anti-faithfulness theory (Alderete 2001; Alderete 2008). Alternatively, the EXPRESS(X) constraints can be implemented as markedness constraints that simply require segments to have specified features (see Zoll (1997) and Finley (2009) for formal proposals). The fundamental difference between these two options is whether EXPRESS(X) asserts a requirement on output forms only (markedness) or if they work on the relation between two forms (output-to-output). For most cases, it would seem that both options are possible, but two examples seem to suggest the markedness approach. In western varieties of Basque, diminutives are formed by shifting the initial consonant (of any place of articulation) to the alveolar palatal affricate *tʃ*, for example /pispildu/ → *tʃispildu* 'become happy after drinking (perfect, diminutive)', but the affricate is also inserted in vowel-initial words, as in /iɲuri/ → *tʃiɲuri* 'ant' (Hualde & Urbina 2003). The lack of input structure here leads to a problem for the correspondence approach because there is no segment in the input for the constraint to palatalize. Another example illustrates expressive palatalization in derived phonological structure, which again lacks a corresponding sound in the input. Many Cree languages have a morphologically restricted rule of *t*-epenthesis that resolves VV sequences at the prefix-stem juncture (Bloomfield 1946; Piggott 1980). Cree languages like Moose Cree and Eastern Swampy Cree also have expressive palatalization in diminutives, shifting *t* and *s* to *tʃ* and *ʃ* in stems, for example /iskwe:w-iʃiʃ/ → *i[ʃ]kwe:ʃiʃ* 'girl' (Melnychuk 2003). Several examples in Melnychuk's datasets exhibit *t*-epenthesis between a person prefix and stem, which then gets palatalized in diminutives, as in /o+awɑʃ+imiʃa/ → *o[tʃ]awaʃimiʃa* 'his/her children', cf. *awaʃiʃa* 'child'. Here again, expressive palatalization seems to affect structure that is not present in the input, suggesting that EXPRESS constraints are output-oriented, and thus like markedness constraints.[6]

The EXPRESS(X) constraints apply in restricted lexical domains. Thus, while the properties of babytalk may leak out into other types of discourse for affective purposes, it is primarily observed in circumscribed domains. Likewise, expressive palatalization in diminutives is limited to this construction and sound symbolic vocabularies are often characterized as restricted lexical domains. The state of the art in phonology affords three basic mechanisms for this kind of restriction: lexically specified correspondence relations (Alderete 2001; Benua 2000; Itô & Mester 1999), morpheme-specific constraints (Pater 2000; Pater 2009), or construction-specific phonology in co-phonologies (Anttila 2002; Inkelas 1998; Orgun 1996). Each of these options can be adopted here, but the assumption above that the EXPRESS(X) constraints are markedness constraints suggests one of the latter two options because correspondence relations are not needed for markedness constraints. For concreteness, we implement the former option below and tag expressive morphemes with the subscript 'expr' to signal the fact that the EXPRESS(X) constraints apply to them specifically.

It is worth noting before moving on that a model of expressive phonology that uses EXPRESS(X) constraints has two properties that fit well with known facts of sound symbolism in general, and expressive palatalization in particular. First, because the EXPRESS(X) constraints are ranked separately from other markedness constraints, expressive grammar can violate phonotactic restrictions in a language, and even introduce sounds that are not present in the phonemic inventory. Sound symbolism is well-known for introducing new segments and violating phonotactics (Dingemanse 2012). At least seven of our 50 cases of expressive palatalization violate established phonotactic restrictions. As illustrated above in Japanese babytalk, expressive palatalization can result in palatal segments appearing before the mid vowel *e*, for example *seːtaː* → *tʃeːtaː* 'sweater', an otherwise phonotactically illicit structure in Japanese (Itô & Mester 1995; McCawley 1968). The distinct rankings made possible by the existence of EXPRESS(X) constraints also account for the fact that sound symbolic structures often resist sound change (de Reuse 1986; Kaufmann 1994; Mithun 1982), because the targets they set for output forms are independent of the normal markedness and faithfulness rankings that account for the sound inventory.

The scope of the EXPRESS(X) constraints also accounts for expressive palatalization that applies to more than one segment in a word. Some cases of expressive palatalizations are restricted to a single sound, which we assume involve domination of the EXPRESS(X) constraints by OCP-like constraints banning multiple occurrences of specified structure (Myers 1997). However, the general pattern is for expressive palatalization to apply iteratively to all segments that fit its structural description, as in as in *osarusan* → *otʃarutʃan* 'monkey (honorific)' in Japanese babytalk. In the constraint systems that follow, expressive palatalization may be limited to language-particular place and manner classes through ranking, but within these classes, palatalization applies exhaustively throughout the output, accounting for multiple palatalizations in the same word.

Finally, we mention that our EXPRESS(X) constraints have some common ground with approaches that have accounted for expressive palatalization with featural affixation (Akinlabi 1996; Hualde 1991; Kurisu 2009; Mester & Itô 1989). In this account, palatalization is the result of docking an abstract morpheme, typically a specific phonological feature, to a base segment. Separate from normal faithfulness, featural affixation requires an additional constraint to ensure overt realization of the

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[6] While these facts support a formal comparison with markedness constraints, our EXPRESS(X) constraints seem unlike markedness constraints because they cause the insertion of marked structure, namely palatals and affricates, just like the constraints proposed in Zoll (1997) and Finley (2009). This aspect of expressive palatalization fits with the anti-faithfulness interpretation, and also the featural affixation approach discussed below.

abstract morpheme (Kurisu 2001; Samek-Lodovici 1993; Urbanczyk 1998), which also accounts for the phonotactic violations we attribute to the EXPRESS(X) constraints.

Despite this common ground, our approach differs in important ways from featural affixation. Whereas expressive palatalization is motivated by the need to realize morphology, our EXPRESS(X) constraints are motivated functionally by the frequency code and the sound-symbolic associations between palatalization and smallness. It could be said that some featural affixation is likewise sound-symbolic, and so it shares this motivation. However, the specific ways in which palatal prosody is realized in featural affixation actually lead to some serious obstacles. First, as mentioned above, expressive palatalization often applies to more than one segment, which is not motivated in featural affixation because feature docking on multiple segments results in superfluous faithfulness violations. Second, featural affixation is intrinsically directional in that affixes are specified as either a prefix or suffix. But expressive palatalization is generally not directional and instead applies to all relevant segments in the base. Finally, and perhaps most problematic, expressive palatalization can be generalized from specific to general environments, and it is difficult to envision how this generalization process is formalized without explicit reference to the substance of expressive palatalization in the constraints themselves, as shown in section 5 with the EXPRESS(X) constraints.

4. EXPLAINING TYPOLOGICAL DIFFERENCES

4.1 A FACTORIAL TYPOLOGY

Our model of expressive palatalization is constructed from the constraints and the representational assumptions introduced above. In particular, a FACTORIAL TYPOLOGY was built by freely ranking EXPRESS[PAL] and EXPRESS[AFFRIC] with the seven faithfulness constraints in 9 and the four markedness constraints relevant to expressive palatalization, namely *C^j, *PAL, *PALSTRID, and *TS in 10. We fed our model inputs from the principal manner and place classes, and allowed all viable output candidates for these inputs. In this model, there are 13! (over six billion) possible rankings, but given the nature of the constraints, and the mappings, the model predicts only 76 distinct language patterns. The factorial typology was constructed with OTWorkPlace, a software suite based in Microsoft Excel that supports creation of OT systems and modern analysis of their properties (Prince et al. 2013). The spreadsheet files documenting the results summarized here are available from the first author's webpage and can be used to further extend the current system. In general, there is a good fit with the data, accounting for 17 of the 22 expressive systems listed in 4-7, which we discuss below. In section 4.5, we propose some reasonable extensions of the constraint system to account for all 22 systems.

4.2 EXPLAINING EXPRESSIVE AFFRICATION

The first set of results concern affrication. Recall from section 2 that expressive palatalization may cause a fricative (even a palatal fricative) to become an affricate, but this is not the case with phonological palatalization, as sketched below.

(15) Affrication: phonological vs. expressive palatalization

Phonological palatalization	Expressive palatalization
t → c ts tʃ	t → c ts tʃ
s → ʃ *ts *tʃ	s → ʃ ts tʃ
ʃ → *tʃ	ʃ → tʃ

This difference follows directly from our core assumptions. In expressive palatalization, fricative affrication is motivated by ranking EXPRESS[AFFRIC] above faithfulness because only an affricate satisfies this constraint. As an example, this approach straightforwardly accounts for Thai babytalk, which systematically shifts *s* to *tʃ*, as in /sǔaj/ → *tʃǔaj* 'pretty' and /sǒŋsǎan/ → *tʃǒŋtʃǎan* 'pity'. By ranking the EXPRESS(X) constraints above *PALATAL and the DEP constraints, the model produces fricative affrication, as shown below.

(16) Expressive palatalization of fricatives in Thai

Input: /sǔaj$_{expr}$/	Outputs	EXPR[AFFR]	EXPR[PAL]	PALSTRID	*PALATAL	*CJ	*SI	DEP[-CONT]	DEP[PLACE]
a.	sǔaj	*!	*						
b.	ʃǔaj	*!			*				*
c.	→ tʃǔaj				*			*	*
d.	tsǔaj		*!					*	
e.	sʲǔaj	*!				*			*

Note that EXPRESS[AFFRIC] is a distinct constraint from EXPRESS[PAL]; simple palatalization above in 16b satisfies the latter but not the former constraint. This assumption also motivates affrication in palatal fricatives, as shown below for Japanese babytalk, for example *oiʃiː → oitʃiː* 'yummy'.

(17) Affrication in post-alveolar fricatives in Japanese babytalk

Input: /oiʃiː$_{expr}$/	Outputs	EXPR[AFFR]	EXPR[PAL]	*PALATAL	*CJ	*SI	DEP[-CONT]	MAX[PLACE]	DEP[PLACE]
a.	oisiː	*!	*			*		*	
b.	oiʃiː	*!		*					
c.	→ oitʃiː			*			*		
d.	oitsiː		*!				*	*	
e.	oisʲiː	*!			*			*	*

The reason phonological palatalization does not exhibit affrication of fricatives in our model is because it does not involve expressive phonology, and the constraints that drive phonological palatalization do not allow this pattern of affrication. Given the constraints from 9 and 10, a place shift and affrication in a fricative is HARMONICALLY BOUND by a simple place shift, as shown below in the boxed region in 18. A candidate mapping *A* harmonically bounds a mapping *B* if *A* has a proper subset of the violations of *B* (Prince & Smolensky 1993/2004). Candidate 18c with affrication has all of the violations of 18b, and something more, namely a violation of DEP[-CONT], because affrication requires an insertion of [-continuant]. In other words, candidate 18c will always be worse than 18b, no matter how the constraints are ranked, so no language will ever favor it to simple palatalization, as attested.

(18) Harmonic bounding of /si/ → *tʃi* palatalization

Input: /si/	Outputs	EXPR[AFFR]	PALSTRID	*SI	*CJ	*PALATAL	MAX[CONT]	DEP[-CONT]	MAX[PLACE]	DEP[PLACE]
a.	si			*!						
b.	→ ʃi					*				*
c.	tʃi					*		*!		*
d.	sʲi				*!					*

To review, a mechanism specific to expressive palatalization is needed to produce affrication of fricatives. We propose that EXPRESS[AFFRIC] is that mechanism. This assumption predicts fricative affrication in expressive phonology, but it has no force in phonological palatalization, so more general constraints on palatalization prevent fricative affrication elsewhere. The role of EXPRESS[AFFRIC] is more extensive and subtle, however, than suggested by the mappings above. EXPRESS[AFFRIC] sets a general output target in expressive systems, and so it also directly accounts for cases of rampant affrication in Georgian and Western Basque (see section 2). These cases of expressive palatalization exhibit extensive neutralization to *tʃ* in all manner classes (stops, fricatives, sonorants) and place classes (coronals and non-coronals). Like the Thai and Japanese cases illustrated above, these systems are predicted by ranking EXPRESS[AFFRIC] at the top of the hierarchy (see the electronic supplement for ranking details). This kind of rampant affrication is unattested in phonological palatalization because the consensus model is incapable of producing all of the mappings. As seen above, affrication of a fricative is impossible, and the analogous one mapping a sonorant to *tʃ* is likewise harmonically bounded.

Finally, the affrication that commonly accompanies expressive palatalization is functionally separate from place shifting palatalization in our dataset. Some languages place shift and produce an affricate: 5b, 5d, 5e, and 6, some just place-shift, as in 5a, 5c, 5g, 5h, and some others just produce alveolar affricates without a shift, as shown in 7. Our model accounts for all these possibilities because the imperatives to insert palatal and affricate feature structure are separate. They can combine forces at the top of the constraint hierarchy to give a place shift with affrication, EXPRESS[AFFRIC] can be demoted below faithfulness to produce palatalization without affrication, and EXPRESS[PAL] can instead be demoted to produce affrication without palatalization. The latter case is illustrated below for Northern Paiute diminutives, as in /sɨsɨʔa/ → *tsɨdzɨʔa* 'little girls' (for clarity, only markedness and faithfulness violations in the initial consonant are shown).

(19) Expressive affrication of fricatives in Northern Paiute

Input: /sɨsɨʔa $_{expr}$/	Outputs	EXPR[AFFR]	PALSTRID	*PALATAL	*CJ	*SI	DEP[PLACE]	DEP[-CONT]	EXPR[PAL]
a.	sɨsɨʔa	*!				*			*
b.	ʃɨʃɨʔa	*!		*			*		
c.	→ tsɨdzɨʔa							*	*
d.	tʃɨdʒɨʔa			*!			*!	*	
e.	sʲɨsʲɨʔa	*!			*		*		

This last result illustrates a theoretical requirement that is central to our account of expressive palatalization. The analysis of specific mappings in Thai (16) and Japanese (17) may give the impression that Express[Affric] is doing all the work, and therefore, it could be relegated to a distinct expressive grammar. In other words, it may not need be integrated into the larger grammar. This is indeed spurious, however, as in both cases, the Express(X) constraints must work in tandem with general markedness and faithfulness constraints to predict all of the correct outcomes. Likewise in 19, it is the general markedness constraint *Palatal, or alternatively, the general faithfulness constraint Dep[Place], that weeds out the competitor with *tʃ* (19d), and allows the ranking to finish the job of picking the alveolar affricate (19c). The degree to which the Express(X) constraints must be embedded in phonological grammar can be illustrated with the split system of Cree babytalk (5e), where /t/ → *tʃ* and /s/ → *ʃ*, but non-coronals and sonorants are unchanged. As illustrated in 20, the Express(X) constraints must dominate the two Dep constraints, but they themselves must be dominated by no less than five general markedness and faithfulness constraints. Additional mappings ignored here involving secondary palatalization and affrication to *ts* require an additional three rankings of general non-expressive constraints.

(20) Split affrication and palatalization in Cree babytalk

Inputs	Outputs	Dep[-Cont]	PalStrid	Ident[Back]	Ident[Son]	Max[Cont]	Expr[Affr]	Expr[Pal]	Dep[+Cont]	Dep[Place]
a. /k/	→ k						*	*		
	tʃ			*!					*	*
	c		*!	*!			*			*
b. /n/	→ n						*	*		
	tʃ				*!				*	*
	ɲ		*!				*			*
c. /t/	t						*!	*		
	→ tʃ								*	*
	ʃ					*!	*		*	*
	c		*!				*			*

As this example makes clear, the Express(X) constraints must co-mingle with other general markedness and faithfulness constraints in order to correctly account for expressive palatalization. This theoretical assumption is also crucial to the place and manner asymmetries, as we show below. Another way to describe our model, therefore, is that it is characterized by simply adding two Express(X) constraints to a set markedness and faithfulness constraints that are independently motivated by phonological palatalization. No special staging or level-ordering assumptions are necessary.

4.3 Explaining the place asymmetry

Palatalization of a non-coronal implies palatalization of a coronal in expressive palatalization, but the same is not true of phonological palatalization (section 2). The reason for this difference in our model stems from a fundamental difference between the two: phonological palatalization is context-sensitive and assimilatory, but expressive palatalization is neither of these. We have already seen how dorsal palatalization is possible in the consensus model of phonological palatalization (11-12). A version of this system that exclusively palatalizes dorsals is predicted by simply demoting the context-sensitive markedness constraints for coronals, namely *TI, *SI, *NI, below faithfulness, and retaining *KI in its top-ranked position. The reason we cannot produce this pattern with the Express constraints is because expressive palatalization is not assimilatory and therefore involves inserting both palatal and affricate feature structure. It turns out that these modifications in coronals are a proper subset of those needed to palatalize non-coronals, which explains the place asymmetry.

The fact that non-coronal palatalization implies coronal palatalization is a result of our model and has been confirmed in the OTWorkPlace datasets we provide. Concretely, in all 76 systems, if a non-coronal is palatalized via secondary palatalization, shifting, or affrication, a coronal is also palatalized in one of these ways.[7] To understand the cost of non-coronal palatalization relative to coronals, it is instructive to consider a case in which both place classes are palatalized. The system in 21 accounts for Western Basque and Georgian diminutives, where both coronals and non-coronals map to *tʃ*. The output of these mappings are identical and the outcomes are fully predicted by the constraints of the first four constraints in the hierarchy. There is an important difference, however, between 21a and 21b in their violations of DEP[PLACE], MAX[PLACE], and most importantly, IDENT[BACK] (boxed below). According to the feature geometric assumptions motivated in section 3, to achieve the Cor+Dors complex place specification, /k/ must insert a Cor specification and flip [+back] to [-back], which incurs both a violation of DEP[PLACE] and IDENT[BACK] for *c* and *tʃ*. The other major difference concerns /k/ → *ts*, which receives both a DEP[PLACE] and MAX[PLACE] violation that is not assigned to the corresponding mapping from coronals. In summary, palatalization is less costly for coronals because it requires less autosegmental action than non-coronals to achieve the Cor+Dors complex place specification.

(21) Coronal and non-coronal palatalization, after Western Basque (6a) and Georgian (6b)

Inputs	Outputs	PALSTRID	*CJ	*TS	EXPR[AFFR]	EXPR[PAL]	DEP[+CONT]	DEP[PLACE]	MAX[PLACE]	IDENT[BACK]
a. /k/	k				*!	*				
	kʲ		*!		*			*		
	c	*!			*			*		*
	→ tʃ						*	*		*
	ts			*!		*	*	*	*	
b. /t/	t				*!	*				
	tʲ		*!		*			*		
	c	*!			*			*		
	→ tʃ						*	*		
	ts			*!		*	*			

While this difference between coronal and non-coronal palatalization is of little consequence in the case above, it has important consequences for our model's typological predictions. In short, if a system goes to the trouble to palatalize a non-coronal, it will also palatalize a corresponding coronal, which explains the place asymmetry.

One way to illustrate this is by listing the ranking requirements of an unattested system in a COMPARATIVE TABLEAU and outlining their fundamental inconsistency (Prince 2002; Tesar 2004). This is done in 22 with a hypothetical system exhibiting dorsal palatalization to *tʃ* but faithful treatment of a coronal stop, that is, the non-existent dorsals-only system. The data in 22 shows the ranking requirements of any valid grammar by registering the results of specific winner-loser comparisons. In

[7] As we explain in section 4.5, the place asymmetry with secondary palatalization is more complex and also involves crucial constraint interaction with markedness constraints.

these comparisons, a ‘W’ mark means that the constraint above it favors the winner in the comparison on the left. Thus, the row 22a below records the ranking requirements for any grammar that prefers the mapping /k/ → *tʃ* to /k/ → *k* (see the corresponding constraint violations in 21a). In this row, the W mark below EXPRESS[AFFRIC] shows that this constraint favors the winner, because the winner satisfies this constraint but the loser does not. An ‘L’ mark in this row means the opposite: the above constraint favors the loser, as three of the faithfulness constraints do in 22a because the loser is the fully faithful candidate. In order to account for the component of the dorsals-only palatalization pattern represented in 22a, there must be at least one W-favoring constraint above all the L-favoring constraints; otherwise, the incorrect outcome is predicted.

Collecting together the ranking requirements for non-coronal palatalization (22a-d), on the one hand, and the lack of coronal palatalization (22e-h), on the other, gives us a glimpse of how the model explains the place asymmetry. While the markedness constraints PALATALSTRIDENCY, *C^j, and *TS account for a good deal of the data (as indicated by the shaded rows), there is no ranking of constraints that can account for both 22a and 22e. The first winner-loser pair 22a requires that three faithfulness constraints be dominated by one of the EXPRESS(X) constraints. But the second winner-loser pair 22e requires the opposite rankings for some of the faithfulness constraints: the EXPRESS(X) constraints must be dominated by either DEP[PLACE] or DEP[+CONT]. Dorsals-only palatalization is impossible, therefore, because no ranking of constraints can satisfy these conflicting ranking requirements.

(22) Inconsistency of non-coronals-only palatalization

	Inputs	Winner ~ Loser	PALSTRID	*CJ	*TS	EXPR[AFFR]	EXPR[PAL]	DEP[PLACE]	MAX[PLACE]	ID[BACK]	DEP[+CONT]
a.	k	tʃ ~ k				W	W	L		L	L
b.	k	tʃ ~ k^j		W		W				L	L
c.	k	tʃ ~ c	W			W					L
d.	k	tʃ ~ ts			W		W		W	L	
e.	t	t ~ tʃ				L	L	W			W
f.	t	t ~ t^j		W			L	W			
g.	t	t ~ c	W				L	W			
h.	t	t ~ ts			W	L					W

To see the faithfulness cost of non-coronal palatalization, contrast 22 with 23, which gives a comparative tableau for exclusive palatalization of coronals. Non-coronal palatalization in 22 above requires three constraints to be dominated by some W-favoring constraint 22a, whereas coronal palatalization only requires two, as shown in 23e. This requirement can be achieved in 23 by ranking IDENT[BACK] above the EXPRESS(X) constraints. This ranking accounts for 23a, which in turn allows the EXPRESS(X) constraints to dominate the two L-favoring faithfulness constraints, DEP[PLACE] and DEP[+CONT], to account for 23e.

(23) Consistency of coronals-only palatalization

	Inputs	Winner ~ Loser	PALSTRID	*CJ	*TS	EXPR[AFFR]	EXPR[PAL]	DEP[PLACE]	MAX[PLACE]	ID[BACK]	DEP[+CONT]
a.	k	k ~ tʃ				L	L	W		W	W
b.	k	k ~ kʲ		W			L	W			
c.	k	k ~ c	W				L	W		W	
d.	k	k ~ ts			W	L		W	W		W
e.	t	tʃ ~ t				W	W	L			L
f.	t	tʃ ~ tʲ		W		W					L
g.	t	tʃ ~ c	W			W					L
h.	t	tʃ ~ ts			W		W	L			

Thus, the difference in faithfulness costs for non-coronals relative to coronals explains the place asymmetry.

This illustration only demonstrates the place asymmetry for a fragment of our typology, but it outlines the main faithfulness cost to non-coronals that is responsible for multiple unattested systems. We also note that this result does not depend on fragile assumptions about feature structure. For example, the difference in IDENT[BACK] violations in 22 and 23 is crucial here, and this is due to our assumption that fronted dorsals retain their Dors specification but flip the [back] value of their dependent. If instead, dorsals deleted their Dors specification and inserted a new one, or, if post-alveolars do not have complex Place and instead have Cor/[-ant] specifications (as in e.g. Hume (1994)), palatalization of non-coronals will still have faithfulness costs that distinguish them from coronals. In a sense, our assumption that coronals and non-coronals differ in IDENT[BACK] violations is the most generous of possible assumptions for the data, and the faithfulness difference is enough to explain the place asymmetry.

Returning to the larger theme of grammar integration, the place asymmetry in expressive grammar is not due to specific theoretical assumptions that relegate expressive palatalization to a distinct domain of grammar. Rather, the asymmetry derives from its non-assimilatory nature, and the faithfulness consequences of this fact. It is the different violations incurred by coronals and non-coronals for garden variety faithfulness constraints like DEP[PLACE] and IDENT[BACK] that account for the typological implication, not special modules or constraints. If we sequester expressive palatalization to the margins of grammar, untouched by these core faithfulness constraints, then we no longer predict this asymmetry. The analysis of the place asymmetry we propose therefore provides an especially strong argument for integration of expressive phonology with core grammar. Failure to do so leads to an undesirable blurring of the distinction between the two types of palatalization.

4.4 EXPLAINING THE MANNER ASYMMETRY

The same argument for grammar integration applies with equal force in our model's explanation of the manner asymmetry. Recall that sonorant palatalization implies obstruent palatalization in expressive palatalization, but this implication does not hold in phonological palatalization (section 2). This asymmetry is predicted by our model, again because of the targets set by the EXPRESS(X) constraints and the costs imposed by faithfulness for reaching those targets. In the illustration below, we contrast the comparative tableaux of sonorants-only palatalization to *tʃ* (24) with obstruents-only palatalization (25). Here again, the three markedness constraints PALSTRIDENCY, *CJ, and *TS, account for most of the data because ranking them at the top accounts for the shaded rows. However, the marked mapping, sonorant palatalization, cannot be achieved without the unmarked mapping because of the extra faithfulness cost the former must pay. In this case, sonorant palatalization incurs a Ident[son] violation that is not incurred by obstruent palatalization: compare the boxed violations in 24a and 25a. It is the lack of a L mark under Ident[son] in 25 that allows this constraint to be ranked above the Express(X) constraints, which in turn may be ranked above the Dep constraints.

(24) Inconsistency of sonorants-only palatalization

	Inputs	Winner ~ Loser	PalStrid	*CJ	*Ts	Expr[Affr]	Expr[Pal]	Dep[Place]	Ident[son]	Dep[+cont]
a.	n	tʃ ~ n				W	W	L	**L**	L
b.	n	tʃ ~ n^j		W		W			L	L
c.	n	tʃ ~ ɲ	W			W			L	L
d.	n	tʃ ~ ts			W		W	L		
e.	t	t ~ tʃ				L	L	W		W
f.	t	t ~ t^j		W			L	W		
g.	t	t ~ c	W				L	W		
h.	t	t ~ ts			W	L				W

(25) Consistency of obstruents-only palatalization

	Inputs	Winner ~ Loser	PalStrid	*CJ	*Ts	Expr[Affr]	Expr[Pal]	Dep[Place]	Ident[son]	Dep[+cont]
a.	n	n ~ tʃ				L	L	W	**W**	W
b.	n	n ~ n^j		W			L	W		
c.	n	n ~ ɲ	W				L	W		
d.	n	n ~ ts			W	L			W	W
e.	t	tʃ ~ t				W	W	L		L
f.	t	tʃ ~ t^j		W		W				L
g.	t	tʃ ~ c	W			W				L
h.	t	tʃ ~ ts			W		W	L		

This illustration just covers a small part of the possible mappings, /t n/ → *tʃ n*, */t n/ → *t tʃ*, but the general manner asymmetry is correctly predicted by our model. If /n/ → *ɲ* in our model, there must either be a corresponding coronal fricative or post-alveolar affricate. If /n/ → *tʃ*, then some obstruent must be an affricate, and if /n/ → n^j, then some obstruent must be either an affricate or have a secondary palatalization. In all cases, sonorant palatalization implies obstruent palatalization, as attested.

The manner asymmetry therefore provides another argument for integration of expressive phonology with the rest of grammar. As with the place asymmetry, we can only explain the restrictions on expressive palatalization by calling upon tried-and-true markedness and faithfulness constraints necessary for phonological palatalization. If instead, we push expressive palatalization to the margins of grammar, with a unique grammar of its own, we cannot explain the restriction. Finally, we note that all of these typological results are natural consequences of the logic of ranking central to Optimality Theory. Unattested patterns phonological palatalization (4.2) and expressive palatalization (4.3-4.4) are predicted by harmonic bounding relationships that depend on this logic. By situating our analyses in OT, we demonstrate that the logic of ranking applies naturally to the analysis of sound symbolism.

4.5 RESIDUAL ISSUES

The discussions above show that integrating the EXPRESS(X) constraints with core phonology accounts for the major typological differences between expressive and phonological palatalization. It also does a remarkably good job at accounting for the range of palatalization systems in 4-7: the constraint system employed above with 13 constraints, 11 of which are motivated on independent grounds, accounts for 17 of these 22 systems. We show in this section that some reasonable extensions of this base constraint system can account for all of the attested patterns.

Three of the problematic systems involve secondary palatalization. In Russian hypocoristics (4b), stem-finals after truncation are palatalized or retain their palatalization in coronals, for example *ivan* → *van*^{j}*-a* 'Ivan', but non-coronals do not retain or get secondary palatalization: *an*^{j}*ik*^{j}*ij* → *an*^{j}*ika* 'Anika'. Greek babytalk (4c) involves secondary palatalization of coronal obstruents, but not coronal sonorants or non-coronals, and Marathi babytalk (4e) only has secondary palatalization in coronal stops. The discussion above implies that our theory should in principle account for these patterns because they exhibit coronal and obstruent biases, but in fact it does not. The reason for this is that secondary palatalization does not have the same faithfulness costs as shifting palatalization, so we do not predict the same faithfulness differentials we saw in 4.3 and 4.4 above. Our constraint system successfully accounts for cases in which secondary palatalization is attested across the board (4a), and other cases with secondary palatalization in some environments and shifting palatalization elsewhere (4d), but these partial systems, namely 4b-c and 4e, are currently impossible because faithfulness does not distinguish the different patterns of secondary palatalization.

A range of evidence suggests that secondary palatalization in non-coronals may be marked, which leads to a general markedness solution to these cases. In Russian, for example, palatalized velars are non-phonemic, or marginally phonemic (occurring in only a handful of words before non-front vowels), so a structural requirement of some kind prohibits these in non-expressive contexts as well. Greek shows a similar pattern because velars are fronted to palatals before front vowels, so this process may also block secondary palatalization in velars. More generally, it seems that secondary palatalization in velars is relatively unstable cross-linguistically, as they tend to shift to palatals (Bateman 2007; Bhat 1978). It seems therefore that we have good grounds to assume that secondary palatalization in dorsals is marked, a proposal in line with Telfer's (2006) constraint system, and we can conjecture the same is true of labials and sonorants. We tested this idea by adding two new constraints *K^j and *N^j to our constraint set and generating a factorial typology. The new factorial typology successfully accounts for all three patterns, or 20 of the 22 patterns in 4-7, without losing our analyses of the other systems. It can be said that this approach changes the analysis of the place and manner asymmetries discussed above, because part of the analysis is due to differences in faithfulness costs (sections 4.3 and 4.4), and another part is due to stringency relations among markedness constraints banning secondary palatalization, namely C^j, *K^j and *N^j. Both accounts, however, crucially depend on general constraints that apply in both expressive and non-expressive contexts, so this motivated extension actually deepens our commitment to grammar integration.

Another problematic case is observed in Wiyot diminutives (5i) in which coronal obstruents map to the alveolar affricate *ts* and fricatives map to *ʃ*. In our current system, these two mappings, /t/ → *ts* and /s/ → *ʃ*, are incompatible because *ts* is marked relative to *tʃ*, so mapping a stop to a marked affricate and failing to do so for the fricative is not allowed. In our current constraint system, *ts* is marked relative to *tʃ* because of the existence of *TS and no analogous constraint, *Tʃ. One tractable approach to the Wiyot pattern is therefore to simply remove this markedness assumption and include the constraint *Tʃ in the constraint set. Given the assumptions from 3.1, this assumption is theoretically plausible because *tʃ* is a complex segment in two ways: it has complex place and complex manner. *tʃ* is also marked in inventories because it implies a major place contrast in stops (Maddieson 1984). Adding the constraint *Tʃ to our base system successfully accounts for the Wiyot pattern without sacrificing our account of affricates or the place and manner asymmetries. Another possible approach is to treat diminutive /t/ → *ts* as an affricate alternative to post-alveolar *tʃ*, because Wiyot employs /t/ → *tʃ* in augmentatives (contrary to the frequency code), requiring a kind of surface comparison of the expressive consonants.

One might employ a similar markedness strategy for the last unaccounted for case, namely the Uto-Aztecan and Quechan pattern in 5c, *k ɲ t ʃ*, by proposing a markedness constraint *PALATALSTOP to account for palatalization in all manner classes except oral stops. Interestingly, this tack runs afoul of our analysis of the manner asymmetry, because positing a constraint that specifically bans palatal stops ruins the harmonic bounding relationship that exists in our current system of /t/ → *ɲ* by /t/ → *c*, and would therefore allow for sonorant palatalization without obstruent palatalization. Instead, what appears to be necessary is a DEPPLACE constraint specific to oral stops. Such a constraint can both prohibit palatalization in stops in 5c and at the same time retain the necessary harmonic bounding relationships.

While this approach is admittedly stipulative, a coherent alternative is possible for some of these cases in which /t/ → *tʃ* is blocked because of high frequency post-alveolars. For example, Hualde (1991) reports some Basque dialects that developed phonological palatalization in consonants adjacent to *i* also lost expressive palatalization in the same contexts. Conversely, Czaplicki (2014) shows how expressive palatalization in Polish gains ground in contexts where phonological palatalization is less established frequency-wise. In Cahuilla, for example, post-alveolar *tʃ* has a much higher frequency than other palalals (Seiler & Hioki 1979), which may help explain why coronal stops fail to palatalize in expressive contexts. Therefore, a tractable future direction for this research, which applies to the Wiyot example above as well, is to investigate how the frequency structure of competing segments can account for systematic gaps, perhaps employing models specifically designed to formalize systems of contrast (Flemming 2002; Lubowicz 2003; Padgett 2003).

5. PHONOLOGICAL EXTENSION OF EXPRESSIVE PALATALIZATION

Our typological study above shows that expressive palatalization must be analyzed differently from phonological palatalization because it exhibits affrication patterns and place and manner asymmetries not found in phonological palatalization. We analyze these differences by proposing output targets for expressive palatalization that are different than phonological palatalization, formalized by the constraints EXPRESS[AFFRIC] and EXPRESS[PAL]. These constraints only work as intended, however, if they are embedded in a larger phonology. A significant theoretical point made in our analysis is therefore that expressive phonology, a phenomenon often relegated to the margins of grammar, must in fact be integrated with core grammar.

This argument for grammar integration lines up with another argument for grammar integration based on pattern induction. From an empirical standpoint, linguistically significant patterns do not always start out as broad generalizations in the minds of speakers, but are instead built up from an ever-widening set of generalizations. This perspective has engendered a research paradigm in which linguistic patterns are 'emergent' from processes of specific-to-general pattern induction. Pattern induction of this kind has been applied productively in a variety of linguistic domains, including the development of verb meanings (Goldberg 1999), syntactic constructions (Tomasello 2003), and phonological alternations in the lexicon (Bybee 1998). In a similar vein, Joseph (1997) argues for a more central role in linguistic analysis of certain 'marginal' phenomena, including sound symbolic structures like that discussed here. In particular, Joseph shows how the patterns found in ideophones, phonesthemes, and registers of marginalized groups can gain a foothold in synchronic grammars and lead to broader generalization. Joseph's argument suggests that we should find similar patterns of induction in expressive phonology in which palatalization processes can be extended to a wider set of lexical domains and phonological environments. Below we present original evidence in our data collection supporting this view. We further argue that the analysis of this kind of phonological extension requires the integration of the EXPRESS(X) constraints with core grammar, again supporting co-mingling.

The first form of evidence for phonological extension comes from the language-internal relationships in our sample. Five languages exhibit expressive palatalization in both babytalk registers and more abstract grammaticalizations, like diminutives, hypocoristics, and affective terms, as shown below in 26. These mappings show the surface pattern from the same inputs assumed above (k = non-coronal, n =sonorant, t = coronal stop, s = coronal fricative). In Japanese, for example, adult native speakers have a command of both babytalk and a rich mimetic vocabulary, where the latter extends palatalization to all manner and place contexts. Babytalk registers are a more concrete type of palatalization than these other constructions because the palatalization is an adult's direct attempt to mimic the speech of small children in an effort to accommodate with their listeners (Kochetov & Alderete 2011). Imitative sound symbolism of this kind is typically distinguished from so-called conventional sound symbolism, like diminutives and sound symbolic vocabularies, because of the sound-meaning associations are one or more steps removed from direct mimicry (Hinton et al. 1994a).

(26) Language-internal relationships (sorted by place and manner)

	concrete	abstract
a. Japanese	k n t tʃ	k^{j} ɲ tʃ ʃ
b. Quechua (Wanca)	k n t ʃ	k ɲ t ʃ
c. Basque (Eastern)	k ɲ c ʃ	k ɲ tʃ ʃ
d. Greek	k n t^{j} s^{j}	k n ts ts
e. Spanish (Chilean)	k n t tʃ	k n tʃ tʃ

When viewed this way, the relationships between concrete and abstract types of palatalization can be seen as an extension of palatalization to new domains and phonological environments. For example, it is very natural to see the meanings associated mimetic palatalization in Japanese, such as 'childishness, immaturity, instability, uncoordinated movement, lack of restraint' as a semantic extension of a more basic concept of 'behaving like a small child' signalled by babytalk palatalization. Indeed, Hamano (1986/1998) claims that the meanings of many mimetic nouns derive from the expressive sign 'palatalization/childlike behavior' and that native speakers are consciously aware of this connection. Furthermore, in both Japanese and the Wanca dialect of Quechua, the abstract types seem to generalize palatalization to a wider set of phonological environments: from fricatives to all consonants in Japanese, and from fricatives to fricatives and sonorants in Quechua. Recent innovations in Polish diminutives (Czaplicki 2014) provide diachronic evidence that expressive palatalization can take over more phonological ground, starting with sibilant fricatives and extending across different places and manners of articulation. While we do not know in most cases if the patterns exhibited in babytalk registers have formed the basis for new coinages, we believe that the idea that babytalk can serve as a kind of incubator for more abstract uses of palatalization is inherently plausible, especially in systems like Japanese.

This continuum between concrete and abstract categories has a clear parallel in reduplication, another construction associated with iconic form-meaning associations. The meanings of reduplicative constraints have often been noted to have a non-arbitrary link between the doubled form and its meaning, including repeated action in verbs and plurals and distributives in nouns (Haiman 1980; Moravcsik 1978; Naylor 1986). Reduplication is often found in babytalk registers (Ferguson 1964; Haynes & Cooper 1986), perhaps because of the frequent occurrence of reduplication in the speech of small children (Fee & Ingram 1982; Ferguson 1983). However, the meanings contributed by reduplication can also be more abstract, including affection, diminution, completion of action, and even highly abstract grammatical categories like imperfects. Regier (1988) conducted a cross-linguistic survey of reduplicative meaning and showed how these more abstract categories could be accounted for with normal processes of semantic extension. Thus, while reduplication can have more abstract sound-meaning associations, these arbitrary associations all relate back through a natural chain of concepts to the non-arbitrary iconic associations ‘baby, repetition, plural’. An important point is that Regier’s semantic extensions show the same kind of extension to new more abstract categories we have proposed for expressive palatalization, and indeed some of the paths he proposes, as in ‘baby’ → ‘small’, have obvious parallels in our sample. It is not a surprise, then, to find that the phonological environments have also been extended in expressive palatalization.

When we look at expressive palatalization cross-linguistically, and sort cases into concrete and abstract types, we see a more robust pattern of phonological extension. The frequencies reported in Table 2 enumerate the substitutions for the four major place/manner classes, cross-classified by concrete (babytalk register) and abstract (diminutives, sound symbolic inventories) types. Two observations can be made. First, the percentages of the unchanged sounds (e.g. *k* → *k*) generally falls from concrete to abstract types, entailing that the percentage of phonologically altered segments increases in abstract types. In substitutions with sonorants, for example, a substitution of some kind is found in 38.9% of the 14 babytalk registers, and 46.9% of the remaining diminutive and sound symbolic systems. The one exception to this pattern is fricatives, which seem to always be palatalized in babytalk registers. However, this pattern is a bit misleading, because 100% of fricatives are also palatalized in sound symbolic inventories. Second, certain substitutions occur in the more abstract dimension that are unattested in babytalk registers, as in *k* → *tʃ* (indicated with “*” in the counts below). In all four place and manner classes, a new segment type is introduced in the abstract class that is not found in babytalk. Thus, when viewed cross-linguistically, expressive palatalization seems to be more pervasive and extend to new sound types in the abstract dimension.

Table 2. Frequencies of sound symbolic substitutions

	k			n				t					s				
	k	k^j	tʃ	n	ɲ	n^j	tʃ	t	c	t^j	tʃ	ts	s	s^j	tʃ	ʃ	ts
BT	17	1	0	11	6	1	0	9	4	3	2	0	0	2	7	7	0
%	*94.4*	*5.6*		*61.1*	*38.9*			*50*	*50*				*0*	*100*			
DIM/SS	26	3	3*	18	10	2	2*	11	4	2	12	3*	3	2	6	16	3*
%	*81.3*	*18.7*		*56.3*	*43.7*			*34.4*	*65.6*				*10*	*90*			

In Kochetov and Alderete (2011), phonological extension of this type is treated in a general model of grammaticalization (Figure 3). In our CONTINUUM MODEL, phonological extension in expressive phonology mirrors the steps taken in phonology generally, from concrete patterns closer to the phonetic origins of phonological patterns, to more abstract patterns in phonemic and morpho-phonemic systems. In essence, we propose that phonological extension in sound symbolism works just like Regier’s semantic extension, through natural processes of analogy. Expressive palatalization thus proceeds from its concrete origins in the mimicry of babytalk, to new coinages in diminutives, and then onto larger sound symbolic vocabularies like that found in Japanese. Like reduplicative meaning and phonology generally, the extension of sound symbolic phonological structure follows well-established paths.[8]

[8] In this respect, our approach is rather different to the analysis given in Dingemanse & Akita (2016), Dingemanse (2016) for the grammatical status of ideophones. These authors argue for a trade-off between iconicity and system integration, where said integration involves a process of de-ideophonization. Our approach assumes no such trade-off or loss of expressiveness with grammar integration.

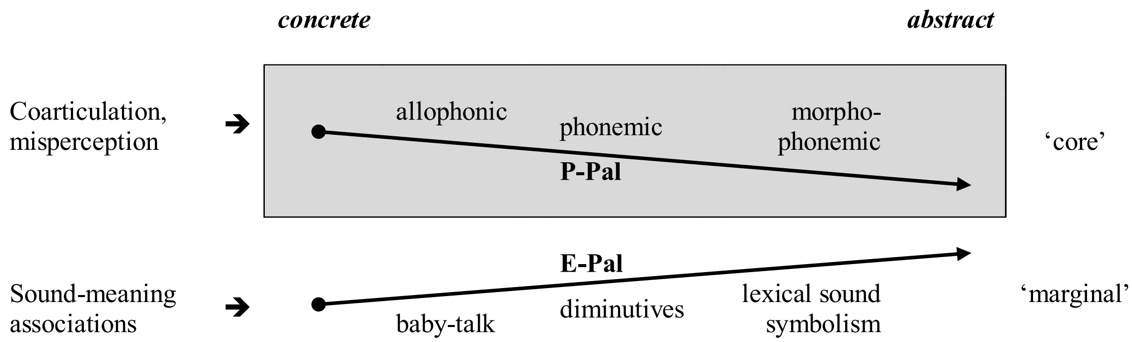

Figure 3. The continuum model of Kochetov & Alderete 2011

It seems sensible that expressive palatalization may follow the same patterns of grammaticalization as other phonological processes. But what is the explicit mechanism for phonological extension? It turns out that the OT system developed in sections 3 and 4 in order to account for the typological findings provides such a mechanism. That is, our OT system both generates a typology of predicted patterns, and formalizes the relationships among these patterns as a function of constraint permutation (see Alber et al. (2016) and Merchant and Prince (2016) for detailed analysis of relationships among languages in an OT typology). For example, the difference between Eastern Basque babytalk and the sound symbolic vocabulary is in the treatment of stops: *k ɲ c ʃ ~ k ɲ tʃ ʃ*. This difference can be characterized as a simple ranking difference, dropping the position of DEP[+CONT] to a position below EXPRESS[AFFRIC], as shown in 27 and 28.

(27) Ranking summary for Eastern Basque babytalk [k ɲ c ʃ]

top stratum	middle stratum	bottom stratum
IDENT[SON], IDENT[BACK] MAX[CONT], MAX[PLACE] DEP[-CONT], ***DEP[+CONT]*** *C^j, *Ts	EXPRESS[AFFRIC] EXPRESS[PAL]	*PAL, PALSTRID, DEP[PLACE]

(28) Ranking summary for Basque sound symbolic vocabulary [k ɲ tʃ ʃ]

top stratum	middle stratum	bottom stratum
IDENT[SON], IDENT[BACK] MAX[CONT], MAX[PLACE] DEP[-CONT] *C^j, *Ts	EXPRESS[AFFRIC] EXPRESS[PAL]	*PAL, PALSTRID, DEP[PLACE] ***DEP[+CONT]***

In another example, the path from Japanese babytalk to the more abstract system of mimetic palatalization involves more ranking permutations. However, the typological system gives formal expression to a chain of smaller steps between the two rather different systems, each of which constitutes an attested system. This is shown below as simple modifications of the basic ranking in 29 for Japanese babytalk, and successive modifications to that ranking, ultimately resulting in the Japanese mimetics pattern in 30d.

(29) Ranking summary for Japanese babytalk [k n t tʃ]

top stratum	middle stratum	bottom stratum
IDENT[SON], IDENT[BACK] MAX[CONT], MAX[PLACE] DEP[+CONT] *Cʲ, *Ts, *PAL, PALSTRID	EXPRESS[AFFRIC] EXPRESS[PAL]	DEP[PLACE], DEP[-CONT]

(30) Successive modifications from Japanese babytalk

a. Dakota babytalk [k n t ʃ]	DEP[-CONT] >> EXPRESS[AFFRIC] EXPRESS[PAL] >> *PAL
b. Cree babytalk [k n tʃ ʃ]	EXPRESS[AFFRIC] >> DEP[+CONT]
c. Basque SS [k ɲ tʃ ʃ]	EXPRESS[PAL] >> PALSTRIDENCY
d. Japanese mimetics [kʲ ɲ tʃ ʃ]	EXPRESS[PAL] >> *Cʲ >> *PAL, PALSTRIDENCY

As these examples illustrate, the OT system embodies a set of structural relationships among the predicted expressive systems, and movement from one system to another is a straightforward ranking matter, in many cases the simple re-ranking of one constraint. The mechanism for capturing the language internal relationships in 26 and the cross-linguistic ones in Table 2 is the same as phonological extension in non-expressive phonology, namely ranking permutation. However, our treatment of these effects depends crucially on the organic integration of the constraints behind expressive palatalization, the EXPRESS(X) constraints, with the rest of grammar. The movements on the continuum sketched above involve small ranking changes to general markedness and faithfulness constraints in relation to the EXPRESS(X) constraints. If expressive systems are handled somehow in a distinct grammatical module with entirely different constraints, then an entirely new analysis of phonological extension is required.

6. CONCLUSION

In this article, we provide a means of integrating sound symbolic phonology with core phonology, and advance a specific analysis of this integration for expressive palatalization. The resulting theory is surprisingly simple: we propose two EXPRESS(X) constraints as the motivation behind expressive palatalization, and let them 'run loose' on the rest of phonology. We show explicitly how this approach both describes the specific patterns of expressive palatalization found in our sample, and further, how it explains the typological differences between expressive and phonological palatalization. Finally, because of the grammatical integration of expressive palatalization, the typological space predicted by our model also naturally accounts for phonological extension of expressive phonology.

Our model clarifies how the distinct phonological traits of sound symbolism can be captured directly, and yet formalized with standard tools of linguistic analysis. Our findings therefore allow us to resolve the impasse that has plagued research on sound symbolism: expressive palatalization is different in kind from phonological palatalization because it has a distinct formal motivation (the EXPRESS(X) constraints), but the architecture for representing and generalizing sound symbolism is not substantively different from the rest of phonology.

One natural question raised by our analysis of expressive palatalization is how it might be extended to other types of phonological patterns found in sound symbolism. As mentioned in section 3.2, the frequency code hypothesis for magnitude sound symbolism has implications for processes other than palatalization, including stopping, glottalization, and fronting of back consonants like velars, as well as language-particular vowel structures associated with size (Ohala 1994). Branching out to other iconic meanings, reduplication is frequently associated with repetition and distributivity, vowel lengthening with long temporal durations, and consonant voicing is often used to code a light/heavy weight distinction, for example *koro: goro* 'a light: heavy object rolling' in Japanese (Shinohara & Kawahara 2016). Furthermore, babytalk registers often have additional neutralization rules and constraints on output form, some of which overlap considerably with the prosodic structure of ideophones. In his study of six babytalk registers, Ferguson (1964) mentions the fronting of velars to apical coronals, substitutions of rhotics for other coronals, nasal assimilation, and cluster simplification. The overlap among these patterns in babytalk, ideophones, and expressive morphology is suggestive of cross-linguistic trends, like palatalization. But how might these parallels be expressed in formal grammar, and is grammar integration possible for these structures as well?

It seems reasonable to expect that many of these structures can be accounted for with an ouptut target formalized with the EXPRESS(X) constraint format proposed here. Stopping, glottalization, fronting, and alternations involving rhotics can all be naturally expressed as an output target, so suitable specification of that structure in the EXPRESS(X) constraint format should accomplish the task. We have already mentioned reduplication and prior research (Yip 1998) arguing for a REPEAT(X) constraint that is a close cousin to our EXPRESS(X) constraints. Both formalize a non-arbitrary sound-meaning relationship and call for the existence of a specified structure, so it too seems like a productive line of approach for reduplication in expressive grammar. While we believe that some of these structures will fall in line, and provide some additional support for our theory, certain other phonological patterns do not seem to fit naturally. For example, cluster simplification is very common in babytalk registers, both as an active process affecting adult forms and a statistical trend in the lexical items of babytalk (Ferguson 1964). And, like many ideophones, babytalk registers often have canonical form requirements for lexical items, for example reduplicated CV-C(:)V words in Berber babytalk and (C)VCCV in Japanese (Ferguson 1977). Connecting the cluster simplification and canonical form facts, it seems that prosodic well-formedness constraints shape the prosodic structure of expressive words, a fact that is rather reminiscent of similar findings in child phonology. Cluster resolution, minimal word requirements, and reduplication are extremely common in child phonology (Demuth 1996; Ferguson 1983), the very patterns that adults seem to be mimicking with babytalk.

The prosodic shape effects could in principle be due to EXPRESS(X) constraints that refer to prosodic structure. For example, EXPRESS[MINIMALWORD] can stipulate a minimal word canonical form requirement, and perhaps similar reference to core CV syllables (Clements & Keyser 1983; Steriade 1982) could account for cluster resolution. It is even plausible that EXPRESS(X) constraints could account for divergent empirical patterns, where expressive phonology strayed from the typical patterns found in a language. For example, the disyllabic minimum requirement in Mexican Spanish diminutives differs from the bimoraic requirement on content morphemes in the rest of the language (Crowhurst 1992), supporting the conjecture that the shape canons for diminutives require a separate analysis. As tantalizing as this approach is, we do not believe that it is satisfactory as a general approach to shape effects in expressive grammar, essentially because these constraints would duplicate the work of other well-established prosodic well-formedness constraints (McCarthy & Prince 1993; Prince & Smolensky 1993/2004). In the context of the larger argument, however, such a conclusion actually strengthens our claim for grammar integration rather than weakens it. If we find that the best analysis of babytalk cluster resolution uses the same constraints as those that has been employed in syllable typology and child phonology, namely ONSET and *COMPLEX (Demuth 1995; Pater 1997), then again expressive phonology must involve core grammar.

Another question raised by this research is just where the EXPRESS(X) constraints come from. We have adopted a standard OT methodology of proposing a constraint type, assuming it to be active in all languages, and showing how the factorial ranking of these constraints can account for cross-linguistic trends. While we assume that the EXPRESS constraints are effectively universal, our arguments above do not depend on this assumption. An alternative analysis is that they emerge in the course of language development as the result of experience with target forms. Recent work on phonological constraint induction has shown that the well-formedness constraints of adult grammars can be learned from exposure to realistic language data (Alderete et al. 2013; Hayes & Wilson 2008), so there is no theoretical obstacle to such an approach. On this view, the cross-linguistic trends emerge not from the universality of the EXPRESS(X) constraints, but from the frequency of expressing ideas of smallness and childlike behavior with linguistic structures that result in high spectral frequency. Thus, on this view, humans do not necessarily have an innate predisposition for EXPRESS(X) constraints. They just tend to interact with children in specialized registers with the particular sound structures required by these constraints.

Investigating precisely how EXPRESS(X) constraints might be induced from speaker-listener interactions is the topic of another article, but we would like to point out a few pieces of evidence that suggest that this is indeed how learning of expressive palatalization takes place. The search for a universal substrate for magnitude sound symbolism is quite old and includes diverse methodologies. Indeed, finding such a structure, for example, high F0 in consonants and vowels, has been something akin to the search for the Holy Grail in sound symbolic research (see Nuckolls (1999) for a review). The broader picture painted by this research is not one of a psychologically primitive, perhaps innate, sound structure underlying magnitude sound symbolism, but rather a statistical universal learned from experience. Thus, experimental work has shown a greater-than-chance correlation between high spectral frequency and intuitions about size (Sapir 1949, Newman 1933, Ohala 1994, Shinohara & Karahara 2016, Dingemanse et al. 2016, cf. Bentley & Varon 1933), but not a categorical effect. Typological research has also shown strong associations between palatal consonants, affricates, and the high front vowel *i* and diminutive concepts and childlike behavors (Jespersen 1933, Nichols 1971, Ultan 1978). But again they document statistical universals, not absolute ones, because there are important exceptions. For example, Diffloth (1994) argues against a universal application of the frequency code hypothesis because in some languages the correlations are exactly the reverse of what is expected, as in Bahnar (Austroasiatic), where high vowels are correlated with the concept of bigness. If the formalization of the frequency code hypothesis is universal and innate, we expect categorical typological universals, not statistical ones. Finally, psychological research on perceived associations between high pitch and small size has been shown to develop much later, not until 11 years of age (Marks & Bornstein 1987), which suggests a developmental trajectory for the frequency code hypothesis rather than an innate predisposition.

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