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Gestures and autosegments: comments on Browman and Goldstein's paper

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21.1 Introduction

The primary goal of Browman and Goldstein's study appears to be that of modeling speech at a level of detail far greater than that to which a phonologist ordinarily aspires. For this reason, phonologists might be tempted to consider their gestural framework not as an alternative to the standard autosegmental model (the model presented in Goldsmith 1976; Clements 1985; and others) but rather as a way of beefing up the autosegmental representations so that they can begin to deal with certain subphonemic aspects of articulatory timing.

In these comments, however, I will assume, that Browman and Goldstein are presenting a distinct theoretical alternative and that they advocate the adoption of gestural representations to the exclusion of autosegmental representations, not just as an interpretive appendix to them. I will begin by outlining the formal differences between gestures and autosegments. I will explain then why the distinct properties of the theory of autosegmental timing remain more useful in phonological analyses. In the last section of my comment, I will try to show that the points on which Browman and Goldstein's representations diverge from standard autosegmental theory have direct application to the description of certain phonological phenomena which have so far remained unexplained.

21.2 Gestures and autosegments

To understand what differentiates the gestural and autosegmental models we must look for answers to two questions: what types of units are the phonological representations made of and what types of relations obtain between these units?

21.2.1 *Units*

Let us consider the first question. Browman and Goldstein's gestures, the units of the gestural framework, correspond to a subset of the units countenanced in

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autosegmental phonology: for instance, a bilabial closing gesture (β in figure 19.5a) corresponds to one instance of the articulator node Labial (Sagey 1986); a velic opening gesture ($+\mu$) corresponds to a [+nasal] specification; a glottal opening and closing gesture (γ) corresponds to one [+spread glottis] value. There are some differences too. Gestures include not only information about articulators and the location of constriction but also about the manner in which the constriction is made: e.g. whether it is a near-closing gesture (as in the case of fricatives: cf. σ in figure 19.5a) or a complete closure. The gestural model does not permit continuancy to be viewed as a distinct object from point of articulation. Although other manner features are not mentioned, I assume that they would also be viewed as integral parts of the gesture, rather than as distinct objects. In contrast, autosegmental models, specifically those of Clements (1985) and Sagey (1986), keep apart point of articulation autosegments from manner specifications. We do not know enough about the phonological patterning of manner features to evaluate this point of difference between the two models. But two observations can be made which indicate that a synthesis of these two approaches is necessary. Manner specifications are seldom if ever subject to assimilation rules, a fact which appears to support Browman and Goldstein's decision not to recognize them as distinct objects. On the other hand, as Sagey (1986) notes, assimilations in point of articulation do not necessarily propagate continuancy or any other manner features.

Assimilations are analyzed gesturally as changes in the relative timing of two gestures: from sequentially ordered to overlapping or simultaneous. When two gestures become simultaneous, one may be perceptually "hidden" by the other: because it goes unnoticed, the hidden gesture may eventually disappear. Since the ultimate outcome of assimilation is the replacement of one gesture by the other, the gestural model predicts, contrary to fact, that all assimilations will involve both the replacement of point of articulation values and that of manner values. A revision may be necessary here. Aside from this point, the choice of units in the gestural model closely parallels that of articulator nodes and terminal features in the autosegmental models of feature organization of Clements (1985) and Sagey (1986).

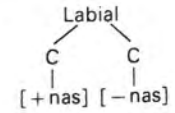
21.2.2 *Relations between tiers: direct vs. indirect timing*

The fundamental difference between the two models emerges when we consider their analysis of the timing relations of precedence, simultaneity and temporal overlap. Gestures are elements with internal duration, a property represented abstractly as an internal 360 degree cycle. The duration allows one to represent directly temporal overlap between two gestures, by specifying the subsequence within each one that is synchronized with a subsequence in the other: for this reason I will refer to the gestural theory as a theory of *direct timing*. An illustration

of the gestural analysis of articulatory overlap appears in figure 19.4d of Browman and Goldstein's article.

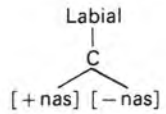
In contrast, autosegments are generally viewed as only points in time where no beginning and endpoints can be distinguished. Between two points one can define precedence and simultaneity but not partial overlap. For this reason and because the distinction between simultaneous and partially overlapping units is highly significant phonologically, standard autosegmental representations must represent articulatory timing as a relation mediated by one and possibly more auxiliary tiers, which play the role of external clocks. A theory of *indirect articulatory timing* is then central to the autosegmental framework. The auxiliary tiers mentioned above are the timing tier (the CV tier of McCarthy 1979; Clements and Keyser 1983; and the alternatives discussed in McCarthy and Prince 1986) and the class node tiers introduced in Clements (1985), Mohanan (1983), Sagey (1986). I illustrate in (1) the role of auxiliary tiers in defining partial overlap between autosegments. The sequence described is a homorganic nasal-stop cluster /mb/: the task is to represent the fact that a single autosegment, the articulator node Labial, stands in partial overlap with the specifications [+nasal] and [−nasal]. For present purposes we need to refer to only one auxiliary tier here: this is the timing tier, seen below in its CV-theory version.

(1)



What is represented in (1) is the overlap between labiality and nasality in a cluster of two consonants, a long sequence. Overlap between the same units can also be represented autosegmentally when it characterizes a short sequence, in this case a single prenasalized consonant:

(2)



21.2.3 *Phonological length and indirect timing*

Although auxiliary tiers are made necessary by the need to distinguish overlap from simultaneity between units lacking duration, their uses extend far beyond this aspect of autosegmental representations. The introduction of just one auxiliary tier permits one to represent as distinct three degrees of phonological length: long, short and extra-short. The Labial autosegment is long in (1), in that it is linked to more than one C. The same autosegment is short in (2), in that it occupies exactly one C. The nasal autosegments are short in (1), but extra-short

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in (2), where they share a single C. These three degrees of phonological length turn out to be necessary in phonological descriptions. The long vs. short distinction is necessary in the representation of geminates or partially assimilated clusters such as /mb/: on this point there is an extensive literature (Leben 1980; Schein 1981; Kenstowicz 1982; Prince 1984; Hayes 1986; Schein and Steriade 1986) demonstrating that phonetically long segments must be phonologically represented as single autosegments multiply linked to two or more positions on the timing tier. Most of the references cited explicitly reject the alternative of representing long segments as sequences of adjacent, identical elements, i.e. in terms of what Browman and Goldstein (1986: 235) refer to as distinct, overlapping gestures on the same tier. The short vs. extra-short distinction is necessary in the description of *contour segments*[2]: units patterning phonologically as single segments but displaying a sequence of distinct specifications for a given feature, such as [nasal] or [continuant]. Prenasalized consonants, such as the /mb/ sequence in (2), and affricates are commonly cited examples of contour segments.[3] Other instances of extra-short segments are the Finnish short diphthongs discussed by Keyser and Kiparsky (1984) and the intrusive stops analyzed by Clements (1987).

Important in assessing the relative merits of the autosegmental and gestural models of articulatory timing is the fact that the distinction between long, short and extra-short autosegments follows without stipulation from the autosegmental model: a mapping between one autosegment and more than one timing unit corresponds to a long segment; a one-to-one mapping corresponds to a short segment; a mapping between several autosegments and one timing unit corresponds to an extra short segment. The autosegmental model does not use distinct primitives in describing the three possibilities: it merely combines the same units in all possible ways.

In contrast, the gestural model of timing appears handicapped when one considers how it can be extended to account for existing segmental quantity distinctions. Browman and Goldstein have not yet considered this issue explicitly and should not be held responsible for my reconstruction of their possible moves on this matter. I see two options. One is to distinguish gestures in terms of their duration: to allow for every gesture a long cycle, a short cycle and an extra-short cycle. This will introduce into the gestural model the types of quantity distinctions that appear to be linguistically significant. While this is a possible move, it is not a desirable one because it leaves unexplained why it is precisely these three length values that must be introduced: why not two or thirteen degrees of length? This question does not arise in the autosegmental framework, where the existing three distinctions correspond to the only conceivable mapping modes between timing slots and autosegments: a one-to-one mapping (short segments), many-to-one mapping (extra short segments) and a one-to-many mapping (long segments).[4]

A second option one could consider is to introduce a timing tier into the gestural model and thus to bring it even closer to the autosegmental framework. If this

option is taken, we must ask to what extent the remaining distinguishing characteristic of the gestural framework, the internal duration of gestures, is phonologically justified. I do not have a clear opinion on this issue, because the evidence bearing on it appears to point in opposite directions. On the one hand, one can argue against giving internal duration to gestures/autosegments on the grounds of restrictiveness. On the other hand, there is at least one class of phenomena, with arguably phonological status, which can be understood only in terms of the representations posited by Browman and Goldstein. I will now develop each one of these points in turn.

21.2.4 *When* simultaneous *equals* overlapping: *an argument against units with internal duration*

It is obvious that if two systems of representation differ only in that one operates with units having internal duration while the other operates with punctual units, the latter will be the more restrictive one. This point can be illustrated by the following considerations. I have noted above that one can represent autosegmentally the articulatory overlap between nasality and labial closure in both long sequences (CC, as in (1)) and in short sequences (C as in (2)). However, the descriptive potential of autosegmental representations changes depending on whether we discuss long sequences or short ones. Suppose for instance that the nasality tier contrasts not two types of autosegments, [+nasal] and [−nasal], but only one autosegment, [+nasal], and its absence. For a long sequence, this change of assumptions will not affect the representation of overlap:

(3)

But for a short sequence, the change from a double-valued nasality tier to a single-valued one means that overlap can no longer be distinguished from simultaneity:

(4)

[5]

In contrast, the representations proposed by Browman and Goldstein where gestures have internal duration make it in principle possible to distinguish partial overlap from simultaneity regardless of the length of the sequence and regardless

of whether each of the tiers involved is assumed to contain one or more than one gesture.

(5)

	Overlap on short sequence	Overlap on long sequence
Tier 1	[– – – – – – – – – –]	[– –]
Tier 2	[– – – –]	[– – – – – – – – – – – – – – – – – –]

It is obvious that for the description of subphonemic aspects of articulatory timing the specification of internal duration in a gestural model is a valuable one. But the fact that autosegmental representations do not allow under certain conditions a distinction between overlap and simultaneity is also valuable, at a more abstract level of representation. An example which illustrates this is the distribution of tonal contours in languages such as Ancient Greek (Vendryes 1945; Steriade 1988) or Lithuanian (Halle and Vergnaud 1987 and references there). In these languages, short vowels are tonally specified as either High (H) or Low (L), while long vowels and diphthongs can be either H, L, falling (HL) or rising (LH). It is plausible to assume that the tonal tiers of both Greek and Lithuanian have only one underlying autosegment, H, and that what we call a L tone is, at the appropriate stage in the representation, simply the absence of H. If we make this assumption, we not only simplify the shape of underlying and intermediate representations but we also explain the asymmetry between tonal contours on long and short nuclei. The range of possible distinctions available on long nuclei is depicted below:

(6)

```
H      H   H
|      |   /\
V V;   V V;  V V;  V V

(V̀ V̀;  V̀ V̀;  V̀ V̀;  V̀ V̀)
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On short nuclei, the lack of distinction between overlap and simultaneity contracts these distinctions to just two:

(7)

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H
|
V;  V

(V̀;  V̀)
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It is important to note that such an analysis predicts that every language in which H is the only underlying tone will exhibit the same asymmetry as Greek: long vowels may exhibit a three or four-way tonal contrast, whereas short vowels will exhibit only a binary contrast. Note that if we adopt a theory like Browman and Goldstein's, in which autosegments/gestures are directly timed relative to

each other, without the intermediary of a timing tier, the neutralization of the LH, HL, H contrast on short vowels must be stipulated. It can perhaps be described: one can require that the gesture equivalent to a H tone have a certain minimal duration, not significantly shorter than that of a short vowel gesture. But this is necessarily a language-specific stipulation, since languages exist in which no such restriction obtains: the best known example of this type is Mende (Leben 1978), where both long and short vowels exhibit contours. Not accidentally, the tonal phonology of Mende, as analyzed by Leben, displays the necessity of an underlying distinction between H tones, L tones and toneless vowels and thus provides an independent difference between Mende and Greek or Lithuanian. The correlation hypothesized here suggests that languages like Mende, which allow tonal contours on short nuclei, will always be languages in which at least two tones will be present underlyingly; whereas languages like Greek and Lithuanian, where contours cannot occur on short nuclei, will always be languages with only one underlying tone. If this correlation holds up, it should count as an important advantage of the autosegmental theory of timing, since that theory, together with the assumptions of underspecification, explains it by restricting the circumstances under which overlap and simultaneity can be distinguished. This advantage of the autosegmental theory follows directly from the assumption that autosegments do not have internal duration.

21.2.5 *Dorsey's Law: an argument for internal duration*

There is, however, a class of phenomena which point in the opposite direction and suggest that there exist phonological uses of the assumption that autosegments have internal duration. I will refer globally to these processes as Dorsey's Law, using the name of the Winnebago rule which exemplifies the entire class. To anticipate, Dorsey's Law looks like a vowel insertion rule which turns CCV(C) syllables into CvCV(C) sequences, where v stands for a copy of V. The problem raised by Dorsey's Law for a standard autosegmental analysis, is that it is difficult to ensure that the quality of the inserted vowel will match that of the vowel tautosyllabic with the cluster in underlying representation. A standard vowel insertion process consists of two steps: inserting the V slot (or equivalent timing unit) and associating with it the appropriate segment. In the case of Dorsey's Law, the insertion of a V slot in a string like /i.tra/ creates a new syllable: /i.tV.ra/. At this point, it is no longer possible to determine that the syllable /tV/ was at some point a part of the last syllable /tra/: it is therefore not possible to tell whether the V in /tV/ should associate to the features of the preceding /i/ or of the following /a/. We shall see that this problem does not arise in Browman and Goldstein's gestural framework.

In Winnebago a vowel is inserted between all underlying consonant clusters of the form Obstruent-Sonorant. This process is referred to as Dorsey's Law by Siouanists and has been analyzed by Miner (1979, 1981), Hale and White Eagle

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(1980) and, most recently, by Halle and Vergnaud (1987). The inserted vowel is always a copy of the vowel which appears to the right of the cluster. The following examples come from Hale and White Eagle's study:

(8) a. sh-wa-zhok → sha̲wazhok 'you mash potatoes'
b. ho-sh-wa-zha → hosha̲wazha 'you are sick'
c. hi-kro-ho → hiko̲roho 'he prepares'
d. hi-ra-t'at'a-sh-nak-shana → hirat'at'asha̲nakshana 'you are talking'
f. wakri-pras → wakiri̲paras 'flat bug'
g. wakri-pro-pro → wakiri̲poro̲poro̲ro 'spherical bug'[6]

Two points must be clarified about the operation of Dorsey's Law. Both Hale and White Eagle and Halle and Vergnaud point out that the rule applies after stress is assigned but that the inserted syllable determines, under certain circumstances, a metrical restructuring of the word. This fact indicates (a) that Dorsey's Law applies *after* syllabification (since it applies after stress and stress is necessarily dependent on syllabification); and (b) that Dorsey's Law inserts, directly or indirectly, a new syllable into the string. The second point can be directly established by observing that some of the syllables resulting from Dorsey's Law appear as stressed in the forms above.

The fact that Dorsey's Law applies only between obstruents and sonorants in prevocalic position, a type of sequence frequently analyzed as a CCV syllable, suggests that the clusters it singles out are *complex onsets*. The hypothesis is then that Dorsey's Law turns an underlying CCV syllable into a CVCV sequence, by copying the nuclear vowel between the members of the complex onset. This suggestion is independently supported within Winnebago by the following detail, mentioned by Miner (1981) and further analyzed by Saddy (1984): Dorsey's Law does not apply to heteromorphemic VC][CV sequences. Thus the /kna/ sequence in /waak-nak-ga/ 'man-SITTING POSITIONAL-DEMONSTRATIVE' (surface /waagnaka/) does not become /kana/.[7] In contrast, the /kn/ of monomorphemic /hiruknana/ 'boss' undergoes Dorsey's Law: the surface form is /hiruka̲nana/. The failure of Dorsey's Law in VC][CV contexts is accounted for by assuming that syllabification proceeds cyclically: on the first cycle, the syllable /waak/ is formed, with /k/ in coda position. Thereafter, this /k/ is unavailable for resyllabification into a complex onset, for general reasons discussed by Prince (1985) and Steriade (1988). Because the /kn/ cluster remains heterosyllabic in this case, Dorsey's Law fails to apply and we obtain /waag.na.ka/. In contrast, the tautomorphemic sequence /hiruknana/ is syllabified /hi.ru.kna.na/ on the first cycle, after which the onset cluster /kn/ undergoes Dorsey's Law. Thus cyclicity of syllabification and the assumption that Dorsey's Law affects only tautosyllabic clusters explains the two different treatments of /kna/ in /waagnaka/ and /hirukanana/.[8]

The phenomenon I call Dorsey's Law is wide-spread and may occur in

languages whose underlying syllabification can be determined more directly. In Late Latin, this process used to operate sporadically, as we can tell from the spelling of inscriptions and from its inherited effects on the Romance languages. The Late Latin syllabification is reconstructible from a variety of phonological indications discussed in Steriade (1987): the complex onsets consist of obstruent-liquid clusters, or perhaps more generally of obstruent-sonorant clusters. The epigraphic evidence collected by Schuchardt (1867) demonstrates that these clusters are frequently broken up by a copy of the vowel to their right.[9]

(9) A.lek.san.dri: Alexandiri
Mi.tra: Mitara
pa.tri: patiri
chla.my.dem: chalamydem
cri.brum: ciribrum
scrip.tum: sciriptum
The.o.pras.tus: Theoparastus
Clau.di.a.nus: Calaudianus
pro.cras.ti.na.ta: procarastinata

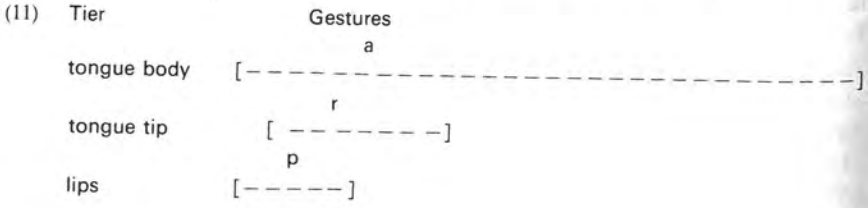
Among the Romance languages, Sardinian appears to have preserved and extended Dorsey's Law. The following examples are among those cited by Wagner (1907):

(10) um.bra: umbara
ci.li.bru: če.li.vu.ru
co.lo.bru: co.lo.vu.ru
xu.cla: ču.ca.ra

Two properties of Dorsey's Law, in both the Winnebago and the Romance version, should be stressed. First, the clusters separated by epenthesis are underlying onsets: this may not be completely clear in Winnebago but is beyond doubt in Romance. Second, the quality of the inserted vowel matches that of the underlying nucleus tautosyllabic with the complex onset: compare for instance /Mitara/ (from /Mi.tra/) with /patiri/ (from /pa.tri/).

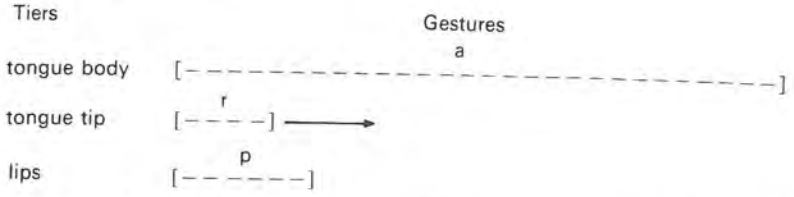
Two aspects of the gestural model can be combined to explain these facts. First, gestures have duration. Second, Browman and Goldstein suggest that within a syllable consonantal articulations are superimposed on the vowel gesture: simplifying somewhat, we can represent gesturally a syllable like /pra/ as below:

(11)



Dorsey's Law can then be viewed as just a change in the relative timing of the three gestures. From an input syllable beginning with two consonantal gestures overlapping in duration with each other, a delay in the onset of the liquid can create a sequence in which the two gestures have ceased to overlap. A significant delay will create a sequence in which the vowel gesture begins to "show" between the consonantal gestures:

(12)



To complete the account, we must add the following assumption about the syllabic interpretation of overlapping vocalic and consonantal gestures: a vowel gesture is interpreted as a monosyllable only if all the superimposed consonantal gestures are peripheral, that is only if the beginning of a *contiguous* cluster of consonantal articulations coincides with or precedes the beginning of the vocalic gesture (or, in the case of a postvocalic cluster, only if the end of the cluster coincides with or follows the end of the vowel). Since Dorsey's Law creates a sequence in which a consonant gesture has come to be nonperipherally superimposed on a vowel gesture, it automatically turns a monosyllable into a disyllable.

What is intuitively satisfying about this analysis is the fact that Dorsey's Law can now be viewed as the effect of a single timing adjustment. As Brownman and Goldstein point out, most phonological processes originate as changes in the timing between articulations: the possibility of viewing Dorsey's Law in the same terms is a significant attraction of the gestural model.

21.2.6 *Variants of Dorsey's Law*

It is in principle possible that the displacement of the second consonant in a syllable initial cluster would carry it all the way to the opposite end of the syllable. In this case, the displaced consonant will be peripheral and the result of displacement will still be interpretable as a monosyllable.

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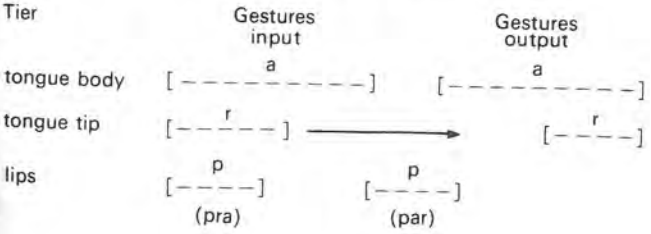

This type of change is also encountered in Latin, although during an earlier stage than Dorsey's Law. Early and prehistoric Latin displays occasional metathesis between the second member of a complex onset and the following vowel. This phenomenon was documented in some detail by Juret (1921)[10]:

(14)	trapezita	tarpezita	"table"
	*plumo:	pulmo:	"lung"
	*dluk^{w}is	dulcis	"sweet"

The gestural analysis of Dorsey's Law given above extends naturally to this case. We can suggest that the intra-syllabic movement of the consonantal gestures has two sets of parameters: the direction (leftwards/rightwards) and whether the target position is peripheral or not. Dorsey's Law is rightwards movement to a nonperipheral position, whereas liquid/vowel metathesis is rightwards movement to a peripheral position. The suggestion then is that Dorsey's Law and intra-syllabic methathesis are in fact one and the same phenomenon: a significant delay in the onset of the second consonant gesture of a complex onset.

Leftward intra-syllabic movement is also encountered, in both the peripheral and the nonperipheral versions.[11] Proto-Slavic CVR(C) syllables (where R is a liquid, /l/ or /r/) shifted their liquids leftwards: South, Central and certain Western Slavic dialects turned CVR(C) to CRV(C), while Eastern Slavic turned CVR(C) to CVRV(C). The Eastern Slavic development is the inverse of Dorsey's Law; the other dialects display the inverse of Latin intrasyllabic metathesis. The history of Slavic CVR syllables is told in Meillet (1934), Vaillant (1950) and Shevelov (1963). The following examples come from Shevelov (1963: 391–421).

(15)	Pre-Slavic		Eastern Slavic	Elsewhere in Slavic
	*karv-	"cow"[12]	Russian /korova/	Slovak /krava/
	*bergh-	"birch"	Russian /bereza/	Slovak /breza/ Polabian /breza/
	*ghord-	"yard" "town"	Russian /gorod/	Old Church Slavic /gradu/
	*melk-	"milk" "moisture"	Russian /moloko/ Ukrainian /voloha/	Old Church Slavic /mleko/ Slovak /vlaha/
	*wolgh-	"force"		Serbo-Croatian /vlaga/

The data examined so far illustrate all four settings of the parameters of intra-syllabic movement: rightwards movement occurs in Winnebago and Romance, leftwards movement in Slavic. Movement to nonperipheral position appears in Late Latin (/Mitra/ → /Mitara/) and Eastern Slavic (/*gord-/ → /gorod/); movement to peripheral position appears in early Latin (/trapezita/ → /tarpezita/) and in most other Slavic dialects (/*gord-/ → /gradu/).

Note that the target position of the moved consonantal gesture must always be a point in the duration of the vowel it is superimposed on (i.e. the tautosyllabic

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in some detail by Juret (1921)[10]:

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novement of the consonantal gestures
ftwards/rightwards) and whether the
's Law is rightwards movement to a
el metathesis is rightwards movement
ıen is that Dorsey's Law and intra-
ame phenomenon: a significant delay
e of a complex onset.
encountered, in both the peripheral
ıvic CVR(C) syllables (where R is a
ftwards: South, Central and certain
CRV(C), while Eastern Slavic turned
evelopment is the inverse of Dorsey's
of Latin intrasyllabic metathesis. The
Meillet (1934), Vaillant (1950) and
ome from Shevelov (1963: 391–421).

ɔ	Elsewhere in Slavic
ɔva/	Slovak /krava/
ɛza/	Slovak /breza/
	Polabian /breza/
od/	Old Church Slavic /gradu/
oko/	Old Church Slavic /mleko/
loha/	Slovak /vlaha/
	Serbo-Croatian /vlaga/

ur settings of the parameters of intra-
occurs in Winnebago and Romance,
to nonperipheral position appears in
ıstern Slavic (/*gord-/ → /gorod/);
arly Latin (/trapezita/ → /tarpezita/)
→ /gradu/).
d consonantal gesture must always be
ıperimposed on (i.e. the tautosyllabic

vowel): this fact explains why sequences like /Mi.tra/ yield /Mi.ta.ra/ rather than */Mi.ti.ra/.

There is a categorical aspect to intrasyllabic movement, in that different dialects select consistently either movement to peripheral or to nonperipheral position and do not appear to mix the two. What is more interesting is that the actual size of the displacement to a nonperipheral position may remain undetermined. We can guess at this from the fact that the inscriptions which attest the Latin version of Dorsey's Law provide a second type of spellings, seen below:

(16) li.bras: liberas
sa.crum: sacerum
su.pra: supera
pa.tri: pateri (cf. patiri in (9))
gra.ci.lis: geracilis
glo.ria: geloria
tri.bu.na.tu: teribunatu

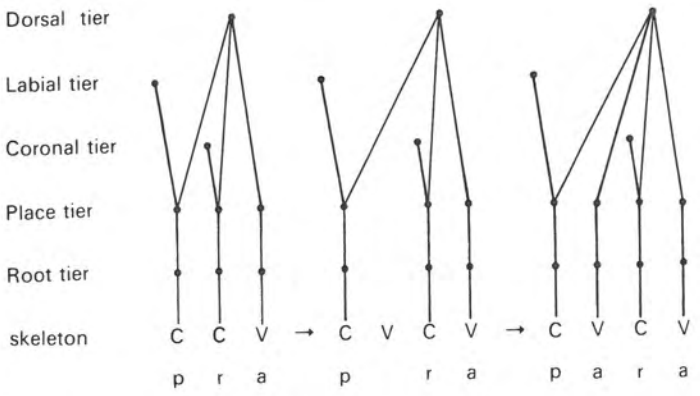
I take the intrusive /e/ of /sacerum/ to stand for a vowel of indeterminate quality, a vowel that does not fall squarely within any phonemic category for which there is a letter in the Latin alphabet. This said, the difference between Dorsey's Law in /patiri/ and /pateri/ (both from /pa.tri/) could plausibly be attributed to the difference between a large enough displacement to leave behind an identifiable vowel quality (in /patiri/) and a displacement that is too small for that purpose (/pateri/). My suggestion then is that there is free variation in the actual size of the timing adjustment that yields the effects we call Dorsey's Law: the only constant aspect of the adjustment is whether the target position of the movement is peripheral or not. In this respect, intra-syllabic movement resembles a phonological rule. One aspect of intra-syllabic movement not discussed here is its relation to conditions of well-formedness on the resulting syllable. Dorsey's Law, as well as rightwards intrasyllabic metathesis (/tra/ → /tar/) apply only to syllables that have complex onsets: changes like /ra/ → /ara/ or /ra/ → /ar/ are not attested. This could be attributed to the fact that such applications of intra-syllabic movement create onsetless syllables.

The account sketched here rests on the possibility of distinguishing several points in the duration of the vowel. To my knowledge this is the only arguably phonological phenomenon that requires this assumption and, as such, deserves more careful investigation. In closing, I would like to explain why the paradigm presented here favors a gestural analysis over autosegmental alternatives.[13]

An essential part of the analysis is Browman and Goldstein's idea that vowel and consonant gestures are superimposed within a given syllable. This idea can be implemented autosegmentally, by associating the features of the nuclear vowel to the matrix of tautosyllabic consonants. To do so, I assume the general outlines of Clement's (1985) and Sagey's (1986) proposals about feature organization. The

change from /pra/ to /para/ can then be viewed as the insertion of a vowel position between the members of the complex onset. I represent below two steps in this process: the insertion of the vowel and its association to the set of tongue–body specifications of the surrounding segments. The vowel specifications are represented on the Dorsal tier; those of /p/ and /r/ on the Labial and Coronal tiers respectively.

(17)



Given the input structure assumed, in which all tautosyllabic segments are associated to the same set of dorsal (= tongue body) specifications, the inserted vowel cannot link up to any other dorsal values.

What remains unexplained, however, is the relation between metathesis and vowel insertion: the relation between the treatment of /*bergh-/ in South Slavic /breza/ and in East Slavic /bereza/. Each option can be described autosegmentally: insertion as shown above and metathesis as insertion plus deletion of the original V slot. But the autosegmental analysis fails in that it provides no connection between the two operations involved in metathesis. We could equally well have coupled vowel insertion with any other change in the relevant syllable: a second vowel insertion, a consonant insertion or deletion, an unrelated assimilation rule. In contrast, the gestural analysis of intra-syllabic movement has a built-in account of such dialectal variation, since the target of movement can be either a peripheral or a nonperipheral position within the relevant domain. No other options can be conceived of.

21.3 Conclusion

I hope to have shown here that one central aspect of the gestural theory of articulatory timing deserves the close attention of phonologists: the idea that the units of phonological representations are not points in time but rather elements endowed with internal duration.

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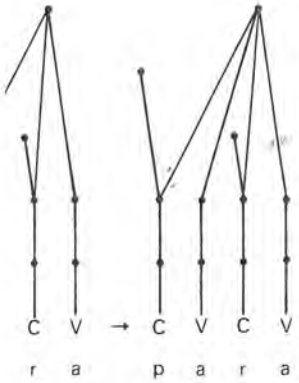

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Notes

1 See, however, Sagey's (1986) remarks on the crossing-lines constraint, which suggest that at least one axiom of the autosegmental model can be derived from general extra-linguistic principles if one assumes that autosegments do have internal duration.

2 A recent and detailed discussion of this class of phonological structures appears in Sagey (1986).

3 The data provided by Browman and Goldstein (1986) support the representation in (2) for prenasalized consonants, showing that the labial gesture of Chaga prenasalized /mb/ is as short as that of a plain /m/ or /p/. More puzzling is the fact that English /mp/, /mb/, which are normally interpreted as phonologically long sequences (as in (1)), turn out to have labial gestures of the same length as simple /p/, /b/, /m/ when pronounced in the same V′_V context. Given that English lacks true geminate stops, it is impossible to tell whether we are dealing here with a subphonemic shortening of the /mb/, /mp/ sequences or with a stress-conditioned lengthening of /m/, /p/, /b/. One should stress that, no matter how the English facts turn out, there is no systematic *phonological* equivalence between the quantity of homorganic nasal-stop clusters and that of corresponding simple stops.

4 One should bear in mind that phonological rules and representations do not count: they can distinguish between one and many units but not between one and exactly three (on this see also McCarthy and Prince 1986). This is why no phonological distinction exists between one autosegment linked to two slots and one linked to three: both are long, in that both display the one-to-many mapping mode.

5 This point is relevant not only for a comparison between the gestural and the autosegmental models but also for the comparison between autosegmental models operating with binary features and those operating exclusively with single-valued features. Note for instance that no framework which combines adherence to the autosegmental theory of articulatory timing with the assumption that all features are single-valued can describe prenasalized stops as distinct from nasal stops.

6 The digraphs ⟨sh⟩ and ⟨zh⟩ denote palatal fricatives, and not clusters.

7 The surface form, /waagnaka/, is derived by a later rule which voices obstruents before consonantal sonorants. In contexts where Dorsey's Law has applied, the voicing rule is bled: hence /hirukanana/ from /hiruknana/, rather than */hiruganana/.

8 One should also point out that the syllabification of heteromorphemic VC-CV sequences differs from that of C-CV sequences, such as /sh-wa/ in /sh-wa-zhok/ → shawazhok. The latter type of cluster is syllabified as an onset, and is hence a possible input to Dorsey's Law, while the former is not. This difference in syllabification can be explained simply. A (C)VC morpheme can be independently syllabified on a first cycle as a (C)VC syllable, with a coda. In contrast, a bare C morpheme cannot be independently syllabified, since Winnebago syllables must contain vowels: the C remains therefore syllabically stray until it can be adjoined to an existing syllable. This is what happens in the case of C-CV morpheme sequences, where the bare C is incorporated as onset into the existing CV syllable of the adjacent morpheme.

9 Schuchardt's collection of vowel insertions is not limited to instances of Dorsey's Law. One also finds cases like /maginam/ from /magnam/, or /exaceto/ from /exacto/: insertions of this type are however, very infrequent and without counterparts in the data inherited by the Romance languages. It is impossible to tell whether they represent sporadic changes in the pronunciation of individual items or spelling mistakes. Other, more regular cases of vowel insertion encountered in Shuchardt's data are discussed below.

10 The asterisks in the following forms denote items reconstructed on the basis of comparative evidence.

11 Latin leftwards movement to a nonperipheral position is occasionally attested in late inscriptions: for instance /inide/ from /in.de/, /initer/ from /in.ter/, /Militiades/ from /Mil.ti.a.des/. However sporadic, leftward nonperipheral movement was apparently continued in Sardinian, as examples like /saragus/ from /sar.gus/ (cited by Wagner 1907) indicate.

12 The Slavic root-final consonant clusters like /rv/ in /karv/ 'cow' were heterosyllabic when a vowel-initial suffix followed: /kar.vV ... /. In such cases, we have a superficial asymmetry between Dorsey's Law (rightwards intra-syllabic movement) and its inverse (leftwards intrasyllabic movement): Dorsey's Law takes place only when the moving consonant is preceded by at least one tautosyllabic segment whereas the inverse of Dorsey's Law is not conditioned by the presence of any following segment. The reason for this difference has to do with the overwhelming preference for syllables with onsets: had Dorsey's Law applied in CV syllables, it would create V.CV sequences containing an onsetless initial. This is apparently being avoided. A related observation can be made about intrasyllabic leftwards movement in Slavic: all dialects of Slavic turn onsetless syllables such as */alk-/ 'hungry' into /lak-/ (Russian /lakat'/ 'lap', Slovak /lakat'/ 'be hungry'), even though Eastern Slavic is expected to yield /alak-/ (on the pattern of */gord-/ → /gorod/). This too can be attributed to the tendency to avoid onsetless syllables.

13 Thanks to John McCarthy for suggesting the autosegmental analysis discussed below.

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