

An Emergentist Model of Split Short-*a* Tensing

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Introduction

American English as generally described contains only one low front vowel, /æ/, which is a reflex of the Middle English short /a/. This vowel is typically lax, but certain dialects exhibit an alternation whereby in certain environments the vowel is pronounced in a way that can be impressionistically described as “tense.” In Northern Cities English, this tense variant occurs in all environments, as part of a chain shift that raised all front vowels. In much of the rest of the country, /æ/-tensing is conditioned by following nasals, a very simple natural class of environments. However, in the Mid-Atlantic states, alternations exist that are conditioned by specific unnatural classes of following consonants (Labov 2005, Ash 2002).

New York City and environs, in particular, exhibit a system of /æ/-tensing that is conditioned by a radically unnatural class of consonants; the voiceless fricatives, voiced stops, and non-velar nasals. Labov (2005) calls this the “split” short-a system.

Unnatural classes are a general problem for phonological theories that derive their notions of markedness from UG. If the featural content of phonemes provides an innate and more or less immutable bias constraining inventories and rules, “crazy” systems like New York City /æ/-tensing require additional assumptions to be derived.

Emergentist models of phonology, on the other hand, relax the inherent constraints UG places on the ability of the grammar to restrict the structure of phonological systems, allowing the grammar to massively overgenerate. This view of UG permits a huge variety of “crazy” systems, including both attested and unattested patterns. Typological distributions are then to be explained by extraphonological pressures on diachrony. Perceptual confusability is a critical prerequisite for the diachronic changes that produce these systems. Thus every system, whether it is in accord with UG assumptions or not, emerges through “innocent misapprehension.”

Crucially, in the evolutionary phonology model, “crazy” systems are capable of arising through misperception and misattribution in language learning, since grammatical markedness does not rule them out. While perceptually-based biases in language transmission will render such systems rare, particular diachronic trajectories can produce effects that are quite surprising, and would be universally ruled out by a model with strong markedness universals built into the grammar. Blevins (2006) and Hansson (2007) show that this diachronically-based method can provide explanations for particular phonological alternations that violate traditional grammatical markedness, and Brown (2008) shows that it can also provide an account of “crazy” consonant inventories.

The overgeneralization that allows this model to capture “crazy” systems is also a potential drawback, in that it shrinks the ability of the model to predictably restrict language variation, so its claims are radically more difficult to falsify than those of the

more restrictive UG models. To the extent that the evolutionary phonology model makes meaningfully restrictive predictions about the extension of conditioning environments to non-natural classes, it seems most fundamentally necessary to provide evidence of perceptual confusability within the putative non-natural class.

I will show that such evidence does, in fact, exist for the unnatural class conditioning /æ/-tensing in the New York City dialect. I will show that preceptual confusability of four different articulatory processes can cause language learners to unify quite different alternations into a single phonological process, and that these processes can be restricted to exactly the environments conditioning split short-a tensing in New York City.

The system

Split /æ/-tensing is related diachronically to other alternations affecting historical short /a/, such as the so-called *bath*-broadening, or *trap/bath* split, in southern England and New England, and the *bad/lad* split in some dialects of England and Australia. It is not known what the historical relationship is between the nasal system and the split system, though both systems coexist in close quarters, in New Jersey, for example (Ash 2002).

Within New York City, the degree of tensing is a strong sociolinguistic marker, but the pattern of conditioning is not socially evaluated. Labov (2005) shows that, while speakers may reduce the amount of tensing in careful speech, the pattern of tense and lax vowels is not disturbed by the effects of obsevation.

Table 1 shows the class of consonants inducing short-a tensing on preceding vowels in New York City:

Table 1

p		t	tʃ	k
b		d	ɟʒ	g
m		n		ŋ
f	θ	s	ʃ	
v	ð	z	ʒ	
		l	r	

No system of feature geometry in common use provides any way to unify the relevant class under a distinctive feature specification, without including a number of consonants that are excluded from the alternation.

The /æ/-tensing rule is a part of what Kiparsky (1996) regards as the lexical phonology. That is, it is subject to particular lexical restrictions. A number of words containing /æ/ superficially in the tense environment are pronounced with lax /æ/. Function words with simple codas, for example, (modal *can, an, had*) are lax. /æ/ in open syllables is typically lax, as in *hammer*, but syllables are considered to be closed by morpheme boundaries, so *planning*, for example, is tense. Initial short-*a* is usually lax, as

in *aspirin* or *asterisk*, but tense in some frequent words, such as *ask*. Abbreviations, foreign words, and late-learned words are lax.

There are additionally some lexical exceptions that have /æ/ in a superficially lax environment, but are pronounced with tense /æ/. One such example is *avenue*.

Labov claims the distinction is phonemic, due to the existence of minimal pairs (modal *can*, noun *can*; *have/halve*). Phonemic status is arguable, due to opaque phonological interactions/lexical phonology.

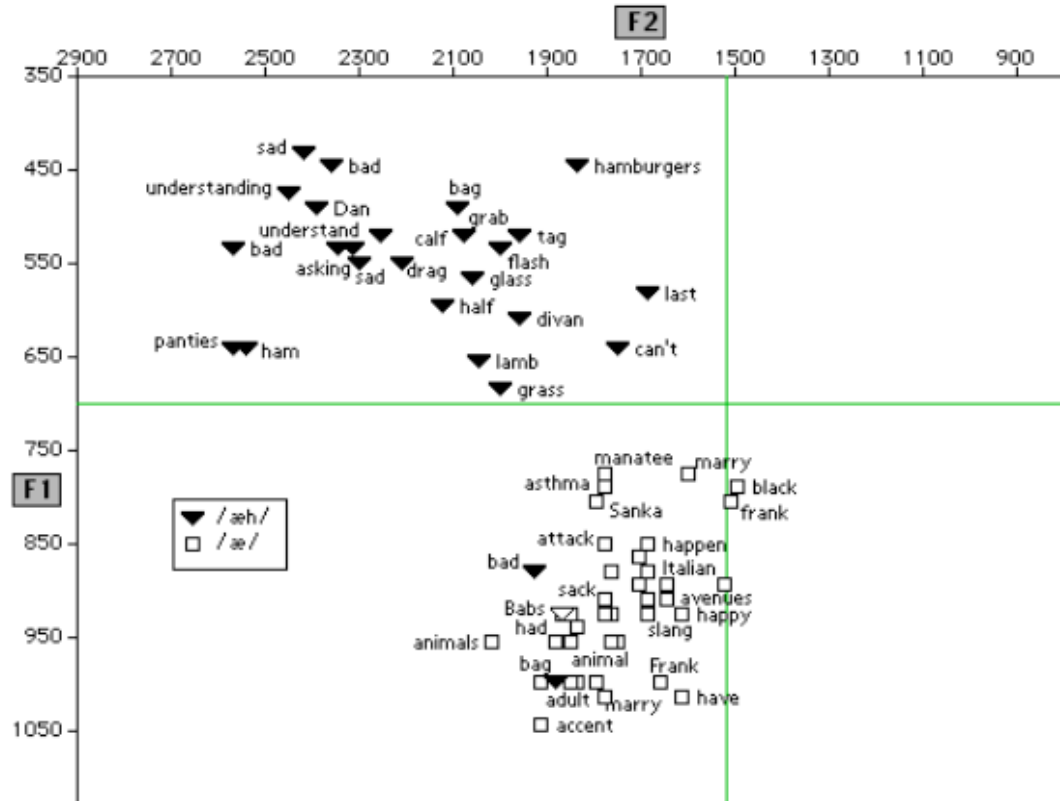
What is “tense”?

The perceptual features often described as correlates of the “tensing” of /æ/ include raising and fronting. In some varieties, the “tense” /æ/ is described as a diphthong, starting near /e/ or /ɛ/ and ending near /ə/.

The “tense” variant of /æ/ does in fact appear to pattern with other tense vowels in English, in one particular way. Tense /æ/ is often described as identical to the vowel in the word “yeah,” even as pronounced in dialects without /æ/-tensing systems. This word is unique in having the vowel /æ/ in a word-final open syllable. This environment is typically restricted to tense vowels in English. This is at least some evidence that the impressionistic characterization of tense /æ/ as “tense” is phonologically relevant.

However, it is far from clear that there is some particular articulatory feature of vowels that makes them tense as opposed to lax in English. And it is even less clear that such a feature would be shared by the “tense” variant of /æ/.

Labov (2005), however, showed that tense variants of /æ/ differ acoustically from lax variants in a predictable way in the speech of New York City residents. In particular, the chart in (2) shows that tense /æ/ has a significantly lower F1, as well as a higher F2, compared to lax /æ/.



De Decker & Nycz (2005) show that New Jersey speakers with the split system do use articulatory raising of the tongue to produce the acoustic raising seen in the tense versions of /æ/.

Diffusion and perception

Kiparsky (1996)'s "lexical diffusion" account of split /æ/-tensing views the class of conditioning environments as a consequence of analogy. The extension of the alternation to voiced stops, for example, involves analogical extension of the existing /æ/-tensing rule to new contexts. This model makes the crucial observation that context-sensitive diffusion is dependent on the prior existence of the change in some other environment. In other words, the /æ/-tensing rule must be established in some environment, through a non-analogical process presumably involving a natural class, before it may diffuse to the current unnatural class of contexts.

However, what the diffusion model cannot explain is exactly why the change was extended to the *particular* contexts in the current system. Analogy is most frequently to perceptually similar forms. Assuming that diffusion was the method of extension to new contexts, we are still left with the fundamental question of how nasals, voiced stops, and voiceless fricatives are perceptually similar.

While we have seen that systems of binary features cannot provide a characterization by which voiceless fricatives, voiced stops, and nasals can be unified, perceptual studies may provide principles by which perceptual confusability may be

established within this unnatural class. Such principles have been shown to be at least partially independent of the characterizations of binary features common in the phonological literature. Kingston et al (2007) put it this way:

On examining how phonological feature distinctions are realized phonetically, one is struck by the sheer number of distinct articulatory and acoustic correlates of any minimal contrast. It has been easy to show that many of the acoustic correlates contribute individually and jointly to the listener's recognition of the feature's value.

In particular, the frequency of F1, traditionally regarded as the acoustic and perceptual correlate of vowel height, has been shown to be an acoustic correlate, as well as a robust perceptual cue, for a number of other phonological features.

A diachronic account

I will begin with the nasal system of /æ/-tensing, which involves a natural class, to demonstrate how the emergentist model can produce a phonological alternation between tense and lax /æ/. Krakow et al (1988) show that nasalization acoustically raises low vowels, both lowering F1 and raising F2. Wright (1975, 1986) demonstrated that nasalized variants of /æ/ are perceived as higher than non-nasalized variants. Plichta (2002) found that tense variants of /æ/ in Northern Cities English were produced with high nasal airflow in both nasal and non-nasal environments, suggesting that nasality is one of the articulatory correlates of tensing in this variety. De Decker & Nycz (2005) found that New Jersey speakers with the nasal system of /æ/-tensing did not raise the tongue to articulate the tense variants of /æ/, and suggest that nasality is the only articulatory correlate of tensing in these varieties.

Additionally, Clumeck (1975) shows that low oral vowels are characterized by higher nasal airflow than high oral vowels. The larger airway opening at the pharynx associated with low vowels results in greater velopharyngeal airway opening, and thus higher nasal airflow.

These data suggest that the nasal system can arise from innocent misapprehension in the following way. Short vowels before nasals in English are known to have coarticulatory phonetic nasalization. This nasalization, as we have seen, causes perceptual raising. This raising is particularly salient for vowels that are low, due to the greater nasalization and greater perceptual influence of nasalization on height. Additionally, coarticulatory nasalization is more salient on short vowels than on long vowels due to the greater percentage of vowel duration occupied with the gestural overlap. As a result of these factors, short *a* is subject to unusually robust perceptual raising before nasal consonants.

Learners hearing this system could misinterpret the high degree of perceptual raising caused by nasal airflow as articulatory raising, and produce short *a* vowels with greater tongue height as a result.

Note that, while dialects with the nasal system show tensing before all nasals, the New York City system, as well as the *bath*-broadening system, both restrict tensing before nasals to front places of articulation, and exclude the velar nasal.

One possible interpretation of this fact is that the suppression of F1 that normally occurs before velars may make the F1 transition less misperceptible before the velar nasal. Learners would infer that the perceptual raising associated with low vowels before velars was a result of the velar place of articulation, in effect compensating for the tensing effect.

It is well-known that nasalization of vowels accompanies nasal consonants crosslinguistically. Historical changes to nasal vowels nearly universally involve sequences of oral vowel+nasal consonant. Ohala & Amador (1981) investigate the phenomenon of “spontaneous nasalization,” whereby some vowels become nasal when they are not originally in the environment of a nasal. Tellingly, this process happens most often before /h/ and voiceless fricatives and affricates. These are segments characterized by high airflow.

They show experimentally that low vowels before voiceless fricatives are perceptually nasalized, and conclude that this is due to the open state of the glottis during articulation of voiceless fricatives, which allows resonance in the subglottal cavity, increasing the bandwidth and lowering the frequency of F1.

While Ohala & Amador did not test for a contrast between voiceless fricatives and voiceless stops, crucially, spontaneous nasalization does not occur before (at least unaspirated) voiceless stops. One possible explanation is that airflow is reduced in the vowel transitions into voiceless stops to prepare for closure, and thus the effect of F1 lowering is not attested.

Notice also that while Ohala & Amador’s perceptual task involved identifying degree of nasalization, we have already seen that the percepts of nasalization and height of low vowels are linked, and the acoustic correlate they identify, lowering of F1, is the principal acoustic correlate of /æ/-tensing.

The convergence of two different articulatory processes on the same acoustic and perceptual cues is a clue to the potential origin of the split /æ/-tensing system. If a nasal /æ/-tensing system arose through misperception of nasalization and reanalysis as articulatory raising, a similar misperception could have caused short *a* to be reanalyzed as articulatorily raised before voiceless fricatives as well, due to the similar behavior of the F1 transition. The prior existence of contrasting tense and lax varieties of /æ/ before nasals could have provided a basic alternation that was extended to the environment of voiceless fricatives based on this perceptual similarity.

Similarly, voiced stops can be shown to provide the relevant cues for the same perceptual confusability, which could result in the same misapprehension-based reanalysis. Kingston et al (1998) show evidence of what they call the “low frequency effect” for voiced stops. This effect is a result of slackening the vocal cords to sustain periodic energy into the stop closure. Its acoustic effect is to lower F0 and F1 in vowel transitions into voiced stops. In voiceless stops, speakers cease vocal cord vibration and do not slacken their vocal cords, so this effect is absent. Voiced fricatives are produced without closure, and the vocal cord vibration remains more or less constant, so the effect is also absent in vowel transitions into voiced fricatives.

Again we see that the same acoustic cue, lowering of F1, is associated with a preconsonantal environment involved in the split /æ/-tensing, and not with the environments not involved. Again it is possible that learners misperceived the lower F1 transition into voiced stops as a result of articulatory raising and reanalyzed it as such.

Ultimately, the existence of perceptual confusability based on F1 transitions in a variety of preconsonantal environments shows how the entire split system can emerge as a telescoping of different changes built on innocent misapprehension. In particular, it provides a real explanation of why lexical diffusion should have operated across the particular environments involved in the split /æ/-tensing system, rather than other environments that may be more similar in terms of the geometry of distinctive features.

Diachronic evidence

One issue with the foregoing analysis that is a potential pitfall of much work in evolutionary phonology is that it is largely a *post hoc* justification. Demonstrating the plausibility of an alternation that already exists is not a measure of the predictive capacity of a theory. It is probably crucial to the overall utility of the model to provide some concrete evidence that diachronic changes might be motivated by the perceptual principles appealed to. Unfortunately, the teleology of diachronic change is not a particularly accessible form of evidence. In the absence of a device that allows us to examine the internal perceptual structure of the human brain, explanations of the perceptual basis for “crazy” diachronic trajectories run a substantial risk of being “just-so stories.” It is desirable to be able to conclude something more than: “and that, o best beloved, is how New York got its /æ/-tensing.”

Some evidence may be produced to mitigate this drawback of the model, however. Direct assessment of the motivations for diachronic change may be impossible, but some motivations may be inferred from the patterns of diachrony. Hansson () shows that this is possible for “crazy” phonological alternations in languages like Karaim.

Showing mutual confusability of the same F1 transition effects in three different (natural) classes of segments in English still does not make the entire system a perceptually natural class. In order for the emergentist model to make sense of the system, it must be regarded as the result of a telescoped system, each step of which proceeds by innocent misapprehension due to perceptual confusability. I have suggested above that this can be explained by a system beginning with misattribution of perceptual raising before (non-velar) nasals, then spreading to voiceless fricatives and voiced stops.

What is known of the diachrony of New York’s split /æ/-tensing is limited, but Babbitt (1896) describes older speakers in late nineteenth-century New York as exhibiting /æ/-tensing in the *bath*-broadening environments still common in Philadelphia, while younger speakers appear to have had the current system.

Wells (1982) describes *bath*-broadening as occurring to short-*a* in a phonological environment restricted to the position preceding front voiceless fricatives and nasal+obstruent clusters. While this change is lexically restricted in unpredictable ways, this environment bears in an interesting way on the perceptual data.

The restriction to the front places of articulation, which excludes the velar nasal from the environments conditioning both the *bath*-broadening/Philadelphia /æ/-tensing and the New York City split system, also applies to the voiceless fricatives in the former systems. That is, the voiceless fricative /ʃ/ is excluded. English of course lacks any fricatives further back. This may also be a result of compensating for the perceptual raising effect in the environment of segments that independently cause downward F1 transitions.

The principal difference between the *bath*-broadening environments and the New York split system is the extension of /æ/-tensing to the voiced stop series.¹ The *bath*-broadening environment, which conditions quite different alternations synchronically in southern England, is still much the same as the relevant environment for /æ/-tensing in Philadelphia dialects. This system can be largely explained if we view the emergence and diffusion of /æ/-tensing as proceeding via the misattribution of perceptual raising before non-velar nasals, and extension to the similar percept before voiceless fricatives.

I am not aware of any diachronic data showing an intermediate stage that could determine whether the alternation was extended to the two sub-environments of *bath*-broadening in the predicted manner, but *bath*-broadening itself shows us an intermediate stage on the path to the New York City split system that is consistent with the prediction that tensing before the class of voiced stops would be generalized all at once, based on a prior alternation that was extended to new environments in a phonetically plausible way, through innocent misapprehension.

Conclusion

What we know of the diachrony of the split /æ/-tensing system in New York City does show the alternation being extended class by class, with the (natural) class of the voiced stops coming last. The only way to make sense of this result, it seems, must hinge on the extension of the /æ/-tensing system to an unnatural class based on a telescoping of smaller, perceptually natural steps. A model such as evolutionary phonology which views markedness-based distinctions like natural classes as an emergent property predicts unproblematically that this kind of telescoping could produce such a superficially improbable system. Modeling markedness strongly within the grammar, however, seems to require a great deal of weakening to accommodate such systems.

¹ The system is also extended to the voiceless fricative /ʃ/ in New York City, but there are dialects in central New Jersey that exhibit the split system, but do not extend tensing to /ʃ/.

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