FOOT, WORD, AND LARYNGEAL FEATURES IN ENGLISH AND ICELANDIC

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1. Introduction

The relation between phonetics and phonology has long been controversial. While it is generally agreed that phonology must be based on phonetics, linguists differ on the extent to which nonphonetic constructs are available to phonology, whether it is more abstract, nonphonetically realized underlying representations or abstract organizational structure. An extreme view on the one hand is expressed by Bybee (2001), who rejects abstract representations and claims that words are listed in phonetic form, including fine phonetic detail, and that such listing is necessarily highly redundant. See (1) and the similar sentiments by Ohala in (2).

(1) “Mental representations of linguistic objects have the same properties as mental representations of other objects…Generalizations over forms are not separate from the stored representations of forms but emerge directly from them…there is no ‘rule/list separation’” (Bybee 2001, 7).

(2) “For the sake of explaining natural sound patterns there are advantages to representations using phonetic primitives—advantages not found in other currently popular phonological representations” (Ohala 1990, 267).

On the other hand, compare the statements in (3) and (4).

(3) “…phonology is not necessarily natural…and there is no reason to expect that all of its constructs should have simple physical parameters” Ladefoged (1990, 403).

(4) Hale & Reiss (2000, 162) “believe that phonology consists of a set of formal properties…that are modality independent and thus not based on phonetic substance. Failure to appreciate this goal has resulted in rampant ‘substance abuse’ in the phonological community.”

As a first approximation, we list (5) some of the properties that may differentiate phonological from phonetic studies (based on Myers 2000).

Laryngeal features are a good testing ground for distinguishing phonological from phonetic phenomena. These features include designations for
voicing, aspiration, glottalization, implosion, and tone. An influential proposal for laryngeal features is found in Halle & Stevens (1971), which we give in (6).¹

(5) Phonology | Phonetic
--- | ---
Sensitivity to prosodic categories | no
sensitivity of morphological categories | no
categorial | gradient
sensitivity to morpheme boundaries | no
sensitivity to lexical exceptions | no
no | sensitivity to gradient factors (e.g., F0) of preceding high tone in downdrift
no | sensitivity to speech rate
no | sensitivity to “careful” vs fast speech
no | sensitivity to anatomical differences among speakers
arbitrary rules | no
may have different/several phonetic correlates | has phonetic “cause”

(6) Distinctive features for glottal state

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>obstruents</td>
<td>b₁</td>
<td>b</td>
<td>p</td>
<td>p*</td>
<td>bʰ</td>
<td>b̄₁</td>
<td>pʰ</td>
<td>b</td>
</tr>
<tr>
<td>glides</td>
<td>w, y</td>
<td></td>
<td></td>
<td>h</td>
<td>h, w, y</td>
<td>?</td>
<td>?w, ?y</td>
<td></td>
</tr>
<tr>
<td>vowels</td>
<td>V (mid tone)</td>
<td>Ṿ (low tone)</td>
<td>V̵ (high tone)</td>
<td>voiceless vowels</td>
<td>breathing vowels</td>
<td>creaky voice vowels</td>
<td>glottalized vowels</td>
<td></td>
</tr>
<tr>
<td>spread glottis</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>constricted glottis</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>stiff vocal folds</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>slack vocal folds</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
</tr>
</tbody>
</table>

¹The symbol b₁ represents a lax voiceless stop as in Danish; the symbol p* represents the moderately aspirated stop of Korean; the symbol ?b represents a preglottalized b (no examples given in Halle & Stevens).
Avery & Idsardi (2001) propose a modification of this scheme, where the laryngeal articulator is regarded as having three dimensions, each of which is associated with two gestures. We give their geometry of laryngeal configurations in (7). They claim that only dimensions are relevant to phonological distinctions, not gestures.

(7) Articulators Dimensions Gestures

\[ \text{Glottal Width} \]
- [spread]
- [constricted]
\[ \text{Laryngeal} \]
- [stiff]
\[ \text{Glottal Tension} \]
- [slack]
\[ \text{Larynx Height} \]
- [raised]
- [lowered]

The first question is whether this proposal is sufficient to make all the required distinctions that are observed in different languages. Under their proposal English and Spanish differ in the distinctive features for stops. In English, it is GW, which is realized as aspiration, in contrast with an unmarked stop, realized as unvoiced but unaspirated. In Spanish, it is GT, distinguishing a fully voiced stop from one that is unvoiced but unaspirated. Languages like Thai and Hindi make use of both GT and GW, distinguishing voiceless aspirated from voiceless unaspirated stops, with Hindi exhibiting also a voiced aspirated stop. K’ekchi distinguishes voiceless glottalized from plain voiceless, while Hawaiian has no laryngeal distinctions. We give their feature scheme for the stops in these languages in (8), from Iverson & Salmons (2003, 46). Empty brackets [ ] in the first column represent the laryngeally unmarked phonemic type.

(8)

<table>
<thead>
<tr>
<th>Language</th>
<th>/p<del>b</del></th>
<th>/b/</th>
<th>/pʰ/~</th>
<th>/p~/</th>
<th>/b~/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hawaiian</td>
<td>[ ]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K’ekchi</td>
<td>[ ]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spanish</td>
<td>[ ]</td>
<td>GT</td>
<td></td>
<td>LH</td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>[ ]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thai</td>
<td>[ ]</td>
<td>GT</td>
<td></td>
<td>GW</td>
<td></td>
</tr>
<tr>
<td>Hindi</td>
<td>[ ]</td>
<td>GT</td>
<td></td>
<td>GW</td>
<td>GT, GW</td>
</tr>
</tbody>
</table>

Additional contrasts are captured with other combinations. I&S (1995, 383) suggest some features for Beja, which contrasts ejectives and voiced implosives,
in addition to the contrasts found in Hindi. We have modified this minimally to conform to Avery & Idsardi’s representations.²

(9) Beja

\[
\begin{array}{llllll}
/p/ & /b/ & /p^{b}/ & /b^{b}/ & /p^{'/}/ & /b^{'}/ \\
\text{GT} & \text{GW} & \text{GT,GW} & \text{LH} & \text{GT,LH} \\
\end{array}
\]

Iverson & Salmons (1995), referring to Kim (1970), suggest that phonetic aspiration is present before a vowel in initial position but is suppressed after [s] in a cluster in English because the [spr gl] feature is shared between the fricative and the stop, as in (10). The [spr gl] (or GW) is realized as aspiration in the singleton, but runs out, as it were, before stop release in the cluster.

(10) a. \( \text{Cluster} \)

\[
\begin{array}{c}
\text{s} \\
\text{[spr gl]} \\
\end{array}
\begin{array}{c}
p \\
\text{p}^h \\
\text{V} \\
\end{array}
\begin{array}{c}
\text{V} \\
\text{[spr gl]} \\
\end{array}
\]

b. \( \text{Singleton} \)

\[
\begin{array}{c}
p \\
\text{[spr gl]} \\
\text{V} \\
\end{array}
= \\
\begin{array}{c}
p \\
\text{[spr gl]} \\
\text{V} \\
\end{array}
\]

The criteria that we suggest for underlying features include the following:

(11) a. Consistence: the same feature difference is underlying in all positions

b. Pattern congruity: all obstruents have the same underlying feature distinction

c. Patterns of assimilation

Iverson & Salmons suggest that fricatives, as well as stops, contrast in aspiration (SG) in English (and Germanic generally, except Dutch). Their argument is that this allows a unified treatment of stop deaspiration after fricatives, and sonorant devoicing after stops and fricatives. They claim that both of these represent a sharing of [SG] by the two segments involved, as in (10). However, fricatives do not contrast phonetically in aspiration in English, though such a contrast exists in Burmese (for example):

(12) Burmese fricatives (Ladefoged and Maddieson 1996, p. 179)

- Voiced: \( \text{zà} \) ‘lace’
- Voiceless unaspirated: \( \text{sà} \) ‘to be hungry’
- Voiceless aspirated: \( \text{s}^{h} \text{à} \) ‘letter’

In Burmese aspirated fricatives contrast with unaspirated. They cannot be analyzed as clusters. Clusters are very restricted in Burmese; /s^{h}t/ is represented by a single symbol in the orthography.


²Iverson & Salmons (1995) give [constricted glottis, voice] for either /b/ (creaky voice) or /b'/; it is not clear which is intended for Beja.
dialect of Armenian. This dialect has a four-way laryngeal contrast in the stops and affricates, like the Hindi stops in (8). Fricatives show only a two-way contrast, that would traditionally be referred to as voiced and voiceless. The future prefix, underlying /k/, added to the present subjunctive, assimilates in voicing and aspiration to a following consonant, as in (13) (Vaux 1998, 498).

(13) \[\begin{array}{ccc}
\text{underlying} & \text{phonetic} & \text{gloss} \\
a. & k\text{-ertº-a-m} & \text{kertºam} & \text{‘I will go’} \\
b. & k\text{-bzz-a-m} & \text{gøbøzzam} & \text{‘I will buzz’} \\
c. & k\text{-l-am} & \text{gølam} & \text{‘I will cry’} \\
d. & k\text{-zt-a-m} & \text{gøzøram} & \text{‘I will bray’} \\
e. & k\text{-øor-n-ie-m} & \text{køøøøriem} & \text{‘I will allow’} \\
f. & k\text{-savor-ie-m} & \text{køøsøvøriem} & \text{‘I will grow accustomed to’} \\
g. & k\text{-bºier-ie-m} & \text{gøbºierriem} & \text{‘I will carry’} \\
\end{array}\]

Vaux attributes this assimilation to the spreading of the laryngeal node, dominating both [spread glottis] and [stiff vocal folds] (in Avery & Idsardi’s terms, GW and GT). This assimilation rule is followed by a rule that inserts schwa after unsyllabified consonants. This pattern of assimilation raises some questions. One is what is the difference between ‘sharing’ a feature as in (10), where the shared [spr gl!] prevents aspiration of the stop after [s], and ‘spreading’ of the laryngeal node in (13), which results in aspiration in two places in (13e). A second question arises with respect to the inserted vowel, which would seem to be necessary for the spread aspiration to be realized, at least when a fricative follows, as in (13f).

The evidence presented by I&S and Vaux for underlying aspiration for English stops and fricatives seems inconclusive. So we suggest that the distinction in English is the feature [voice] (or GT), the same as Spanish, for both stops and fricatives and that aspiration ([spread], GW) is not distinctive in either language. The realization of the two values is different in the two languages by language-particular phonetic implementation (which is also systematic).

2. **Aspiration in English not directly dependent on stress.**

Iverson & Salmons (1995, 378) claim that the degree of aspiration in English correlates with the degree of stress. They cite Kim’s (1970) pioneering work on laryngeal phonetics, in which he claims that

\[(14) \text{‘it seems to be safe to assume that aspiration is nothing but a function of the glottal opening at the time of release’ (Kim 1970, 111).}\]

Iverson & Salmons identify the location of aspiration in English as the beginning of a stress foot. We claim that this insight is basically correct, but with a revised conception of the foot, defined as in (16). Unstressed syllables are
Chomsky adjoined to an adjacent foot, such as the initial syllables of *terrain, potato*, in (15).

(15)  
\begin{align*} 
\text{time} & \quad [t^h]ime \\
\text{terrain} & \quad [t^b]errain \\
\text{typhoon} & \quad [t^h]yphoon \\
\text{potato} & \quad [p^b]otato \\
\end{align*}

Foot (definition): a prosodic unit consisting of one or more syllables, of which one (and only one) is stressed.

(16)  

There are also cases where aspiration appears at the beginning of word-internal unstressed syllables, as in (17).

(17)  
\begin{align*} 
\text{òppor[t^h]unístic} & \quad \text{àbra[k^h]adábra} \\
\text{míli[t^b]arístic} & \quad \text{Mèdi[t^b]erránean} \\
\end{align*}

We follow Withgott (1982) in assuming that, when two unstressed syllables arise between stressed syllables (say, as a result of destressing), they are adjoined one to each side. This accounts for aspiration in (17). Chomsky-adjunction is illustrated in (18) with *potato*.

(18)  
\begin{align*} 
\text{po} & \quad \text{ta} \\
\text{to} & \quad \rightarrow \\
\end{align*}

3. **Aspiration is not distinctive in English**

Lisker and Abramson (1964) propose voice onset time as an acoustic measure that correlates with aspiration. They justify this by pointing out that the noise heard as aspiration occurs during the period of voicelessness between the release of the stop and the start of voicing of the following vowel, as in (19).

(19)  
“Aspiration…is regarded simply as a large delay in voice onset.” (Lisker and Abramson 1964, p. 387).

“…the feature of aspiration is directly related to the timing of voice onset…” (Lisker and Abramson 1967, p. 15).

Kim (1970) proposes that the voicing delay after voiceless stops is due to the narrowing of the glottis before voicing starts, as in (20).

(20)  
“…the length of aspiration or voicing lag appears to be equal to the time it takes for the open glottis to close for the vibration of the following vowel.” (Kim 1970, p. 109)
In a cineradiographic study of Korean stops, Kim measured both voice onset time and glottal opening for each type of stop. Korean stops are distinctive for 3 degrees of aspiration, as in (21). Voice onset times for each phoneme are given in (21). Note that the three degrees of aspiration are widely separated by voice onset time. Note also that all the consonants have a positive voice onset time, including the unaspirated voiceless stops. That is, even for unaspirated stops, voicing does not begin immediately upon the stop release, but there is a period of voicelessness — though small — between the release and the start of voicing.

(21) Voiceless stops in Korean: 3 distinctive degrees of aspiration (Kim 1970, p. 108)

<table>
<thead>
<tr>
<th>Unaspirated</th>
<th>Slightly aspirated</th>
<th>Heavily aspirated</th>
</tr>
</thead>
<tbody>
<tr>
<td>/p'ali/ ‘washer’</td>
<td>/t'al/ ‘daughter’</td>
<td>/k’ali/ ‘villain’</td>
</tr>
<tr>
<td>/pal/ ‘leg’</td>
<td>/tal/ ‘moon’</td>
<td>/kali/ ‘stack’</td>
</tr>
<tr>
<td>/pʰal/ ‘arm’</td>
<td>/tʰal/ ‘mistake’</td>
<td>/kʰal/ ‘knife’</td>
</tr>
</tbody>
</table>

Voice onset time

<table>
<thead>
<tr>
<th>Unaspirated</th>
<th>Slightly aspirated</th>
<th>Heavily aspirated</th>
</tr>
</thead>
<tbody>
<tr>
<td>/p’/, /t’/, /k’/</td>
<td>/p/, /t/, /k/</td>
<td>/pʰ/, /tʰ/, /kʰ/</td>
</tr>
<tr>
<td>10 msec</td>
<td>35 msec</td>
<td>90 msec</td>
</tr>
</tbody>
</table>

Voiceless unaspirated stops of Puerto Rican Spanish—a Romance language—also have a small voice delay of 0–55 msec (average 14 msec) (Lisker and Abramson 1964, 392).

Kim’s measurements of glottal opening of stops in Korean (22) show a direct correlation with voice onset time as measured in (21). Notice that the glottis is never completely closed, even for unaspirated stops.

(22) Voiceless stops in Korean: approximate degree of glottal opening (in millimetres) (Kim 1970, p.110)

<table>
<thead>
<tr>
<th>Unaspirated</th>
<th>Slightly aspirated</th>
<th>Heavily aspirated</th>
</tr>
</thead>
<tbody>
<tr>
<td>/p’/ 1 mm</td>
<td>/p/ 3.5 mm</td>
<td>/pʰ/ 10 mm</td>
</tr>
<tr>
<td>/t’/ 2 mm</td>
<td>/t/ 3.5 mm</td>
<td>/tʰ/ 9.5 mm</td>
</tr>
<tr>
<td>/k’/ 1 mm</td>
<td>/k/ 3 mm</td>
<td>/kʰ/ 10 mm</td>
</tr>
</tbody>
</table>

Lisker et al. (1969) did a transillumination study of the larynx in connected speech in English, which measured the light being transmitted through the glottis as it opened. The amount of light transmitted correlates directly with the degree of opening of the glottis. In the example sentence in (23), the three stops at the beginning of stressed syllables—/p/ in put, /t/ in tape, and /t/ in tube—show successively larger glottal openings, corresponding to the increase in stress. Main sentence stress is on tube, which has the largest glottal opening. The unstressed /p/ in tape preceding the unstressed vowel of around has a very small glottal opening. We suggest that the /p/ in tape is unaspirated or only slightly aspirated.
Don’t ‘put a dirty ‘tape around the ‘tube. (Lisker et al. 1969, 1545)

Lisker and Abramson (1964, 1967) measured average voice onset time for stressed initial stops in isolated words in English (24). The voiced stops divide into two discontinuous groups, some with negative voice onset time, and some with positive voice onset time. The ranges of the voiced and voiceless stops in each homorganic pair do not overlap. Lisker and Abramson conclude that (the measure of) voice onset time serves to distinguish each homorganic pair — /b/ from /p/, /d/ from /t/, and /g/ from /k/.

Lisker and Abramson (1964, 1967) measured voice onset time for stops in sentence contexts in English (25). They included stressed and unstressed voiced and voiceless stops in initial and non-initial position. They broke down the measurements into values for stressed and unstressed stops. They found first, that unstressed /p, t, k/ tend to have shorter delays in voice onset than do stressed /p, t, k/. Second, those voiced stops with positive voice onset time tend to have longer delays in voice onset in unstressed than in stressed position. Consequently, the voiceless and voiced stops are less clearly separated when unstressed than when stressed. The ranges show overlap in both stressed and unstressed position for voiceless stops and those voiced stops with positive values, indicating that the voicing lag does not clearly separate voiced from voiceless stops. They note, however, that they did not include in the chart the many (“nearly all”, p. 18) instances of non-initial /b, d, g/ that are voiced throughout. We might conclude that in sentences, voiced and voiceless stops are generally distinguished by voicing rather than by voicing lag or “aspiration.”

Stressed initial stops in isolated words in English
Mean voice onset time in msec. (Lisker and Abramson (1967), p. 6)

<table>
<thead>
<tr>
<th></th>
<th>/b/</th>
<th>/p/</th>
<th>/d/</th>
<th>/t/</th>
<th>/g/</th>
<th>/k/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>101</td>
<td>58</td>
<td>102</td>
<td>70</td>
<td>88</td>
<td>21</td>
</tr>
<tr>
<td>Number</td>
<td>17</td>
<td>51</td>
<td>102</td>
<td>13</td>
<td>16</td>
<td>13</td>
</tr>
</tbody>
</table>

Range: -130:~20 / 0:5  20:120  -155:~40 / 0:25  30:105

Stressed and unstressed stops in sentences (English)
Mean voice onset time in msec. (Lisker and Abramson (1967), pp. 12-14)
(Initial versus non-initial position did not make a significant difference.)
We conclude that aspiration in English is categorial (phonological) in foot-initial position. In phonetic implementation there may be some aspiration in other positions. This is gradient and phonetic, not phonological. Voiceless and voiced stops may be distinguished by aspiration in foot-initial position in isolated words, but in running sentences, they are generally distinguished by other cues, such as the unbroken voicing of voiced stops between vowels.

In Icelandic, by contrast, stops are distinctive for aspiration, and are always voiceless (26).

(26) a. panna [pʰanːa] ‘pan’
    banna [panːa] ‘forbid’

    b. tala [tʰaːla] ‘speak’
    dala [taːla] ‘valley (gen pl)’

    c. kaldur [kʰałtvːr] ‘cold’
    galdur [káltvːr] ‘magic’

Unaspirated stops are always voiceless, even between vowels (27).
(27)  a. Icelandic *aldur* [æltyr] ‘age’; compare English *alder* [ældər]
    b. Icelandic *Líbanon* [liːpanɔn]; compare English *Lebanon* [liːbənən] (Berkov 1962)
    c. Icelandic *túba* [tʰuːpa]; compare English *tuba* (Rögnvaldsson 1989, p. 29)
    d. Icelandic *sigaretta* [sikarehta]; compare English *cigarette* (Rögnvaldsson 1989, p. 29)

In the southern dialect, aspirated stops neutralize with unaspirated stops in non-word-initial position (28). Both are voiceless unaspirated in this context.

(28)  a. Southern (Reykjavík)  b. Northern (harðmæli)
      api [tʰapr]      api [tʰapʰi]  ‘ape’
      hata [hɑ:tə]    hata [hɑ:tʰə]  ‘to hate’
      loka [ɬɑ:kə]    loka [ɬɑ:kʰə]  ‘to close’
      sápa [sɑuːpa]   sápa [sɑuːpʰa]  ‘soap’
      taka [tʰaːkə]   taka [tʰaːkʰə]  ‘take’

4. **Sonorant Devoicing**

Kim observed (1970, 114) that, in a syllable-initial cluster of /s/ plus a voiceless stop, the glottis is open to the same degree as for a syllable-initial stop alone, but that, by the time /p/ is released the glottis has narrowed so that the voicing for the following vowel begins immediately after /sp/ instead of after a lag as after /p/. This provides a phonetic explanation for the lack of aspiration in /s/ plus stop clusters. Our phonological interpretation is that voiceless stops after /s/ in such cases are not foot initial, so they fail to aspirate for the same reason as voiceless stops in other foot-internal positions, as in (29).

(29)  sting [stɪŋ]  satyr [saːtβɪr]
      abstain [æbstɹain]  hospital [ˈhɒspɪtl]
      after [æftər]  night owl [nɪghtɔlv]

Iverson & Salmons interpret this autosegmentally as a single gesture [spread glottis] as in (10) above.

I&S claim that sonorant devoicing also falls under this generalization. Sonorants are devoiced after voiceless stops in (30) (I&S 1995, 373; their transcriptions).

(30)  plan [plɑːn]  crow [kɔː]
Lehiste (1964, 77) provides a spectrogram of hatred which shows voiceless r following t. But there is no devoicing of sonorants that follow a voiceless stop in another syllable, as in (32).


This is because tl is not an acceptable onset in English, so /t/ and /l/ are necessarily in different syllables in Atlas. In niceness and nicely, the s and the sonorant are in separate syllables, assuming that resyllabification does not apply to Level II derived words.

After fricatives, devoicing is not so apparent. Iverson & Salmons (1995, 373) also transcribe devoiced sonorants following fricatives in (33).

(33) slip [slIp] shrimp [ʃImp]
sneeze [snIz] fleet [flIt]

Preliminary phonetic investigation of these and similar words suggests that sonorants are not devoiced reliably after voiceless fricatives (at least not to the extent that they are devoiced after voiceless stops.) We found for one speaker (M) that nasals are devoiced after /s/, but not for the other speaker (J).

A number of published spectrograms show voiced sonorants following /θ/, /ʃ/, and /s/ in fricative-sonorant onset clusters, for example, three (Ladefoged 1982, 187), fly, free (Potter et al. 1966 p. 265, p. 257), and smoke, snow, small, sleep (Potter et al. 1966, p. 196, p. 196, p. 239, p. 257).

Iverson & Salmons (1995) consider the deaspiration of stops by a preceding s, as in (10a), as indicating that fricatives are phonologically [+spread]. But Kim (1970) describes this deaspiration as an instance of coarticulation, analogous to the lip rounding found on onset consonants preceding a round vowel in Russian (34).

(34) Cf. Kim 1970, fn. 10, p. 113: “in syllables of the type stu, ntu, dnu, etc. of Russian, the lip protrusion began practically simultaneously with the beginning of the first consonant. What makes the string realized in a serial order is...not a separate and direct instruction for each segment from the speech center...but a sort of reflex mechanism connecting several movements...”

Kim notes that the glottal widening during /s/ in anticipation of /p/ is possible since /s/, being voiceless, does not need the glottis to be closed. That is, the articulation of /s/ is “compatible” with a widening of the glottis. The deaspiration in (10a) would not be possible if /s/ were incompatible with glottal widening. However, the fact that /s/ facilitates coarticulation in this way does
not justify assigning it a phonological feature [+spread]. In view of the evidence that fricatives may not devoice following sonorants, we conclude that fricatives in English are not phonologically [+spread] (or GW). If devoicing of sonorants after fricatives is phonetic implementation rather than a phonological rule, then it is interesting that it appears to be sensitive to syllable boundaries, as in (32). On the other hand, we propose that sonorant devoicing after stops is phonological and is triggered by a feature denoting voicelessness.

References


Bérvov, V.P. (1962) Íslenzk-Rússnesk Orðabók, Moscow.


