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The Representation of Nasal + Stop + Obstruent Clusters in English: Stop Insertion or Stop Deletion?

Abstract: The medial stop of English nasal+stop+obstruent clusters is present only optionally (indicated by italics or superscript in the transcription, following Wells 2008): e.g. *sphincter* [ˈsfɪŋ*k*tə] and *concert* [ˈkɒn^{t}sət]. The question then arises if the stop is deleted or inserted in this context. I argue that in fact both processes exist, accounting for the differences between them. I propose a Government Phonological analysis, where deletion is caused by lack of proper government, whereas insertion involves creation of a contour structure. I show that the latter process applies at the stem level, while the former belongs to the word level. The analysis is then extended to a third process of optionally reducing affricates to fricatives after nasal or oral stops (as in *angel* [ˈeɪn*d*ʒəl] and *actual* [ˈæk*t*ʃuəl]), represented as loss of the affricate's stop half.

Keywords: cluster simplification, emergent stop, government, contour structure, Strict CV, Element Theory

1 Introduction

The occurrence of CCC-clusters is severely limited in English, unless C_2C_3 form a possible branching onset (as in *country* [ˈkʌntri]). If this is not the case, then either C_2 must be [s] (as in *substitute* [ˈsʌbstɪtjuːt]), or a homorganic nasal+stop cluster is followed by an obstruent. The medial stop of such nasal+stop+obstruent clusters is present only optionally, indicated by italics or superscript in the transcriptions of (1a) vs (1b), following Wells (2008). (Data in this paper have

Acknowledgements: This paper is dedicated to Harry van der Hulst, to express my gratitude for everything I have learned from him and for all the fun we have had discussing phonology and other important questions of life. I would also like to thank Péter Siptár, Jeroen van de Weijer, an anonymous referee, and audiences of presentations at the 6th Fonologi i Norden Meeting, and at the 28th Manchester Phonology Meeting, for valued comments on previous versions of this paper.

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https://doi.org/10.1515/9783110730098-010

been collected from the electronic database of Lindsey and Szigetvári (2013), and all examples cited have been checked in Wells 2008.)

(1) *nasal+stop+obstruent clusters*

a.	empty	[ˈem*p*ti]	b.	concert	[ˈkɒn*t*sət]
	tincture	[ˈtɪŋ*k*ʧə]		infant	[ˈɪn*t*fənt]
	sphincter	[ˈsfɪŋ*k*tə]		length	[leŋ^{k}θ]
	function	[ˈfʌŋ*k*ʃən]		hamster	[ˈhæm^{p}stə]

The question then arises if the stop is deleted or inserted in this context. Szigetvári (2020) proposes to analyse both cases as insertion. However, I will show that important differences between the two types remain unexplained under such an analysis. Therefore, I will argue that there is both deletion and insertion (in (1a) and (1b), respectively, as suggested by the transcriptions of Wells), and I will provide a Government Phonological analysis, in terms of Strict CV (Lowenstamm 1996) and Element Theory (Backley 2011). I will also extend the analysis to a third process, the reduction of affricates to fricatives, applying optionally after nasal or oral stops (as in *angel* [ˈeɪn*d*ʒəl] and *actual* [ˈæk*t*ʃuəl]). This cannot be analysed as insertion either because it does not happen in forms like *action* [ˈækʃən].

2 Deletion vs Insertion

Comparing (1a) and (1b), the following differences between the two types can be identified. (i) In (1b), C_3 is always a fricative, while in (1a), C_3 is mostly a stop or an affricate. (ii) When the third consonant in the cluster is a fricative, the alternation does not occur in the context of a following stressed vowel (e.g. *concert* (noun) [ˈkɒn^{t}sət] vs *concert* (verb) *[kən^{t}ˈsɜːt]), whereas in case of a stop the alternation is also found pretonically (e.g. *punctilious* [pʌŋ*k*^{t}ɪliəs]). (iii) An optional [t] can be found before a fricative (e.g. *infant* [ˈɪn^{t}fənt]), but never before a stop (e.g. *melancholy* *[ˈmelən^{t}kəli]). As a coronal stop cannot occur in a word-internal coda in English (words like *chapter* [pt] and *doctor* [kt] exist, but the reverse clusters, [tp] and [tk], are ruled out), this difference between (1a) and (1b) can be explained if the nasal+stop+stop clusters in (1a) must be underlying but the [t] in forms like *concert* [ˈkɒn^{t}sət] in (1b) is excrescent in some way. (iv) [ŋ] is normally only permitted before a velar plosive morpheme internally at the stem-level, which would be contradicted by forms of type (1a) if the [k] was not underlying. (v) Finally, voiceless stops are also optionally deleted in the parallel forms containing the word-level suffixes *-s* and *-ed*: e.g. *jumped* [ʤʌm*p*t], *prints* [prɪn*t*s], and *thanks* [θæŋ*k*s], where an inser-

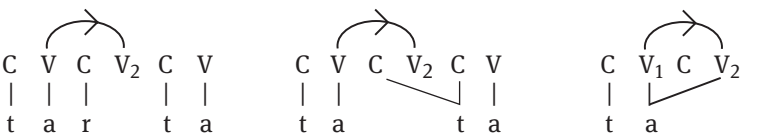
tion analysis is not feasible, shown by the fact that the stops are also present in the unsuffixed form (where there is no alternation). Therefore, I maintain that forms in (1a) involve deletion of the medial stop, while forms in (1b) exhibit insertion.

3 Analysis of Deletion

Deletion of the medial stop in (1a) can be easily understood in a Strict CV analysis (following Lowenstamm 1996). In this approach, syllable structure consists of strictly alternating C and V positions. As a consequence, the representation of closed syllables, geminate consonants and long vowels involves an empty position, as shown by the hypothetical forms in (2).[1]

(2) *Strict CV* (Lowenstamm 1996)

a. *closed syllable* b. *geminate consonant* c. *long vowel*



Geminates and long vowels are built up of two CV units. In a geminate the consonantal melody straddles an empty V position, while in a long vowel the vocalic melody straddles an empty C.

Following Rowicka (1999a, 1999b), I employ trochaic (left-to-right) proper government instead of the more usual right-to-left type,[2] as defined in (3) (argued for extensively in Polgárdi 2012, 2015a, 2015b).

(3) *Trochaic (left-to-right) Proper Government* (Rowicka 1999a, 1999b)
A nuclear position *A* properly governs a nuclear position *B* iff
(a) *A* governs *B* (adjacent on its projection) from left to right
(b) *A* is not properly governed

1 In this approach, there is no syllabic structure above the skeleton, all we have are the CV units, with some positions potentially remaining empty. For ease of exposition, I will keep using expressions like rhyme, closed syllable, branching onset etc., but only as descriptive terms, referring to specific configurations in the data, which then will receive a CV-analysis.

2 Iambic proper government was proposed by Kaye (1990), and Kaye, Lowenstamm, and Vergnaud (1990), and it has been employed by most proponents of Government Phonology. Advocates of trochaic proper government include Gibb (1992) and Yoshida (1999).

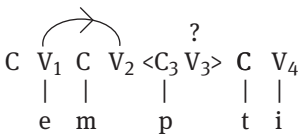
Government is a binary, asymmetric relation between skeletal positions. Proper government, indicated by a curved arrow in (2), is a special form of government, which works in conjunction with the Empty Category Principle, given in (4).

(4) *Empty Category Principle (ECP)* (Kaye, Lowenstamm, and Vergnaud 1990: 219)
A position may be uninterpreted phonetically if it is properly governed.

As a result, an empty V position may remain silent if it is properly governed, as shown by V_2 in (2a–b) above. According to Rowicka (1999a, 1999b), the relationship between the two halves of a long vowel is also one of proper government, as shown in (2c). The difference between this case and the one in (2a–b) is that in (2c) the C position between V_1 and V_2 is unfilled, and therefore the governing relationship is manifested by spreading the melodic content of V_1 into V_2, in Rowicka's proposal. The ECP permits properly governed positions to remain uninterpreted, but it does not demand that they do so. Therefore, the realisation of V_2 in (2c) does not contradict the ECP.

Deletion of the medial stop in forms like (1a) can then be analysed as presented in (5).

(5) *deletion of ungoverned CV unit*



In this representation, V_1 properly governs the empty V_2 inside the homorganic cluster, thus enabling it to remain silent. Being properly governed, however, V_2 can now not govern V_3.[3] Therefore, it is no surprise that the cluster is optionally simplified, by deleting the C_3V_3 sequence (indicated by angle brackets).[4] Note that

3 The situation seems to be the same when the consonant cluster occurs word-finally, as in *lamp* [læmp], but in this case no alternation is found. To take care of the second empty nucleus in the sequence, either domain-final licensing of empty nuclei is proposed to be permitted parametrically (e.g. Yoshida 1999), or a Loose CV approach is adopted which dispenses with inaudible domain-final empty nuclei altogether (e.g. Polgárdi 2015a).

4 What is surprising, though, is why this deletion only happens optionally and not obligatorily. While I do not have a satisfactory answer for this question at the moment, note that similarly surprising forms are also sometimes (optionally) created by syncope, as in *comp(a)ny* [ˈkʌmpni] and *vict(o)ry* [ˈvɪktri], where the third consonant following the coda-onset cluster is of course a sonorant (Polgárdi 2015a).

with iambic proper government, V_3 would be governed by the following filled V position. In that situation, we would not expect that CV unit to delete, but rather the previous one, contrary to what actually happens.

4 Analysis of Insertion

As the lexical representation in (5) is ill-formed, we do not expect another process to create it. The appearance of a stop in (1b) thus cannot result from segment insertion. I propose that a contour structure is created, similar to that of the two root node analysis of affricates by Harris (1994) (see also Clements 1987).

To represent this process, I use Element Theory, as introduced for example in Backley (2011). In this version, there are three resonance elements and three manner/laryngeal elements, all monovalent, presented in (6a–b).

(6) *Element Theory* (Backley 2011)

a. *resonance elements*

		acoustic pattern
I	[i]	*dIp*: low F_1, high F_2 merged with F_3
A	[a]	*mAss*: high F_1 merged with F_2
U	[u]	*rUmp*: lowered formants

b. *manner / laryngeal elements*

		acoustic pattern
?	[ʔ]	*stop*: sudden and sustained drop in acoustic energy
H	[h]	*noise*: raised F_0, aperiodic noise (continuous/transient)
L	[ɯ̃]	*nasal*: low frequency energy, murmur

The list in (6) gives the representation of the element in bold, its phonetic interpretation when it constitutes a segment by itself (in a V position in (6a) and in a C position in (6b)), followed by the name of the element in italics, and a brief description of the acoustic pattern it is mapped onto. All elements can occur in both V and C positions, although their interpretation differs depending on the position.

In the case of vocalic expressions, the resonance element |**I**| occurs in front vowels, |**A**| in non-high vowels, while |**U**| in rounded vowels. The unmarkedness of the vowels [i a u] is expressed by their simplex nature, that is, that they are made up of a single element. Elements can also combine, resulting in compound expressions, mapping onto composite spectral patterns, comprising the acoustic characteristics of contributing elements. For example, the mid vowel [ɛ] is repre-

sented by the compound |**A I**|, combining the openness of |**A**| with the frontness of |**I**|. In addition, following Dependency Phonology (Anderson and Ewen 1987), the notion of headedness is also employed. This gives an element acoustic prominence or strength (as in the contrast between [e] |**A <u>I</u>**| as a lowered front vowel vs [æ] |**<u>A</u> I**| as a fronted low vowel). As we shall see below, non-headed expressions and expressions with more than one head are also allowed.

Turning to the manner/laryngeal elements, the stop element |**?**| occurs as non-headed in oral and nasal stops (and affricates) and in creaky vowels, and as headed in ejectives. Non-headed |**H**| can be found as noise in fricatives and released stops (and affricates), while headed |**<u>H</u>**| is interpreted as voicelessness or aspiration in languages such as English, where a phonologically active voiceless series of obstruents contrasts with a phonologically neutral series of voiced obstruents lacking a laryngeal property. Conversely, in languages like French, where the phonologically active obstruent series is voiced, this series possesses the headed element |**<u>L</u>**|, representing voicing, in contrast to the neutral series, again lacking an active laryngeal element. Non-headed |**L**|, on the other hand, stands for nasality, in both consonants and vowels. In addition to aspiration and voicing in obstruents, headed |**<u>H</u>**| and |**<u>L</u>**| in vowels represent high and low tone, respectively.

The elemental representation of the English consonant system is given in (7), except for the laryngeal distinction. (The non-headed |**H**| in (7) represents neutral obstruents, and it is replaced by headed |**<u>H</u>**| in their voiceless counterparts.) The articulatory labels are provided for ease of reference here, and they might not always match the phonetic details. The representational classes in Element Theory are based on phonological behaviour and not simply on articulatory properties.

(7) *representation of consonants in English, voicing disregarded*

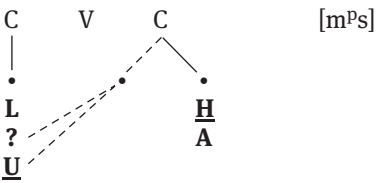
		lab	dent	alv	pal-alv	pal	vel	glott
		<u>U</u>	**A I**	**A**	**A <u>I</u>**	**<u>I</u>**	**U**	–
stop	**? H**	p b	t d		ʧ ʤ		k g	(ʔ)
fric	**H**	f v	θ ð	s z	ʃ ʒ			h
nasal	**? L**	m		n			ŋ	
approx	–	w	l	ɹ		j		

Affricates and stops are treated as phonologically identical, only distinguished by their resonance properties (resulting in a difference in release phase in their phonetic interpretation). Place of articulation is defined by the resonance elements, with variation in headedness again representing a difference in the strength

of their acoustic cues. The parallelism with vowels is quite clear in the case of headed |**U**| standing for labials, non-headed |**U**| for velars, and headed |**I**| for palatals. The coronal area is more complex, and it also shows more language-specific variation. Palato-alveolars may share a class with palatals or they may be separate, as proposed here, bearing the specification |**A I**|. Dentals and alveolars may be represented by non-headed |**I**|, |**A**|, or |**A I**|, depending on their behaviour. I have chosen to represent [t d θ ð] in English as |**A I**| to be able to formulate the restriction against homorganicity within branching onsets in a straightforward way (i.e. *[tl dl θl] vs [tɹ dɹ θɹ]),[5] but nothing hinges on this with respect to the story of nasal+stop+obstruent clusters. (Headed |**A**| is used for uvulars and pharyngeals, or for retroflexes, in languages that have these types of consonants.) Finally, glottals lack a resonance element altogether.

The representation of stop "insertion" is provided in (8), on the example of the medial cluster in *hamster* [ˈhæmᵖstə].

(8) *creation of a contour structure*



Here, [m] is built up of the nasal element |**L**|, the stop element |**?**|, and the place element |**U**| (for labial), while [s] comprises the headed |**H**| element, standing for voicelessness and noise, and the place element |**A**| (for alveolar). During the process, the stop and place elements of the nasal spread to the following fricative (expressing extension of oral closure), and an additional root node (•) is created to host them, producing a contour structure (see also Clements 1987). This representation is similar to that proposed by Harris (1994) for affricates, except that here the two root nodes bear separate place specifications.[6] Analysing the emergent stops of (1b) as part of a contour structure makes the prediction that they should be shorter than the underlying stops of (1a). In fact, there has been some experimental evidence for this, measured in pairs of minimally distinct words like *dense* [denᵗs] vs *dents* [dents] (Fourakis and Port 1986).

5 Note that *[ðl] and *[ðɹ] are ruled out independently because voiced fricatives cannot occur in complex onsets in English.

6 In Backley's (2011) system, affricates are not contour segments, as shown in (7), an issue that I will come back to in Section 5.

The process only applies when the fricative is voiceless (e.g. *hamster* [ˈhæmᵖstə] vs *crimson* *[ˈkrɪmᵇzən]) which, therefore, always bears headed |**H**|. In my view, this element does not need to spread to the root node of [p] because neutral obstruents in languages like English only exhibit passive voicing when they are surrounded by voiced sounds (essentially vowels and/or sonorant consonants), whereas next to a voiceless obstruent passive voicing is blocked (Iverson and Salmons 1995). Or if |**H**| does spread, I think, this should be an automatic consequence of a general requirement on root nodes within the same segment to share their laryngeal specifications, and it should not be specified as a separate part of this process.

A question that arises at this point concerns the motivation for this process: in what sense is the sequence [mᵖs] better than the sequence [ms]? Nasals like to be homorganic with a following obstruent, but this does not suffice as an explanation because the process also applies in homorganic nasal+fricative clusters (as in *comfort* [ˈkʌmᵖfət]). The motivation provided in the literature is rooted in the challenging nature of the relative timing of articulatory gestures during the production of this sequence: closure of the velum and release of the oral closure for the nasal must be synchronised to produce a neat transition between the nasal and the fricative. If release of the oral closure lags behind, an epenthetic stop is produced (e.g. Ali, Daniloff, and Hammarberg 1979; Ohala 1997; see Page (1997) for an overview and further references). I propose to represent this extension of oral closure of the nasal in Government Phonology as in (8). Both the two root node analysis and the idea that this process is not motivated by syllable structure are supported by the finding of Solé (2007) that an epenthetic stop also occurs in the mirror image fricative+nasal context (i.e. when the cluster /sm/ is realised as [sᵖm], e.g. in *Christmas* [ˈkrɪsᵖməs]). In this case, oral closure for the nasal precedes lowering of the velum. Because such emergent stops are nasally released, they are perceptually much less salient than the ones occurring in nasal+fricative clusters (and they are not indicated in Wells (2008)).

Having an articulatory motivation might suggest that the process applies at a very low, perhaps even phonetic, level. This is, however, not the case. One argument against this is provided by the fact that it is lexically variable: that is, in the same prosodic and melodic context, epenthesis applies in one word (e.g. *infant* [ˈɪnᵗfənt]), but not in another (e.g. *infamous* *[ˈɪnᵗfəməs]), showing that the process must belong to the lexical phonology.[7] In fact, it can be demonstrated that it is

7 One factor involved in this difference is probably relative usage frequency of lexical items.

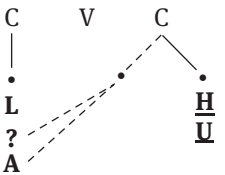
restricted to the stem level, as it applies before stem-level suffixes (e.g. *month* [mʌnᵗθ]) but not before word-level ones (e.g. *painful* *[ˈpeɪnᵗfəl]). Stem-level status of *–th* is evidenced by shortening of the stem vowel to conform to phonotactic restrictions characterising monomorphemic items. The lack of such shortening testifies to word-level status for *–ful*. (For a discussion of the stem vs word level distinction, see Harris 1994; Kaye 1995 in Goverment Phonology; Kiparsky 1982; Borowsky 1993 in Lexical Phonology; and Kiparsky 2000; Bermúdez-Otero 2012 in Stratal OT.)

This leads us to the question of how the few items like *length* [leŋᵏθ] can be derived. That suffixation of *–th* has applied at the stem level is also clear from umlaut of the stem vowel. However, simplification of /ŋg/-clusters is restricted to domain final position at this level, as in *long* [lɒŋ] vs *longitude* [ˈlɒŋgɪtjuːd]. The /g/ of /leŋgθ/, therefore, cannot be deleted by it. The only way I see to analyse this form is to assume that the /g/ has been devoiced, standing next to a voiceless obstruent, and it is optionally deleted, similarly to the parallel forms in (1a). Thus, it does not exemplify epenthesis. If emergent stops turn out to be systematically shorter than underlying stops, then the validity of this analysis could be tested by measuring the duration of the alternating stop.

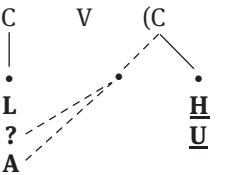
As discussed in Section 2, insertion of an epenthetic stop fails to occur preceding a stressed vowel: e.g. *inference* [ˈɪnᵗfərənᵗs] vs *infer* *[ɪnᵗˈfɜː]. The representations of the medial clusters are given in (9a–b).

(9) *no spreading across a foot boundary*

a. *inference* [ˈɪnᵗfərənᵗs]



b. *infer* *[ɪnᵗˈfɜː]

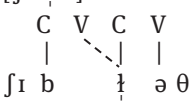


The difference involves presence or absence of a foot boundary (indicated by a parenthesis on the CV-tier in (9b)) between the trigger and target of spreading. The generalisation thus seems to be that spreading cannot cross a foot boundary, while it is allowed to apply within the same foot. In fact, this restriction is not specific to the emergence of epenthetic stops, but it can also be found with respect to another stem-level process, syllabic consonant formation (Polgárdi 2015a), which is also prohibited pre-tonically: e.g. *shibboleth* [ˈʃɪbə̩lɛθ]/[ˈʃɪbələθ]/[ˈʃɪbɫ̩əθ], where a syllabic [ɫ̩] is only possible when the following vowel is reduced. Relevant parts of the representations are given in (10).

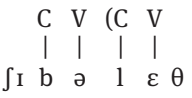
(10) *English syllabic consonant formation*

a. [ˈʃɪbələθ]

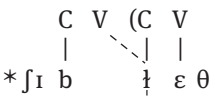
b. [ˈʃɪbl̩əθ]



c. [ˈʃɪbə˛lɛθ]



d. *[ˈʃɪbl̩ɛθ]



Syllabic consonants in English are analysed in Government Phonology as resulting from spreading of the melody of the consonant to a preceding V position (Szigetvári 1999; Scheer 2004; Polgárdi 2015a), accounting for their alternation with a schwa plus non-syllabic consonant sequence, as in (10a–b). The representations in (10c–d) show that such spreading is illicit when it would involve crossing a foot boundary, similarly to what we have seen in the case of emergent stops. In fact, if these emergent stops were analysed as resulting from regular epenthesis (i.e. insertion of a CV unit), then this restriction would remain unexplained, as the explanation crucially relies on the involvement of spreading to the C position of the fricative.

5 Reduction of Affricates

Finally, there is an interesting further process in English that applies in a partly overlapping context (which I have not seen discussed in the literature), whereby affricates following nasal or oral stops optionally reduce to fricatives, as illustrated in (11a–b).

(11) *reduction of affricates*

a. *nasal+affricate clusters*		b. *stop+affricate clusters*	
angel	[ˈem*d*ʒəl]	actual	[ˈæk*t*ʃuəl]
century	[ˈsen*t*ʃəri]	capture	[ˈkæp*t*ʃə]

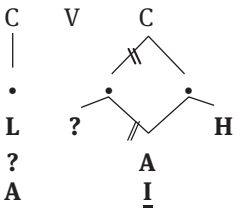
This process is not the exact reverse of that exemplified in (1b), not only because it applies after oral stops too, but also because it affects voiced affricates as well, although only when they follow a nasal (e.g. *subjugate* *[ˈsʌbʒəgeɪt]). Another difference is that here the stop part of the affricate of course shares its place properties with the fricative part, and not (necessarily) with the preceding nasal or

stop. This reduction is lexically variable in the context of an oral stop (e.g. *structure* [ˈstrʌkʃə] vs *stricture* *[ˈstrɪkʃə]), but after a nasal no such variation is found. In addition, the process is prevented from applying by a following stressed vowel (e.g. *angel* [ˈeɪnʒəl] vs *angelic* *[ænˈʒelɪk]).

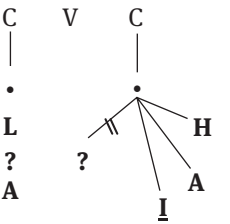
It is not entirely obvious how to analyse this process. If affricates are represented as contour structures, then their reduction is sort of the reverse of stop insertion in (8), given in (12a), by losing their stop half (including one of their root nodes).

(12) *reduction of affricates: angel* [ˈeɪnʤəl]

a. *affricate as a contour structure*



b. *affricate as a stop*



However, in Backley's (2011) system, affricates are generally treated as phonologically identical to stops, in which case reduction simply means loss of their stop element, without further simplification of the structure, as in (12b). Restriction to non-pretonic position can be explained by the nature of the process as a type of lenition which we do not expect to apply in a strong position, as the one preceding a stressed vowel.

The question then is why two processes with the exact opposite result would apply in (almost) the same context. I think, the reduction of affricates might be a natural extension of the stop "insertion" process. As the latter applies optionally, a form like *censure* will sometimes appear with a nasal+fricative sequence, as [ˈsenʃə], and at other times with a nasal+"affricate" sequence, as [ˈsenᵗʃər]. It then will be easy for speakers to extend the alternation to forms like *venture* [ˈventʃə] with a nasal+affricate sequence and pronounce it sometimes with a nasal+fricative sequence, as [ˈvenʃə]. In this way, the surface forms become completely analogous, even though coming from different sources.[8] Perhaps this "conspiracy" provides an argument in favour of the two root node analysis of

8 It might, of course, also be that the chronology of these developments was the reverse, or that they happened at the same time. My point here is simply that they were probably related.

affricates. Extending the pattern further, to stop+affricate clusters, is interesting because in stop+fricative sequences like *action* [ˈækʃən] emergent stops are not found. Perhaps what helps here is that underlyingly stop+stop+fricative clusters (such as [ktʃ]) are also illicit in English because the second stop should be a [t] which, however, cannot occur in an internal coda (as mentioned in Section 2).

6 Summary

In this paper, I have examined the alternation exhibited by the medial stop of nasal+stop+obstruent clusters in English. I have argued for the existence of two separate processes: deletion of an underlying stop between a nasal and an obstruent (mostly a stop), and formation of an emergent stop in a nasal+fricative context. These are supplemented by a third process, reducing an affricate to a fricative after a nasal or oral stop.

I have analysed deletion of an underlying stop in a Strict CV framework, as caused by lack of proper government of the relevant CV unit. The representation of emergent stops in a nasal+fricative context involves creation of a contour structure, by spreading the stop and place elements of the nasal to the following fricative. This spreading is restricted to apply only within the domain of a foot, a parallel of which can be observed in syllabic consonant formation. Both of these processes apply at the stem level, whereas deletion of an underlying stop applies at the word level, evidenced by the fact that it can also be triggered by word-level suffixes. Finally, the reduction of affricates is analysed as a process which is sort of the reverse of the one creating emergent stops, by loss of the affricate's stop half. An insertion analysis is not possible in this case either, as it would overgenerate in stop+fricative sequences like *action* *[ˈækᵗʃən].

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