

# ***Prosody and melody in vowel disorder\****

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## **Abstract**

The paper explores the syllabic and segmental facets of phonological vowel disorder. The independence of the two dimensions is illustrated by the case study of an English-speaking child presenting with a vowel impairment which can be shown to have a specifically syllabic basis. His rendition of adult long vowels displays three main patterns of deviance — shortening, bisyllabification and the hardening of a target off-glide to a stop. Viewed phonemically, these patterns appear as unconnected substitutions and distortions. Viewed syllabically, however, they can be traced to a single underlying deficit, namely a failure to secure the complex nuclear structure necessary for the coding of vowel length contrasts.

## **1 Introduction**

One problem with attempting to specify the nature of disorders affecting the phonology of vowels lies in the notion VOWEL itself. VOWEL is a lay term which is ambiguous in so far as it can refer either to a sound's syllabic position or to its phonetic quality. In the first sense, it describes a sound which occupies the nuclear portion of a syllable. In the second, it describes the quality of a sound produced with open approximation of the articulators. The notion has no unique embodiment in modern non-linear constructions of phonological representation, in which the syllabic and qualitative dimensions are kept formally distinct. Syllabic constituents are integrated into the prosodic hierarchy, where they dominate skeletal positions and are themselves gathered into feet and phonological

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words. Phonetic quality for its part expresses the melodic content of segments, composed of featural categories which are autosegmentally deployed on separate tiers. From a non-linear perspective, a 'vowel' disorder could in principle selectively target either prosody or melody.

Here we discuss the case study of an English-speaking child who was initially diagnosed as presenting with a vowel impairment. The disorder, we will argue, has a specifically syllabic basis. His production of adult long vowels displays three main patterns of deviance — shortening (as in *wid weed*), bisyllabification (as in *tɔyə tyre* ( $y = \text{IPA } j$ )) and, most strikingly, hardening. Under the last of these, the second portion of a target long vowel/diphthong is hardened to a labial or palatal stop, as in *kab cow*, *yɪb you*, *sɪʃ see*.

Described in traditional phonemic terms, shortening, bisyllabification and hardening might give the impression of being an arbitrary collection of unconnected substitutions and distortions. Viewed in relation to syllable structure, however, they can be shown to stem from the same underlying deficit, namely a failure to secure the complex nuclear structure necessary for the coding of vowel length contrasts. The deficit might have been expected to produce across-the-board vowel shortening, including monophthongisation of the sort reported in certain other studies of developing phonology (e.g. Bleile 1989, Davis & MacNeilage 1990) and disordered phonology (e.g. Gibbon, Shockey & Reid 1992, Pollock & Keiser 1990, Reynolds 1990). However, the generalisation of this effect throughout the child's phonology is apparently forestalled by various pressures to retain the overall quantity of target forms. Glide hardening, we will argue, represents a response to the conflict between quantitative imperatives and the nuclear deficit.

Before introducing the case study in §3, we set the scene in §2 by considering what we see as the main issues in the specification of vowel disorder. In §4, we provide arguments supporting the assumption that the deficit presented in the case study is authentically phonological in nature. §5 summarises the main conclusions.

## 2 Phonological universals and vowel disorder

### 2.1 Phonological 'deviance'

Research has largely vindicated Jakobson's (1971) claim that explicit parallels can be drawn between the universal preferences exhibited by primary phonological systems and the sorts of phenomena that occur in language impairment and the early stages of

language acquisition. The congruities are particularly clear in the realm of syllable structure. Broadly speaking, syllabic configurations that are cross-linguistically disfavoured tend to be suppressed in secondary systems — emergent or disordered approximations of primary grammars. The best known examples involve the syllabification of consonants: the relatively low incidence of consonant clusters and word-final consonants in the world's languages is matched by a high incidence of consonant deletion and consonant-supporting vowel epenthesis in language acquisition and impairment. These patterns confirm the unmarked status of, among other things, simplex onsets, open syllables and vowel-final words.

Although the facts of consonant syllabification relate to the constituency of onsets and codas, they suggest a general preference for non-branching structure which might be predicted to extend to the syllabification of vowels within nuclei. Only a minority of languages possess a lexical contrast between short and long vowels, expressed syllabically as a distinction between non-branching and branching nuclei (as in English **bid** versus **bead**). If the Jakobsonian insight is of general validity, we should expect vowel length contrasts to come under pressure to restructure in language acquisition and disorder. This matter has been largely ignored in the relevant literature, but the expectation appears to be borne out by the available evidence, some of which we discuss here.

To the limited extent that the use of the ambiguous notion VOWEL allows us to formulate explicit hypotheses about the nature of phonological impairment, it makes no particular predictions about whether disorders so designated will target either the qualitative or the syllabic dimensions of segments. If anything, it encourages us to expect a uniform impairment type that affects both dimensions simultaneously. Although non-linear theory does not rule out such composite disorders in principle, the formally established independence of melody and prosody explicitly predicts the occurrence of impairments which target one dimension to the exclusion of the other. This seems to tally with the empirical record. Broadly speaking, patterns traditionally referred to as additions and omissions can be shown to have a primarily prosodic basis, while those described as substitutions and distortions are primarily melodic in nature. Some reported cases of 'vowel' impairment evidently fall into the melodic category; that is, they specifically target vowel quality (examples of which we discuss presently). The case study to be discussed below, we will argue, exhibits the other error type predicted to affect vowels, one in which the prosodic subsystem is the primary site of disturbance (admittedly with melodic side-effects).

According to an essentially Jakobsonian line of thinking, the totality of unmarked phonological alternatives defines the initial state in language acquisition. Normal linguistic development proceeds via the switching of options in cases where the target system shows the marked alternative. Any holdup in this resetting process will result in a secondary system that is parochially deviant — one which belongs to the set of universally possible primary systems but is inappropriate in relation to the ambient model. It is a moot point whether impaired development can ever produce a grammar that is universally deviant in the sense that it generates phonological structures which are unattested in the world's primary languages.

In the case study to be presented in §3 and §4 below, the child's system shows itself to be parochially deviant with respect to the organisation of nuclear structure. The disorder consists in a failure to consolidate the branching constituent setting necessary for the full acquisition of English vowel length contrasts. The perseverance of unmarked non-branching structure results in a nuclear subsystem that is well-formed in many languages but is inappropriate for languages such as English.

## 2.2 Melody

The model of melodic representation which we employ in our case-study analysis incorporates the following design properties: (i) all phonological distinctions are privatively expressed in terms of monovalent elements; (ii) a single set of elements codes resonance contrasts in nuclear positions ('vowels') and non-nuclear positions ('consonants'); and (iii) each element is phonetically interpretable in isolation from other elements. We assume the traditional tricorn set of resonance elements, symbolised here as [A], [I] and [U] (cf. Anderson & Jones (1974), Schane (1984), van der Hulst (1989), Kaye, Lowenstamm & Vergnaud (1985), and the references in Harris (1994: ch 3)). Individually, these define the corner vocalic values in (1)a; the two-element combinations in (1)b define mid vowels.

(1)	(a)	[A]	<i>a</i>	(b)	[A,I]	<i>e</i>
		[I]	<i>i</i>		[A,U]	<i>o</i>
		[U]	<i>u</i>			

One manner category will figure in the analysis below, the stop element [ʔ]. This inheres in non-continuant sounds, manifesting itself as an abrupt and sustained drop in

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overall amplitude. When [ʔ] appears in isolation, this effect is achieved by a glottal stop. Otherwise, as illustrated in (2), the location of the stop gesture is determined by whatever resonance element [ʔ] is combined with.

- |     |              |       |
|-----|--------------|-------|
| (2) | Labial stop  | [U,ʔ] |
|     | Palatal stop | [I,ʔ] |

The categorisation of vowel space in terms of [A], [I] and [U] enjoys certain significant empirical advantages over one based on the orthodox features [ $\pm$ high], [ $\pm$ low], [ $\pm$ back] and [ $\pm$ round]. The element-based approach more directly reflects the fundamentally triangular organisation of vowel space that is evidenced in phonological universals, speech production and language acquisition. For example, the cardinal values represented by *a*, *i* and *u* are by far the most common categories encountered in the vowel systems of the world; indeed in many languages they are the only vowels (Maddieson 1984). This universal preference is evidently related to the finding that the corners of vowel space defined by these three cardinal points constitute 'quantal' areas in speech production — regions which exploit the most robust match between distinctive acoustic structure and possible articulatory gestures (Stevens 1989). The primacy of these points is also demonstrated in the early post-babbling stages of vowel acquisition (e.g. Bond *et al.* 1982).

Within an orthodox feature framework, the tricorn organisation of vowel space is no more than a contingent fact. The intersection of one height feature, [ $\pm$ high] say, with [ $\pm$ back] counterfactually predicts a basic rectangular pattern (expanded to further dimensions by the addition of [ $\pm$ low] and [ $\pm$ round]). Unmarked triangularity can only be derived by the ad hoc expedient of introducing supplementary redundancy rules or constraints, such as one which disables the [ $\pm$ back] contrast in low vowels.

In an element-based model, on the other hand, the triangular patterning of vowel space follows as a necessary consequence of there being three basic elements. Moreover, the unmarked status of *a*, *i* and *u* is directly reflected in the fact that, since they consist of only one element each, they are representationally simpler than more marked non-corner vowels, which contain at least two elements each. Any process that pushes contrasts towards the periphery of vowel space is thus straightforwardly expressible as element simplification. This 'centrifugal' effect is widely attested in the raising and lowering of mid vowels that occur in primary grammars. In many languages — Portuguese, Catalan and Bulgarian, for example — the maximal system of vowel contrasts is restricted to

positions bearing main word stress; elsewhere we find contracted sets of peripheral values.

The primacy of corner vowels and the marked status of mid vowels are further supported by the fact that similar centrifugal effects are observable in the early stages of vowel acquisition. Levelt's (1994) study of normal Dutch-acquiring children amply illustrates the prevalence of processes which, in element terms, constitute melodic simplifications. Mid vowels are subject to lowering ((3)a), raising ((3)b) and diphthongisation ((3)c).

- |     |     |                 |              |             |            |
|-----|-----|-----------------|--------------|-------------|------------|
| (3) | (a) | [A,I] > [A]     |              | [A,U] > [A] |            |
|     |     | Adult           | Child        | Adult       | Child      |
|     |     | <i>χεk</i>      | <i>hak</i>   | <i>bom</i>  | <i>bam</i> |
|     |     |                 | 'silly'      |             | 'tree'     |
|     | (b) | [A,I] > [I]     |              | [A,U] > [U] |            |
|     |     | Adult           | Child        | Adult       | Child      |
|     |     | <i>zεs</i>      | <i>zis</i>   | <i>pɔp</i>  | <i>pup</i> |
|     |     |                 | 'six'        |             | 'doll'     |
|     | (c) | [A,U] > [A] [U] |              |             |            |
|     |     | Adult           | Child        |             |            |
|     |     | <i>kokə</i>     | <i>kawkə</i> |             | 'cook'     |

Representationally, each of these processes produces melodic simplification: a two-element compound, defining an adult mid vowel, is dissolved in one way or another. In the case of lowering ((3)a) and raising ((3)b), the result is a straightforward reduction to one element. Viewed in articulatory terms, diphthongisation of *o* to *aw* ((3)c) presents itself as an increase in complexity: a single basic gesture gives way to a movement between two gestures. However, unlike the mid-vowel articulation, the manoeuvres involved in the production of the diphthong execute universally favoured corner qualities, in this case *a* and *i*. This change to unmarked structure is captured elementally as a decrease in melodic complexity: a two-element compound is unpacked into a linear sequence of single elements.<sup>1</sup>

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<sup>1</sup>A good case can be made for saying that the reduction in representational complexity accompanying the diphthongisation of mid vowels to *aw* and *ay* goes hand in hand with a decrease in acoustic complexity. The acoustic signatures of mid vowels can be viewed as amalgamations of simpler spectral patterns associated with the corner vowels (Harris & Lindsey 1995).

Processes which shift vowels in the opposite direction to mid-vowel raising and lowering can only be expressed as an increase in melodic complexity. High-vowel lowering, for example, involves the addition of [A]. In primary grammars, this type of shift almost always occurs under the harmonic influence of a neighbouring non-high vowel. Context-free lowering of high vowels is extremely rare and runs counter to the general patterns reported for early vowel acquisition.

Element theory thus provides a direct formal correlation between relative markedness and degree of melodic complexity in vowels: the outputs of processes which move a system towards an unmarked state are simpler than those with more marked directionality. No such correlation is possible in orthodox feature theory, in which any vowel shift, regardless of directionality, has to be expressed as the substitution of one set of feature values by another. For example, an unmarked rule of mid-vowel raising is formally no simpler than a marked rule of high-vowel lowering.

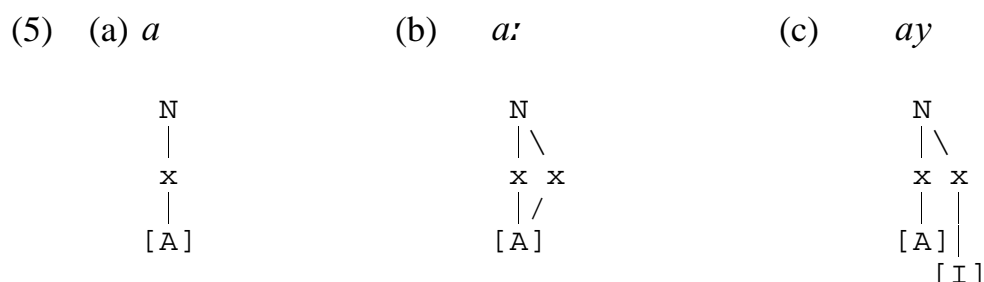
The unmarked status of simplification processes in normal acquisition suggests that the occurrence of similar effects in developmental vowel impairment should be considered indicative of delay. This would be the case in the examples of mid-vowel lowering and diphthongisation in (4), reported in the disordered output of RC, one of the children included in the Central Scottish Vowel Project (Watson, Bates, Sinclair & Hewlett 1994).

- |     |     |                     |     |                   |
|-----|-----|---------------------|-----|-------------------|
| (4) | (a) | [A,I] > [A]         | (b) | [A,I] > [A] [I]   |
|     |     | <i>tade</i> teddy   |     | <i>nayst</i> nest |
|     |     | <i>sal</i> shell    |     | <i>ayg</i> egg    |
|     |     | <i>padlz</i> pedals |     | <i>ðaym</i> them  |

Further exemplification of the favoured status of corner vowel qualities in developmental disorder is provided by Reynolds (1990) and Stoel-Gammon & Herrington (1990). In contrast, processes which increase melodic complexity by introducing elementary material that has no correspondent in the relevant adult target forms are more likely to be deviant in relation to age norms. Lowering of high vowels, involving the addition of [A], would fall into this category. Reynolds (1990) provides examples (such as *ɛp leaf*, *tsɔː shoe*) which he himself describes as idiosyncratic.

## 2.3 Prosody

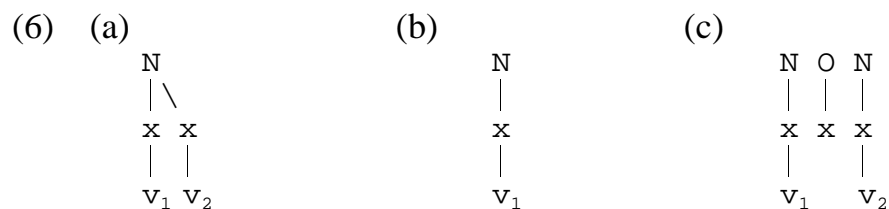
Quantity contrasts in vowels, it is now generally agreed, are represented in the same constituent-based terms as the syllabification of consonants in onsets and rhymes. A short vowel takes up one nuclear position, while a long monophthong or diphthong takes up two such positions. In other words, short in this context implies non-branching nuclear structure, as in (5)a, while long implies branching structure, as in (5)b and (5)c.



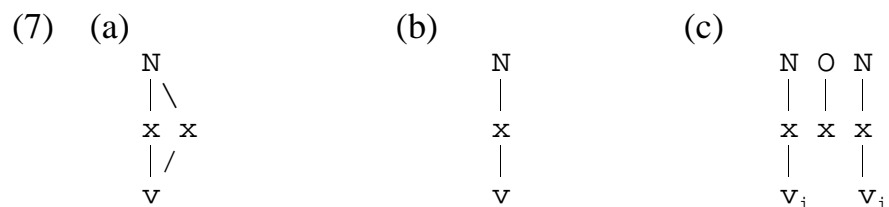
In terms of their constituent status, short vowels are the nuclear counterpart of simplex onset consonants, while long vowels are equivalent to onset clusters. Moreover, complex nuclei may be considered left-headed in the same way as other syllabic constituents. For example, as in branching onsets, the first position is distributionally better endowed than the second. In English, virtually any vocalic quality can appear in the first nuclear slot (although the details vary from dialect to dialect). Where the second slot is qualitatively distinct from the first, as in a diphthong, it can only support an off-glide.

The universal preference for non-branching structure in onsets and rhymes extends to nuclei, indicating that length contrasts in vowels are marked. This raises the question, barely touched on in the relevant literature, of whether a preference for non-branching nuclei is also manifested in phonological acquisition and impairment. If such a parallel does indeed exist, we should expect it to consist in a disruption of vowel length contrasts. In the case of onset clusters (consisting of an obstruent followed by a resonant), two main simplification patterns manifest themselves in emergent or disordered phonology - loss of the second consonant (e.g. *pley* > *pey* **play**) and epenthesis of an intervening vowel (e.g. *pəley*). Corresponding developments in diphthongs would produce the restructurings in (6)b and (6)c.

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Straightforward truncation of the right-hand position of the adult branching nucleus in (6)a would result in a short monophthong, as in (6)b — the counterpart of cluster reduction in onsets. Given the left-headedness of branching constituents, it is the first portion of a target diphthong that would be expected to survive shortening. The equivalent of consonant-supporting vowel epenthesis would be the split-nucleus alternative in (6)c. Here the second slot of a target branching nucleus is salvaged through assignment to the nucleus of an independent syllable. In this case, an adult long diphthong would in effect be rendered as a sequence of two short vowels. Corresponding developments affecting target long monophthongs would be expected to produce the outcomes in (7)b (short monophthong) and (7)c (two identical vowels in hiatus).



Both sets of alternatives in (6)b/(7)b and (6)c/(7)c are attested in the literature on normal acquisition (even though particular examples are not always described in syllabic terms). In a detailed study of the early emergence of prosodic structure in Dutch, Fikkert (1994) reports the widespread appearance of shortened reflexes of adult long vowels (pattern (6)b/(7)b) during a period before the stabilisation of length contrasts. A version of the split-nucleus pattern in (6)c/(7)c is in fact well established in some dialects of English, where it represents the 'broken' development of original long vowels, particularly before historical *r* and *l* (as in *fi:yə(r)* **fear**, *fi:yəl* **feel**). Significantly, it is also reported in early child approximations of dialects which do not display the broken variants (e.g. Smith 1973: 130).

There is some indication that the alternative treatments of target long vowels in (6)b and (6)c also occur in developmental disorder. Published evidence potentially relating

to shortening is not always easy to interpret, since the relevant vowel disorders are often described in terms of phonemic substitutions, and not all phonemic transcription systems record vowel length. Cases of diphthong reduction (e.g. Gibbon *et al.* 1992, Pollock & Keiser 1990, Reynolds 1990) present *prima facie* evidence of shortening, but before drawing any such conclusion it would be necessary to exclude the possibility of compensatory lengthening in the output monophthong. The generalised laxing of English tense vowels, reported in some studies of developmental disorder (see Stoel-Gammon & Herrington 1990 for references), almost certainly also implies concomitant shortening. We discuss some unambiguous examples of shortening below.

As to the bisyllabification pattern in (6)c, Reynolds reports a particularly clear case, with forms such as *pɪyəd* **peas**, *ʃɛwə* **shoe**, *bayəd* **boys**, *layət* **light** and *awət* **out** (1990: 131). Examples such as these conform to the normal broken development just mentioned in that they contain a medial glide. This, it is reasonable to assume, represents the onset that splits independent nuclei. The quality of the onset either extends that of the preceding nucleus (e.g. palatal in *ɪyə*) or retains some portion of that present in the adult target (as in the labial of *ʃɛwə* **shoe**). (The use of a transcription such as *ɪy* in such cases is thus a segmentalised way of alphabeticising the simultaneous association of a single melodic unit ([I] in this instance) to a nucleus and a following onset.)

The intrusion of a *y* or *w* glide in the split-nucleus development reflects the suitability of palatal and labial vocoids as onset occupants. It is instructive to consider what happens when neither quality is available in the first position of an input nucleus — that is, when this portion contains an open vowel (as in *aɪ*, *aw* or *ay*, for example). Bisyllabification might be expected to be blocked under these conditions, and this is indeed what we find in the study of disorder to be presented below. (It is also what occurs in those varieties of adult English which otherwise show the broken pattern described above.) However, we have encountered the case of a phonologically impaired child in which the split-nucleus strategy does appear to have been adopted in precisely this context.

DB, aged 4;1 at the time he was recorded as part of the Queen Margaret College Cluster Acquisition Database project (Hardcastle, Fletcher, Gibbon & Scobbie 1997), displays thorough-going monophthongisation of Scottish English *ay*, which has long and short reflexes in the adult system. His production of the long reflex is characterised by a suite of variably present phonetic effects which are typically activated roughly midway through the vowel; these include an abrupt change in phonation, especially to creaky voice, an abrupt change in pitch, and an interval of significantly reduced overall amplitude (for a detailed instrumental analysis, see Scobbie & Harris, in prep.). Most frequently, the extent of amplitude reduction is such as to indicate the presence of an

intervening glottal stop (i.e. *aʔa*). A good case can be made for treating the medial period of laryngeal activity as the consonantal reflex of an onset separating two short vowels — in other words, an example of the split-nucleus pattern in (6)c.

Unlike simple truncation in (6)b, bisyllabification in (6)c preserves the overall bi-positional quantity of an input branching nucleus, albeit redistributed over two nuclei. There is in principle another means of retaining weight in the absence of branching nuclear structure — vowel shortening accompanied by conversion of the second position to a non-nuclear position (i.e.  $VV > VC$ ). Provided the non-nuclear position in question bears weight (as in a closed VC rhyme, for example), it will compensate for the loss of the nuclear slot. Several reported cases of vowel disorder appear to fit this pattern. SD, one of the children studied by the Central Scottish Vowel Project (Watson *et al.* 1994), shows a tendency to render target diphthongs as a short vowel followed by a nasal stop, e.g. *tanʒ ties*, *amz eyes*, *hans house*, *klans clouds*, *ban boy*. Here and below, a similar pattern is recorded by Gibbon *et al.* (1992). A more dramatic version of this strategy, we will argue, is observable in the case study to which we now turn.

### 3 Nuclear disorder: a case study

#### 3.1 PS

PS was referred by his speech-language clinician to the Central Scottish Vowel Project at 4;11 years, on the grounds of unusual vowel production. He had a history of recurrent otitis media; audiometric testing at 4;10 years revealed a conductive hearing loss (30-40 dB) in the left ear. At 5 years his receptive language ability was judged to be at a stage of 7+ years and his expressive language skills at 6+ years. Although PS lived in the north of Ireland (Belfast) until he was three and has subsequently been resident in Scotland (Edinburgh), his main target system appears to be essentially of the standard type historically associated with the south of England (henceforth simply the 'southern' system). This is the dialect of the family home (although his father is from the north of England (Nottingham) and his mother from Belfast) and is also used by his sister (four years his elder) and his neighbouring maternal grandparents.

The data to be discussed here were collected during eight sessions when PS was aged between 4;11 and 6;7 years and have previously been reported in Bates & Watson (1995) and Bates, Hewlett, Kaighin, Sinclair, Sweet & Watson (1993). The bulk of examples

are drawn from two corpora: one comprises 493 vowel tokens elicited during three presentations of a single-word picture naming task at 4;11, 5;5 and 6;2 years; the other (exploiting PS's precocious reading ability) consists of 317 read tokens gathered at 5;7 and 6;7 years. The productions were transcribed phonetically both at the time of data collection and afterwards from audio-recordings (Sony TCD D3 DAT with ECM S220 microphone).

### 3.2 Shortening and glide hardening

We start by considering PS's subsystem of short stressed vowels. Here he shows a five-way contrast in place of the standard six-term inventory. As illustrated in the forms in (8), the distinction between short *ɪ* and *ʊ* is collapsed under *ɪ* in PS's output.

(8)	lick	<i>lɪk</i>	book	<i>bɪk</i>
	red	<i>wɛd</i>	mug	<i>mʌg</i>
	jam	<i>dæm</i>	socks	<i>sɒks</i>

It would probably be wide of the mark to view the merger as a straightforward substitution of *ʊ* by *ɪ*. All of the adult systems to which PS has had prolonged exposure have relatively fronted variants of high round vowels, both short and long. Representationally, this quality comprises not only [U] (contributing labiality) but also [ɪ] (palatality). PS's *ʊ/ɪ* merger thus consists in a failure to sustain [U] in this combination; the *ɪ* in a word such as **book** manifests the residual target [ɪ].

The most noteworthy characteristics of PS's vocalic phonology occur in his version of the adult long subsystem, comprising both diphthongs and long monophthongs. Although adult-like long vowels occasionally appear in his data (more so in the later recording sessions), his output diverges in a number of systematic ways from the presumed target. Three main developments are in evidence here. One is shortening, exemplified by the following forms:

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(9)	(a)	weed	<i>wɪd</i>	beak	<i>bɪk</i>
	(b)	height	<i>hɔd</i>	tube	<i>tɪb</i>
		spade	<i>spɪd</i>	groan	<i>ɡwɪn</i>
	(c)	class	<i>kwæs</i>	grass	<i>ɡwæs</i>
		branch	<i>bwæns</i>	banana	<i>bənænə</i>

As the forms in (9)b illustrate, shortening goes hand in hand with monophthongisation. The words with short low front *æ* in (9)c are included here on the grounds that they have long broad *a:* in the southern system.<sup>2</sup> A second pattern is bisyllabification, as in *tɔyə* **tire** and *fkawə* **flour**.

The third main development in the long subsystem, and perhaps the most striking feature of PS's phonology, is a process of hardening. In its most general form, this results in an adult up-gliding vowel being rendered as a short vowel followed by an oral stop. The hardened offset retains the basic place property of the target, producing labial *b* for *w* and palatal *j* for *y*, as in forms such as *kab* **cow** and *sɪj* **see**.

Hardening of the labial up-gliding series is illustrated by the following forms :

(10)	<i>uw = ɪb</i>	<i>əw = əb</i>	<i>aw = ab</i>
	to <i>tɪb</i>	know <i>nəb</i>	cow <i>kab</i>
	you <i>yɪb</i>	so <i>səb</i>	now <i>nab</i>
	do <i>dɪb</i>	toe <i>təb</i>	

Note the absence of rounding in the vocalic portion of *uw = ɪb*, an effect that is consistent with the merger of *ʊ* and *ɪ* in the short subsystem (cf. (8)). (Lack of rounding

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<sup>2</sup>Of the other dialects to which PS has been exposed, northern Irish English also shows a long vowel in at least some of the words in (9)c (albeit one that is phonologically conditioned rather than distinctive as in the southern system). A corresponding short vowel can occur in some of the relevant varieties of Scottish English. The father's geographical background in the north of England (where shortness is the basic pattern) is an unlikely source of the short vowel in (9)c, since his dialect is basically southern in type. We cannot rule out the possibility that PS's short vowel here reflects a system-internal development. Whatever its source, the favouring of shortness over southern length is consistent with what we will try to show is the overall design of PS's vowel system.

in the corresponding portion of the vowel in **know**, **so**, etc. is unremarkable, given the  $\text{əw}$  value of this diphthong in the southern system.)

The effects of hardening on the palatal up-gliding series are exemplified in (11).

- |                    |                               |
|--------------------|-------------------------------|
| (11) (a) $iy = iʃ$ | $ey = eʃ$                     |
| we $wi\ddot{i}$    | they $\delta\epsilon\ddot{i}$ |
| see $sIʃ$          | bay $b\epsilonʃ$              |
| he $hiʃ$           | day $d\epsilonʃ$              |
|                    |                               |
| (b) $ay = aʃ$      | $\text{ɔ}y = \text{ɔ}ʃ$       |
| eye $aʃ$           | boy $b\text{ɔ}ʃ$              |
| sky $skaʃ$         |                               |

Where the short vowel before the hardened reflex is front, as in the examples in (11)a, the whole VC sequence is fully palatal. The basic palatal identity of the stop is confirmed by the fact that it is retained even after a back vowel ((11)b). This gives rise to a transitional palatal glide between the vocalic and consonantal phases; narrowly transcribed, a form such as **eye** is thus  $a^yʃ$ .

For reasons to be expanded on presently, we consider it significant that shortening in PS's output only occurs preconsonantly, as suggested by the forms in (9). Glide hardening is also possible in this context, e.g. *miʃt* **meat**, *siʃt* **shoot** (more extensive exemplification below). Also taking into account the occasional appearance of adult-like long tokens, we are thus faced with the fact that PS's output diverges from the adult target in a variable fashion. This observation will hardly come as a surprise to anyone familiar with the nature of speech data reflecting disorder. An important general point that should be borne in mind in this connection is that variability does not necessarily imply a lack of systematicity (something that can also be said of sociolinguistic variability in adult speech). The manner in which PS's phonology deviates from the adult long-vowel subsystem may not be fully invariant, but it is not at all random. This point is acknowledged in the very use of the terms HARDENING and SHORTENING as labels for observed regularities. Moreover, as we will see below, these processes are not fully interchangeable in PS's output but are sensitive to significantly different sets of regular phonological conditions.

Before proceeding with our analysis of PS's disorder, we should first ask ourselves

whether it is indeed phonological at all. In considering the possibility that the deficit might be located outside the grammar, our attention is naturally directed towards the process of glide hardening. We might speculate that PS experiences some difficulty in executing the fine-tuned tongue and lower mandible manoeuvres necessary to sustain an approximant gesture that is close enough to deliver high vocalic quality but not so close as to cause friction. Or we might appeal to some notion of tense articulatory set. Either way, the articulatory closure effected by hardening would be attributed to target overshoot.

Any suggestion that hardening might be symptomatic of some global deficit in motor programming can be discounted straight away. Given a purely mechanical basis, the effect would be expected to manifest itself in vocalisations which do not draw directly on phonological knowledge. However, PS has no difficulty in producing quasi-iconic utterances which involve simultaneous lip rounding and high back tongue bunching ('woooo!') and which he is able to sustain for time intervals much longer than anything normally associated with vowel production proper.

Two important considerations tilt the balance of evidence in favour of a phonological explanation of hardening. Firstly, the regularity needs to be evaluated in conjunction with shortening and bisyllabification. These processes conspire to produce output that is commensurate with what we will try to show is a parochially deviant system. In other words, the combined effect of the processes is consistent with the conclusion that they replace one possible primary phonological grammar by another. It would be somewhat far-fetched to suggest that this substitution could be accidentally achieved by some grammar-external deficit.

Furthermore, the regularities of PS's disorder can be shown to be sensitive to contextual effects which have no obvious articulatory dimensions but are straightforwardly defined in phonological terms. As we will see presently, there is one site in which hardening occurs to the total exclusion of shortening — adult long vowels in absolute word-final position. The absence of shortening in this context is attributable to an independent constraint on the minimum size of the English word. It is quite implausible that the constraint has a basis in articulation, particularly in view of the fact that it is active in some languages but not others. On the other hand, it has a very obvious phonological definition, one that invokes prosodic constituency.

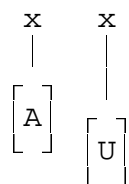
We develop these points in the next section.

## 4 The prosodic dimensions of PS's vowel disorder

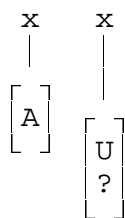
### 4.1 The syllabic basis of shortening and hardening

The effects of hardening in PS's system receive straightforward expression in the element-based model of melodic form outlined in §2.2. In general, a hardening or fortition process consists in the addition of the stop element [ʔ] to a segment, such as a fricative or glide, which otherwise lacks it. A vocalic glide contains a single resonance element — [U] in the case of *w*, [I] in the case of *y*. The fusion of either of these elements with [ʔ] produces a homorganic oral stop; as shown in (2), [U,ʔ] defines *b*, while [I,ʔ] defines *ʃ*. In PS's case, this yields an outcome such as *ab* for adult *aw*, as in *kab cow*:

(12) (a) Adult *aw*



(b) PS *ab*



One question that arises at this point is whether PS's output forms containing the hardened representation in (12)b are independently stored (as would be assumed under a dual-lexicon account (cf. Menn & Mattei 1992) or are derived from input forms containing adult-like representations of the type in (12)a (cf. Macken 1992). Although we happen to prefer the first of these alternatives, it should be stressed that this issue is a derivational matter and is thus quite independent of the representational question of how hardening is best expressed melodically.

Our transcription of PS's stopped reflexes indicates that they are in some sense voiced. This is to be understood in the same way that the label is attached to the so-called voiced plosives of normal English — the series that may exhibit full vocal-fold vibration in phonetically voiced contexts (for example intervocalically) but typically not elsewhere. That is, stops of this type are not independently voiced in the way that, say, French *b/d/g* are. In element theory, absence of true voicing in obstruents signals the absence of any independent laryngeal specification. [U,ʔ] and [I,ʔ] are thus full representations of the hardened sounds in PS's output; no additional elements relating to voicing, or indeed to

any other effect, need to be specified in order to secure their phonetic interpretability.

The correspondence between (12)a and (12)b illustrates how the segmental effects of hardening follow directly from the inherent design properties of element theory. Note that there is no call for supplementary patch-up rules such as would be required in a feature-based treatment of the same facts. (In conventional feature terms, glide hardening has to be expressed as the rewriting of no fewer than three specifications (more if vowels and consonants are represented in terms of different place categories): [+continuant] → [-continuant], [-consonantal] → [+consonantal] and [+sonorant] → [-sonorant].)

Of course, specifying the melodic effects of hardening does not in itself explain why the process occurs in the first place. In particular, why should the glide portion of a target vowel acquire an extra element that is more usually associated with a consonant? The reason, we contend, is rooted in the syllabic contexts the sounds in question occupy: while the adult glide resides in a nucleus, PS's corresponding stop appears in a non-nuclear position. Whether this position forms the coda portion of a closed rhyme or an onset is a question we can set on one side here.<sup>3</sup> Of more immediate relevance is the fact that oral closure is the most favoured manner state for sounds occurring in non-nuclear positions. Glide hardening produces conformity with this unmarked state of affairs.

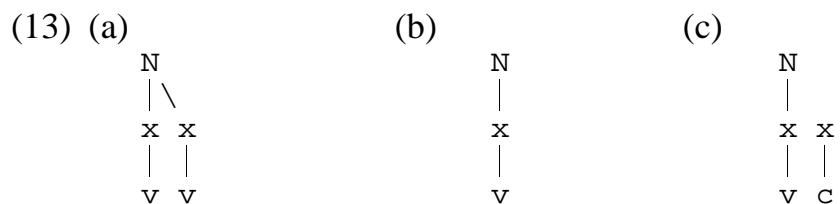
The most direct way of accounting for this resyllabification effect is to assume that PS's nuclear template is simply not big enough to accommodate the adult glide. This we interpret as a failure to establish the marked branching setting necessary for the representation of vowel-length contrasts. In the absence of branching structure, a nucleus only makes provision for the first portion of an adult long vowel (the head). If the second portion is to receive phonetic interpretation, it must be accommodated in some other type of constituent. This account is consistent with the fact that PS's system also exhibits shortening of adult long vowels. Here the lack of a second nuclear slot is not compensated for by the reassignment of the adult glide to a non-nuclear position. As a result, the glide has no corresponding realisation in PS's output.

Under this account, shortening and hardening may thus be viewed as different

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<sup>3</sup>Under one widely held view, a form such as *stj see* would be deemed to end in a closed VC rhyme. This analysis is at odds with a significant body of facts which show that a word-final consonant behaves more like a word-medial onset than a coda (see Harris 1994 (66 ff.) for a fully referenced summary of the evidence). This is consistent with a more ancient tradition, associated with various eastern syllabic writing systems, which treats a word-final consonant as the onset of a syllable with a silent nucleus. For our immediate purposes, we may sidestep this theoretical disagreement, since the two approaches converge on the main point being made here: the hardening site is a non-nuclear position.

responses to the same fundamental prosodic deficit. As anticipated by the discussion in §2.3, they represent two of the possible outcomes predicted to occur whenever syllabic restructuring is forced by an absence of branching nuclear structure. Simple truncation of the right-hand position of a branching nucleus ((13)a) produces vowel shortening, as in (13)b (repeated from (6)).



Preservation of the second slot can be achieved by reassigning it to a non-nuclear position, as in (13)c, where the melodic content falls under the influence of hardening in PS's system.

Further confirmation of the essentially syllabic nature of PS's vowel disorder comes from the observation that he also shows some evidence of the split-nucleus alternative in (6)c. Here the second slot of a primary branching nucleus is salvaged by assigning it to the nucleus of an independent syllable. Although not so prevalent as shortening and hardening, this strategy is observable in PS's rendition of adult in-gliding vowels (mostly originating from historical *VVr*; the relevant southern target system is non-rhotic). As illustrated in (14)a and (14)b, these are frequently treated as bisyllabic:

(14) (a)	hire <i>hɔyə</i>	tire <i>tɔyə</i>
	cure <i>kɔɾwə</i>	flour <i>fɔawə</i>
(b)	here <i>hɪjə</i>	disappear <i>dɪsəpɪjə</i>
(c)	idea <i>æydɪjə</i>	fewer <i>fɔɾwə</i>

The independent nuclei in such forms are separated by an onset that is filled by a glide (as in (14)a) or its hardened counterpart (as in (14)b). The bisyllabicity of the relevant sequence makes it prosodically identical to the structure encountered in PS's version of adult heterosyllabic sequences of long vowel followed by schwa (see (14)c). The nuclear split here is strongly reminiscent of the breaking that occurs in some primary types of English, although it is not particularly well-established in any of the dialects to which PS

and melody in vowel disorder

has had prolonged exposure. A significant difference is that the initial vowel in such sequences is long in the relevant primary systems but short in PS's case, in keeping with his nuclear branch deficit,

As noted in §2.3, the bisyllabification of originally tautosyllabic vocoids extends to historical (V)VI sequences in some primary types of English, as in *fi:yəl feel*, etc. This development is potentially bound up with vocalisation of post-vocalic *l* to *w*, a process that is attested to some extent in PS's linguistic environment and appears to be quite general in the early stages of normal phonological acquisition. Vocalisation potentially swells the set of words containing labial up-gliding vowels. Both bisyllabification and some analogue of *l*-vocalisation show up in PS's system.

In one pattern involving the lateral, hardening affects original VI forms no less than Vw, as the following examples demonstrate:

(15) (a) bull	<i>bɪb</i>	(b) school	<i>skɪb</i>
milk	<i>mɪbk</i>	wheel	<i>wɪb</i>
pencil	<i>pɛnsɪb</i>		
tell	<i>tɛb</i>		
belt	<i>bɛbt</i>		

In primary dialects, *l*-vocalisation has not necessarily resulted in a merger of historical VI-V: contrasts.<sup>4</sup> In PS's case, however, the neutralisation of the standard vowel-length contrast before *b* in the forms in (15) (compare adult short (15)a with long (15)b) shows vocalisation to have produced potentially diphthongal inputs to hardening which are, as far as we can tell, indistinguishable from original Vw.

The other relevant pattern affecting laterals, which typically co-occurs with hardening, is bisyllabification, exemplified in the following forms:

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<sup>4</sup>In London English, for example, the original contrast between *u:* and *ul* is maintained as a vowel-quality distinction (compare *təw two* with *tow tool*). Lowland Scots, in contrast, does bear the marks of merger (e.g. *ku:* 'cow', *pu:* 'pull').

(16)	seal	<i>sɪʃʊ</i>	eel	<i>ɪʃəb</i>
	wheels	<i>wɪʃɪbz</i>	field	<i>fɪʃɪt</i>
	bale	<i>bɛʃəb</i>	bell	<i>bɛʃʊ</i>
	tail	<i>tɛʃʊ</i>	tile	<i>tɔʃʊ</i>

The bisyllabicity evident in such forms further confirms that nuclear split is available to PS as a means of dealing with the nuclear branch deficit. The validity of this conclusion is not diluted by whatever doubts there might be about whether bisyllabification before an original lateral is a development that is internal to PS's system or is triggered by primary input.

#### 4.2 Prosodic minimality

There is yet another piece of evidence which confirms the prosodic basis of PS's vowel disorder: the variation between hardening and shortening is not entirely free. Under one set of conditions that can only be specified in prosodic terms, hardening occurs to the total exclusion of shortening. As we will now see, shortening is blocked if it presents a threat to the minimal size of the English phonological word.

Before a word-final consonant, both hardening and shortening are in evidence in PS's system. In the case of hardening, this results in VCC] sequences, both in the palatal ((17)a) and the labial ((17)b) series:

(17) (a)	meat	<i>mɪʃt</i>	Keith	<i>kɪʃf</i>
	sheet	<i>sɪʃt</i>	teeth	<i>tɪʃf</i>
	neat	<i>nɪʃt</i>	seep	<i>sɪʃp</i>
	wheat	<i>wɪʃt</i>	leaf	<i>wɪʃf</i>
	sweets	<i>swɪʃts</i>	leave	<i>wɪʃf</i>
	bees	<i>bɪʃz</i>	five	<i>fajv</i>

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(b) shoot	<i>sɪbt</i>	boat	<i>bəpt</i>	out	<i>apt</i>
rude	<i>wɪbd</i>	coat	<i>kəbt</i>	loud	<i>wəbt</i>
food	<i>fɪbt</i>	goat	<i>gəbt</i>	crowd	<i>kwəpt</i>
Luke	<i>wɪbk</i>	bone	<i>bəbn</i>	house	<i>həps</i>
bruise	<i>bwɪbz</i>	cone	<i>kəbn</i>	mouse	<i>məps</i>
lose	<i>wɪbs</i>				
smooth	<i>smɪbf</i>				
roof	<i>wɪbf</i>				
move	<i>mɪbf</i>				
groove	<i>gwɪbf</i>				

Shortening also occurs freely before a word-final consonant. (18) expands on the exemplification already provided in (9).<sup>5</sup>

(18) (a) weed	<i>wɪd</i>	white	<i>wɪd</i>	groan	<i>ɡwɪn</i>
beef	<i>bɪf</i>	height	<i>hɪd</i>		
spade	<i>spɪd</i>	sight	<i>sɪt</i>		
(b) beak	<i>bɪk</i>	tube	<i>tɪb</i>		
week	<i>wɪk</i>	boob	<i>bɪb</i>		
meeK	<i>mɪk</i>	soup	<i>sɪb</i>		
seek	<i>sɪɡ</i>	robe	<i>rəb</i>		

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<sup>5</sup>Many of the forms in (18) (and in (19) below) also have short vowels in Scottish English, conditioned by the following consonant in accordance with a regularity known as Aitken's Law (see Lass 1974 for analysis and references). However, the Scottish pattern does not disturb the basic tense-lax contrast, with the result that shortened *bɪd* **bead**, for instance, remains distinct from **bid**. The fact that shortening in PS's case does potentially produce neutralisation (under the lax series, as in *bɪk* **beak**) suggests that this is an independent development which is internal to his system.

It is interesting to speculate that PS's vowel-length deficit might at least in part be a response to conflicting primary input data derived from the typologically distinct grammars that are represented in his linguistic environment. He is confronted on the one hand by the southern system, in which vowel length is lexically distinctive, and on the other by Scottish English, in which length is largely determined by phonological context. One effect of this is that many words will be presented to him in long- and short-vowelled variants. In the absence of any conclusive evidence bearing on this possible explanation, it must remain a matter of conjecture.

As suggested by the examples in (18)b, shortening is particularly favoured if the final consonant of the target is already of the same manner and general place as the hardened reflex of the glide. For example, the labial stop of *trb tube* coincides both with the final consonant of the adult form and with the output of hardening. A related effect is observable in sequences which consist of a labial up-glider followed by coronal nasal in the adult grammar. In PS's rendition of forms featuring this structure, we find shortening accompanied by a transfer of the labiality onto the nasal:<sup>6</sup>

- (19) throne *fwim*                  brown *bam*  
       sown *sim*                    crown *kəwam*  
       loan *lim*                    bounce *bams*  
       bone *bəm*

Significantly, the preconsonantal site is the only one in which shortening is permitted in PS's system. The process never affects a word-final vowel. In this particular context, PS's grammar apparently responds to some imperative to preserve the overall quantity of an adult final long vowel (VV]). In the absence of branching structure, the second portion of the long vowel cannot be accommodated within the nucleus in PS's output and must instead be assigned to a following non-nuclear position, where it falls prey to hardening — the result illustrated in forms such as *trb two* and *wɪʃ we* (see (10) and (11)). The explanation for this contextually determined ban on shortening appears to lie in a constraint which places a lower limit on the size of the phonological word in English. The fact that adult VV] forms are the only ones to resist shortening reflects the fact that this is precisely the context where the process would place the quantitative minimum in jeopardy.

Consider the following well-known facts about words containing a single stressed vowel in English. They are required to end either in a long vowel (**see**, **cow**, etc.) or in at least one consonant, in which case the preceding vowel can be either long (**bead**,

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<sup>6</sup>Representationally, this effect consists in the labial element [U], cut adrift from the nucleus through truncation of the second position, docking onto the following non-nuclear position:



The syllabic repositioning of labiality has also been observed in normal development (Smith 1973: 16).

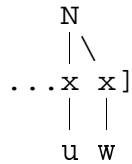
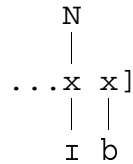
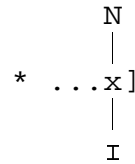
**shout**, etc.) or short (**bid**, **bit**, etc.). There are no words ending in a short stressed vowel (\**bI*, \**sɛ*, etc.). These facts follow from the assumption that, as in many other languages, the phonological word in English must consist minimally of a bimoraic foot — a metrical unit containing two weight-bearing positions (see McCarthy & Prince 1986). (Only rhymal positions contribute to the calculation of weight.) The bimoraic minimum is satisfied in words that end in VV] or VC]. In VV] words (**see**, **cow**, etc.), the two weight-bearing positions are housed within a final branching nucleus. In VC] words (**bit**, **back**, etc.), weight is distributed over a nucleus (V) and a following non-nuclear constituent (C).<sup>7</sup> The requirement is also met in (V)VCV] words (**city**, **treaty**, etc.), with each nucleus contributing at least one mora's worth of weight. The ungrammaticality of forms such as \**bI* or \**sɛ* is due to the fact that, in containing a final single-position nucleus, they fall below the bimoraic threshold.

The failure of PS's nuclear branch deficit to produce across-the-board shortening finds explanation in the assumption that prosodic minimality is respected in his grammar no less than in the adult's. This accounts for why shortening can be found in PS's version of adult VC] but not VV] words. In the absence of branching nuclei, one way in which PS's system can retain the bimoraicity of VV] forms is to render them as VC]. In other words, while hardening is an option in this context (see (20)b), shortening is not. Simple nuclear truncation of VV] to V] would allow a word to slip below the bimoraic minimum (see (20)c).

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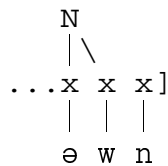
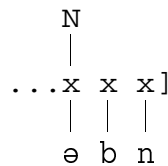
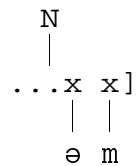
<sup>7</sup>According to one of the two approaches outlined in note 4, final VC] is defined as a bimoraic rhyme. The other treats the C as the onset of syllable containing a silent nucleus. Under the latter approach, it is the silent nucleus that constitutes the second mora of a final VC] sequence. A form such as **pit** (CVCØ) is binuclear and hence bimoraic in just the same way as, say, **pity** (CVCV). The disagreement between the two approaches does not undermine the main point in hand — the fact that the English word is subject to a bimoraic minimum.

The second approach allows us to maintain that feet universally contain two nuclear positions; that is, there are no 'degenerate' mono-nuclear feet. This in turn avoids a potential anomaly whereby non-branching structure would have to be deemed unmarked in all syllabic constituents but marked in feet. In the case of PS, this would have made it difficult to explain why branching feet but not branching nuclei are firmly established in his system.

(20) (a) Adult *duw do*(b) PS *dɪb*(c) \**dɪ*

Bisyllabification is also an option in this context (as in *tɛʃu tail*), since it preserves two weight-bearing positions, albeit split between separate syllables.

On the other hand, shortening in the VVC] context does not threaten prosodic minimality, because the final consonant already satisfies the bimoraic minimum irrespectively of whether a long or short vowel precedes. In this context, PS's system thus has options for either hardening ((21)b) or simple shortening ((21)c).

(21) (a) Adult *bəwn bone*(b) PS *bəbn*(c) PS *bəm*

## 5 Conclusion

PS's version of the adult subsystem of long vowels is characterised by three main developments — shortening, bisyllabification and glide hardening. Each of these has clear analogues in developments affecting primary systems, for example in linguistic change and inter-language borrowing. For instance, shortening occurred in the evolution of Latin, which had a vowel length contrast, into daughter languages such as Italian and Spanish, which do not. In Sesotho (Bantu, southern Africa), English loan words containing diphthongs are subject to nuclear split (e.g. *biya* 'beer'). The hardening of original VV to VC is attested in certain dialects of Romansch (e.g. *fayra* > *fɛgra* 'market'; Lutta 1923). All three of these examples reflect a situation in which the earlier or donor language possesses branching nuclei but the later or recipient language does not.

The same type of syllabic mismatch, we have argued, is responsible for the appearance of similar processes in PS's output. Far from being accidental, the co-occurrence of these

effects within the same system thus stems from a single fundamental deficit — a failure to secure the branching structure necessary for the acquisition of nuclear length contrasts in English. The entrenchment of non-branching nuclear structure reflects the perseverance of an unmarked alternative which would make for a well-formed primary subsystem but happens not to coincide with what is required for English.

Besides offering insights into the syllabic dimensions of vowel disorder, the case study provides external confirmation of the independence of the prosodic and melodic facets of phonological representation.

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