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A foot domain account of prosodically-conditioned substitutions

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Abstract

Children's prosodically conditioned substitutions have been recently described in terms of syllable structure. In this paper we present an alternative analysis, based on the position of the consonant within the foot. We review data from a previous case study (Chiat, 1989) that provide evidence in favour of a foot domain account and against the syllable structure account. One consequence of this finding is that it may be unnecessary to postulate that intervocalic consonants are captured into the coda of the previous syllable. While we caution that more evidence is needed to further test the foot and syllable accounts, we suggest that the foot be considered as a locus of substitution errors in phonology-disordered children.

Keywords: phonological disorders, intervocalic consonants, foot structure, syllable structure.

Introduction

A recent issue of *Clinical Linguistics and Phonetics* (Volume 16, issue 3, 2002) was dedicated to investigating the realization of intervocalic consonants (henceforth IVCs) in child phonology. The motivation for this work was two-fold. From a theoretical point of view, seeing whether IVCs pattern as onsets, codas, both or neither can provide a clue as to their syllabic location. From a practical point of view, the approach taken when treating IVCs in therapy is likely to depend on how they syllabify.

The results of all the papers in that issue were interpreted within the framework

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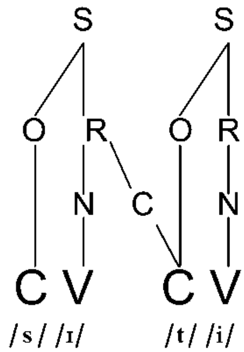

Figure 1. *Ambisyllabicity resulting from coda capture.*

of a syllable structure theory that appeals to the notions of coda capture and ambisyllabicity. Following Kahn (1976), a word-final consonant such as the /t/ in *sit* is syllabified into a coda. The syllabification of IVCs is less straightforward. It is assumed, in line with onset maximisation (Selkirk, 1982), that an IVC such as the /t/ in *city* is attached to an onset at the basic level of syllabification but is then additionally linked to the preceding rhyme and is therefore also a coda. This operation is termed coda capture, and the IVC is said to be ambisyllabic because it belongs to both syllables. The result is that *city* contains two syllables, /sit/ and /ti/. The resulting structure is shown in figure 1.

An alternative version of coda capture is that the IVC is detached from the onset position, resulting in full resyllabification of the onset into the coda of the preceding syllable (Borowsky, 1986). The resulting structure is shown in figure 2.

Not all IVCs are subject to coda capture. The process is stress-sensitive, so that the /t/ of *city* is in a coda whereas the /d/ of *today* is not. If we espouse coda capture and ambisyllabicity, we would predict that IVCs might pattern as onsets, codas, or both onsets and codas. Confounding the issue is the possibility that IVCs might pattern uniquely through the assimilation of features such as [+voiced] or [+continuant] from their flanking vowels, a process that Stemberger and Bernhardt (2002) term 'plateauing'.

The results reported in *Clinical Linguistic and Phonetics*, 16 (3) are inconclusive, and they are difficult to compare because different methodologies were used to collect and analyse the data. Kehoe and Lleo investigated the behaviour of

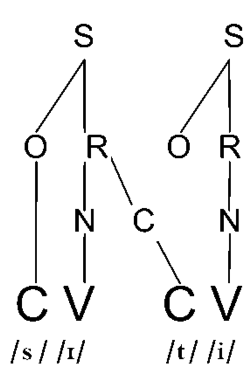

Figure 2. *Resyllabification resulting from coda capture.*

/f, ʃ, ts, k and l/ in five normally developing German children aged 1;3 to 3;3, and compared the realization of consonants in word-onset and word-final coda position with those in IVC positions. The criteria for patterning were similar percentage realisation scores and substitution patterns. Out of the 25 conditions (five children × five phonemes), nine patterned like codas and only two like onsets. However, five patterned as neither onsets nor codas, three exhibited dual patterning (where the percentage realization scores and substitution patterns differed) and for the remaining six conditions there was insufficient information to reach a verdict. The authors conclude that, at least for some children and some phonemes, IVCs pattern as word-final codas. Of particular interest for the data that we will present in this paper is Kehoe and Lleo's finding that fricatives patterned like codas. However, they caution that just because fricatives pattern like codas doesn't mean they are codas. They suggest that an alternative explanation for the pattern could be the distinction between foot-initial and non-foot-initial positions. Nevertheless, they conclude that a syllable-based explanation rather than a foot-based explanation is correct on the grounds that word-initial fricatives show similar error patterns whether they occur in stressed or unstressed syllables. In a later section of the present paper we will dispute this conclusion.

Rvachew and Andrews (2002) investigated the substitution errors of 13 English-speaking pre-school children with delayed phonological skills. In line with the patterns prevalent in Kehoe and Lleo's data, they found that IVCs patterned more often with word-final codas than with onsets, particularly if they were velars, fricatives or affricates. On the other hand, Bernhardt and Stemberger (2002) looked at IVCs in the speech of 44 English-speaking children aged 3–6 years with phonological disorders, and concluded that IVCs patterned more often with onsets, in that they are deleted less often than word-final codas. Where there was no deletion, IVCs were more likely to be segmentally unique than like either onsets or codas. Despite the discrepancies between the overall treatment of IVCs observed in this paper and the previous two, there is one point of agreement: that velars and fricatives patterned with word-final codas. Bernhardt and Stemberger (2002) suggest that fricatives are favoured in intervocalic position because there is assimilation of the feature [+continuant] from the flanking vowels, while velars are favoured because there is assimilation of the feature [Dorsal].

Stoel-Gammon (2002) investigated IVCs in the disyllabic babbles and first CVCV words of normally-developing children aged 6–24 months and found that they patterned more like onsets than codas in terms of inventories and sequential patterns (i.e. the two consonants in CVCV words were more likely to be identical than different). However, it is difficult to compare these findings with those from the other studies which looked at IVCs where the stress was truly strong-weak, because the stress pattern on disyllabic babbles and first CVCV words is most likely to be strong-strong (which is essentially the point made by Allen and Hawkins, 1980, and references therein). This means that the IVCs are more likely to be syllabified as onsets rather than ambisyllabically, and so Stoel-Gammon's finding that they pattern as onsets is exactly what we would expect.

Reconsidering the syllabification of IVCs

The data that encouraged us to reconsider the issue of IVC syllabification are from a 14-year-old boy, T, who has a severe phonological disorder (Ebbels, unpublished data). T reduces word-final stops to glottal stops, although word-initial stops are unaffected. Ebbels asked him to repeat two-syllable words and phrases that form near-minimal pairs, where one of the pair is stressed on the first syllable and the other is stressed on the second syllable:

weak-strong stress IVC		*strong-weak stress IVC*	
Today	/d/	Tidy	/ʔ/
Forget	/g/	Foggy	/ʔ/
A pea	/p/	Happy	/ʔ/

These data show the same IVC target being preserved in the weak-strong context, but subject to glottal substitution in the strong-weak context. This pattern of correct realisation and substitution echoes patterns observed in two previous case studies. Chiat (1983) reported a child who realised word-final velar stops correctly but fronted them word-initially. He preserved intervocalic velars between strong and weak syllables, e.g.:

baker /beɪkə/ → [beɪgə]

but fronted them between weak and strong, e.g.:

because /bɪkɒz/ → [bɪdɒz]

(The voicing changes are not relevant to the present discussion).

Chiat (1989) observed exactly the same pattern in a second child, Stephen, who stopped fricatives word initially but preserved them word-finally. Intervocalic fricatives were correct between strong and weak syllables, e.g.:

person /pɜːsən/ → [pɜːsən]

but stopped between weak and strong, e.g.:

before /bɪfɔː/ → [bɪpɔː]

Some of the data reported in *Clinical Linguistics and Phonetics* 16 (3) include examples of IVC targets which show the same pattern. For example, Allison (Rvachew and Andrews, 2002), also stopped fricatives word-initially (e.g.: *sadly*) and in IV weak-strong positions (*casino*). However, in word-final (*yes*) and IV strong-weak positions (*glasses*) she realized them correctly.

Chiat describes the different realisation of IVCs in terms of the ways in which these are syllabified in different prosodic domains. She points out the similarity between the domain in which IVCs are preserved and the foot domain of metrical structure (Chiat, 1989). The descriptions in Chiat's papers do not, however, differentiate between syllabification and metrical accounts, nor between the differing predictions they make, and these are the issues at the heart of the present paper.

An alternative proposal

An alternative proposal is that the patterns seen in the realization of IVCs can be described by reference to their location within the foot rather than within the syllable. The foot is a rhythmic unit made up of either one or two syllables. The basic type of foot structure in English is the trochee, which can consist of either a single syllable as in the words *sit* and *tea*, or a disyllable with strong-weak stress, as in *city*. In a word such as *today*, /dɛi/ is the trochee and /tə/ is an adjoined, unstressed syllable. In this paper we will use curly brackets to indicate the boundaries of the trochaic foot, so the disyllabic examples we have considered so far would be /{sɪti}/ and /tə{dɛi}/.

As has already been discussed in the introduction, the coda capture approach posits a different syllabic position for IVCs in words with weak-strong stress, compared to those in words with strong-weak stress. In the former the IVC is in the onset of the second syllable, whereas in the latter it is either ambisyllabic, i.e.: simultaneously in the coda of the first syllable and in the onset of the second (see figure 1), or fully resyllabified into the coda (see figure 2). However, the stress facts suggest an alternative way of looking at the syllabification of IVCs. Suppose instead that /t/ is in the onset position in both words, i.e.: that it syllabifies identically in both. The location of coda capture can be generalized over the position of the IVC within the foot. We saw in the previous paragraph that *city* and *today* have different foot structures – the feet are /{sɪti}/ and /tə{dɛi}/. This means that the location of the IVC within the foot is different in this pair of words – in *today* the IVC is foot-initial where as in *city* it is foot-internal. So the stress patterns that lead the /t/ in *city* to undergo coda capture, whereas the /d/ in *today* does not, can be characterized by considering their location within the foot – an IVC is subject to coda capture when it is internal to a trochee. But how does thinking about this problem in terms of foot structure help us to explain why the IVC might be realized differently in these two words?

The foot exhibits asymmetric distributions of both vowels and consonants (Harris, 1994, 2000; Harris and Urua, 2001). In a number of languages the full range of vowel contrasts is supported only in the stressed nucleus. English is a good example, with its rich vowel inventory being greatly reduced in unstressed nuclei. Other languages allow the full inventory of consonants foot-initially, but not in other foot positions. For example, Danish allows both aspirated and unaspirated voiceless plosives foot-initially, but only unaspirated plosives foot-medially and foot-finally. The location of other phonological processes, such as the lenition of /t/ in English (which different dialects manifest in different ways, including tapping and glottaling), can also be described with reference to the position of the consonant within the foot – foot-initial /t/ cannot undergo lenition. Harris (2000) has proposed that the foot be divided into two domains – a strong domain and a weak domain. In a two-syllable trochee, which is the favoured foot type in English, the strong domain (or foot head) is the initial CV and the weak domain (or foot tail) is everything that follows it. This means that a word-final consonant and an IVC in a trochee are both in the weak domain, while a word-initial onset is in the strong domain, as shown below in figure 3.

This conception of foot structure predicts that when children make substitutions, word-final consonants and IVCs in trochees will pattern differently to foot-initial consonants. It allows us to dispense with the notion of coda capture because there is no requirement for the IVC and the final consonant to be in the same syllabic position. This is desirable because a close look at final consonants and internal codas unearths compelling evidence to suggest that they are different (Harris, 1994; Harris and Gussman, 2002). For example, if word-final consonants and word-internal codas were equivalent, we would expect a two-way typology

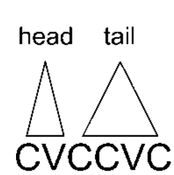

Figure 3. *Strong (head) and weak (tail) domains in the trochaic foot.*

whereby languages either allow both final and internal codas or allow neither. However, the typology actually splits four ways, because there exist languages with internal codas but no word-final consonants (e.g.: Italian, Telugu), and languages with word-final consonants but no internal codas (e.g.: Yucatec Maya, Luo). Although the term coda is commonly used in the literature for both internal and final positions, we should beware that they are not identical.

The existence of coda capture is only invoked in languages such as English and German that allow internal codas – in languages that permit only CV syllables word-internally, it is accepted that IVCs are syllabified as onsets. A foot domain approach allows for a more restrictive, and therefore more desirable, theory. Most recent work on the behaviour of IVCs in both normal and disordered child phonology has been carried out within the framework of coda capture and ambisyllabicity, which recognizes the role of stress in IVC syllabification, but which does not explicitly acknowledge the role of the foot. We are advocating a different approach, one which describes the observed patterns as occurring at the level of the foot and which does not need to make reference to the syllable.

Testing the two theories

It should be clear from the exposition thus far that focusing on the behaviour of single IVCs will not enable us to determine whether the foot domain or the coda capture account is correct, because both accounts make the same predictions (albeit for different reasons). We need to find structures for which the two theories make conflicting predictions.

One such structure is an intervocalic cluster that is unable to occur word-finally, and whose second consonant has to be syllabified as an onset (Selkirk, 1982). Whilst under an extreme coda capture approach (e.g.: Wells, 1990) a permissible word-final cluster such as /lf/ or /st/ might be assumed to undergo capture in its entirety into a coda, this is not the case for illegal word-final clusters – the second consonant cannot be syllabified into the coda along with the first. Take /kf/ for example, as in the word *breakfast*. No English words end in /kf/, and so *breakfast* has to syllabified as /brɛ̱k.fəst/. The predictions for clusters such as /kf/ occurring medially in trochees are:

1. Coda capture theory – The second C of the cluster is an onset and so will pattern like a foot-initial onset. (see figure 4a)
2. Foot domain theory – The second C of the cluster is in the weak domain of a foot and so will *not* pattern like a foot-initial onset. (see figure 4b)

The coda capture theory *will* make the same prediction as the foot domain theory if it makes reference to strong and weak syllables, a distinction that is based on

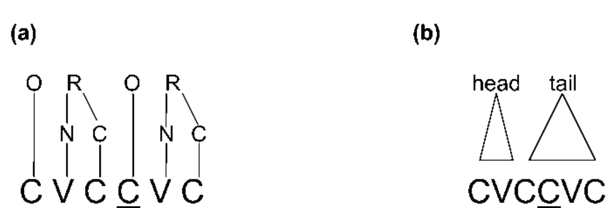

Figure 4. *Diagrams of the predictions. The consonant of interest is underlined. (a) The coda capture account (b) The foot domain account.*

those syllables' location within the foot – the strong syllable is the one that receives stress. However, this is just a restatement of the foot domain account, which can account for the data without making reference to the syllable.

Data

The case study reported by Chiat (1989) includes words with clusters that are illegal word-finally. Stephen was aged 4;7–4;10 during the period of investigation. Recall that he stops fricatives in word-initial positions but realises them correctly word-finally:

Position in word	*Realization of fricative*
Word-initial, e.g. *sun* /sʌn/	incorrect
Word-final, e.g. *miss* /mɪs/	correct

Intervocalically, Stephen stops fricatives when they occur foot-initially in a primary-stressed foot, and realises them correctly foot-internally and foot-initially in a secondary-stressed foot:–

Position in word	*Realization of fricative*
IV, weak-strong, e.g. *decide* /dɪs<u>aɪ</u>d/	incorrect
IV, strong-weak, e.g. *person* /p<u>ɜː</u>sən/	correct
IV, strong-secondary stress, e.g. *missile* /mɪsaɪl/	correct

Now for the cluster data, which will enable us to test the conflicting predictions of the coda capture and foot structure theories. The coda capture account predicts that Stephen will stop fricatives when they occur in the second position of a foot-internal cluster, since they must be syllabified as onsets. This is unless, as discussed at the end of the previous section, a distinction is made between strong and weak syllables, with weak onsets being predicted to behave differently from strong onsets. The foot domain account predicts that fricatives in the second position of a cluster will not be stopped, since they are not in the strong domain of a primary foot. Because Stephen's fricatives show virtually only two types of behaviour – they are either realised correctly or stopped (very rarely the fricative is omitted), the foot structure account can make the stronger claim that this second consonant will be realised correctly. See figure 5 for the different realisations of fricatives as predicted by the two accounts.

Stephen was asked to repeat each of the following words three times: *spiteful*, *breakfast*, *obvious*, *blissful*, *infant*, *comfort*, *harmful*, *canvas*, *anvil* and *envy*. For details on the method of data collection and transcription, see Chiat (1989). The data are reported below:

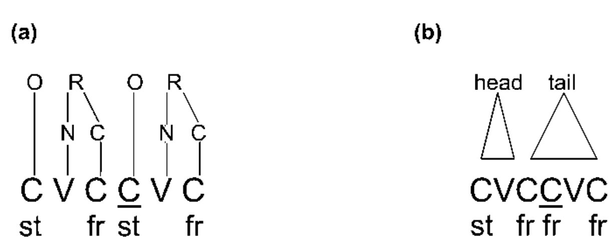

Figure 5. *Diagrams of the predictions. The consonant of interest is underlined, and the realization of fricatives is shown by st=stop and fr=fricative. (a) The coda capture account (b) The foot domain account.*

Word	*Number of correct realizations of the fricative*
Spiteful	3/3
Breakfast	3/3
Obvious	2/3
Blissful	3/3
Infant	2/3
Comfort	2/3
Harmful	3/3
Canvas	1/3
Anvil	0/3
Envy	0/3

Chiat (1989) describes the variable treatment of these consonants in terms of the phonotactic possibilities of English, but does not account for the tendency to treat them like foot-internal targets. What we aim to show now is that both analyses are needed in giving an adequate treatment of the data. First of all, it is evident that the /v/ in /nv/ clusters is more likely to be stopped than to be realized correctly. However, if the data set is treated apart from these /nv/ tokens, it can be seen that the majority of Stephen's fricatives in the second position of an illegal word-final cluster are realised correctly, as predicted by the foot domain account. A binomial test on those remaining 21 tokens (3 stopped, 18 correct) shows that this result is statistically significant, with $p = 0.001$ (two-tailed). This result therefore supports the prediction of the foot domain theory but not that of the coda capture theory.

We need to consider, as indicated above, whether we are justified in treating words containing an /nv/ cluster separately from those containing other clusters. An obvious explanation is that Stephen refoots words containing /nv/, so that the second syllable becomes the primary stressed one and the /v/ is therefore foot-initial. The /v/ would be stopped because it is treated like any other primary foot-initial fricative. However, this is not the case – Stephen does not change the stress patterns of those words.

An alternative way of dealing with the problematic /nv/ clusters is to consider whether this is a feature of nasal + fricative clusters as a whole. Stephen does make one error with the cluster of *infant* and one error with the cluster of *comfort*. We looked back over Stephen's productions of nasal + fricative clusters that are permissible word-finally, and found the following (note that all these words were given to Stephen with primary stress on the first syllable and secondary stress on the second, and that he repeated them only once):

Word	*Number of correct realizations of the fricative*
Enzyme	1/1
Consort	1/1
Incense	1/1
Inside	0/1
Outside	0/1
Insult	0/1
Insect	0/1
Insight	0/1
Concept	0/1
Total correct	3/9

These data show that Stephen is variable in his treatment of fricatives when they occur post-nasally, even when the nasal + fricative cluster is permissible word-finally (in words such as *bronze*, *lens*, *pence* and *once*). The foot domain account might explain the stopping in these particular words by arguing the fricative is actually initial in its own (secondary stressed) foot, and hence undergoes stopping in the same way as a fricative that is initial in a primary-stressed foot. The problem with this explanation is that in this exact location singleton consonants are hardly ever stopped: tokens such as *missile*, *coffin*, *perfume* and *ozone* are invariably realised correctly. So it appears that Stephen does treat fricatives at the head of a secondary stressed syllable as though they were in the weak domain. His grammar appears to be atypical in allowing just one strong domain in a disyllabic word. While this might be problematic for the foot domain account, it is also problematic for the coda capture account because the IVC does not undergo coda capture in this position.

Now that we have started to consider Stephen's realization of fricatives in nasal + fricative clusters that are permissible word-finally, we should complete the picture by looking at the data where /l/ + fricative clusters, which are permissible word-finally, occur foot-medially. These data are presented below:

Word	*Number of correct realizations of the fricative*
Elvis	3/3
Wilful	3/3
Pilfer	3/3
Salvage	3/3
Alfie	3/3
Kelvin	3/3
Dolphin	3/3
Silver	2/3
Skilful	3/3
Selfish	3/3
Total correct	29/30

A binomial test shows these thirty tokens (29 correct, 1 incorrect) shows the difference to be highly statistically significant, with $p < 0.001$. These data confirm then that Stephen's difficulty is with nasal + fricative clusters rather than any others – /l/ + fricative, fricative + fricative and stop + fricative are correct a significant proportion of the time.

So what can explain the high proportion of stopping in nasal + fricative clusters? One possible explanation is that the manner feature [+stop] spreads from the nasal to the fricative, strengthening the fricative to a stop. This phenomenon could in turn be linked to the intertwined pressures of sonority and cluster frequency. In an optimal foot-internal cluster, the second consonant must be lower than, or equal to, the first in terms of their relative sonority (Harris, 1994). When Stephen stops fricatives after a nasal, the resulting nasal + stop cluster has a higher sonority difference than the original nasal + fricative cluster; this change would be favoured if the pressure to create a greater sonority difference outranked the pressure to remain faithful to the input. Relative sonority differences are likely to explain why nasal + stop clusters are higher in frequency in English than nasal + fricative clusters, and it could be that Stephen is sensitive to these relative frequencies.

One final issue to be addressed in this section is why Stephen tends to stop fricatives more often in spontaneous data compared to the repetition data that have already been presented. As well as eliciting tokens by repetition, Chiat (1989) recorded tokens containing fricatives in directed play sessions with Stephen. During one such play session, Stephen correctly realized the fricative in *breakfast* only three times out of eight (compared to three times out of three correct when directly repeating *breakfast*). On the other hand, *obvious*, which also contains a stop + fricative cluster, was correctly realized three out of three times. The spontaneous data confirms the tendency of the post-nasal fricative to stop – in *infant* it is correctly realized only three times out of five, while in seven tokens of *anvil* it is stopped each time. The fricative in /l/ + fricative clusters is less vulnerable to stopping in the spontaneous data than the fricative in other clusters – it is realized correctly in nine out of 11 tokens. The spontaneous data therefore show the same patterns as the repetition data, but with slightly higher frequencies of stopping across-the-board. However, it is not unexpected that Stephen is more likely to retain the fricative in a repetition scenario where he is producing it immediately after hearing the stimulus, and the analysis of the preceding paragraphs is not challenged.

We therefore propose that the data presented here provide evidence in support of a metrical account of IVCs, whereby IVCs are treated according to their location in the foot rather than according to their syllabification. The cluster in foot-internal position shows some variability, which appears to depend on the segmental characteristics of its consonant members. The only way to rescue the coda capture account would be to acknowledge the role of foot structure. The first syllable in these strong-weak words can be considered strong because of its location in foot the stressed position of a foot, whereas the second syllable can be considered weak. So while the word-initial onset and the fricative are both in an onset, they would not be expected to behave identically because they have different strengths. However, this amounts to no more than an appeal to foot structure. A model which can explain Stephen's substitution patterns using foot structure alone, with no reference to syllable structure, is more restrictive, and therefore more desirable, than one which needs to invoke both syllable and foot structure. Note that a foot structure model takes no stance on the constituency of syllables – it just claims that there is no need to posit the coda capture of the IVC in words of the form CVCV(C). Whether there is such a thing as the syllable (and Harris has claimed that there isn't: see Harris, 1994) is also irrelevant to the present discussion.

Further issues

Stephen stops fricatives in the strong foot domain and preserves them in the weak domain. This pattern of substitutions conforms to Harris's claim that strong positions support greater segmental complexity (stops being more complex than fricatives, Harris, 2000); Stephen appears to have over-generalised this rule, so that he doesn't allow fricatives in strong domains. On the other hand, we might reasonably have expected to find positional faithfulness in the strong foot domain rather than the weak domain (e.g. Beckman, 1998; Zoll, 1998; De Lacy, 2001). We might also have expected to find phonological contrasts being neutralized in weak positions. A brief survey of other case studies reported in the literature reveals that some substitutions follow Stephen's pattern of showing positional faithfulness in the weak domain while others show the opposite pattern. We set out two of each type below.

Substitutions showing positional faithfulness in weak positions (same pattern as Stephen)

Allison (Rvachew and Andrews, 2002). Substitution of /s/ by stops

Word initial	*sadly*	incorrect [d]
Intervocalic, weak-strong	*casino*	incorrect [t]
Word final	*yes*	correct
Intervocalic, strong-weak	*glasses*	correct
Syllable final within word	*police chief*	correct

E (Inkelas and Rose, 2002). Substitution of velar stops by coronals ('velar fronting')

Word initial	*come*	incorrect [t]
Intervocalic, weak-strong	*again*	incorrect [d]
Word final	*duck*	correct
Intervocalic, strong-weak	*soccer*	correct
Syllable final within word	*octopus*	correct

Substitutions showing positional faithfulness in strong positions (opposite pattern to Stephen)

Kristina (Rvachew and Andrews, 2002). Substitution of /f/ by stops

Word initial	*food*	correct
Intervocalic, weak-strong	*uniform*	correct
Word final	*chief*	incorrect [p]
Intervocalic, strong-weak	*waffle*	incorrect [t]
Syllable final within word	*Daphne*	incorrect [t]

LN (Marshall, Ebbels, Harris and van der Lely, 2002) Substitution of /f/ by [θ] in non-words

Word initial	/fɪp/	correct
Intervocalic, weak-strong	/dɪfɪp/	correct
Word final	/pɪf/	incorrect [θ]
Intervocalic, strong-weak	/pɪfɪ/	incorrect [θ]

The data above show that even though each pattern of substitution can be described in terms of foot structure, we cannot predict which way positional faithfulness and neutralization will go. It may be that the pressures for neutralisation lie outside the phonological system. Inkelas and Rose (2002), for example, propose that E's velar fronting in certain positions is motivated by articulatory pressures, but that the effects then become phonologized.

Nor can we predict how unfooted consonants will behave, although their behaviour may provide useful insights as to the processes involved in the substitutions. We might ask whether in Stephen's case the pressure is on strong foot positions to be neutralized, or on weak foot positions to remain faithful to the input. If the pressure were on strong positions to be neutralized, then we would expect unfooted fricatives to behave like fricatives in the weak domain, i.e., not to be stopped. Alternatively, if the process is one of positional faithfulness in weak foot positions, it will not operate outside weak foot positions. Unfooted fricatives would therefore be expected to behave like those in the strong domain and undergo stopping.

Chiat (1989) collected 64 realizations of words with an unfooted intervocalic fricative, from both repetition and informal speech. Examples included *elephant* /{ɛ̲lɪ}fənt/, *medicine* /{mɛ̲dɪ}sɪn/, *opposite* /{ɒ̲pə}zɪt/ and *Oliver* /{ɒ̲lɪ}və/. The results were:

C correct – 12/64 times (repetition – 5/16, spontaneous data – 7/48)
C incorrect – 52/64 times (repetition – 11/16, spontaneous – 41/48)

A binomial test shows this result to be statistically significant, with $p < 0.001$ (two-tailed). This result strongly suggests that for Stephen the pressure is on fricatives in weak foot positions to remain faithful to the input. Note that with these singleton IVCs, as with the clusters discussed previously, the repetition data are more likely to be correct than the spontaneous data.

Stephen's data echo those of Bernd (Kehoe and Lleo, 2002). At one stage Berndt substituted coronal stops for /f/ in foot-initial positions and labial stops for /f/ in weak foot positions. In word-initial unfooted syllables he is reported to have produced coronal stops. So like Stephen, Berndt realized consonants in weak foot positions differently from those in strong foot and unfooted contexts. Kehoe and Lleo presumably predicted that all unstressed consonants would behave identically, and so held that their data militate against a foot-based account; we argue that there are two types of unstressed syllables and that under a foot-based account those inside a foot are not expected to be realized identically to those outside.

Conclusion

We have presented evidence from a single case-study of a boy who stops fricatives in certain prosodic positions, and shown that the coda capture theory cannot account for all of these substitutions unless it makes explicit reference to foot structure, whereas a theory that makes a distinction between strong and weak foot domains can account for the data without needing to invoke coda capture. However, any theory of prosodic conditioning must also take segmental content into account – prosody alone cannot explain all the data. We stress that we have presented data from only one child to support the foot domain account, although they do echo patterns seen in limited data available from other studies; it remains to be seen whether the substitution patterns of other children, and for sounds other than fricatives, can be analysed in this way. In order to establish this, future research will need to include a range of targets in a wider variety of prosodic consonants than is usually the case in such studies. In the meantime we suggest that the foot be considered as a candidate for the locus of certain phonological errors in phonology-disordered children. If further data can be accounted for by our analysis, this increases support for the view that phonological theory should dispense with the notions of coda capture and ambisyllabicity.

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