

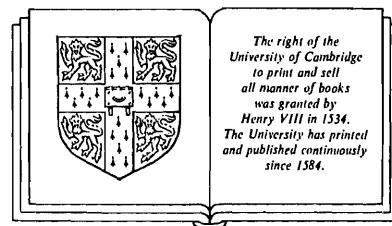
Papers in Laboratory Phonology II
Gesture, Segment, Prosody

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Segment

present itself for analysis directly and unambiguously. Phonetic detail can only be gleaned by examining speech performance, and speech performance has different facets: production, the acoustic signal, and perception, at least. Perhaps surprisingly, these facets are not always isomorphic. For instance, experimental investigation of phonetic detail appears to throw up cases where produced distinctions are not perceived (see work on sound changes in progress, such as the experiment of Costa and Mattingly [1981] on New England [USA] English, which revealed a surviving measurable vowel-duration difference in otherwise minimal pairs such as *cod-card*, which their listeners were unable to exploit perceptually). In such cases, what is the reality of the linguistic structure the phonologist is trying to model?

10.5 Conclusions

This paper has aimed to show that place assimilation is a fruitful topic of study at the interface of phonology and experimental phonetics. It has been found that place assimilation happens gradually, rather than discretely, in production; and that residual cues to alveolars can be exploited with some degree of success in perception.

It is argued that the facts of place assimilation can be neither modeled adequately at a symbolic, phonological level, nor left to be accounted for by the mechanics of the speech mechanism. Instead, they must be treated as one of those areas of subcontrastive phonetic detail over which speakers have control. The representation of such phenomena is likely to require a more radical break from traditional segmental notions than witnessed in recent phonological developments.

Clearly, much remains to be done, both in terms of better establishing the facts of assimilation of place of articulation, and, of course, of other aspects of production, and in terms of modeling them. It is hoped that this paper will provoke others to consider applying their own techniques and talents to this enterprise.

Comments on chapter 10

BRUCE HAYES

The research reported by Nolan is of potential importance for both phonetic and phonological theory. The central claim is as follows. The rule in (3), which is often taught to beginning phonology students, derives incorrect outputs. In fluent speech, the /t/ of *late calls* usually does not become a /k/, but rather becomes a doubly articulated stop, with both a velar and an

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alveolar closure: [lei{k}ko:lz]. The alveolar closure varies greatly in its strength, from full to undetectable.

$$(3) \quad \left[\begin{array}{c} \text{alveolar} \\ \text{stop} \end{array} \right] \rightarrow [\alpha \text{ place}] / \text{—} \left[\begin{array}{c} \text{C} \\ \alpha \text{ place} \end{array} \right]$$

Nolan takes care to point out that this phenomenon is linguistic and not physiological – other dialects of English, and other languages, do not show the same behavior. This means that a full account of English phonology and phonetics must provide an explicit description of what is going on.

Nolan also argues that current views of phonological structure are inadequate to account for the data, suggesting that “The representation of such phenomena is likely to require a more radical break from traditional segmental notions than witnessed in recent phonological developments.”

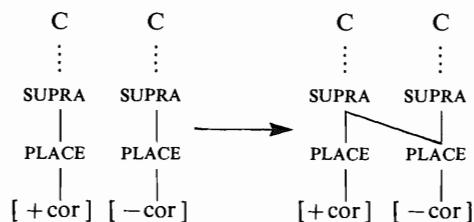
As a phonologist, I would like to begin to take up this challenge: to suggest formal mechanisms by which Nolan’s observations can be described with explicit phonological and phonetic derivations. In fact, I think that ideas already in the literature can bring us a fair distance towards an explicit account. In particular, I want to show first that an improved phonological analysis can bring us closer to the phonetic facts; and second, by adopting an explicit phonetic representation, we can arrive at least at a tentative account of Nolan’s data.

Consider first Nolan’s reasons for rejecting phonological accounts of the facts. In his paper, he assumes the model of segment structure due to Clements (1985), in which features are grouped within the segment in a hierarchical structure. For Clements, the place features are grouped together under a single PLACE node, as in (4a). Regressive place assimilation would be expressed by spreading the PLACE node leftward, as in (4b).

(4)a.



b.



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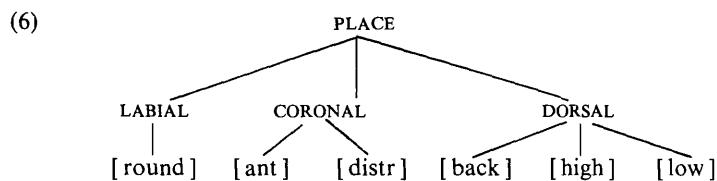
A difficulty with this account, as Nolan points out, is that it fails to indicate that the articulation of the coronal segment is weak and variable, whereas that of the following noncoronal is robust. However, it should be remembered that (4b) is meant as a *phonological* representation. There are good reasons why such representations should not contain quantitative information. The proper level at which to describe variability of closure is actually the phonetic level.

I think that there is something more fundamentally wrong with the rule in (4b): it derives outputs that are *qualitatively* incorrect. If we follow standard phonological assumptions, (4b) would not derive a double articulated segment, but rather a contour segment. The rule is completely analogous to the tonal rule in (5), which derives a contour falling tone from a High tone by spreading.

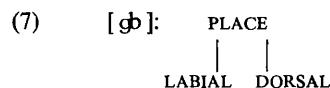


Following this analogy, the output of rule (4b) would be a contour segment, which would shift rapidly from one place of articulation to another.

If we are going to develop an adequate formal account of Nolan's findings, we will need phonological and phonetic representations that can depict articulation in greater detail. In fact, just such representations have been proposed in work by Sagey (1986a), Ladefoged and Maddieson (1989), and others. The crucial idea is shown in (6): rather than simply dominating a set of features, the PLACE node dominates intermediate nodes, corresponding to the three main oral articulators: LABIAL for the lips, CORONAL for the tongue blade, and DORSAL for the tongue body.



The articulator nodes are not mutually exclusive; when more than one is present, we get a complex segment. One example is the labiovelar stop, depicted as the copresence of a LABIAL and a DORSAL node under the same PLACE node.



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Note that the LABIAL and DORSAL nodes are intended to be simultaneous, not sequenced.

Representations like these are obviously relevant to Nolan's findings, because he shows that at the surface, English has complex segments: for example, the boldface segment in *late calls* [lei{k}ɔ:lz] is a coronovelar, and the boldface segment in *good batch* [gu{b}bæt] is a labiocoronal.

A rule to derive the complex segments of English is stated in (8). The rule says that if a syllable-final coronal stop is followed by an obstruent, then the articulator node of the following obstruent is spread leftward, sharing the PLACE node with the CORONAL node.

(8) *Place Assimilation*

Spread the articulator node of a following obstruent leftward, onto a syllable-final [-^{continuant}_{CORONAL}] segment.⁴

In (9) is an illustration of how the rule works. If syllable-final /t/ is followed by /k/, as in *late calls*, then the DORSAL articulator node of the /k/ is spread leftward. In the output, it simultaneously occupies a PLACE node with the original CORONAL node of the /t/. The output of the rule is therefore a corono-dorsal complex segment.

(9) *late calls: /tk/ → [{}k]*



To complete this analysis, we have to provide a way of varying the degree of closure made by the tongue blade. Since phonological representations are discrete rather than quantitative, they are inappropriate for carrying out this task. I assume then, following work by Pierrehumbert (1980), Keating (1985, 1988a), and others, that the grammar of English contains a phonetic component, which translates the autosegments of the phonology into quantitative physical targets. The rule responsible for weakening alveolar closures is a phonetic rule, and as such it manipulates quantitative values.

⁴ There is an additional issue involved in the expression of (8): the rule must generalize over the class of articulator nodes without actually spreading the PLACE node that dominates them. Choi (1989), based on evidence from Kabardian, suggests that this may in fact be the normal way in which class nodes operate: they define sets of terminal nodes that may spread, but do not actually spread themselves.

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The form of rules in the phonetic component is an almost completely unsettled issue. For this reason, and for lack of data, I have stated the phonetic rule of Alveolar Weakening schematically as in (10):

(10) *Alveolar Weakening*

Depending on rate and casualness of speech, lessen the degree of closure for a COR autosegment, if it is [-continuant] and syllable-final.

In (11) is a sketchy derivation showing how the rule would apply. We start with the output of the phonology applying to underlying /kt/, taken from (9). Next, the phonetic component assigns degree-of-closure targets to the CORONAL and DORSAL autosegments. Notice that the target for the DORSAL autosegment extends across two C positions, since this autosegment has undergone spreading. Finally, the rule of Alveolar Weakening lessens the degree of closure for the CORONAL target. It applies variably, depending on speech style and rate, but I have shown just one possible output.

(11) a. *Output of phonology*

b. *Translation to quantitative targets*

c. *Alveolar weakening*

C	C	C C	C C	
PLACE	PLACE	1 _____	1 _____	ALVEOLAR
COR	DORS	x	x	closure
		0 _____	0 _____	value
		1 _____	1 _____	DORSAL
		xxxxx	xxxxx	closure
		0 _____	0 _____	value

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This analysis is surely incomplete, and indeed it may turn out to be entirely wrong. But it does have the virtue of leading us to questions for further research, especially along the lines of how the rules might be generalized to other contexts.

To give one example, I have split up what Nolan treats as a single rule into two distinct processes: a phonological spreading rule, Place Assimilation (8); plus a phonetic rule, Alveolar Weakening (10). This predicts that in principle, one rule might apply in the absence of the other. I believe that this is in fact true. For example, the segment /t/ is often weakened in its articulation even when no other segment follows. In such cases, the weakened /t/ is usually

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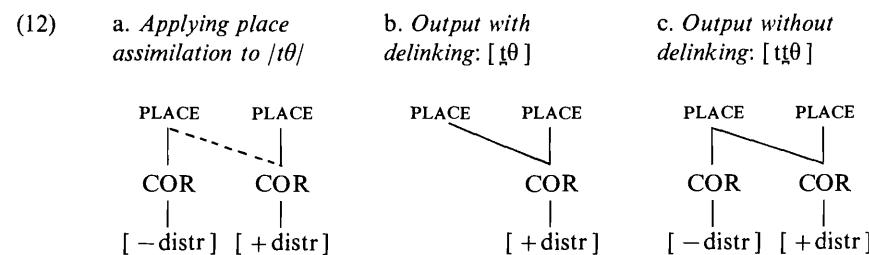
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“covered” with a simultaneous glottal closure. Just as in Nolan’s data, the degree of weakening is variable, so that with increasingly casual speech we can get a continuum like the following for *what*: [wʌt], [wʌt[?]], [wʌp[?]], [wʌp?].

It is not clear yet how Alveolar Weakening should be stated in its full generality. One possibility is that the alveolar closures that can be weakened are those that are “covered” by another articulation. A full, accurate formulation of Alveolar Weakening would require a systematic investigation of the behavior of syllable-final alveolars in all contexts.

My analysis also raises a question about whether Nolan is right in claiming that Place Assimilation is a “gradual process.” It is clear from his work that the part of the process I have called Alveolar Weakening is gradual. But what about the other part, which we might call “Place Assimilation Proper”? In my analysis, Place Assimilation Proper is predicted to be discrete, since it is carried out by a phonological rule. The tokens that appear in Nolan’s paper appear to confirm this prediction, which I think would be worth checking systematically. If the prediction is not confirmed, it is clear that the theory of phonetic representation will need to be enriched in ways I have not touched on here.

Another area that deserves investigation is what happens when the segment that triggers Place Assimilation is itself coronal, as in the dental fricatives in *get Thelma, said three, and ten things*. Here, it is impossible to form a complex segment, since the trigger and the target are on the same tier. According to my analysis, there are two possible outcomes. If the CORONAL autosegment on the left is deleted, then the output would be a static dental target, extending over both segments, as in (12b). But if there is no delinking, as in (12c), then we would expect the /t/ to become a contour segment, with the tongue blade sliding from alveolar to dental position.



My intuitions are that both outcomes are possible in my speech, but it is clear that experimental work is needed.

To sum up, I think Nolan’s work is important for what it contributes to the eventual development of a substantial theory of phonetic rules. I have also tried to show that by adopting the right phonological representation as

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the input to the phonetic component (i.e. an autosegmental one, with articulator nodes), the task of expressing the phonetic rules can be simplified.

Comments on chapter 10

JOHN J. OHALA

Nolan's electropalatographic study of lingual assimilation has given us new insight into the complexities of assimilation, a process which phonologists thought they knew well but which, the more one delves into it, turns out to have completely unexpected aspects.

To understand fully place assimilation in heterorganic medial clusters I think it is necessary to be clear about what kind of process assimilation is. I presume all phonologists would acknowledge that variation appears in languages due to "on-line" phonetic processes and due to sound changes. The former may at one extreme be purely the result of vocal-tract constraints; for example, Lindblom (1963) made a convincing case for certain vowel-reduction effects being due to inertial constraints of the vocal mechanism. Sound change, at the other extreme, may leave purely fossilized variant pronunciations in the language, e.g., *cow* and *bovine*, both from Proto-Indo-European *gʷʰoūs. Phonetically caused variation may be continuous and not represent a change in the instructions for pronunciation driving the vocal tract. Sound change, on the other hand, yields discrete variants which appear in speech due to one or the other variant form having different instructions for pronunciation. There are at least two complicating factors which obscure the picture, however. First, it is clear that most sound changes develop out of low-level phonetic variation (Ohala 1974, 1983), so it may be difficult in many cases to differentiate continuous phonetic variation from discrete variation due to sound change. Second, although sound changes may no longer be completely active, they can exhibit varying degrees of productivity if they are extrapolated by speakers to novel lexical items, derivations, phrases, etc. It was a rather ancient sound change which gave us the k > s change evident in *skeptic* ~ *skepticism* but this does not prevent some speakers from extending it in novel derivations like *domesticism* (with a stem-final [s]) (Ohala 1974).

I think place assimilation of medial heterorganic clusters in English may very well be present in the language due to a sound change, but one which is potentially much more productive than velar softening. Nevertheless, its full implementation could still be discrete. In other words, I think there may be a huge gap between the faintest version of an alveolar stop in *red car* and the fully assimilated version [reg ka:].

Naturally, the same phonetic processes which originally gave rise to the