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Extrasyllabic consonants in CV phonology: an experimental test

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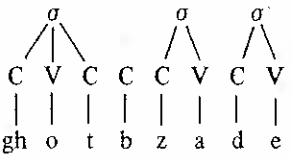
Abstract: Extrasyllabic consonants, which are not associated with any syllable, play a prominent role in CV phonology. Clements & Keyser (1983) posit both temporarily and permanently extrasyllabic consonants for English. Temporarily extrasyllabic consonants are posited in the inflectional system. Permanently extrasyllabic consonants are hypothesized to be pronounceable. We test these hypotheses by examining errors in inflectional processing. It is shown that, if a rule of shwa insertion or shwa deletion is posited in the grammar, the errors can only be accounted for by assuming that temporarily extrasyllabic consonants exist and that permanently extrasyllabic consonants are not pronounceable.

Recent research in autosegmental phonology has led to the hypothesis that syllables are composed of a sequence of nonsyllabic (C) and syllabic (V) syllable positions, with segments associated with these positions (McCarthy, 1981; Clements & Keyser, 1983). There are a large number of phenomena in many languages, both morphological and phonological in nature, that support this point of view. Moreover, analyses of adult speech errors (Shattuck-Hufnagel, 1979, Stemberger, 1982, 1983*a*, *b*, 1984) point to some psychological reality for this approach. In this paper, we will focus on a small part of the theory of CV phonology as put forth by Clements & Keyser (1983): the existence of extrasyllabic consonants. An extrasyllabic consonant is a consonant that is associated with no syllable, appearing before, after, or between the syllables of the word. Clements and Keyser postulate two types of extrasyllabic consonants, depending on whether they are *permanently* extrasyllabic (i.e. are never associated with a syllable at any point in phonological processing) or *temporarily* extrasyllabic (i.e. are briefly unassociated with any syllable before being integrated into the syllable structure).

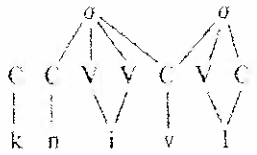
Clements and Keyser maintain that permanently extrasyllabic consonants occur in English in the usual pronunciations of foreign names and words like *Ghotbzadeh* and *Knieval*, as show in (1).

1(a)



0095–4470/84/040355 + 12 $03.00/0

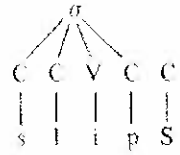
1(b)



In 1(a), the /b/ in the center of the word is extrasyllabic, while in 1(b), the /k/ at the beginning of the word is extrasyllabic. Clements and Keyser note that these extrasyllabic consonants are usually followed by a very short shwa-like element, such as occurs after the first member of a consonant cluster in many languages, but argue that it is not a full shwa and in fact contrasts with the full shwa in words such as *canoe*. Since the permanently extrasyllabic consonants in (1) are actually pronounced by speakers of English, this entails the assumption that permanently extrasyllabic consonants are pronounceable. This assumption about the pronounceability of permanently extrasyllabic consonants will be addressed in this paper.

Clements and Keyser maintain that temporarily extrasyllabic consonants appear briefly after the application of an inflectional rule before being integrated into the syllable structure. English has a number of suffixes that are usually represented with a single underlying consonant, though the rules of English create syllabic allomorphs of all of them. In CV phonology, the inflectional rule adds the consonant and its associated C-position to the base word, as in (2) for *slips* and *kisses*; the capital letter /S/ here stands for an archisegment unspecified for voicing (cf. Stemberger, 1981).

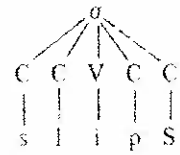
2(a)



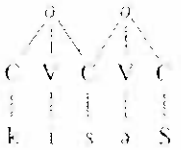
2(b)

The extrasyllabic /S/ in (2) does not remain extrasyllabic for long, but is quickly integrated into the syllable structure. There are resyllabification conventions in English that restructure syllables to include these temporarily extrasyllabic consonants, providing for a description of what constitutes a legal syllable in English. In 2(a), a legal syllable will result if the /S/ of the suffix is associated with the syllable of the base word, so that operation is carried out, as shown in (3).

(3)



In 2(b), however, this is not possible. English does not allow sequences of two such (nearly) identical consonants in the same part of the syllable, so the resyllabification conventions cannot simply link the consonant to the preceding syllable. Instead, a new syllable is created, via a rule of shwa insertion, and the /S/ of the suffix is associated with this new syllable, as in (4)

(4) 

Together, shwa insertion and the resyllabification conventions remove all instances of extrasyllabic consonants from the inflectional system. For the sake of discussion, it would be noted that some linguists have proposed that the underlying form of the *-s* morphemes is /əz/, with a rule of shwa deletion applying in words such as *slips*. In CV phonology, the /z/ of the suffix would be rendered temporarily extrasyllabic after the deletion of the shwa, yielding a representation similar to that in 2(a), and the extrasyllabic /z/ would then be integrated into the syllable structure by the resyllabification conventions to yield a representation similar to that in (3), as discussed above. For our purposes, we may consider shwa deletion to be equivalent to shwa insertion, since both involve temporarily extrasyllabic consonants. Clements & Keyser (1983) show that these temporarily extrasyllabic consonants play a large role in the phonology of Klamath, and Marlett & Stemberger (1983) have shown this for Seri.

Work within CV phonology has made very strong assumptions about the consequences of syllables and the CV-tier for motor programming. Clements & Keyser (1983) emphasize that each syllable position on the CV-tier should be taken to represent one timing unit for motor programming. Segments associated with two syllable positions, for example, must therefore also be associated with two timing units, so they must be produced as long vowels or consonants. Segments associated with no syllable position on the CV-tier, on the other hand, can be associated with no timing unit and therefore cannot be produced (McCarthy, 1981). Stemberger (1982) discusses in more detail how syllable structure and the CV-tier is used in producing utterances. He suggests that the syllable structure is an adaptation for determining the serial ordering of segments in language production. The syllable tier controls the ordering of positions on the CV-tier, which in turn control the production of the segments of the word associated with those positions. Through the CV-tier, the syllable units are responsible for the correct ordering of the segments of the word during production, in the same way that the syntactic structure determines the order of lexical items. Given Stemberger's description of the role of syllables in serial ordering, permanently extrasyllabic segments, while possible, cannot be pronounced. Since they are not associated with a syllable unit, they cannot be integrated into the serial ordering of the other segments and hence cannot be produced. A C-position associated with no syllable should lead to the "deletion" of the associated consonant, much as a consonant that is associated with no C-position is "deleted". The existence of permanently extrasyllabic segments is not possible given Stemberger's view of serial ordering. While Stemberger's view is not the only possible one, it does raise questions about the viability of permanently extrasyllabic consonants.

It is always desirable to try to find psycholinguistic evidence for or against phonological hypotheses. Stemberger (1983*a*) notes that autosegmental phonology often fares better in such tests such as the examination of speech errors, than do many other phonological theories. In this paper, we will test whether extrasyllabic consonants are psychologically real to speakers of English, and whether permanently extrasyllabic consonants are pronounceable. We would like to emphasize at the outset that our conclusions on these matters are contingent on the rule system that is posited. Specifically, they are true of any analysis where the shwa associated with the *-s* morphemes is inserted or deleted by rule. Given other analyses

(e.g. with the suppletive allomorphs /S/ and /ɔz/), our data have little to say about extrasyllabicness. However, we feel that they are nonetheless very important, since most linguists believe in a rule of shwa insertion or shwa deletion. Our conclusions can be taken as valid for most current phonological theories.

Inflectional processing can provide a way to test the concept of extrasyllabic consonants. By investigating what happens when inflectional processes go wrong, we may be able to determine if temporarily extrasyllabic consonants exist. MacKay (1976), Bybee & Slobin (1982), and Stemberger & MacWhinney (1984) provide an experimental paradigm for investigating these processes. Subjects are given one inflected form (e.g. *is slipping*) and must produce a specific inflected form (*slips*). Here, the task will be to produce the third person singular present form of verbs, requiring the presence of the suffix *-s*.[1] Despite the simplicity of this task, subjects make errors. Since CV phonology posits different processes for the nonsyllabic (e.g. *slips*) and syllabic (e.g. *kisses*) allomorphs of *-s*, we will contrast the error rates on these allomorphs in detail. For reasons that will become clear below, we will also contrast verbs that end in /s/ or /z/ with verbs that end in palatal consonants, though both groups take the syllabic allomorph.

Experiment

Method

Subjects

Subjects were 60 undergraduate students at Carnegie-Mellon University, who received credit in an introductory psychology course for their participation in the experiment.

Materials

A list of 90 one-syllable English verbs was constructed. There were 30 pseudo-present verbs that ended in /s/ or /z/ (such as *toss* and *doze*), with an average frequency of 72.4 for all forms of the word in the word frequency count of Francis & Kučera (1982), and 3.3 for the present tense form alone; these take the syllabic allomorph /əz/, i.e. undergo shwa insertion. There were 30 fully regular verbs that ended in the palatal fricatives /š/, /č/, and /j/ (such as *crash*, *watch*, and *judge*), with an average frequency of 59.5 for all forms of the word, and 2.4 for the present tense form alone; these also take the syllabic allomorph. There were 30 verbs that ended in other consonants or in a vowel (such as *bark* and *dry*), with an average frequency of 66.2 for all forms of the word, and 3.3 for the present tense form alone; these take the nonsyllabic allomorph /s/ or /z/. The full list of stimuli is presented in the appendix.

Procedure

The verbs were presented one at a time in the frame "IS _ING" in the center of the CRT display screen of an IBM personal computer. This frame was included to ensure that the subject perceived the presented word as a verb, since related nouns often existed. The subject read the verb silently, then spoke the present tense form of the verb out loud into a microphone connected to a voice key. Subjects were instructed to use the present tense form that would be appropriate for the subject *he*, just as the word "IS" in the frame is. Instructions emphasized the need to react as quickly as possible. At the onset of the verbal

[1] This experiment is also reported in Stemberger & MacWhinney (1984), where the data are used to examine an entirely separate issue. We will not analyze the data from this task in full, but will concentrate only on the relevant parts; readers who are interested in the conclusions that can be drawn for morphological processing are referred to Stemberger and MacWhinney's discussion of this and six other similar experiments.

response, the computer removed the verb from the display screen. The next verb was presented 1.5 s later. The subject's verbal responses were recorded manually by the first author, who sat slightly behind the subject and to the left, where he could see the verb presented and hear the subject's response clearly. The room was quiet, and listening conditions were optimal. Responses were not tape-recorded, since we had found in previous experiments (Stemberger & MacWhinney, 1984) that the experimenter's judgements during the experiment were completely accurate. There were five practice trials to ensure that the subject understood the task properly, followed by the 90 experimental trials, randomized differently for each subject.

Results

Two types of errors were observed: no-marking errors, where just the base form of the verb was produced (5), and allomorphy errors, where the wrong allomorph of the suffix was produced (6).

5(a) buzz, coax, hiss, raise
(b) crash, judge, splash, watch
(c) bend

6(a) buzzz, danes, hisss, presss
(b) blushs, chargz, launchs, watchs
(c) cuttes, pettes, restes

A word about the allomorphy errors in 6(a) is required. In these errors, the final /s/ or /z/ was pronounced long. These were easily distinguished from correct productions (such as *buzzes* and *hisses*), because (a) no shwa was present, and (b) the pitch dropped at a late point at the end of the word characteristic of consonant clusters rather than at the slightly earlier point characteristic of unstressed syllables. They were easily distinguished from no-marking errors such as *buzz* and *hiss*, because (a) the final consonant was much longer, and (b) the vowel was noticeably shorter before the consonant cluster. The experimenter had no difficulty making these judgements, even though it had not occurred to us beforehand that such errors would occur. The experimenter was a trained phonetician with a good ear for consonant and vowel length, has taught phonetics and concentrated on teaching how to distinguish between long and short consonants, has field experience with Hindi and Choctaw, which distinguish between long and short consonants, and is a non-native speaker of Swedish, which also distinguishes between long and short consonants. The room was quiet, the speaking loud, and the target known to the experimenter in advance. Under such optimal conditions, the judgements about whether an allomorphy or no-marking error had occurred were not difficult.

The rates of no-marking and allomorphy errors are quite different on the three groups of verbs, as shown in Table I. Note first that both types of errors are quite rare with verbs that take the nonsyllabic allomorph of *-s*, i.e. in those instances where shwa insertion cannot

Table I No-marking and allomorphy errors in experiment 1

	No-marking	Allomorphy	Total
s/z	68	9	77
palatals	18	36	54
nonsyllabic	1	3	4

apply, and the resyllabication conventions associate the consonant of the suffix directly with the preceding syllable. These error rates are significantly lower than for verbs that end in /s/ or /z/ and verbs that end in palatals, for no-marking errors (one-tailed t-test, $t = 5.39$, $P < 0.001$, and $t = 3.47$, $P < 0.001$, respectively) and for allomorphy errors ($t = 1.68$, $P = 0.048$, and $t = 3.72$, $P < 0.001$, respectively). Verbs that end in /s/ and /z/ show significantly more no-marking errors than verbs ending in palatals ($t = 3.76$, $P < 0.001$), and significantly fewer allomorphy errors ($t = 2.92$, $P = 0.003$). The overall error rate on verbs that end in /s/ and /z/ is greater than that of verbs that end in palatals ($\chi^2(1) = 4.19$, $P < 0.05$).

Discussion

There is more than one way that the process of applying an inflectional rule can fail, as the two observed types of errors attest. First, the speaker can fail to produce the suffix entirely, resulting in a no-marking error. Secondly, the speaker can produce the suffix with the wrong allomorph. In the latter case, either the syllabic allomorph /əz/ is incorrectly used, as in 6(c) above, or else the nonsyllabic allomorph /S/ is incorrectly used, as in 6(a) and 6(b) above. What are the causes of these two types of errors, and why are some verbs more prone to these errors than others?

Allomorphy errors

The varying rates of allomorphy errors on the three groups of verbs (Table 1) can easily be accounted for. The nonsyllabic allomorph (/S/) of the present -*s* suffix is very common, accounting for 90.4% of all tokens of that suffix in Francis & Kucera (1982). The syllabic allomorph (/əz/) is relatively infrequent, accounting for the remaining 9.6% of tokens. As in many other language processes, there should be a frequency effect, with a higher error rate on lower frequency processes. The nonsyllabic allomorph should show few errors, with the consonant being associated easily with the syllable of the base. The syllabic allomorph should show many more errors, often being replaced by the higher frequency nonsyllabic allomorph. In CV phonology, the relatively low-frequency operation of shwa insertion fails to apply, and the consonant erroneously undergoes a higher-frequency operation and is associated with the syllable of the base. The difference in rate between verbs that end in /s/ and /z/ and verbs that end in palatals is straightforward. The resulting sequences after /s/ and /z/ (/ss/ and /zz/) are greater violations of English syllable structure conditions than are sequences involving palatals (/šs/, /čs/, and /jz/). Sequences such as /ss/ are harder to pronounce and perceive, constituting one of the more difficult phonological problems encountered by speakers of English in learning a foreign language or in studying phonetics. Since the resyllabification conventions are intended to create legal syllables only, failure should usually result in syllables that are close to legal structures. As a result, there should be more errors with palatals than with /s/ and /z/, as observed (cf. Stemberger & MacWhinney, 1984). The characteristics of allomorphy errors are thus expected given the characterization above of the processes involved in CV phonology. Of course, any system presumably needs some way to define allowable sequences. If we assume two suppletive allomorphs /S/ and /əz/, we also predict a higher error rate of /əz/, and possibly predict that errors are less likely if they produce more deviant sequences. The CV phonology explanation is compatible with the data but is by no means required.

No-marking errors

There is apparently more than one cause underlying no-marking errors. There seems to be an inherently low rate of failure to add the suffix at all, since only a single no-marking error was observed on verbs that take the nonsyllabic allomorph (Table 1). At the same time, there was

a high rate of no-marking errors on (1) verbs that end in /s/ and /z/ and (2) verbs that end in palatals, the two groups of verbs that take the syllabic allomorph of *-s*. There appear to be factors that are raising the rate of no-marking errors on verbs that take the syllabic allomorph, relative to verbs that take the nonsyllabic allomorph. We will now examine how the elevated error rates on these groups of verbs can be accounted for. We will first discuss one way in which the rate of errors on verbs that end in /s/ and /z/ can be successfully accounted for. We will then discuss four possible explanations of the rate of errors on verbs that end in palatals, showing that only two of them are tenable, with one of them requiring the existence of extrasyllabic consonants that are not pronounceable when rendered permanently extrasyllabic.

In regard to no-marking errors on verbs that end in /s/ and /z/, Stemberger (1983*b*) and Stemberger & MacWhinney (1984) have argued that the higher rate of no-marking errors after /s/ or /z/ results from an error tendency in the language system whereby the phonological material in an affix is equated with the adjacent material in the base work and not overtly added. In these cases, the /s/ or /z/ at the end of the word carries two functions, that of the suffix and that of part of the base word, as argued in autosegmental phonology by Stemberger (1981). Stemberger (1983*b*) and Stemberger & MacWhinney (1984) demonstrate that other approaches cannot properly account for all the psycholinguistic data.

In regard to the elevated rate of no-marking errors on verbs that end in palatals, a first explanation attempts to derive both no-marking errors and allomorphy errors from the same underlying cause (with the understanding that some no-marking errors after /s/ and /z/ are different, as argued above, and as demonstrated clearly by the fact that the overall error rate on verbs that end in /s/ and /z/ is greater than the overall error rate on verbs that end in palatals). It might seem possible to argue that there is only a single basic type of error on verbs that end in palatals: the allomorphy error. Allomorphy errors where shwa insertion has failed to apply always result in an illegal syllable in English. Perhaps the resulting violations are detected by the speaker at a later stage of processing, with the speaker subsequently deleting the suffix entirely to remove the violation. If detection is related to the degree of violation, this would lead to a greater rate of no-marking errors on verbs that end in /s/, /z/, and palatals, with the greatest error rate after /s/ and /z/. This is an unlikely explanation, for two reasons. First, Stemberger (1983*a*, p. 33) shows that adjustments to the phonological form of an error to avoid violations of syllable structure conditions are very rare in spontaneous speech.[2] Secondly, in this task, it seems unlikely that the violation would always be corrected by deleting the suffix. Some errors would be expected where the final consonant of the base word is deleted, e.g. **charz* for 'charges', but no such errors were observed. Indeed, Derwing & Baker (1980) found that young children commonly simplify the consonant cluster of the base verb to avoid the difficult clusters that result from adding the /S/ of the suffix, and much more rarely fail to add the suffix. This further suggests that deleting the suffix to avoid violations of syllable structure is unlikely. Thus, no-marking errors and allomorphy errors are distinct types of errors, and another explanation must be sought to account for the behavior of verbs that end in palatals.

[2]The only two cases observed in Stemberger's corpus of 6300 total errors involved sequences that have only recently been lost from the dialects of the speakers who made the errors and still occur in other dialects often heard by the speakers involved: /ny/ at the beginning of a syllable and /æ r/. These were changed to /n/ and /er/, respectively, the same adjustments made when adapting names or new words from other dialects that contain these sequences. No cases of eliminating other kinds of violating sequences such as seen in *dlorm* and *atk* have ever been observed.

A second possible explanation is that the elevated rate of no-marking errors on palatals results from the similarity of palatals to the phonological material of the *-s* suffix, much as the elevated rate of no-marking errors on verbs that end in /s/ and /z/ results from the identity of /s/ and /z/ to the phonological material of the suffix.[3] Stemberger & MacWhinney's (1984) mechanism does not predict this, and mechanisms that do predict it are not adequate to account for other aspects of the data. There is also some empirical data that may be brought to bear to show that similarity to the suffix without identity does not lead to an elevated rate of no-marking errors, at least in adult speech. Stemberger & MacWhinney report the results of another experiment (their experiment 1) investigating no-marking errors with past tense *-ed*, employing the same task used here but having subjects produce the past tense forms of the verbs. We can do a post-hoc analysis of their data to address this question. Stemberger and MacWhinney used 20 verbs that ended in /t/ or /d/, taking the syllabic allomorph, and 20 verbs that take the nonsyllabic allomorph. Of these last 20 verbs, 16 end in /p/, /b/, /k/, /g/, /č/, or /n/, the six consonants that are closest to /t/ and /d/ phonologically, as evidenced by the rates of errors observed in speech errors (e.g. Shattuck-Hufnagel & Klatt, 1979). There were 15 no-marking errors that occurred on the verbs that end in /t/ or /d/, and none on the other verbs that ended in similar consonants; there were two additional no-marking errors that occurred on the four other verbs that ended in segments less similar to /t/ and /d/. There is thus no evidence here that similarity to the suffix without identity has any effect on the rate of no-marking errors in the speech of adults. We must look elsewhere to account for the elevated rate of no-marking errors on palatals.

A third possibility can successfully account for the data, by making the following assumption: there is no rule of shwa insertion or shwa deletion applying to the output of inflectional rules in English. The alternative assumption is made, that there are two suppletive allomorphs /S/ and /əz/, and that the speaker simply chooses between these two allomorphs on the basis of the final phoneme of the base word. Let us examine how this can account for the elevated rate of no-marking errors after palatals. No-marking errors would result from failing to access either of the two allomorphs, just as allomorphy errors would result from accessing the wrong allomorph. The relatively low frequency of the syllabic allomorph would result in a greater rate of accessing failures, accounting for the elevated rate of no-marking errors on verbs ending in palatals. Note that this possibility does not require any particular assumption about the existence of temporarily extrasyllabic consonants, which still could occur with the nonsyllabic allomorph, or about the pronounceability of permanently extrasyllabic consonants. It works whether or not they exist and are pronounceable. In any system that does not employ a rule of shwa insertion or shwa deletion, the results of our experiment are of interest only in that they show that the suffixes and their allomorphs show frequency effects just like nouns and verbs, despite their high frequency. While suppletive allomorphy leads to the prediction of an effect of allomorph frequency in no-marking errors, note that any system that uses a rule of shwa insertion or shwa deletion does not. When such a rule exists, there is only a single underlying allomorph that is suffixed to all words, so there is no way that the frequency differences between the allomorphs can affect the rate of no-marking errors.

Finding an adequate explanation for our data within systems that employ a rule of shwa insertion or shwa deletion at first appeared to be quite difficult, but there is one way that

[3]This has often been suggested to account for similar errors occurring in early child language (Berko, 1958; MacWhinney, 1978; Derwing & Baker, 1980). While it is highly controversial there as well, the data available to us here addresses this possibility only in adult language processing.

will work. In such systems, the inherent rate of errors where the suffix is not added must be quite low, since we observed only a single no-marking error involving the nonsyllabic allomorph (Table I). As we have already argued, the low frequency of the syllabic allomorph cannot account for the high rate of no-marking errors here, nor can we simply delete the consonant of the suffix after it has been added. The only way out is to make the following two assumptions. First, temporarily extrasyllabic consonants occur in inflectional processing. Second, permanently extrasyllabic consonants are not pronounceable. Let us see how making these two assumptions can account for the data as a failure to integrate the consonant of the suffix with the syllable structure. If shwa insertion fails to apply (or if shwa deletion overapplies), it is not a foregone conclusion that the resyllabification conventions will associate the consonant of the suffix with the syllable of the base. Another possibility is that the resyllabification conventions will also fail to apply, since application could only result in illegal structures, and the extrasyllabic consonant of the suffix will remain extrasyllabic. The normally temporarily extrasyllabic consonant has now become permanently extrasyllabic. The consonant of the suffix is thus never associated with any syllable unit on the syllable tier. In Stemberger's (1982) model of production, this means that there is no way for the consonant to be integrated with the other segments of the word in serial ordering, and it cannot be produced. A no-marking error would necessarily result. This accounts fo the elevated rate of no-marking errors after palatals (and presumably for part of the elevated rate after /s/ and /z/ as well). However, no-marking errors would result from these failures *only* if permanently extrasyllabic consonants are unpronounceable. If they are pronounceable, as Clements & Keyser (1983) assume, they would be produced. The resulting errors would be indistinguishable from allomorphy errors, since the consonant /S/ but not the shwa should be present. The elevated rate of no-marking errors after palatals would not be explained. Thus, unless we assume that extrasyllabic consonants are present and are not pronounceable when permanently extrasyllabic, we cannot account for the data in a system that contains a rule of shwa insertion or shwa deletion. Clements & Keyser's (1983) concept of extrasyllabicness thus seems to be psychologically real to speakers of English, but permanently extrasyllabic consonants are not pronounceable and presumably arise only in errors during inflectional processing.

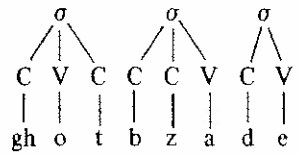
We have no unequivocal empirical evidence to bring forward the show that there is a rule of shwa insertion or shwa deletion used on the output of inflectional rules by speakers of English during language production. There is data that reveals the reality of the phonological conditioning on the syllabic and nonsyllabic allormorphs (e.g. Stemberger, 1983*a*, *b*), but the data are consistent with suppletive allomorphy as well. However, most phonologists work with systems containing one of these rules. Further, if there are any phonological or morphophonemic rules in English at all, shwa insertion (or shwa deletion) is one of the best candidates, applying in many, often frequent words and having no exceptions. Clements & Keyser (1983) and most other phonologists base their work on the assumption that there are many rules in English that have far less data to motivate them than does shwa insertion or shwa deletion. If these rules are to be abandoned, serious questions must be raised about the reality of their entire approach to phonology, and that of most other approaches as well. However, present data do not justify the rejection of such a promising approach or of theoretical phonology as a whole. We therefore suggest that temporarily extrasyllabic consonants do exist, but that we abandon the hypothesis that permanently extrasyllabic consonants are pronounceable. In any event, we can draw these strong conclusions for any system that includes a rule of shwa insertion or shwa deletion. We must leave to the future a conclusive demonstration that one of these rules exists. As Derwing & Baker (1980) note,

it is very difficult to differentiate between suppletive allomorphy and a single allomorph with a rule of shwa insertion, since they make similar predictions about errors, language acquisition, and even reaction times. We present these contingent conclusions at this time, and note that a final definitive conclusion may be a long time in coming.

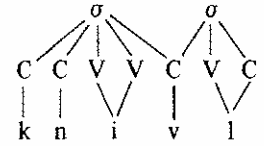
Alternatives to permanently extrasyllabic consonants

Having argued that permanently extrasyllabic consonants should be eliminated from phonological analyses of English, we are required to show that the data that Clements & Keyser (1983) used to motivate their existence can be accounted for in other ways. There are other ways to account for words such as *Ghotbzadeh* and *Knieval* that do not involve positing extrasyllabic consonants. The simplest way is to assume that speakers have learned to use syllable structures for these adopted foreign words that are illegal in the native vocabulary and still sound unusual and are difficult to pronounce even in these foreign words. We can posit the syllable structures in (7).

7(a)

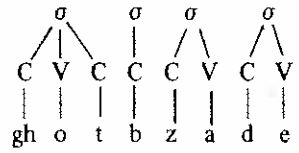


7(b)

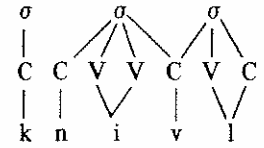


A more complex alternative would be to posit a degenerate syllable composed only of a C-position, as in (8).

8(a)



8(b)



This would allow the consonant to be integrated into the syllable structure and hence to be produced. The data that led Clements and Keyser to posit permanently extrasyllabic consonants that could be pronounced can thus be accounted for in other ways, allowing us to abandon the hypothesis.

Conclusion

We have examined errors that occur in inflectional processing to determine the psychological reality of the concept of extrasyllabic consonants proposed for CV phonology by Clements & Keyser (1983). Temporarily extrasyllabic consonants that result from the addition of a

suffix by an inflectional rule are implicated by the data obtained in our experimental study. However, it is necessary to assume that permanently extrasyllabic consonants, because they are not integrated with the syllable structure, cannot be serially ordered or produced, and hence are "deleted", just as segments that are associated with no syllable position on the CV-tier cannot be ordered or produced. The hypotheses that temporarily extrasyllabic consonants do not exist and that permanently extrasyllabic consonants are pronounceable are tenable only if there is no rule of shwa insertion or shwa deletion in the system. Given the presence of such a rule in the system, temporarily extrasyllabic consonants must exist, and permanently extrasyllabic consonants cannot be pronounceable.

APPENDIX: stimuli for experiment

buzz	blush	bark
cause	bulge	beg
chase	change	bend
choose	charge	bid
close	clutch	break
coax	crash	breed
cross	crouch	bribe
dance	crush	build
doze	dash	climb
force	fish	cut
freeze	flash	drop
gaze	forge	dry
glance	itch	dump
guess	judge	fib
hiss	launch	gloat
mix	march	howl
ooze	pitch	pet
pass	plunge	point
place	push	read
please	reach	rest
pose	rush	roll
praise	search	shout
press	slash	sleep
race	snatch	spank
raise	splash	spin
sneeze	stretch	spoil
squeeze	teach	stack
tease	touch	sway
toss	wash	trap
trace	watch	yank

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