A PHONETICS-PHONOLOGY INTERFACE VIEW OF CASUAL ENGLISH CONSONANT LENITION: Alveolar Taps[1]

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INTRODUCTION[2]

Phonetically, the existence of the English alveolar oral tap, [ɾ], is well-established compared with its nasal counterpart, [ɾ̃] (see Hagiwara, 2006; Akmajian et al., 2001; de Jong, 1998; Carmell, et al., 1997 among others). Phonologically, the lenition of the alveolar nasal /n/ to a tap of [ɾ̃] in English is not well-established either (see Akmajian et al., 2001; Fromkin et al., 2000; Giegerich, 1992 among others)[3]. However, we suggest that in fact a nasal tap occurs in the casual speech of English, both word-internally and across morpheme and word boundaries, and that therefore this tap should be considered a nasal allophone, alongside the traditional three usually noted, including [m], [n], and [ŋ]. To this end, we provide phonetic evidence obtained by using two different systems of phonetic analysis, including the Praat speech digitizing program, and the Kay-Pentax Nasometer II-Model 6400, followed by phonological arguments and analyses for both the alveolar oral tap lenition and the alveolar nasal tap lenition, suggesting an ambisyllabicity-oriented tap rule.

Two basic claims

In accordance with our preliminary statement, we address two fundamental claims which clarify and define the problem of alveolar tap lenition. These two basic claims will be confirmed in terms of both analogical reasoning and acoustic experiments as the reader shall see in the succeeding sections.

(1) **Basic Claim 1:** Acknowledging the existence of [ɾ̃], the lenition of /n/ to [ɾ̃] in English is as legitimate and natural as the lenition of /t/ and /d/ to the oral tap, [ɾ] as exemplified by the underlined segments in (a-c).
a. writer /ɹaɪt̲ɚ/→[ɹaɪɾ̲ɚ]
b. rider /ɹaɪd̲ɚ/→[ɹaɪɾ̲ɚ]
c. liner /laɪn̲ɚ/→[laɪɾ̲̃ɚ]

(2) **Basic Claim 2:** A phonological rule, which accounts for the alveolar tap lenition, should be based on ambisyllabicity.

PART I. Phonetic Perspectives on Nasal Tap Lenition

I.1 Purposes and organization

This paper is organized into two parts: Part I and Part II. The purpose of Part I is twofold. First, we provide analogical arguments for the legitimacy and naturalness of the claim that an alveolar nasal /n/ lenites into the alveolar nasal tap [ɾ̃]. Second, we substantiate this claim through two acoustic experiments. In the first experiment, we examine the difference in occlusion duration between alveolar stops and alveolar taps, and show that the alveolar taps are shorter in duration than the alveolar stops. In the second experiment, we examine the presence of nasality in the alveolar nasal tap, and that this [ɾ̃] retains its nasality from its host, the alveolar nasal stop. The purpose of Part II is to consider phonological arguments that can account for the lenition of alveolar stops in casual English, and to trace ideas advanced over the last half century or so, up to the present day, before settling on a preferred solution to lenition for all three alveolar stops ([t, d, n]) to taps, offered at the end of Part II.

I.2 Phonetic Arguments for Basic Claim 1

I.2.1 Analogical arguments

We now show the legitimacy of **Basic Claim 1** (that the lenition of /n/ to [r̃] in English is as legitimate and natural as the lenition of /t/ and /d/ to the oral tap, [ɾ]), in terms of analogical reasoning. There are at least five corroborative arguments. First, not only /t/ and /d/ but also /n/ share the same place of articulation: alveolar. Second, not only /t/ and /d/ but also /n/ share the same manner of articulation: stop. Third, the three alveolar stops, /t, d, n/, form a natural class of sounds sharing the features of [+alveolar, +stop, +coronal]. Fourth, since /t/ and /d/ have an allophone of [ɾ], we expect /n/ to have an allophone of [r̃]. Indeed it does as we have seen in (1c). Fifth, since [ɾ] occurs both inter- and cross-syllabically in the same metrical foot, we expect [r̃] to do the same as shown by the underlined segments in (3). Here the segments in parentheses are optional in pronunciation.

(3) a. shut up [ʃʌɾ̲əp]
 b. head out [hɛɾ̲aʊ(t)]
 c. an old man [ər̲̃oʊl(d)mæn]

A significant pattern of similarity for oral and nasal taps emerges from the above discussion. We note that the alveolar oral tap and the alveolar nasal tap share the following four characteristics: (i) the point and manner of articulation, (ii) phonetic plausibility criteria of natural class, (iii) allophonic realization, and (iv) inter- and cross-syllabic metrical structure. The only difference is that the alveolar oral tap is acoustically well-attested, while the alveolar nasal tap is not. Based on the above line of reasoning, therefore, we can draw analogically the following conclusion.

(4) Analogical conclusion
 If the alveolar oral stops can surface as a tap, then the alveolar nasal stop can also surface as a tap of its nasal counterpart, since /t/, /d/, and /n/ share the same phonetic and phonological evaluation criteria.

I.2.2 Acoustic characteristics of alveolar taps

De Jong's (1998: 293) study reveals three characteristics of the alveolar oral tap among which is the shorter occlusion duration[4]. De Jong's and four other previous studies (Carmell, et al. 1997; Fukaya & Byrd, 2005; Zue & Laferriere, 1979; Byrd, 1993; and Ali, et al. 2001), have also acknowledged the comparatively shorter occlusion duration of taps than that of stops. The average occlusion duration rate of the unlenited stops for all studies was 53.5 ms, while the average occlusion rate for the taps was just 24.3 ms, clearly showing that the occlusion duration of the alveolar tap [ɾ] is shorter than that of the alveolar stops [t] and [d].

Bearing the above observations of the relative differences in durations between taps and stops in mind, we shall now turn to acoustic analyses to establish experimental evidence to support our claim that the alveolar nasal tap, [r̃], exists as an allophone retaining the nasality feature of its underlying 'host' phoneme, /n/. In this connection, two points have to be established. First, that the alveolar nasal tap [r̃] is shorter than [n] just like [ɾ] is shorter than [t] and [d], and second, that the alveolar nasal tap retains nasality from its host.

I.2.3 Acoustic evidence in support of Basic Claim 1

Acoustic experiments were conducted to obtain three kinds of data: (i) the duration difference between the alveolar oral stops [t], [d], and the alveolar oral tap [ɾ]; (ii) the duration difference between the alveolar nasal stop [n] and alveolar nasal tap [ɾ̃]; and (iii) the degree of nasality in the oral tap [ɾ] and the nasal tap [ɾ̃]. The acoustic analyses were divided into two parts: an occlusion duration experiment and nasality experiment. The former was conducted using Praat involving five native speaking English subjects, while the latter was done employing the Kay-Pentax Nasometer II-Model 6400 involving two native speaking Engilsh subjects (for dialectic consistency, all speakers were from the United States).

I.2.4 Methodology for acoustic experiments

The method of the acoustic experiments using Praat involved first taping all subjects using an H4 Zoom Digital Recorder, and having them speak several words and sentences presented to them on a list, first using carefully articulated speech, and then followed by casually produced speech. These recordings were subsequently analyzed on a computer using the Praat speech digitizing software. Nasalance levels were tested with a Nasometer II-Model 6400.

I.2.5 Results of the Praat analysis

For all three stops, the durations of the carefully articulated alveolar stops were on the average of twice as long as their casually articulated counterparts.

(5) /t, d/[5] Occlusion Rate, Careful Speech
Range: 35.0 ms - 63.0 ms Mean: 45.6 ms

(6) [ɾ] Occlusion Rate, Casual Speech
Range: 18.0 ms - 27.0 ms Mean: 20.2 ms

(7) /n/ Occlusion Rate, Careful Speech
Range: 42.0 ms - 50.0 ms Mean: 46.6 ms

(8) [ɾ̃] Occlusion Rate, Casual Speech
Range: 14.0 ms - 27.0 ms Mean: 22.1 ms

We can see that the Praat experiment shows that the occlusion duration of the alveolar stops, [t] and [d] ranged from 35 ms to 63 ms with a mean of 45.6 ms, while that of the alveolar tap [ɾ] ranged from 18 ms to 22 ms, with a mean of 20.2 ms. Since no overlaps were observed between (5) and (6), and between (7) and (8), no statistical analysis was necessary. Consequently, we can conclude that the alveolar tap has a shorter occlusion duration compared to that of the alveolar stops, where in fact carefully articulated stops are more than twice as long as the casually produced tap, in the same place of articulation. This result also supports the previous acoustic studies discussed in section I.2.2. Second, the experiment also shows the difference in occlusion duration between [n] and [ɾ̃]: The mean duration of the carefully produced [n] is 46.6 ms, whereas that of the casually produced [ɾ̃] is 23.2 ms for "liner" or 22.1 ms for both "liner" and "wanna" combined—similar rates to those attested to for the alveolar stops, [t] and [d], when they lenited to [ɾ].

The data summarized in (5)-(8) provide enough evidence to support our claim that a tapped alveolar nasal does exist, and that its properties, at least from the perspective of duration, are very similar to that of its two more common counterparts, the alveolar stops [t] and [d].

I.2.6 Results of the Nasometer II-Model 6400 analysis

The results of our acoustic analysis of nasality[6] using the Nasometer II-Model 6400 are summarized in (9) and (10).

(9) Average Nasalance for /t, d/ in Careful Speech: 10.25%
Average Nasalance for [ɾ] in Casual Speech: 11.75%

(10) Average Nasalance for /n/ in Careful Speech: 91.0%

Average Nasalance for [ɾ̃] in Casual Speech: 86.5%

In this experiment, two significant pieces of evidence were obtained. First, the alveolar nasal taps show a high percentage of nasalance (86.5%), a level very close to that of the non-tap alveolar nasal stop (91.0%). This means that the alveolar nasal tap can be accurately described as a nasal sound. Second, the alveolar taps show lower percentages of nasalance (11.75%); values that are similar to that of the non-tap alveolar oral stops (10.25%)[7].

I.2.7 Discussion and Summary

Three major findings were obtained. First, the Praat experiment shows that the alveolar tap has a shorter occlusion duration compared to that of the alveolar stops, where in fact carefully articulated stops are more than twice as long as the casually produced tap, in the same place of articulation. Second, the experiment also shows the occlusion rates of [n] and [ɾ̃]: have similar rates to those attested to for the alveolar stops, [t] and [d], when they lenited to [ɾ]. Third, the Nasometer II-Model 6400 experiment shows that the alveolar nasal tap, [ɾ̃], maintains nearly the same high level of nasality as it has in its form as a carefully articulated alveolar nasal stop, [n]. The findings from the two acoustic experiments, combined with the analogical correlations discussed earlier in this section confirm the legitimacy of **Basic Claim 1** discussed in the introduction: The lenition of /n/ to [ɾ̃] in English is as legitimate and natural as the lenition of /t/ and /d/ to the oral tap, [ɾ]. As a result, we believe we have provided conclusive evidence, from the vantage point of phonetics, for the existence of the alveolar nasal tap [ɾ̃] as an allophone of /n/, to be considered on a par equal to the acknowledgment that the alveolar oral tap [ɾ] is an allophone of /t/ and /d/.

PART II. Phonological Perspectives on Nasal Tap Lenition

II.1 Overview

Having concluded our discussion of how relevant aspects of *phonetics* have supported our contention that the alveolar nasal stop indeed lenites to an alveolar nasal tap in casual English, we will now consider relevant *phonological* issues and implications concerning the tap[8] rules in casual spoken English. We will first review three basic stages that mark the evolution of how tapping in English has been described by modern generative phonologists over the last fifty years or so, tracing its evolution up to the present day. Along this route, we look at stress-based rules, syllable-based rules, stress- and syllable-based rules, as well as constraint-based generalizations afforded by the recent advent of Optimality Theory. We conclude this section by offering our own possible solution to how tapping can be characterized in English, not only for the standard lenition (to taps) of the standard [t] and [d] to [ɾ], but also of the lenition of the nasal alveolar stop [n] to [ɾ̃].

II.2 Historical Perspectives

Over the last half century or so, there have been numerous attempts to characterize tapping (see Akmajian, et al. 2001, Fromkin, et al. 2000, and Giegrerich, 1992). These analyses naturally assumed the style and presentation of the period in which they were developed. Most have assumed that tapping is a rule-governed process, enacted in the course of casual speech production. In general, the previous tap rules have been characterized as word-level rules and they can be basically classified into three types: stress-conditioned, syllable-conditioned, and stress & syllable-conditioned though in fact many analyses overlap with one another, or diverge at unexpected points. It is neither possible nor necessary, however, to review each and every one of these earlier approaches, but rather, it is sufficient for our purposes here to review some of the more representative approaches before considering our own contributions to this avenue of investigation.

II.3 Stress-conditioned lenition rules

We begin by looking at the tap rule as just that: an adjacency rule that is governed by a feature or features found on a neighboring segment. To this end, Fromkin, et al. (2000) recalls one of the earlier approaches to tapping as a rule which produces a variant of the /t/ phoneme, as depicted in (11).

(11) Tap Rule

$$/\text{t}/ \rightarrow [\text{ɾ}]/[+\text{vowel}] \_\_\_ \begin{bmatrix} +\text{vowel} \\ -\text{stress} \end{bmatrix}$$

This rule easily accounts for the common lenition of /t/ in words such as "city" (/sɪti/→[sɪɾi]). Notably, though qualities of two adjacent segments are referred to by this rule, we classify this as a stress-based rule. Both referenced segments must be vocalic, and the right segment must be additionally unmarked for stress (or, actually, marked for *lack* of stress). It further assumes that the voiced alveolar stop, /d/, does not serve as input to this rule, since it was not explicitly stated, and thus assumes that intervocalic /d/ does not lenite to a tap in casual speech. However, words such "caddy" (/kædi/→[kæɾi]) clearly indicate to us that /d/ as well as /t/ can serve as input to this rule. We suggest, later, that in fact the designation of [+alveolar, +stop] also naturally extends to the nasal stop, /n/, as well.

The tap rule proposed in (11) demonstrates much of what was good, and bad, about the rule-governed phonology of the early days of generative phonology, up to and including work in the 1970s and 1980s. It recognizes adjacent segmental features as triggers, which in this case include the recognition of the vocalic feature on *both* sides of the lenition site, as well as a further condition stipulated on one of the vowels, the right adjacent vowel, that it not be marked for stress of any kind. There are obvious shortcomings to this approach. One is the duality of influence caused by the need to stipulate features on both sides of the lenition site, and another is the rather odd requirement of specifying what the right segment may *not* be, as opposed to what it may be. All this, combined with the crucial fact that it completely overlooked the lenition of /d/ in similar situations suggest that this was a less than adequate approach.

II.4 Syllable-conditioned lenition rules

The next approach that we consider here appears to take the argument completely in the opposite direction, where the syllable (a rhythm-based prosodic unit) is identified as the key influencing factor. This view is reviewed post hoc by Akmajian et al. (2001), who suggest the following tap rule.

(12) Tap Rule

The English stops /t/ and /d/ are flapped between vowels that are contained in the same metrical foot. (Akmajian et al., 2001: 134)

$$\begin{bmatrix} +\text{alveolar} \\ +\text{stop} \end{bmatrix} \rightarrow [\text{ɾ}]/\overbrace{[+\text{vowel}] \_\_\_ [+\text{vowel}]}^{F}$$

This rule is based on a different level of phonological operation than rule (11), above, recognizing the prosodic domain of the foot, and though not directly stated as such, also recognizing the syllable. The Tap Rule suggested in (12) relies completely on the prosodic structures of both the syllable and the foot, with no reference to adjacency features of any type. Though "vowels" are critically referred to in this rule, this is nothing more than simply referring to two independent nuclei, or in even simpler terms, two independent syllables adjoined under a single foot. Note that at this stage, there is no dominance implied between the two syllables.

At first glance this is clearly a more elegant approach than the earlier rule-governed adjacency approach. However, elegance comes at a price. As Hayes (forthcoming) and others have noted, casual speech (and lenition) is not restricted to single word domains, but can apply across word boundaries in certain instances, requiring a restructuring of underlying feet. Such restructuring may result in syllable and foot loss, in syllable and foot coalescence, and in foot and syllable reshaping—all of which would render rule (12) powerless to account for these situations. From this position, rule (12) is not sufficient.

II.5 Stress- and syllable-conditioned lenition rules

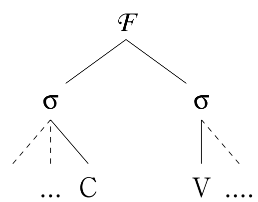
So, we have now seen that a purely syllable-based approach, addressing the prosodic domain of the foot, is also not entirely satisfactory in explaining the casual speech phenomena of alveolar tapping in English. This brings us to a natural third stage in the evolution of our approach to tapping, which is based on an amalgamation of the best that went before. This version, then, can be characterized as both segmental-feature *and* syllable based, or in other words, involves a segmental rule that is licensed by addressing information at a higher prosodic domain. Let us now see whether this purchases a better explanation of the English lenition process. For illustrative purposes, we will adopt Giegrerich's (1992) proposals to consider the merits of this type of analysis. Essentially, Giegrerich simply combines the two previous approaches into one, mentioning both the need for a consideration of intervocalic environment (intersyllabic), and the need for the right adjacent vowel to be at least the second syllable of a foot. Note Giegerich's example, repeated here as (13) (Giegerich (1992) p 242).

(13) Tap Rule (segment & syllable-conditioned)

$$\begin{bmatrix}\text{-cont}\\ \text{-son}\\ \text{+cor}\end{bmatrix} \rightarrow [\text{ɾ}]/[\text{+son}]\ \#.\#\_\_\_\_\ [\text{+son}]$$

Note that several changes and additions have been made by Giegerich, in the basic formulation of the tapping rule. Most notably, the site of lenition is described as the open onset position of the second syllable (shown here as "#__"). Further, rather than depicted as occurring intervocalically, the environment has been eased to simply refer to all sonorants. However, as we will see below, the first condition, that lenition takes places in the onset position of the second syllable of a foot is completely untenable, since virtually all flapping candidates are of the form heavy syllable-light syllable, where the coda C of the heavy syllable is the one that is lenited.

(14) Basic Flapping Foot Template



It seems odd, then, that the site of lenition would be the onset position of the second syllable in the foot, where the original underlying consonant is in the coda position of the first, heavy, syllable. So while, well-intentioned, we find this approach unsatisfactory as well. Where does that leave us?

II.6 Summary of historical perspectives on lenition

Let us take a moment to update ourselves on what we have learned about flapping. We will summarize some of the observations we have gleaned from the earlier studies, and then try to weed out some of the contradictory points, and hopefully arrive at a determination of the key factors and conditions.

(15) The Basic Facts of English Tapping

a. Tapping occurs intervocalically--though it appears in fact "+son____+vowel" may be suitable.

b. Tapping occurs at one inner edge of two syllables within the same foot, within a single word.

c. Tapping occurs at one inner edge of two syllables in different feet, which as a result of casual speech, have been joined together into a single foot.

d. Pre-lenition, the stop that undergoes lenition is in the coda position of the first of two adjacent syllables.

e. Pre-lenition, the second of the two adjacent syllables has no onset.

f. Pre-and Post-lenition, the second of the two adjacent syllables has no stress.

g. Onset-less syllables can be stressed elsewhere (see "entrance" for one example).

h. From a weight perspective, closed syllables dominate open syllables (where open can refer to either onsetless or codaless syllables).

i. English favors a trochaic relationship for two syllables in the same foot, where the first syllable dominates the second.

The "facts", stated above, in some cases overlap with each other, but only from the perspective that they seem to deal with the same phenomena, but differ from the level of prosody at which they are viewed. Clearly the segmental levels referred to in facts (15a) and (15f) offer different perspectives of flapping issues than those of say (15d) and (15e), which look at the constituency of the syllable, and still different from higher prosodic issues such as the foot and syllable relationships referred to facts (15h) and (15i). Just as clearly, we see our task as eliminating as many of these overlaps, and to determine minimally what is necessary to offer an appropriate characterization of flapping in English.

II.7 Modern perspectives on lenition-OT and beyond

OT is a system of developing and evaluating different configurations, or hierarchies, of constraints that are ordered language-dependently to produce desired phonological outcomes. Each of the constraints carries with it a certain weight, or value, that dictates where it will fall in the hierarchy. Not all OT constraints are relevant here, but certainly those that pertain to syllable configurations are relevant, particularly **FAITH, WEIGHT-TO-STRESS, FOOTBIN, ALIGN, ONSET, NOCODA, PARSE-2** and **NOONSET**[9]. Before we consider how these OT constraints might shed light on the lenition of alveolar stops to taps, let us breifly revisit the questions regarding the site(s) where lenition takes place (and results in, if different) and how we may be able to represent the lenition to tap rule in present day terminology. As discussed above (see (11)-(13)), there are three possible sites to be considered for the lenition of alveolar stops to taps, shown below recharacterized as (16), (17) and (18).

(16) Tapping Site as the Coda of the First Syllable

[[…__] σ   σ [V…]] $\mathcal{F}$.

(17) Tapping Site as the Onset of the Second Syllable

[[…V] σ   σ [__V…]] $\mathcal{F}$.

(18) Tapping Site Shared Ambisyllabically
[[…__] σ σ [__V…]] *F*.

Though **FAITH, WEIGHT-TO-STRESS, FOOTBIN, ALIGN, ONSET, NOCODA, PARSE-2** and **NOONSET** all are relevant to us here, we will see that not all are required for all lenition candidates, with words behaving somewhat differently than phrases with respect to these constraints.

Turning to specifics, FAITH supports (16) optimally, (18) partially, and (17), not at all. WEIGHT-TO-STRESS similarly would prefer (16) ranking it over (18) and (17), respectively. FOOT BIN only becomes an issue when tapping occurs across words, where two monosyllabic feet are preferably joined, over being allowed to occupy independent foot status. ALIGN, and ONSET, both however, favor (17), which requires an empty onset to be filled if a consonant is available (it is). (17) is also favored by NOCODA. Notice, however, that both ALIGN and ONSET also favor the ambisyllabic characterization provided in (18), as well as WTS, and remembering that FAITH is at least partially honored (over (17)), its only real violation (besides FAITH) is NOONSET, which to us at least, seemed to have been more of an ad hoc description of what was readily observed, rather than an explanation or a principle, for operation. Tentatively, we present a tableau below that gives us a rough idea of how this all plays out. This discussion is tentative, since it is in fact too early in our analysis to actually provide definitive evidence in support of either of the two leading contenders. Rather, as we have stated previously, we hope to demonstrate through our earlier acoustic analysis which of the two solutions is preferred, thereby, through a unique phonetics/phonology interface, we can provide our strongest arguments for the actual ranking of the constraints described here. With that caveat in mind, let us consider the tableau below, for a word like "city" ([sɪɾi]).

According to Tableau 1, our optimal lenition site is our first option, the site depicted above as (16), which is the coda position of the first (heavy) syllable of a trochaic foot. This is probably the most intuitively logical site as well, as it is indeed the original site of the stop that then undergoes lenition in the course of casual speech production. However, again, first glances can be deceiving. One obvious fact is that casual speech, virtually by definition, alters the underlying phonology in such a way so as to always violate the FAITH constraint (see Skaer, 2001, for a detailed discussion of this). So, if we were to naturally move FAITH to a lower ranking in the relevant constraints, even if we demote it just one rank lower (see Tableau 2), we arrive at a different optimal candidate, that of one favoring the ambisyllabic characterization of (18), shown here as our favored candidate on the third row (chosen over the second because there are no major violations, though both have some minor violations).

With these ideas in mind, we are at last prepared to consider tapping from an

Tableau 1. Lenition Site Ranking or "city" (Standard OT Ranking)

	FAITH	ALIGN	NOONSET	ONSET	NOCODA	WTS
☞ [[…__] σ [V…] σ] F		*		!	!	
[[…V] σ [__V…] σ] F	*		!			!
[[…__] σ [__V…] σ] F	!		!		!	

Tableau 2. Lenition Site Ranking for "city" (FAITH demoted one rank)

	ALIGN	FAITH	NOONSET	ONSET	NOCODA	WTS
[[…__] σ [V…] σ] F	*			!	!	
[[…V] σ [__V…] σ]F		*	!			!
☞ [[…__] σ [__V…] σ]F			!		!	

acoustic/phonetic perspective, which should help to shed some light on the ordering of these constraints for the purposes of characterizing English casual speech rules in general, and the English tapping rule in particular. Before turning to these issues, we conclude this section by a proposed rule for English taps.

II.8 A proposed English tap rule

We claim that a tap is basically ambisyllabic, with the closing (*close*) of the tap coinciding with the coda of the first syllable, and the opening (*open*) of the tap coinciding with the onset of the second syllable. This suggests a binarily split geometry of the tap feature matrix. Further, we suggest that while the tap segment is ambisyllabic, its weight is equal to only a very brief single segment (tentatively set at 20 to 22 ms in this study and around 30 ms in Raymond, et al. 2006). Thus, we propose the lenition rule (unaffected by stress) in (19), where the alveolar stops, /t, d, n/, all may serve as input. The domain of the rule is the prosodic Foot, and the site of lenition is the coda of the first syllable in the trochaic foot. However, the result of lenition is a tap that is shared ambisyllabically by the coda of the first syllable and the onset of the second syllable.

(19) The Phonological Description of the English Tap Rule (a casual speech option)

$$\begin{bmatrix} +\text{stop} \\ +\text{alveolar} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{tap} \\ +\text{alveolar} \end{bmatrix} / [\cdots V_1 \_\_\_ (\#\#) V_2 \cdots]\, \mathcal{F}$$

where: 1. $\mathcal{F}$ is a foot.

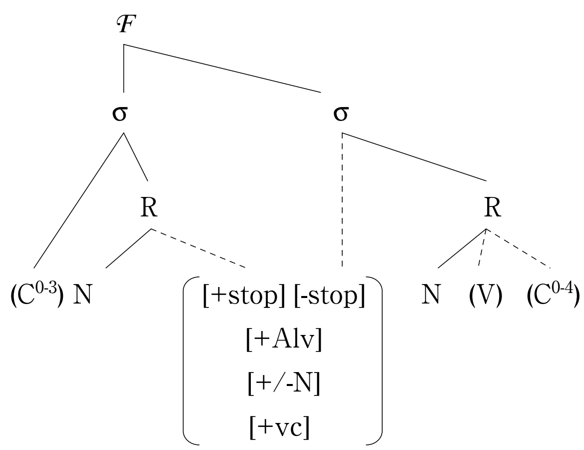
2. # is a word boundary.

3. [+tap] = [σ^1_{Coda} [close] → σ^2_{Onset} [open]] (≤30ms)

Note that this rule allows for lenition in words such as "winner," "caddy," and "city," while disallowing lenition in words such as "titanic," "addition," and "announcement." Also, rule (19) allows for lenition in phrases such as "get out," "get Ed," "get Alice," and "an old man."

Let us now view these issues using a tree diagram. The proposed segment matrix for taps (and really for all stops), allows us to show how ambisyllabic segments, such as taps, can be aligned as both a coda for the first syllable, and the onset for the second, without causing any issues of weight distribution, overlapping feature association lines, and so forth, as depicted below, in (20).

(20) Schematic View of an Ambisyllabic Tap.



Most notably, and at the crux of our proposal, is that all alveolar stops, oral and nasal, can lenite to flaps in casual speech.

II.9 Summary of Part II.

In Part II, we reviewed relevant phonological arguments that concern the issue of how to characterize tapping in casual English speech. We noted several different viewpoints from a historical perspective, and pointed out both the benefits and shortcomings of each, before we concluded with what we consider the best solution, which embraces some of the insights gleaned from the earlier studies, but is not encumbered with the earlier noted shortcomings. Specifically, through the unique vantage point that Optimality Theory affords us, we have presented an outline of what we should expect in carefully spoken English, where the principle of FAITH is ranked high, and where we would therefore not expect changes such as lenition to take place. Further, we have demonstrated that in properly characterizing casual spoken English speech patterns it is necessary to demote the FAITH constraint by at least one rank, as it represents the main feature of signaling a natural change from careful speech to casual speech, in virtually all situations. And, by demoting FAITH, we can see that the optimal solution to the proper description of the lenition of the three alveolar stops, [t, d, n], to their tap counterparts, [ɾ, ɾ, ɾ̃], respectively, is one that suggests an ambisyllabic positioning of the lenited consonant, favored over the retention of the consonant in the coda position of the preceding syllable, or in the (sometimes moved) position of the onset position in the following syllable, thereby supporting our primary **Basic Claim 2**, offered in the introduction.

PART III. Overall Summary and Conclusions.

One of the primary purposes of this thesis was to present arguments from two rather different perspectives, phonetic and phonological, on the proper characterization of a set of specific sound patterns, and by doing so, offer some insights into how such an interface approach to sound pattern investigations may be both beneficial, and illuminating. We have thus offered several phonetics-based arguments in favor of lenition of not only the traditional alveolar stops, [t] and [d], but also of the nasal alveolar stop, [n], to their tap counterparts. These arguments were in the form of both analogical and experimental observation, as described in Part I. And, in Part II, we provided phonological explanations for the various lenition processes, and demonstrated that here too, all three alveolar stops, including the nasal, lenite in casual spoken English to alveolar taps, occupying an ambisyllabic position between two syllables.

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[1] No consensus has yet been reached with respect to the definition and terminology of tap and flap among researchers of phonetics, phonology, and theoretical linguistics. For the sake of simplicity, we adopt the term 'tap' as our target structure, which can be thought of as a very quick stop, where the tongue extends, touches the roof of the mouth, and retracts, all within a shorter occlusion time than the stops.

[2] This is one of several papers by the present authors related to the topic of nasal lenition. This version most accurately reflects the contents presented at Phonetics Today, in Moscow, Russia, in November 2007. In the final preparations of this manuscript, we are greatly indebted to two anonymous reviewers who made valuable comments which surely served to improve this paper. Unfortunately, due to time and space limitations, we were not able to follow all of their suggestions completely, and therefore are responsible for whatever inadequacies remain.

[3] Schuh's (2005) rule accounts for both the alveolar oral tap lenition and the alveolar nasal tap lenition taking the intra-syllabic stress condition into consideration. His rule, however, fails to account for the fact that the same lenition phenomenon also occurs cross-syllabically.

[4] The other two characteristics discussed in de Jong (1998: 293) are (i) shorter voice onset time, and (ii) high voicing percentage. The former illustrates that alveolar oral taps are unaspirated, while the latter shows that alveolar oral taps are voiced.

[5] As an anonymous reviewer pointed out, in a more comprehensive study, the occlusion rates of the two alveolar stops should be viewed separately, however for our

introductory purposes here, we have grouped them together.

[6] Nasalance is computed by measuring the acoustic energy at the nasal passage (An), and the acoustic energy at the mouth (Ao). The nasalance ratio is expressed as a percentage, An/(Ao+An).

[7] A small amount of nasalance shows up even in the non-nasal sounds due to the nature of Nasometer II-Model 6400 measurement device (a headgear apparatus which slightly restricts smooth upper mouth movement). This fact does not undermine our claim since the point of the experiment is to show the similarity between the alveolar nasal stop and the alveolar nasal tap, and that the two share the very close resemblance in nasality.

[8] As noted above, in footnote one, we will not concern ourselves with the arguments of the finite differences that separate "flaps" from "taps", and simply adopt the generally assumed view that the closure of a flap (tap) is of much shorter duration than a stop—what distinguishes a tap from a flap however, is not germane to our discussion here.

[9] OT stands for Optimality Theory, and in this paper, the following constraints are referred to:

- **ALIGN FOOT LEFT:** Align syllables to left.
- **FAITH:** Retain faithfulness to input.
- **FOOTBIN:** A Foot needs a dependent.
- **HEAD (L):** Metrical feet are left-headed.
- ***LAPSE (σ):** Adjacent unstressed syllables must be separated by a foot boundary.
- **NOONSET:** Stressless medial syllables are onsetless.
- **PARSE-2:** One of two adjacent stress-units must be parsed by a foot.
- **WEIGHT-TO-STRESS (W-T-S):** Heavy syllables should be stressed.