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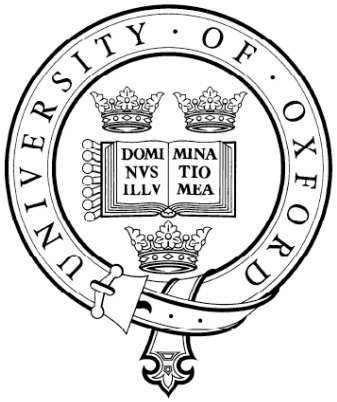


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# (t,d): the Variable Status of a Variable Rule

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## Abstract

Tagliamonte and Temple (2005) describes an attempt to replicate on a variety of British English some of the many and varied North American studies of the sociolinguistic variable known *inter alia* as "-t,d deletion" or "coronal stop deletion", that is the variable deletion of word-final /t/ or /d/ in two-consonant clusters. The results of that study were not entirely compatible with previous accounts and could not be explained away by reference to extra-linguistic variables. The present paper represents the first stage of investigating alternative explanations of the apparent incompatibility of the British and North American findings by exploring some of the methodological and analytical questions raised during the production of Tagliamonte and Temple, but which the authors were not able to address or develop explicitly in that paper.

## Key Words

Sociophonetics, Coronal Stop Deletion, Variable Rules

## 1.0 Introduction

(t,d) is a well known variable phonological rule which deletes the second consonant in word-final clusters ending with a coronal stop, as in *fact* > [fakt]/[fak] or *walked* > [wɔːkt]/[wɔːk], and is said to apply to all varieties of English. The great level of interest in (t,d)[1] since it was first explored in, for example, Labov *et al* (1968), Wolfram (1969) and Fasold (1972) stems from the fact that this phonetic/phonological variable occurs in morphologically complex contexts as well as morphologically simple ones and therefore provides a potentially interesting locus for exploration of the interaction between variationist and (morpho-)phonological theory. Tagliamonte and Temple (2005, henceforth T&T) examined the three

[1] It will become clear in the course of this paper why I consider terms such as "*-t,d* deletion" problematic. Although this variable notation also implies acceptance of the fact of consonant deletion it should not be taken as such: it is used purely for the sake of convenience, as is the word "deletion".

independent linguistic variables[2] found to be most robust in conditioning patterns of (t,d) variation in North American studies: the following phonological segment, the preceding phonological segment, and the morphological structure of the word[3]. Their data were taken from sociolinguistic interviews with 38 speakers of British English resident in the city of York recorded for the York English Corpus described in Tagliamonte (1998). After careful transcription by two independent researchers the data were coded and analysed in various configurations using Goldvarb 2.0 (Rand & Sankoff, 1990) to perform multivariate analysis. The overall results are reproduced here as Table 1.

| Corrected mean: | | .18 | |
|---|---|---|---|
| Total N: | | 1118 | |
| | FACTOR WEIGHT | % | N |
| **FOLLOWING PHONOLOGICAL SEGMENT** | | | |
| Obstruent | .84 | 55 | 325 |
| Glide | .69 | 38 | 106 |
| /r/ | .60 | 28 | 29 |
| /l/ | .50 | 25 | 24 |
| Vowel | .29 | 8 | 507 |
| Pause | .20 | 6 | 127 |
| *Range* | 65 | | |
| **PRECEDING PHONOLOGICAL SEGMENT** | | | |
| /s/ | .68 | 42 | 303 |
| Other sibilant | .58 | 31 | 64 |
| Nasal | .50 | 21 | 329 |
| /l/ | .40 | 21 | 126 |
| Stop | .40 | 16 | 169 |
| Other fricative | .27 | 12 | 127 |
| *Range* | 41 | | |
| **MORPHOLOGICAL CLASS** | | | |
| Monomorpheme, e.g. *mist* | [.53] | 30 | 602 |
| Irregular past, e.g. *kept* | [.50] | 21 | 128 |
| Regular past, e.g. *missed* | [.45] | 19 | 388 |

*Table 1. Results of Variable rule analysis of the contribution of factors selected as significant to the probability of –t,d deletion. After Tagliamonte and Temple (op. cit., p. 293, Table 4). Factor groups not selected as significant are shown in square brackets.*

[2] T&T also tested extra-linguistic variables, but these are not central to the discussion.
[3] Detailed explanation of these variables can be found in T&T. Because that paper is recent and easily available, details which can be found there will be kept to a minimum in the present paper.

In Table 1, factor groups (in linguistic terms, the independent variables) are presented in descending order of their significance in accounting for the patterns of variability in the data. For each factor group, the factors (variants) are listed in descending order of their tendency to favour deletion of final /t,d/. The rightmost column gives the number of tokens with that particular factor, the middle column gives the percentage of tokens with that factor whose /t,d/ is deleted and the leftmost numerical column gives the probability of deletion occurring with that factor as assigned by Goldvarb on a scale of 0 to 1. Thus, the first line of figures shows that there were 325 tokens with following obstruents (e.g. *old carpets*); of these 55% had deleted /t,d/ and when the whole pattern of variation is taken into account, these tokens have a 0.84 chance of being pronounced without a final surface reflex of /t,d/. The range of probabilities, given at the end of each significant factor group, is the difference between the highest and lowest for that group and provides an indication of how important the group is in accounting for the patterns of variation: the greater the range, the more important the relative contribution of that factor group.

The results for phonological context were broadly consistent with other studies and provided further evidence pertinent to ongoing debates in the literature. Following segment has been found to have the strongest effect in most if not all studies of (t,d), as it is here. The hierarchy of factor weights was consistent with previous studies, except for the proximity of /r/ and /l/, which lent further support to Labov's (1997) argument that the patterning of following effects cannot be explained in terms of resyllabification, as proposed in Guy (1991). Preceding phonological segment has been considered a relatively weak constraint (e.g. by Labov, 1989, 1995) but one for which it is possible to draw broadly consistent language-wide generalisations. Thus Labov identifies /s/ > stops > nasals > other fricatives > liquids as a generally consistent cross-dialectal pattern (1989, p. 90). This is not the hierarchy produced in T&T's results, nor do their results sit comfortably with an account in terms of the Obligatory Contour Principle, as proposed in Guy & Boberg (1997). T&T considered that fact in itself not to be unduly problematic, since it is generally acknowledged that the strength of effect and hierarchy of variants have varied from study to study (*cf.*, e.g., Guy, forthcoming). However, we shall return to this constraint below.

The results for morphological context in Table 1 are altogether more perplexing. Guy (1991) elaborated an explanation for the frequently observed effect of the morphological makeup of any given word containing a final $CC^{[+cor]}$ cluster within the framework of Lexical

Phonology. The analysis predicts that deletion will occur most frequently in monomorphemic forms such as *round* and least frequently in regular past tense forms ending in *–ed*, such as *trashed*. So-called semi-weak verbal forms, with a past-tense suffix but also a vowel alternation in the stem, for example *kept*, will pattern intermediately between the other two categories[4]. Many subsequent studies have provided support for this analysis, which has become generally accepted as correct (e.g. Santa-Ana, 1992; Bayley, 1995). However, as Table 1 shows, this was not the case for T&T: although the trend was in the expected direction, morphological class was not selected as significant in their analysis. Moreover, T&T found that other predictions of the Lexical Phonology-based account were not borne out in their data. Whereas the hierarchy of factor weights for following phonological segment was consistent across morphological classes, as predicted, the range of those factor weights was not (T&T: 294-5, Tables 5a, 5b), which runs counter to expectations. The morphological effect did not show the expected consistency across speakers even when the category with the smallest number of tokens (semi-weak forms) was disregarded.

T&T concluded that although their study clearly confirmed that the second consonant in word-final $CC^{[+cor]}$ clusters behaves variably, none of the major theoretical explanations of the variability (resyllabification, the OCP, Lexical Phonology) held for their data, despite the fact that they had made every effort to replicate the methodology of previous studies. Their suggestion was that the most fruitful way to move towards a more successful explanation would be to start from a "bottom-up" investigation of the combinatorial phonetic properties of these word-final clusters, given that there is plenty of evidence to show that speakers are capable of manipulating fine phonetic detail (e.g., Docherty, 1992; Docherty et al., 1997; Temple 2000). The purpose of the present paper is to explore further some of the issues which led to that conclusion as a preliminary to a further bottom-up study. These issues initially arose as methodological difficulties encountered by T&T, about which there appeared to be little or no discussion in the available literature, but as we shall see, they have both methodological and theoretical implications. They will be explored under three broad headings, distributional issues, issues concerning the nature of "deletion" and issues of how the variable rule fits into the phonology as a whole. However, as will become obvious, questions within and across these categories interact with each other creating a

[4] Although there are explanations for why they might pattern with one of the other classes (e.g. Guy & Boyd, 1990), they should not show more deletion than monomorphemes or less than regular past tense forms.

complex web which appears to indicate the need for some radical rethinking about variationist approaches to data such as these.

## 2.0 Distributional Issues

T&T used Goldvarb 2.0 (Rand & Sankoff, *op. cit.*), a multiple regression-based statistical package designed for linguistic analysis, and they followed a strict protocol in selecting tokens for analysis, taking for each speaker the first twenty tokens from each morphological category to maximise even distribution across categories, and only the first three tokens of any given lexical item to control the type-token ratio (following, e.g., Wolfram, 1993, p. 214). However, the morphological categories were still somewhat uneven, with particularly low numbers of tokens in the semi-weak category. Since Goldvarb is designed to cope with such uneven data sets this was not considered too problematic in itself. What does seem potentially problematic, however, is the distribution of preceding phonological context across the morphological categories. Table 2 shows this distribution for preceding (underlying) segments, ordered according to their factor-weight rankings in Table 1, with those most favouring deletion at the top. Sibilants other than /s/ are grouped together because they have the same (restricted) distribution across morpheme categories, whereas this is not the case with stops or weak fricatives, which are shown individually. Combined cells in the Factor Weight column indicate that the relevant tokens were tested as a single factor for Table 1. Cells with bold outlined borders are those representing around 20% or more of the tokens for that particular morphological group. The cells for /s/ and other sibilants are outlined together in the regular past tense column because although the factor weight assigned to the two groups was different when the whole data set was analysed (Table 1 above), when morpheme categories were tested separately (cf. T&T: 294, Table 5a), all the sibilants were assigned the same weight (0.69) for this group, which is the only one to have sibilants other than /s/[5].

[5] This is a consequence of the distribution of /s/ versus /z, ʃ, ʒ/ across the vocabulary of English rather than a function of T&T's particular data set. It means that the factor weights generated in for Table 1 (and in other studies) are in some sense rather misleading.

| PRECEDING SEGMENT | N | PROPORTION OF TOTAL DATA SET | OVERALL RATE OF –T,D DELETION | FACTOR WEIGHT (TABLE 1) | PROPORTION OF MORPHEME CATEGORIES | | |
|---|---|---|---|---|---|---|---|
| | | | | | MONO-MORPHEMES | SEMI-WEAK | REGULAR PAST |
| /s/ | 303 | 27% | 42% | .68 | 41% | 11% | 10% |
| other sibilants | 64 | 6% | 31% | .58 | - | - | 17% |
| /n/ | 430 | 29% | 21% | .50 | 46% | 5% | 12% |
| /l/ | 130 | 11% | 21% | .40 | 7% | 33% | 11% |
| /k/ | 109 | 10% | 17% | .40 | 3% | - | 23% |
| /p/ | 53 | 5% | 15% | | 0.5% | 21% | 6% |
| /b/ | 4 | 0.4% | 0 | | - | - | 1% |
| /g/ | 3 | 0.3% | 0 | | - | - | <1% |
| /v/ | 74 | 7% | 7% | .27 | - | - | 19% |
| /f/ | 53 | 5% | 19% | | 2% | 30% | 0.8% |

*Table 2. Distribution of preceding phonological contexts across morpheme categories (percentages higher than 2 have been rounded up to the nearest whole number).*

Comparison across categories shows that only the regular past tense forms have a fairly even distribution across favouring and disfavouring preceding phonological contexts, with 27% of tokens in contexts most favouring deletion, 20% in contexts most disfavouring it and the rest distributed across neutral and mildly disfavouring contexts. Almost half the monomorphemes (46%) are preceded by /n/, which has a neutral effect (factor weight 0.5); the vast majority of the remaining 54% of tokens (82%, i.e. 41% of the total) are preceded by /s/, which highly favours deletion, whereas very few tokens occur in moderately disfavouring contexts (10.5%) and only 2% have strongly disfavouring preceding /f/. By contrast, the majority of semi-weak tokens are preceded by moderately or highly disfavouring preceding contexts (51% and 31% respectively). Thus, in preceding contexts having a favouring or disfavouring effect on the variability, arguably 80% of monomorphemic tokens have preceding consonants which favour deletion, whereas 80% of semi-weak tokens have preceding consonants which disfavour it, as do well over 60% of regular past tokens. This would appear to explain why in Table 1 the hierarchy of frequencies of deletion is apparently consistent with the Lexical Phonology account of (t,d) but the factor group is not selected as significant in accounting for the variability, suggesting that the frequency differences between morphological categories are an artefact of the distribution of favouring and disfavouring

phonological contexts across those categories. The restricted set of preceding phonological contexts which can occur in semi-weak forms is acknowledged by some authors but the fact that monomorphemes too have a somewhat skewed set of preceding contexts does not seem to figure in discussions of this variable.

A further run, replicating Table 1 but without testing preceding phonological context, produced the same significant range and hierarchy of effect for following context, but a different result for morphological category: the factor group was selected as significant and the rank ordering of factors was monomorphemes (.58) > semi-weak forms (.42) > regular past-tense forms (.39). This is strongly suggestive of an interaction between the preceding segment and morphological category factor groups[6]. Disregarding the numerically small semi-weak category does not affect the flipping between significance and non-significance: when all three factor groups are included morphological category is not selected as significant (monomorphemes (.57) > regular past-tense forms (.40)) whereas when preceding context is not tested morphological category is selected as significant with exactly the same distribution of factor weights. As a control exercise, the same procedure was followed disregarding the following context. This made no difference to the non-selection of morphological category, with or without the semi-weak forms, indicating that any interactions there may be between morphological context and following context are well within the capacity of logistic regression to correct (*cf.*, e.g., Sigley, 2003, p. 229).

This brief sketch of the distributional problem raised by T&T's findings does not prove anything but it does demonstrate that morphological category, upon which the Lexical Phonology account of (t,d) crucially depends, is inherently subject to interaction effects with preceding phonological context, effects which seem to have received little attention in the literature on the variable. Rather than exploring these interactions in greater depth, we now turn to another methodological problem area at the opposite end of the spectrum, that of the classification of the data which are input to the variable rule analysis.

## 3.0 Problems with the interpretation of natural(istic) data

The statistical modelling of variation in speech crucially depends on accurate categorisation of the raw data. On the face of it, (t,d) is a relatively straightforward variable to model, involving as it does a

[6] In the sense of Sigley's (2003) second type of interaction effect, that is associations between factors in different factor groups which lead to unevenly occupied cross-tabulation cells.

categorical alternation between the absence and a phonetic surface realisation of a word-final coronal stop. It is generally acknowledged that an apical stop following a token constitutes a "neutralizing environment" (Guy, 1980, p. 4) and tokens in such contexts are excluded from analyses on the grounds that it is not possible to tell whether a stop produced in that context is just a reflex of the following stop or a reflex of both that and the word-final stop. However, the phonetic analysis and coding of the data for T&T showed that this kind of difficulty arose in far more cases than merely the tokens which are conventionally excluded on the grounds of neutralisation. This section will firstly review what constitutes neutralisation and then examine some other phenomena which can make it difficult to determine where a deletion may or may not have applied. Since the account critiqued here is the one grounded in Lexical Phonology, the working assumption is that if it is correct, (t,d) must be a phonological rule; thus, any phonetic reflex of underlying /t,d/ must mean that the rule has not applied and any ambiguities in the phonetics must raise a question mark over whether it has applied.

### *3.1 Neutralisation*

As already mentioned, so-called "neutralising" environments are a context where problems in identifying variants have long been acknowledged: "... in word-final consonant clusters it is necessary to exclude clusters which are immediately followed by a homorganic stop (e.g. *test day*) from the tabulation since it is sometimes impossible to determine whether the final consonant of the cluster is present or absent." (Wolfram, 1969, p. 48). The exclusion of "neutralisation" contexts seems to have been normal practice since Wolfram's study, although half the studies referred to in T&T give no information about their treatment of clusters in these contexts. Only one of the remaining studies T&T consulted (Bailey, 1995) also excludes tokens with following interdental fricatives, on the grounds that they are frequently realised as stops by Bailey's Tejano subjects. As it is well known that these consonants are frequently realised as lax stops in British English, they were also excluded by T&T. However, there are other following consonants which could arguably also have this kind of neutralising effect on the variation, but which, to our knowledge, are never mentioned. The most notable is [n], which is also articulated with apical/laminal occlusion at the teeth/alveolar ridge. It might be argued that the presence of nasality would always differentiate the nasal from the preceding stop, and stops, particularly voiceless ones, are often clearly audible even if there is no release before the following nasal. However, nasality as a phonetic property is notoriously non-segmental, that is it is rarely strictly co-

temporal with all the other properties of the segment to which it "belongs". In (1), for example, the [s] is followed by a brief, nasalised puff of aspiration and a partially devoiced nasal consonant (the transcription is somewhat misleading because of the sequential limitations of the font).

(1) *they try their <u>best</u> not* [bɛ$^{h}$˜$_{\circ}$snɑʔ] *to stay on*[7]

As with [t#d] and other accepted "neutralisation" sequences, release of the word-final plosive would not be expected in normal casual, unscripted speech. The nasality is clearly audible from the end of the [s], but it is very difficult to say whether there is actually a reflex of an underlying /t/ with nasal assimilation or whether the /t/ has been deleted and the nasal, which does not sound unduly long, is merely devoiced. Such decisions cannot be made on an *ad hoc* basis: decisions of principle need to be taken as to what is to be deemed a sufficient cue to the surface presence of /t,d/. Discussions of these principles tend in the literature to be limited to consideration of segmental variants such as flaps or glottal stops, whereas (1) illustrates a context where the question is what subsegmental properties are sufficient to cue a /t/, in this case whether the voicelessness is ascribable to the juxtaposition of /n/ and /s/ alone.

With all following consonants sharing alveolar or dental articulation with /t,d/, one might consider a definition of neutralisation closer to the conventional structuralist one and ask whether in some sequences [t] or [d] on the one hand and zero on the other are both truly possible pronunciations. For example, in /sts/ sequences in certain syntactic / discourse contexts (e.g. "at the <u>last</u> second"), where one might ask whether [sts] is a possible pronunciation in natural, fast speech. These problems are, however, not limited to such "neutralisation" contexts and we now turn to examine some areas which, I would argue, also need principled decisions to be taken about how to interpret the data and which in some cases are impossible to interpret definitively with only auditory and acoustic information.

### *3.2 Masking Effects*

[7] All numbered examples are taken from T&T's data. In each case the word with (t,d) is underlined in the orthographic transcription and the phonetic transcription is of that word and the following word only. It is not practicable to give spectrographic illustrations for all examples, so we rely on detailed transcription and description for most.

The problems T&T encountered with the raw data are grouped here somewhat arbitrarily: other groupings are possible and the problems illustrated for each group overlap sometimes to a considerable degree. They all concern phenomena which are instantly recognisable as normal to phoneticians familiar with continuous speech processes (CSPs) and which have been much studied since the early invention of such articulatory techniques as static palatography, since supplanted by electropalatography and more recent techniques such as Electromagnetic Articulography (EMA). General comments regarding CSPs here should be taken as referring to varieties of British English; No detailed knowledge of the phonetics of other varieties studied with reference to (t,d) is claimed. The term "masking" is used to denote the possibility of an articulatory gesture, possibly an incomplete one, which is physiologically and/or acoustically hidden by the articulation of surrounding consonants.

Where there is a following vowel, the duration of the stop closure, the audible release and the visible formant transitions into the vowel make the reflex of the (t,d) token easy to identify, as in (2) and (3):

(2) *er Simon and I <u>kept</u> in touch* [kʰɛpˀtʰɪntʊtʃ]

(3) *if if a <u>project</u> or* [pˌɹəʊdʒɛʔtʰɔˑ] *contract comes up*

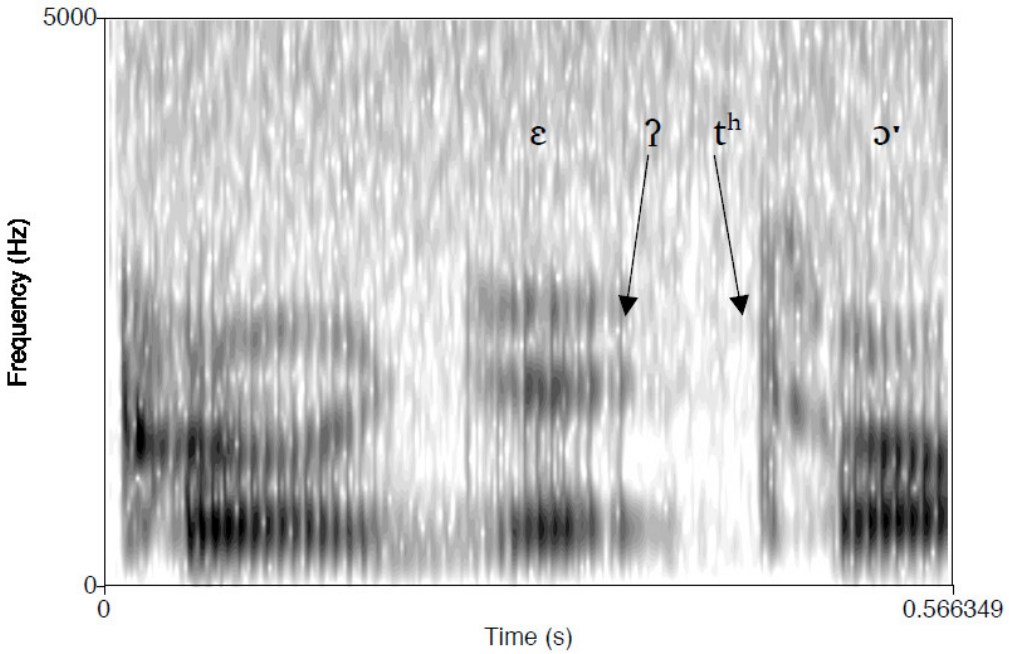


*Figure 1. Spectrographic representation of "<u>project</u> or" (3); male speaker.*

Figure 1 is a spectrogram of part of (3) showing the preceding /k/ realised as a glottal, a clear closure period and a release with formant transitions consistent with an alveolar plosive reflex of the word-final /t/ of *project*.

In the absence of a release, however, the unambiguous identification of the deletion of word-final /t,d/ is much more difficult, as is the case with the token in (4), which is illustrated in Figure 2:

(4) *having this lego <u>kept</u> me* [$k^h$ɛ̰p˺$mi^j$] *occupied for years.*

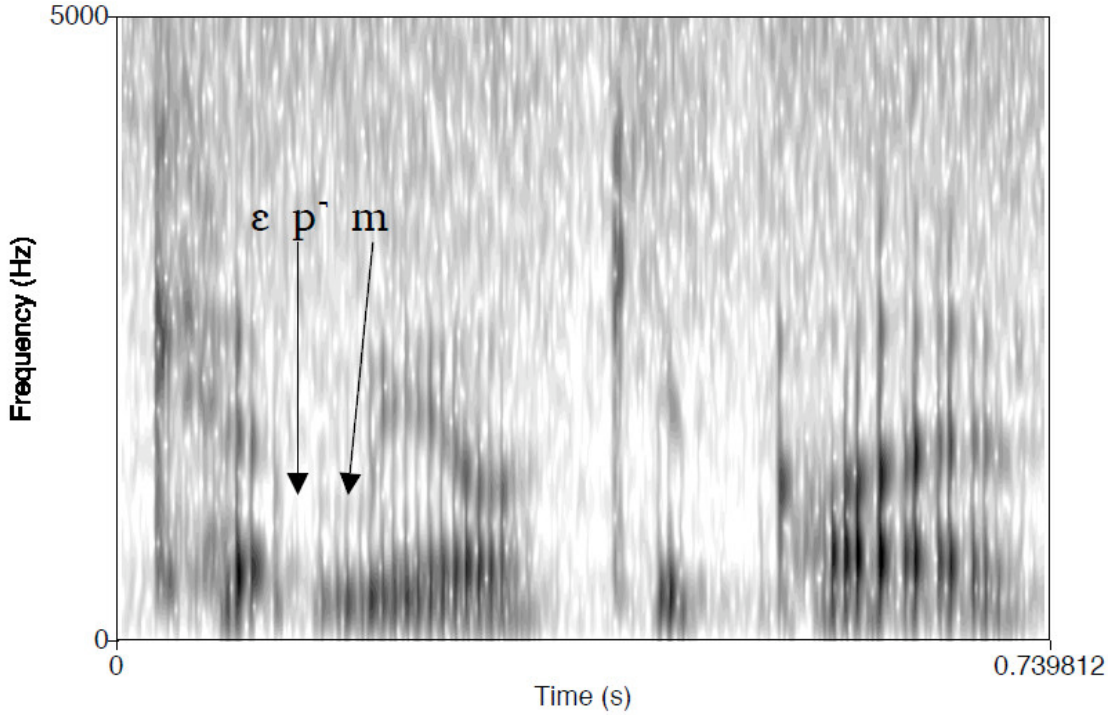


*Figure 2. Spectrographic representation of "<u>kept</u> me occupied" (4); male speaker.*

As Figure 2 shows, there is glottalisation of the vowel of *kept* and possibly glottal reinforcement of the [p], but auditory analysis reveals that there is also unambiguous bilabial closure. The following [m] is clearly visible. There is no evidence in the spectrogram or auditorily of a [t] between the [p] and the [m], but it is not possible to state categorically that there is or is not a stop gesture present. It is quite possible that an apical closure gesture could occur between the two, but unless the preceding bilabial closure was released before the /t/ gesture, and the following bilabial closure happened after it, it would not be perceived auditorily[8]. The unreleased /p/-to-homorganic-/m/ sequence is, of course, exactly what one would expect from a fluent native speaker of English

[8] The relatively short duration of the closure in *kept* compared to the /p/ of *occupied* is ascribable to a rapid deceleration of speech rate and cannot necessarily be taken as an indication of /t/ deletion.

and it is impossible to tell for certain whether the /t/ has truly been deleted or whether a residual gesture might remain. Even assuming the absence of a lingual gesture, the presence of glottalisation could be interpreted as a reflex of /t/ in a glottal stop, but this interpretation is no more straightforward: the presence of a masked glottal stop is no easier to identify, and the creak on the preceding vowel and in the diphthong of *occupied*, clearly apparent in Figure 2, means that this could just be a function of the speaker's register.

There were many tokens which showed this masking effect in T&T's data. In (4) the place of articulation of the preceding and following consonant is the same, but (5) and (6) demonstrate how this is not necessary for masking to occur:

(5) *well it was all <u>pressed</u> bits of* [pˌɹɛsbɪʔ͡tə] *meat you know*

(6) *but there was all <u>old</u> carpets* [ɔ̰lkʰa̲pʰɪʔs] *and pictures.*

In each case there is a preceding coronal gesture towards the alveolar ridge. Since word-final stops are not obligatorily accompanied by oral release (and, I would argue, not normally so in this type of context), the absence of an audible or visible release burst cannot be taken as the unambiguous absence of /t,d/: in (5) the blade and tip of the tongue could have raised from their fricative position to form a closure during the articulation of the "following" [b], just as the side(s) of the tongue could have raised to complete a post-lateral closure in (6). In both cases, the coronal release would have been masked by the closure of the following stop. It is, of course, equally possible that the tongue tip/blade was never raised further than for a fricative in (5) and was released as the dorsum (and sides) raised for [k] closure in (6). The problem is that it is impossible to tell either way without fine-grained articulatory data.

Masking is particularly problematic where there is glottalisation of the preceding consonant and with combinations of preceding nasals and following plosives or nasals. (7) is taken from the same subordinate clause as (6), focusing on the second (t,d) token; the relevant extract is shown in Figure 3:

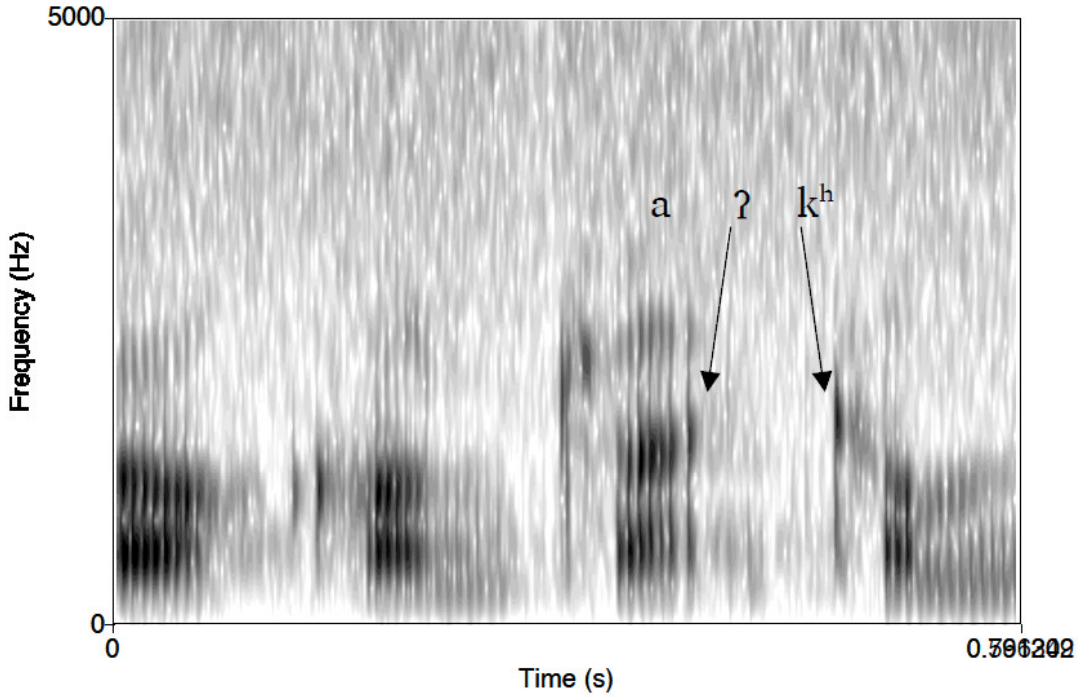


*Figure 3. Spectrographic representation of "contract comes" (7); male speaker.*

(7) *if if a project or contract comes* [kɒntɹ̥aʔˈkʊmz] *up*.

Again, the preceding and following segments are unproblematic: there is a clear closure into a glottal reflex of the preceding /k/ of *contract* and a clear velar release of the initial plosive of *comes*. Again it is not possible to state categorically that there is not a [t] gesture present, but if this were the case the glottal gesture would have to be released before the release of a [t] and crucially before the velar closure for the following /k/, for the presence of the /t/ to be perceived independently or show up on the spectrogram. Alternatively, given that a glottal stop is a common reflex of /t/, this could be construed as a further neutralising context since the presence of a preceding glottal stop makes it impossible to detect whether the glottal reflex is present or not (or, more accurately, it is impossible to tell whether the glottal is a reflex of /k/ or /t/ or both – see 3.3.4 below).

The parallel problem with nasals is illustrated in (8) to (10):

(8) *you know we were educated, trained people* [tɹ̥eˈnpiˈpl̩] / [tɹ̥eˈndˈpiˈpl̩]

(9) *they've found me asleep* [faʊnmiʲəslɪp] *in their bedroom*

(10) *they were over a thousand quid* [θaʊˈzn̩kwɪd] *each*

Occasionally, such cases could be disambiguated from spectrographic evidence, for example a sharp cessation and resumption of voicing with word-final /t/ followed by a voiced stop, but unsurprisingly, the majority are more like (8), represented spectrographically in Figure 4. The energy showing faintly between the [n] and the [p] release in Figure 4 is from the interviewer speaking over the informant; the informant's closure period between the bold vertical lines crossing the x-axis is unambiguously voiceless. Prior to that it is possible to see the nasal energy falling off in frequency, but

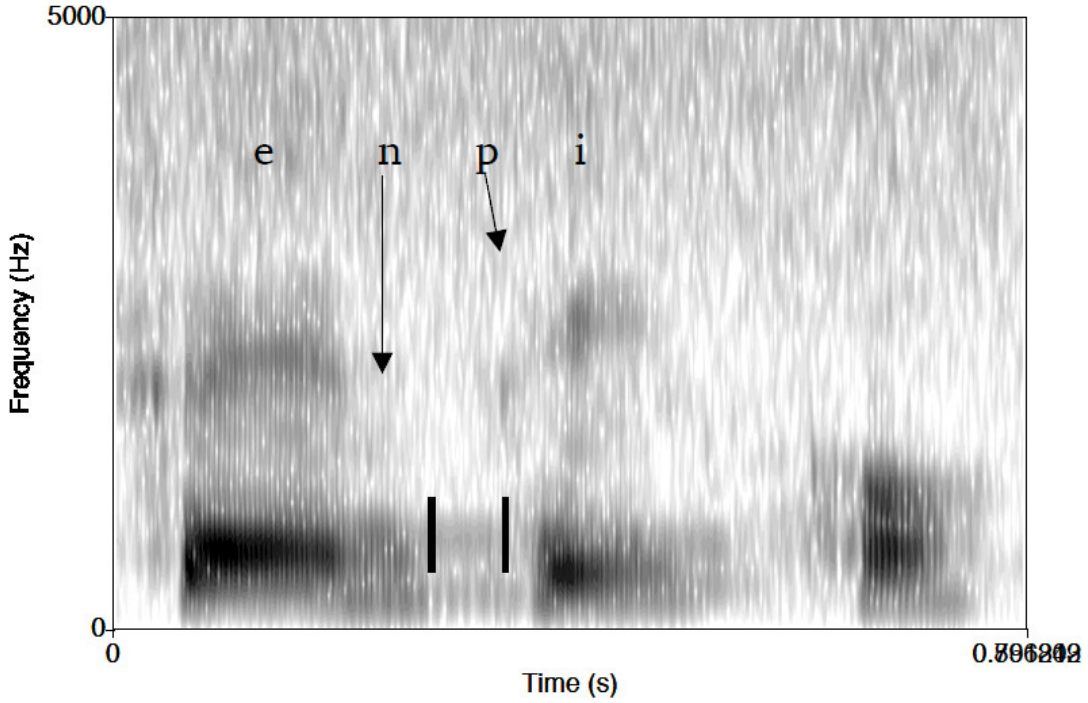


*Figure 4. Spectrographic representation of "trained people" (8); female speaker.*

there is no stretch of non-nasalised voicing consistent with a fully voiced [d]. The lack of voicing could be explained by the word-final assimilatory devoicing characteristic of many Yorkshire speakers, but in the absence of a release this potential explanation is of no help in determining whether or not the word-final stop is present.

Tokens in these contexts rarely have released [t,d], and those which do have audible release usually involve hesitation or a prosodic pattern signalling a pragmatic or discourse effect. This is the case in (11) and Figure 5, where the speaker is introducing the computer game Minesweeper as the source of his friend's problems with distraction at work and produces a micro pause after *found* followed by a lengthened diphthong in the first syllable of *Minesweeper*:

(11) *and he <u>found</u> Minesweeper* [faʊn̥d maːɪnswiːpʰə]*, have you played Minesweeper?*

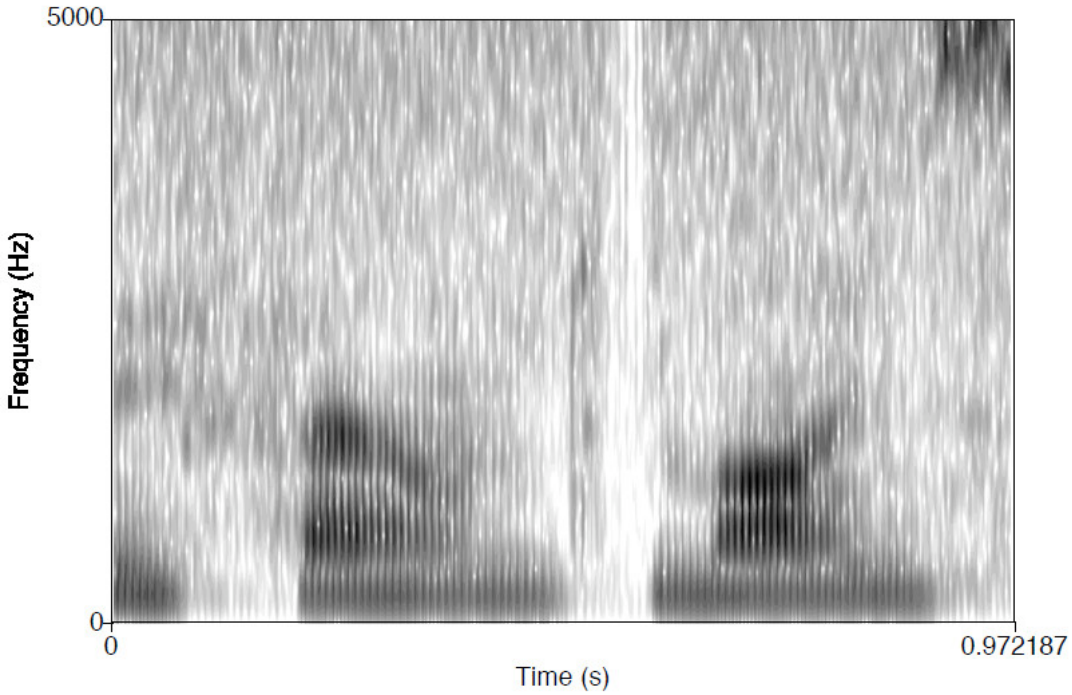


*Figure 5. Spectrographic representation of "<u>found</u> mines[weeper]" (11); male speaker.*

Examples (8) (Fig.4) and (11) (Fig. 5) were produced by different speakers and the durations are different, but the spectral pattern in *found* (11) is almost identical, *mutatis mutandis*, to that in *trained* (8): in both cases there is clear formant structure throughout the voiced portion of the closure for [n(d)] and no voicing bar without it, as there would be in a canonical voiced [d]. The plosive release in Figure 5 is completely voiceless, though not aspirated. This is again quite normal in English and it is difficult to see on what grounds one could possibly state definitively whether or not the stop in (8) (Fig. 4) has been deleted. In that case, even techniques like palatography would not disambiguate the token. It is thus hard to see the justification for extrapolating a phonological rule of deletion from these and the other examples in this section, and even if deletion could be demonstrated, it is hard to see how to justify the claim that it is governed by the same rule that deletes, say, the final /t/ of "I've never seen the film Gorillas in the <u>Mist</u> [mɪs]."[9] The latter would be

[9] An invented example is given here, since there is not a single example of a sentence-final coronal stop cluster with deletion in the data set analysed in T&T.

marked for speakers of York English and one would expect it to behave quite differently from the examples which are governed by their normal CSPs, yet the same variable rule is purported to apply to all these cases.

*3.3 Assimilation*

The problem of masking is compounded in cases of assimilation across the (t,d) token. Again, this is particularly a problem with nasals, which frequently assimilate to the place of articulation of a consonant following (t,d). When the underlying token is voiceless, it is sometimes possible still to detect a glottalised reflex of it, as in (12):

(12) *she's on a <u>different</u> plane* [dɪf̥ɪm̥ ˀp̥lɛˑn].

Reflexes of /d/ are, however, much harder to detect, as in (13), where the speaker is describing an early record player, and (14), which is shown in Figure 6.

(13) *a a a <u>sound</u> box* [saʊmbɔks] *was only a diaphragm*

(14) *we built, um, Bradford <u>combined</u> court* [kʰəmbaĩŋkʰɔːʔ] *centre*.

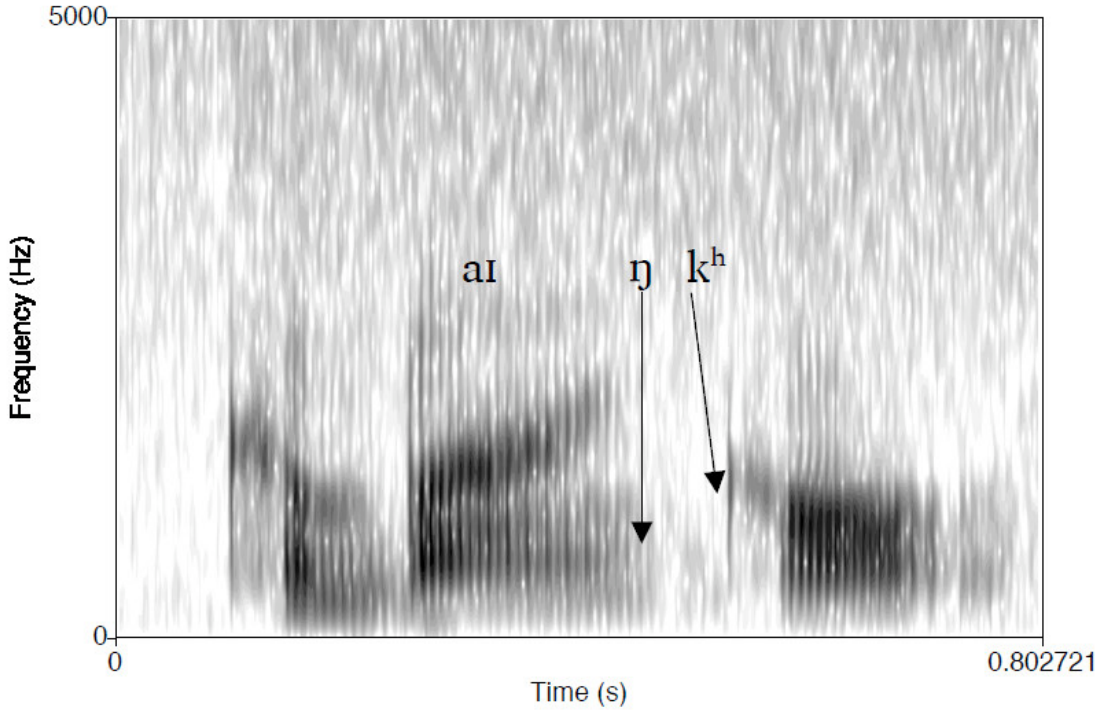


*Figure 6. Spectrographic representation of "<u>combined</u> court" (14); male speaker.*

It could be argued that these assimilation cases constitute evidence in support of a lexical rule of word-final coronal stop deletion: the assimilation in (14) can only occur because the /d/ between the nasal of *combined* and the velar plosive of *court* has been deleted before the postlexical rule of assimilation across word boundary applies. However, examples like (12) show that deletion is not a prerequisite for assimilation, since assimilation of the /n/ in *different* to the place of articulation of /p/ in *plane* occurs across the glottal reflex of the word-final stop, showing that segmental adjacency is not a prerequisite for assimilation.

*3.4 Sequentiality*

Example (4) above raises a further question, albeit one which is partly bound up with masking and assimilation, that is the possibility that a phonetic reflex of (t,d) might not occur sequentially between its "preceding" and "following" segments. The spectrogram in Figure 2 shows the audible glottalisation on the vowel of *kept* and into the [p] closure. It is well known that the phonetic cues to segmental identity are not restricted to the temporal slot implied by phonemic (or indeed generative) representations. The cueing of coda voicing by the duration of the preceding vowel is a commonplace. So it might be argued that there is a reflex of /t/ present in the *kept* of (4), although it is not sequentially aligned in the word-final position. Again, this is a topic which merits further experimental exploration, into both perception and production, beyond the scope of the present paper, but again the problem is raised of how to classify such tokens for variable rule analysis. T&T decided to classify them, not without some misgivings, as having undergone deletion because they were trying to replicate Guy (1991) and so far as they could ascertain, this would have been Guy's practice.

In (4), there is clear oral articulation of the [pˀ] of *kept* as well as the glottalisation. By contrast, voiceless velar stops immediately followed by another stop in York English (and many British varieties) are frequently realised as glottals without any velar articulation[10]. These tokens pose a different problem for classifying segments in sequence: in (15) the [$t^h$] of *worked* is released so [ʔ] and [$t^h$] can be taken as sequential reflexes of /k/ and /t/ respectively:

[10] Very occasionally, preceding /p/ is also realised as a glottal, as in *the whole place <u>except</u> us* [iʔsɛ̰ʔˈ$t^h$ʊs].

(15) *and that was where my dad worked and* [wɜ̃ ʔtʰən] *where the Barbican...*

However, this is not possible in (16) to (18), which are all from different speakers:

(16) *I w- worked part-time* [wəʔäʔtaɪm] *in funerals*

(17) *She knocked straight* [nɒʔstɻɛɪ̃ ] *into us yeah*

(18) *being an infant teacher was helpful in that respect because* [ɹɪsbɛ̰ʔˈbɪkʊz̥].

The preceding segment in each case is realised as a glottal stop, and it appears that the (t,d) token is absent. A parallel example, (7), was discussed under *Masking* above, but even if there were no masked alveolar gesture, [ʔ] is also a possible pronunciation of (t,d) in this variety, as shown in (19), so an alternative (or concurrent) interpretation of the problem is that it is impossible to disambiguate whether [ʔ] is a reflex of /k/ or /t/ or both.

(19) *you felt as* [fɛlʔəz] *if you moved you'd fall off*

It would be necessary to do detailed phonetic comparisons of a number of tokens with potential sequences of glottals to establish whether there is, for example, a regular pattern of variation between a lengthened [ʔ] in *worked* versus a shorter glottal reflex of /k/ in *(I) work*, which would indicate (although not conclusively) that there was an undeleted /t/ in this token of *worked*.

In their replication study, T&T again opted to code tokens such as (4) and (16) to (18) as deleted because that appeared to be the North American practice, but this is a rather problematic strategy. The problems are further complicated by the fact that preceding /k/ is very unevenly distributed across the data, as shown in Table 2 above: whereas 23% of regular past tense forms have preceding /k/ only 3% of monomorphemes and none of the semi-weak forms do. Since ambiguous glottals are overwhelmingly produced in tokens with preceding /k/ and following consonants this could be further skewing the findings for morphological class.

## 4.0 Variable (Lexical) Phonological Rules and (t,d)

Having addressed some of the problems of method and interpretation posed by the phonetic and statistical analysis of (t,d) data, we now turn to their theoretical implications. Although variable rules have their roots in generative grammar and specifically generative phonology, their ontological status has been a matter of debate (see, for example, Fasold (1991) or the brief overview in Mendoza-Denton, Hay and Jannedy (2003)): do they represent a convenient statistical tool for measuring variation or are they an albeit imperfect model of speakers' competence[11]? Whatever the general answer to this question, the linguistic characterisation of (t,d) in terms of the generative Lexical Phonology (henceforth LP) model, which drives the predictions concerning morphological class tested in T&T, entails that the rule be a phonological rule, at least so far as morphological class and preceding context are concerned, that is, it applies during the derivation of the word (as well as post-lexically). The question thus arises of how this particular rule fits into the phonology as a whole. It is unproblematic for processes strictly associated with the derivation of verbal forms, such as the deletion of the suffix vowel of {*-ed*} and voicing agreement of the final consonant, to occur before the variable deletion rule applies. However, the timing of the application of the rule with respect to processes affecting preceding and following consonantal segments does have direct bearing on the analysis. This is perhaps best examined with reference to further examples from T&T's data.

In (20) there is a clear release of the [$t^h$] accompanied by a short aspiration burst, so the token is an unambiguous example of non-application of the rule:

(20) *he was a bit wet when it comes to <u>contact</u> sports* -
[$k^h$ɒnt$^h$a̰ʔt͡$^h$spɔːʔs]

[11] Notwithstanding the problems outlined in this paper, (t,d) is an interesting example of how the statistical model of a variable rule can differ from the linguistic variable rule being modelled: morphological category is an independent factor group in the statistical analysis whose function is to model the consequences of the iterative application of the linguistic variable rule, which in the LP view has no need of the input of an independent variable of morphological category, since it falls out of the structure of the phonological component of the grammar. This mismatch between a putative linguistic variable rule and the statistical modelling of its behaviour is not in itself problematic.

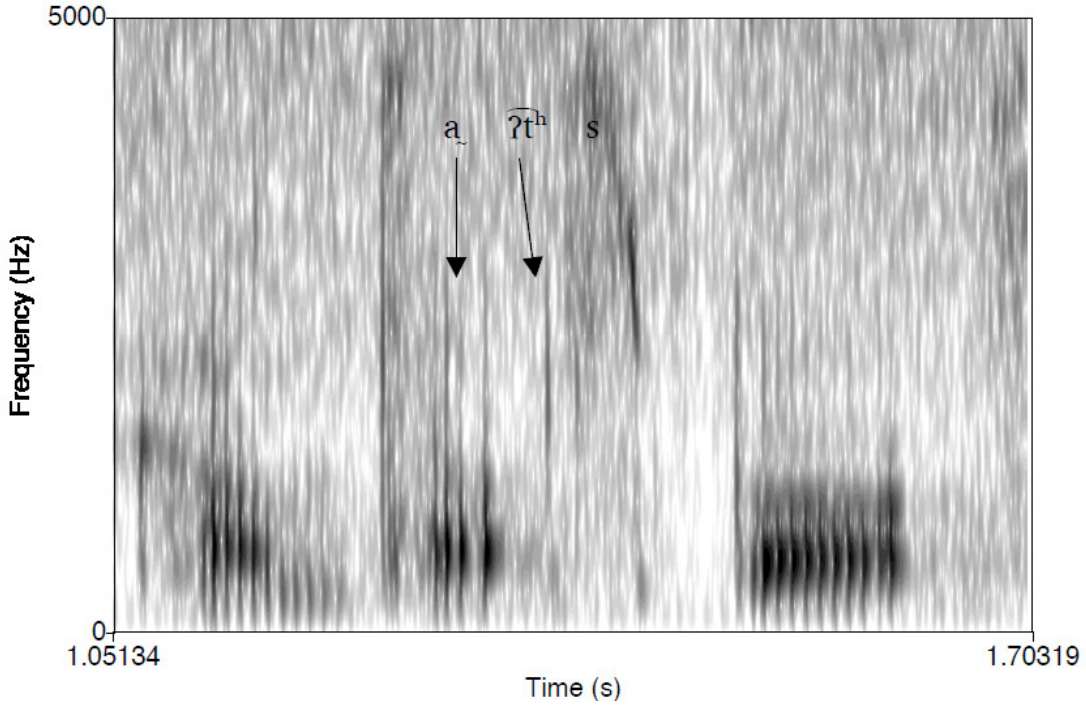


*Figure 7. Spectrographic representation of "contact sports" (19); male speaker.*

The following context is unproblematically [s]. However, the preceding context is less straightforward: /k/ is realised as a glottal, which raises the question of what exactly the preceding context was when the rule applied, [k] or [ʔ][12]. It might be argued that what matters for the rule is that [ʔ] is a stop, and its place of articulation is not important, but phonetically it is realised as creak on the /a/ vowel (see Figure 7), as arguably something which is qualitatively very different from [k]. Of the 1118 tokens in Table 1, 71 preceding /k/s are phonetically glottal stops and 5 are glottalised; glottals thus represent nearly 7% of the data set and 45% of preceding stops, so this is far from a trivial question.

A similar problem occurs with vocalised /l/, as in (21):

(21) *So she told me off* [tʰɐʊmiɔf] *for shouting at her*

York English is not known as a strongly /l/-vocalising variety, but there are ten such tokens in the data set and one where there is no obvious sequential reflex of /l/:

[12] Since the rule applies iteratively, the answer to this question may actually be different at different stages in the derivation, thus introducing a further complicating element.

(22) *my friend told me right* [tʰəmɻɻaɪ] *yesterday*

In these and other cases of the absence of a preceding phonetic consonant, the question arises of how long in the derivation the underlying cluster remained a cluster and so subject to the (t,d) rule. Whereas tokens with preceding phonetic laterals have a mean rule application rate of 19%, of the ten tokens[13] where the word-final consonant is preceded by a phonetic vowel in the surface form, six (60%) have the final consonant deleted. This may be simply due to the small number of tokens, but it is interesting that syllabic phonetic laterals, also few in number, pattern in the same way as the non-syllabics which surface phonetically (25% deletion, N=8).

Questions of rule ordering also affect the following phonological context. In cases like (23), where the /t/ coarticulates with the following /j/, the same question arises: what is the following context when the rule applies, in this case postlexically?

(23) *like [the baby] kept you up* [kʰɛpˀt͡ʃʲʊpˀ] *24 hours a night*

Following /h/ is particularly problematic in this respect. In (24) the following context is phonetically a vowel, but underlyingly it is consonantal. What, then, is the following context when the rule applies?

(24) *Yeah that that was it we was walking down Micklegate and we grabbed him* [gɹabdɪm]

These problems are compounded when the processes affecting adjacent consonants also affect (t,d), as illustrated by (16) above, reproduced here:

(16)… *I w- worked part-time* [wəʔäʔtaɪm] *in funerals*

Here, [ʔ] is a perfectly normal reflex of both coda /t/ and /k/ in many varieties of British English so it is not only the preceding consonant whose identity is in question at the point of application of the rule, but the surface (t,d) token itself: is it deleted or not? If not, has /t/-glottalisation occurred before or /k/ glottalisation and/or (t,d)?

[13] There were in fact 18 tokens in the whole data set, but some were excluded on other grounds for the analysis shown in Table 1. The problem would, of course, be more serious in other varieties of British English where /l/-vocalisation is more common.

The questions raised here cannot be dismissed by saying the rule relates to abstract phonological units or categories of sonority, major class features etc: in order to carry out variable rule analysis, the analyst has to code each token for preceding context, and it is crucial to know what that context is. This is particularly important in cases where the preceding context could be a vowel, which means the cluster may not actually be a consonant cluster when the rule applies, and equally so where the following context may be a vowel, given that following consonant versus following vowel has been known (unsurprisingly) to have the most robust effect on (t,d) since the very earliest studies. With an iterative rule, such problems are intractable. It is difficult to see how to determine whether the chicken of rule application came before or after the egg of, say, /l/-vocalisation.

## 5.0 Discussion and conclusions

This survey of a range of problems which came to light during T&T's attempts to replicate North-American studies of (t,d) with data from northern England has been somewhat brief, due to space constraints, and apparently rather eclectic. However, as already indicated, many of the issues are inter-related and all raise questions not only about (t,d) as a linguistic variable analysable in terms of Lexical Phonology but also about the nature of variable rules in general and indeed about the relationship more broadly between phonetic output and phonological analysis.

The phenomenon of masking might seem to pose purely practical problems, and the argument could be adduced from the point of view of perception that the masking causes the hearer not to hear a reflex of /t,d/ and it is thus reasonable to model its perceived absence as a result of deletion. However, the generally accepted treatment of "neutralisation" in (t,d) by excluding tokens in neutralising (following) contexts on the grounds that it is impossible to perceive whether the (t,d) token is deleted or not, demonstrates that (t,d) is modelled on the basis of production rather than perception. Since masking and neutralisation introduce the same uncertainty in the first step of the analysis, that is deciding whether a token is realised or not, they should at the very least be treated in the same way: either neutralised tokens should be included in the analysis because they form part of what the hearer hears (and presumably recognises as (t,d) sites), or masked tokens should be excluded because, as with neutralisation, it is impossible for the analyst or the hearer to detect whether deletion has occurred. Given that production and perception must ultimately be linked, this decision might still be construed as merely a practical, operational one, but it must nevertheless

be addressed and it cannot be given proper consideration without also considering the abstract model of the behaviour of (t,d), to which we shall return below.

Assimilation was presented in §3.3 above as compounding the problem of masking. Could it be the case, on the other hand, that it confirms that deletion has taken place? In this view, deletion would lead to, e.g., an underlying /n/ and /b/ being adjacent in *sound box* (13), making the assimilation of place of articulation unsurprising. However, the problem of undetectable gestures for [t,d] remains, and the evidence of *different plane* (12), pronounced [dɪfɹ̥m̥̩˕~ʔp̥l̥ɛˑn], shows clearly that assimilation can still take place when the intervening segment is not deleted, so its usefulness as a diagnostic is rather doubtful. Moreover, assimilation and the other processes affecting preceding and following consonants raise the question, addressed in §4, of how (t,d) relates to other processes affecting its conditioning: does it apply before or after /l/ vocalisation, /h/ deletion or indeed assimilation? Does it perhaps feed any of those processes? So far as T&T could ascertain, the assumption in the literature seems to be that (t,d) takes underlying phonological units as its input. This assumption has to be justified, however: on what basis can it be argued that (t,d) belongs in the (lexical) phonology whereas those other processes are either phonetic or post-lexical or even lexical but applying after (t,d)?

This brings us to the fundamental problem of the nature of (t,d), its relation to phonology and phonetics, and the nature of variable rules. Why, one might ask, should deletion be a phonological rule at all? The original conception of variable rules was a part of a Generative Phonology-type rule. As I have acknowledged, variable rules have evolved into more of an analytic construct than a theoretical one, but they nevertheless retain their claim to model, albeit at some remove, how speakers produce and perceive variable patterns of speech. (t,d), as I have also acknowledged, goes further than this, working backwards from the observation that the variable appears to be conditioned by the morphological class of words to the assumption that it really is a phonological rule operating both lexically and post-lexically. It behoves the advocates of this view of (t,d) not only to demonstrate that the patterns of variability are consistent with the predictions of LP (which T&T were unable to do), but just as importantly, to demonstrate the compatibility of the variable rule with the model in other respects, in other words to demonstrate that this is a (lexical) phonological rule. In its lexical component, LP deals with contrastive phonological units and their morphophonological alternations. There is no reason why lexical LP rules should not be variable, but that does not of itself make (t,d) a candidate to

be a lexical rule any more than l-vocalisation or the glottalisation of /k/ in *worked* (15) or *knocked* (17) would be. The conditions for (t,d) are introduced by the morphology (except, of course in the case of monomorphemes) but there is no phonological contrast between /t,d/ and zero (except in the trivial sense that anything might be said to contrast with zero) and no morphophonological alternation involved.

An alternative analysis might be that (t,d) is a phonetic Continuous Speech Process. Being phonetic does not preclude being variable and structured, but as well as allowing a more holistic approach in the light of what is known of other CSPs in English, viewing it this way obviates the need to justify a more abstract phonological analysis. It does not, of course, mean that issues like masking, the ordering of processes and assimilation disappear, nor does it obviate the need to make a reasoned case for such an analysis, but that analysis will have to await a further, fuller treatment.

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