Phonetic enhancement and three patterns of English æ-tensing

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English æ-tensing has received numerous treatments in the phonological and sociolinguistic literature (e.g. in the OT era: Benua 1997; Morén 1997; McHugh 2003; Labov 2007; Becker & Wong 2010), but few have addressed why it occurs (i) at all, and (ii) in its particular disjunctive phonological environments. This paper presents a novel phonetic enhancement account of æ-tensing in Philadelphia, New York City (NYC) and Belfast English. Each dialect exhibits an alternation between a short lax [æ] and a tense, raised diphthongal variant, transcribed in this paper as [eə]. The tense variant surfaces preceding particular classes of coda consonants. I propose that these seemingly unnatural conditioning contexts can be unified by phonetic motivations.

Core æ-tensing environments: In Philadelphia, for example, lax [æ] always surfaces in stressed open syllables (1). In closed syllables, however, either lax [æ] (2) or tense [eə] (3) can surface; the variant depends on the coda consonant (Benua 1997, McHugh 2003, Labov 2007).

(1) [æ] in all (stressed) open syllables

[ˈpæ.mə.lə]	'Pamela'
[ˌkæ.fə.ˈti.riə]	'cafeteria'
[ˈplæ.nət]	'planet'
[ˈpæ.sədʒ]	'passage'

(2) [æ] before tautosyllabic stops and voiced fricatives

[ˈkæt]	'cat'
[ˈtæp]	'tap'
[ˈtæg]	'tag'
[ˈhæv]	'have'

(3) [eə] before tautosyllabic nasals and voiceless fricatives

[ˈheəm]	'ham'
[ˈkeəf]	'calf'
[ˈpleən#ət]	'plan it'
[ˈpeəs]	'pass'

[eə] is more restricted in Philadelphia English than in other varieties. In NYC, [eə] also occurs before tautosyllabic voiced stops (Labov 2007); in Belfast, the tense variant surfaces before all coda fricatives, voiced stops and [l] (Harris 1985, 1989). The coda conditioning environments for each dialect therefore cannot be characterised in terms of natural classes or any harmonic scale, leading some to suggest that æ-tensing has been lexicalised (e.g. Kiparsky 1995, Labov 2007). A lexicalisation account, however, does not explain why tensing is phonologically predictable.

	Sonorants		Voiced obstruents		Voiceless obstruents	
	Laterals	Nasals	Fricatives	Stops	Fricatives	Stops
Philadelphia	lax	tense	lax	lax	tense	lax
NYC	lax	tense	lax	tense	tense	lax
Belfast	tense	tense	tense	tense	tense	lax

Proposal: æ-tensing is best understood as a phonological process which *enhances* the phonetic properties of coda consonants in English. Speakers advance their tongue root and raise the tongue body in order to facilitate voicing and frication in codas, creating a tensing effect on the previous vowel. This approach unifies the apparently unnatural phonological environments in which the tense variant surfaces and also predicts the attested dialectal patterns. The regularity and phonetic predictability of æ-tensing suggests that it is in fact a synchronic phonological process.

Phonetic enhancement: Tensing, which involves tongue root advancement (ATR) and/or raised tongue body (RTB) (Archangeli & Pulleyblank 1994, De Decker & Nycz 2012), reinforces the phonetic characteristics of English coda consonants by facilitating voicing, frication and nasality.

1. *Voicing* is difficult in obstruents, because supraglottal pressure builds up behind the constriction, preventing airflow. ATR widens the supraglottal cavity, increasing its volume and reducing supraglottal pressure (Westbury 1983). ATR helps facilitate airflow and voicing, thereby mitigating the devoicing of [+voice] obstruents (Ahn 2015). In American English, manner of articulation also affects the rate of devoicing: 79% of word-final voiced fricatives are partially or fully devoiced, but only 55% of word-final voiced stops undergo devoicing (Davidson 2016).

I propose that ATR occurs in order to reinforce obstruent voicing, resulting in a tensed preceding vowel. This makes the prediction that obstruent voicing should correlate with vowel tensing. Since word-final stops are more likely to be phonated than fricatives, we would expect final voiced stops to trigger tensing more readily than their fricative counterparts. That is, tensing should co-occur with phonated fricatives iff it also occurs with phonated stops. This prediction is indeed borne out in the comparison between Belfast, where æ-tensing is triggered by all voiced obstruents, and NYC, where tensing is triggered by voiced stops but not voiced fricatives. This also captures the fact that voiceless stops, which are never phonated, do not trigger tensing in any dialect. Finally, since 90–95% of word-medial stops and fricatives remain fully or partially voiced in American English (Davidson 2016), we can also account for the lack of æ-tensing in open syllables.

2. *Fricative duration* is reinforced by tensing in much the same way as voicing is. A fast, continuous stream of air is required to produce fricatives. ATR increases the volume of the oral cavity, which lowers supraglottal pressure and facilitates airflow, allowing frication to be maintained for a longer period of time. Following the same logic as with voicing, then, we would expect tensing to correlate positively with the duration of frication. In Philadelphia English, voiceless fricatives trigger tensing and voiced fricatives do not. Studies have shown that the duration of frication for voiceless fricatives in American English is 50–90% longer than that of voiced fricatives (Crystal & House 1988, Stevens et al. 1992). The prediction is thus borne out: voiceless fricatives are longer in duration than voiced fricatives and therefore more likely to be reinforced by æ-tensing.

3. Finally, *nasality* is enhanced by RTB, another major articulatory correlate of tensing. Nasals require lowering of the velum. In low vowels, however, the velum has to lower farther in order for nasalisation to be perceptible (House & Stevens 1956). RTB reduces the distance the velum needs to lower in order to generate nasalisation on the low vowel. Thus æ-tensing both enhances vowel nasalisation and facilitates the articulation of the nasal consonant itself. This explains why nasal-induced tensing only occurs with the low [æ] and not other vowels.

Given these distinct phonetic conditions, we expect their enhancement via tensing to be articulatorily realised in different ways or to different degrees. This is shown in De Decker & Nycz's (2012) ultrasound study: speakers who exhibited NYC-like tensing had greatest ATR in *pan*, followed by *pad* and *pass*, then *pat*; this suggests that nasals and voicing trigger greater ATR than frication. Furthermore, as predicted by my account, only nasal codas conditioned significant RTB.

Conclusion: I have argued for English æ-tensing as a phonetically-motivated process, allowing for unification of its conditioning environments and thus providing evidence for its synchronic status.

Selected references: Ahn 2015. Utterance-initial voiced stops in American English | Archangeli & Pulleyblank 1994. *Grounded Phonology* | Becker & Wong 2010. The short-a system of New York City English | Benua 1997. *Transderivational identity* | Crystal & House 1988. Segmental durations in connected speech signals | De Decker & Nycz 2012. Are tense [æ]s really tense? | Davidson 2016. Variability in the implementation of voicing in American English obstruents | Harris 1985. *Phonological variation and change* | Kiparsky 1995. The phonological basis of sound change | Labov 2007. Transmission and diffusion | Westbury 1983. Enlargement of the supraglottal cavity and its relation to stop consonant voicing.