Syllables and Segments
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SPEECH ERRORS INSIDE THE SYLLABLE

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1. Speech Errors

Over the past decade, several investigators have been examining speech errors for clues to the nature of the linguistic mechanisms underlying speech production. The errors have told us a great deal about syllable structure and segment organization. They have shown that syllables constitute a fundamental unit in terms of which segments are organized and that syllabication is not a simple matter of inserting syllable boundaries into a string of segments.

These are the basic facts. Some segments such as consonant clusters and even syllables themselves can behave as a unit in speech errors. Segments that interchange usually share many common features and always share major class features: vowels always interchange with vowels and consonants with consonants. Interchanged units always belong to the same syllabic position, e.g. syllable-final consonants never interchange with syllable-initial consonants.

Such facts led to the development of a model to account for how we generate segments in proper serial order when we do and improper serial order when we don't, as in the case of spoonerisms. The central concept of the model was the syllable rule, and speech errors were viewed as misexpansions of these rules. For example, an error such as *coat thrutting* instead of *throat cutting* reflects a misexpansion of the syllabic rule for determining the initial consonant group in these two adjacent syllables. The general model postulated two types of syllabic rules: syntagmatic and paradigmatic. The syntagmatic rules account for the relations between three types of nested units: the initial consonant group, the vowel group, and the final consonant group. Like phrase structure rules, the syntagmatic rules proceed hierarchically by means of serial or one-to-more-than-one "expansions." These expansions recode a syllabic constituent into two or more serially ordered subunits. The first and most general syntagmatic rule is a universal syllabic component, required for producing any syllable in any language. It expands the symbol S into two subcomponents: an initial consonant group and a vowel group. The "leftmost" subunit, in this case the initial consonant group, is then expanded as one or more consonants until a paradigmatic rule is reached. Unlike syntagmatic rules, paradigmatic rules always incorporate a one-to-one expansion. Four paradigmatic rules (designated by asterisks) are illustrated below for the syllable /spin/:

Syllable → initial consonant group + vowel group

Initial consonant group → C_1 + C_2

*C_1 → /s/

*C_2 → /p/

Vowel group → vowel + final consonant group

*Vowel → /i/

*Final consonant group → /n/

Besides providing a solution to Lashley's (1951) problem of serial order, syllabic rules explained a large number of facts, notably, the internal structure of syllables as seen in speech errors, differences in the ease of learning word games such as Pig Latin and Double Dutch, and the relative complexity of syllables as seen in a number of perception and production tasks (see MacKay, 1974). However, it was recognized from the start that the paradigmatic rules were too simple and probably had to be written in terms of distinctive features, especially in view of Fromkin's (1973) demonstration that some features or feature complexes may be independently controlled in speech production. Specifically, Fromkin (1973) reported several speech errors that could be explained as distinctive feature switches, e.g. *Terry and Julia* mispronounced as *Derry and Chulia,* where only the values of the property of voicing seem to be reversed, and not the intact segments /t/ and /ǰ/. There was even a possibility that many seemingly segmental switches actually involved switches of autonomous features or feature complexes, since most reversed segments differed by only a single distinctive feature.

However, the evidence for independently controlled distinctive features was inconclusive. The vast majority of speech errors (over 99 percent in most corpuses) were readily explained as involving whole segments rather than autonomous features. Moreover, the small number of errors that appeared to reflect distinctive feature autonomy could result from a quite different underlying process: phoneme fusion rather than feature switching. Under the fusion hypothesis, segments are composed of a passive set of features which cannot be independently controlled in the speech production process. What look like distinctive feature switches are really only accidental combinations of the passive components of simultaneously activated segments.

The present study describes a technique for experimentally inducing speech errors to explore whether subsegmental properties can be independently controlled. The advantages of laboratory-induced errors are many. One is the ability to collect large numbers of errors in a short period of time under optimal conditions for observation and analysis. Another advantage of special relevance to the present study is that experimentally induced errors can go beyond the lacunae of natural corpuses. For example, naturally occurring speech errors almost invariably involve interactions between *different* syllables rather than interactions between segments or features within a single syllable. Individual syllables, by their very nature, are apparently too highly structured and coherent within themselves for internal breakdowns to appear with any frequency in natural speech production. The absence of interactions within single syllables limits the usefulness of naturally occurring speech errors for determining the underlying organization of segments and syllables. To explore such issues fully, we need a way of "getting inside" a single syllable to see how its features are organized and to determine the effect of a change in that internal organization. The present study describes one such way.

2. The Technique

The basic idea was to determine the consequences of having subjects change a single distinctive feature in a segment of a syllable. This would be simple if our subjects were trained phonologists: we could simply instruct them to apply, say, a voicing dissimilation rule to frontal stops in the syllables they were about to hear and they would change /p/ to /b/ and vice versa. Using trained phonologists as experimental subjects is not generally advisable, however, and we found we could investigate the equivalent of voicing dissimilation rules by having naive subjects operate on whole segments. The subjects heard syllables which might or might not contain one of two critical segments: /p/ or /b/. If the syllable contained a /p/, they were to change it to /b/ as quickly as possible and produce the resulting syllable. Likewise, if the syllable contained /b/ they were to change it to /p/ and generate this new syllable.

We had several reasons for choosing /p/ and /b/ as critical consonants. One was the existence of natural speech errors such as *glear plue* for *clear blue* which suggested the possibility that voicing may be an independently controllable feature. Voicing also allowed us to investigate the processes underlying voicing assimilation. For example, subjects changing /p/ to /b/ in, say, /taps/ should produce /tabz/ rather than /tabs/ if voicing assimilation plays an on-line role in the production of English plurals.

However, the results told us a great deal more than we had anticipated in the original design. The /p/-/b/ transformations were accompanied by hundreds of errors with systematic bearing on the internal organization of syllables. It was as if changing one component in the syllable altered the stability of many other components, and thereby revealed some of their underlying principles of organization.

Materials for the main experiment consisted of 302 monosyllabic English words with either VCC, CCVC, CVC, or CVCC structure, where C stands for a consonant and V stands for a long or short vowel. Of these, 104 were practice stimuli which preceded the experiment proper and are discussed no further here. The remaining 198 words fell into two categories: experimental (N = 158) and control (N = 40). Experimental words contained /p/ or /b/, the "critical consonants," as in *pins* or *bins* while the otherwise similar control words (e.g. *fins, wins*) contained neither /p/ nor /b/. The experimental words were selected in pairs such that each word containing /p/ in a particular phonological environment (*pin*) was paired with another word containing /b/ in an identical or virtually identical environment (*bin*). Critical consonants occurred in either initial (e.g. *pin*, N = 80) or non-initial syllabic position (*nip*, N = 78). Some of the words had a fairly low frequency of use, but the average frequency of the /p/ and /b/ words was equated using Carroll, Davies, and Richman (1971). Noncritical consonants (i.e. all other consonants but /p/ and /b/ in the experimental and control words) were as often voiced as unvoiced, to prevent possible biases in the subjects' search for voiced vs. unvoiced features. The 198 words were recorded four times in different random orders, spoken clearly at normal rate and loudness, one every 7.0 seconds approximately, by a female native of California. Each subject was randomly assigned to hear one of the four orders.

The subjects were 25 native speakers of English enrolled in an introductory psychology course, 14 male and 11 female, with a mean age of 19.2; 22 wrote with their right hand, 3 with their left; none reported a history of either abnormal hearing or articulatory problems.

The subjects were instructed that they would hear words, some of which contained either /p/ as in *pig* or /b/ as in *big*. Their task was to respond to the sound (and not the spelling) of these words, to change /p/ to /b/ or /b/ to /p/ as quickly as possible and produce the resulting form: e.g. if they heard *big* they would quickly respond *pig*. If the stimulus contained neither /p/ nor /b/, they were to respond "no" as quickly as possible. They then wrote out the word that they heard on a numbered check sheet so we could determine whether they had heard the word correctly.

Responses were timed by means of a standard voice key apparatus, but only the errors will be described here. Chi-square tests were used throughout in analyzing the data.

3. Misperceptions

In view of the normal efficiency of everyday phoneme perception we were quite unprepared for the large number of misperceptions which occurred and had to be excluded from analysis of speech errors, the main purpose of the study. In part the high probability of misperception (P = .05 per subject per stimulus) was due to the absence of everyday redundancies such as intonation, observable lip movements, facial expression, the environmental situation, and the semantic and grammatical cues provided by prior and subsequent sentential context-- all of which play an overwhelming role in constraining everyday phonemic interpretations. The fact that plosives lack acoustic invariants and can be described acoustically only in terms of adjacent speech sounds may also have contributed to the high probability of misperceptions. However, the main reason was the fact that the subjects were searching for critical segments, since the probability of misperception decreased by an order of magnitude (P = .005) in a task where subjects simply listened to the tapes and wrote out what they heard. In both tasks, misperceptions were scored from the check sheets whenever the word written failed to match the stimulus word (obvious misspellings ignored).

Misperceptions in the main study were interesting and instructive in their own right. For example, /b/ was misheard as /p/ significantly more often than the reverse (P < .005). And /b/ was misheard as a noncritical consonant (e.g. *bills* misheard as *dills* more often than was /p/ (e.g. *pomp* misheard as *comp*), although these were infrequent. However, both of these effects varied with syllabic position, as shown in the table below.

Misperceptions of:	/p/	/b/
Initial syllabic positions	15%	30%
Final syllabic positions	29%	26%

As can be seen, /p/ was misperceived significantly more often (P < .05) in final syllabic positions (e.g. *rips* or *lip*) than in initial syllabic position, whereas /b/ was misperceived slightly more often in initial than final positions (though not significantly so). This finding indicates that the discriminability of /p/ and /b/ depends upon syllabic position, and perhaps reflects the aspiration of unvoiced obstruents in initial but not final syllabic positions. Other explanations are possible, however, and further research into interactions between syllabic position and segment discriminability seem warranted.

Misperceptions of ononcritical consonants were also interesting. When noncritical consonants were misperceived (*nip* misheard as *mip*), the misperceived consonants usually differed from the target consonant by a single distinctive feature, most often place of articulation (90 percent) rather than any other feature or feature cluster (10 percent). The substituted place in the place of articulation misperceptions was usually more frontal than the target place, e.g. *napt* was misperceived as *mapt*, where the substituted /m/ is more frontal than the target /n/. Specifically, place of articulation misperceptions were more frontal on 85 percent of the occasions and less frontal on 15 percent, a difference significant at the .01 level. This bias toward frontal misperceptions was all the more interesting because it disappeared in the task where subjects simply listened to the tapes and wrote down what they heard. It was as if instructions to identify frontal consonants (/p/ and /b/) biased the internal feature analyzers to record a frontal place of articulation, independent of input. And being responsive to simple instructions, the sensitivity of internal feature analyzers must be highly flexible rather than rigidly built in.

A "feature bias" hypothesis also provides an interesting account of the relative discriminability of /p/ and /b/. Under this account, the internal feature analyzers are "programmed" to record the most common or expected feature value in any given phonological environment. Since [-voice] is the most common or expected value of voicing in the case of obstruents, it would pay to bias a decision in favor of [-voice] in the absence of strong evidence against this expected reading. Such a bias would explain the fact that /b/ was misperceived as /p/ more often than vice versa. On the other hand, [+voice] is the expected or most common value of voicing in the case of sonorants, where it would pay to bias a decision in favor of [+voice] in the absence of strong acoustic evidence to the contrary. This hypothesis suggests the interesting possibility that feature analyzers for manner and voicing may operate in sequence rather than in parallel and are not independent but interact, such that the manner analyzers can bias the voicing analyzers towards the value [-voice] in the case of obstruents and [+voice] in the case of sonorants.

4. Speech Errors

Incorrect responses to correctly perceived stimuli were classified as speech errors. The errors involved either critical or noncritical segments.

4.1. Critical consonant errors (N = 92). There were three types of errors involving critical consonants in the stimulus: nonidentifications ("no" responses for stimuli containing /p/ or /b/), nontransformations (stimulus repetition without transformation; e.g. the response *bin* to the stimulus *bin*), and mistransformations (incorrect changes in a critical consonant, e.g. the response *niv* instead of *nip* to the stimulus *nib*). Nontransformations were most frequent (N = 56), nonidentifications less frequent (N = 28), and mistransformations least frequent (N = 8).

Critical consonant errors were significantly more common ($P < .05$) in noninitial (N = 58) than initial (N = 34) syllabic position. However, this effect was largely due to errors in transforming /b/ to /p/ as can be seen in the table below:

Errors:	/p/ to /b/	/b/ to /p/
Initial syllabic positions	21	13
Final syllabic positions	22	36
Total	43	49

Overall, /p/ to /b/ errors (N = 43) and /b/ to /p/ errors (N = 49) were about equally common but for some reason the /b/ to /p/ transformation was much more difficult in final than initial syllabic position ($P < .05$). One as yet untested explanation of this finding is that the /b/ to /p/ transformation requires a special glottal adjustment to stop the voicing in final positions since the phonological environment of final obstruents is always voiced.

4.2. Noncritical segment errors (N = 441). Noncritical segment errors represented inadvertent side effects of changing or attempts to change the critical consonants. There were three types of side effects: omissions, additions, and substitutions.

Omissions (N = 69): most of the omissions involved inflectional endings (N = 46), e.g. *pans* transformed as *ban*. The remaining omissions (N = 23) occurred in syllable-final clusters, e.g. *bunk* transformed as *puk* rather than *punk*. These usually involved a fricative, liquid, nasal, or nasalized vowel next to a final stop and resembled in some ways the omissions of children acquiring English. Like adults, children usually simplify sequences containing a nasal, fricative, or liquid plus a stop by dropping the nasal, fricative, or liquid, e.g. *milk* produced as *mik*, *desk* produced as *dek*, and *jump* as *dup* (Smith, 1973). The one exception is a tendency to drop voiced stops in nasal plus voiced stop sequences, e.g. *hand* usually gets misproduced as *han* rather than *had*. Whether adults display a similar tendency remains to be determined since there were too few stimuli with this characteristic in the present study.

Additions (N = 96): Additions always involved inflectional endings, which were often added in lieu of changing a critical consonant, e.g. *fob* transformed as *fobbed* rather than *fop*.

Consonant substitutions (N = 214):

i) Substitutions of noncritical consonants (N = 138): In these errors, one noncritical consonant substituted another, e.g. *pack* transformed as *bag* rather than *back*. These substitutions obeyed a segment similarity principle: using Wickelgren's (1966) distinctive feature system, substituted consonants usually differed from the target or intended segment in a single distinctive feature (N = 116), e.g. *nap* transformed as *mab* rather than *nab*; differences in two features (N = 10), or three features (N = 6) were progressively less frequent.

Some features were switched more often than others. Voicing substitutions were most frequent, making up 58 percent of the feature switches, e.g. *peakt* transformed as *beagd* rather than *beakt*, place of articulation substitutions were next, making up 27 percent of the feature switches, e.g. *lop* transformed as *wob* rather than *lob* and *nip* transformed as *mib* rather than *nib*, and manner changes, e.g. *fops* transformed as *mobs* rather than *fobs*, accounted for the remaining 15 percent.

Interestingly, the feature switches were usually "in sympathy with" some aspect of a critical consonant situated elsewhere in the syllable. For example, voicing substitutions always mirrored the voicing change in the critical consonant; i.e. [+voice] to [-voice] for syllables containing /b/ and vice versa for /p/, as when *peakt* was transformed as *beagd* rather than *beakt*. It was as if the subjects were applying a voice switching operation to transform /p/ to /b/ or vice versa and sometimes misapplied this operation to an inappropriate segment. As such, these errors constitute the strongest evidence to date for distinctive feature autonomy.

ii) Substitutions of critical consonants (N = 46): In these errors, subjects substituted a critical for a noncritical consonant in initial position of CVCC syllables, e.g. *nibs* transformed as *pibs* rather than *nips*. These errors support a three-stage model of the present task, incorporating detection of a critical consonant, localization (or in the present examples, mislocalization) of the critical consonant, and application of a segment or feature switching operation at that location.

Vowel substitutions (N = 62): There were three classes of vowel substitutions, described below. Over 96 percent of these errors occurred in conjunction with other errors.

i) Diphthong simplifications (N = 20): As Fromkin (1971) points out, complex vowels, traditionally represented as V+y or V+w as in /iy, ey, æy, aw, ow, uw/ usually behave as a unit in speech errors. Diphthongs are not indivisible units, however, since in 20 errors in the present study a complex vowel was simplified by dropping its glide, e.g. /piyk/ transformed as /bik/ rather than /biyk/. These errors suggest that complex vowels may be generated by means of rules for expanding an underlying unit, call it the Vowel Nucleus, into underlying components V + glide. In producing these errors, the speakers failed to apply the diphthongization rule which adds the appropriate glide to the underlying vowel.

ii) Complex vowel substitutions (N = 10): In these errors, a complex vowel was substituted for a simple vowel plus a liquid, usually /r/, e.g. stimulus *serb* misproduced as *soup* rather than *serp*, and stimulus *bork* misproduced as *powk* rather than *pork*. Fromkin (1973) reports similar errors in natural speech production, e.g. *soup* misproduced as *serp*, *goal* misproduced as *girl*, and *fight* misproduced as *fart*. Such errors are readily understood if the vowel nucleus constituent can be expanded or misexpanded as either vowel+glide as in the case of diphthongs or as vowel+liquid. This being the case, many words previously thought to have a final consonant cluster may actually have (C((VC)C)) structure.

iii) Simple vowel substitutions (N = 22): In these errors, one simple vowel replaced another, e.g. *rip* transformed as *wep* rather than *rib*, and *nip* transformed as *nap* rather than *nib*. The substituted vowel invariably differed from the target by a single characteristic, namely height of articulation, and always occurred with critical consonants in syllable-final position (in contrast to diphthong simplifications where the critical consonants always occupied syllable-initial position). For some as yet unknown reason, vowel height appears to interact with the voicing of final obstruents.

4.3. Phonological constraints. In natural speech errors, segments interchange only if the resulting form is in keeping with the phonological constraints of the language. Examples such as *flay the pictor* instead of *play the victor* (from Fromkin, 1973) suggest further that these constraints take the form of actively applied rules which can alter the nature of transposed segments. Again, however, such errors are rare and alternate explanations are possible.

In order to further investigate the nature of phonological constraints, the present study contained four additional conditions which have so far received no direct mention. In all four conditions, a /p/ to /b/ transformation, applied as per the instructions, resulted in a sequence such as /-sb/, /-bt/, or /-pd/ which are nonoccurring in normally produced English words.

i) The /-pt/ condition: This condition consisted of the single word *apt*, which subjects invariably transformed as /abd/.

ii) The /-sp/ condition: This condition consisted of six words: *gasp, wisp, cusp, lisp, wasp,* and *rasp*. Each subject received all six words, which was probably a mistake in design since some subjects appeared to develop unnatural strategies for producing /-sb/ clusters on subsequent encounters with the remaining words. To prevent this, it is recommended that future studies using the present experimental paradigm adopt a counter-balancing procedure, so that transformations resulting in non-occurring sequences do not occur more than once per subject per session. Even in the present study, however, subjects only produced the /-sb/ cluster on about 10 percent of the trials. On 83 percent they produced /-zb/; on 5 percent they dropped the /s/, e.g. *wasp* transformed as *wab*; and on 2 percent they dropped the critical consonant itself: *cusp* transformed as *cus* rather than *cusb*.

iii) The /-np/ condition: Like the /-sb/ condition, this condition consisted of six words: *lamp, dump, limp, rump, hump,* and *romp*. Subjects released the /b/ in the resulting /-mb/ clusters on 26 percent of the trials; they dropped the nasal on 17 percent, e.g. *limp* transformed as *lib*; and they dropped the /b/ in 57 percent, e.g. *limp* transformed as *lim*.

iv) The inflectional endings: There were some 900 opportunities to produce nonoccurring clusters such as /-bs/ or /-pd/ in transforming syllables with critical consonants immediately preceding an inflectional ending, e.g. *laps, ribd*. Not once did subjects produce such a cluster: voicing assimilation occurred in every instance.

All four findings suggest the operation of phonological constraints which bring about voicing agreement in obstruent clusters within the same syllable. These phonological constraints did not just prevent nonoccurring forms, since the most common outcome in the /-sp/ condition was /-zb/, a nonoccurring final cluster in English. The interesting possibility for further research is that the fricative in /-sp/ receives its voicing from the plosive by means of a voicing assimilation process so that changing the voicing of the plosive automatically changes the voicing of the fricative.

4.4. Lexical factors. Lexical factors were markedly absent. We found no difference in response times or errors for non-lexical transformations, e.g. *serb-serp, bid-pid,* as opposed to lexical transformations, e.g. *bin-pin*. Response errors were as often nonwords as words and no effect of stimulus frequency was observed. And since a subsequent study with *only* nonlexical stimuli and responses (see Appendix) gave similar results, lexical factors probably play little role in the present task.

5. General Discussion

The present results are relevant to two general theories of phonological retrieval processes, the linguistic mechanisms governing what, whether, when, and how phonological information becomes available in producing speech. The more general of the two is the theory of phonological availability. Under this theory, more available or "stronger" phonological programs are retrieved faster than less available programs, and therefore have a lower probability of being omitted and a higher probability of substituting less available programs. Syntactic, semantic, and lexical processes normally play a large role in determining the relative availability of phonological programs in the perception, production, or acquisition of speech, but it is also possible to isolate some strictly phonological processes. One is syllabic position: consonants in an initial consonant group are more available than identical consonants in a syllable-final consonant group, and consonants in initial position in an initial consonant group are more available than those in next to initial position (MacKay, 1969). Syllabic stress (MacKay, 1971), phonological suppression (MacKay, 1969), and phonological disinhibition (MacKay, 1970) also play a role in phonological availability. The present study adds to these an "availability hierarchy" for stops, fricatives, liquids, and glides, such that stops are stronger or more readily available than fricatives, and fricatives are stronger or more readily available than liquids and glides (see Section 4.2).

The results also indicated that at least one distinctive feature or subsegmental component constitutes an independently controllable planning unit, subject to segment structure and syllable structure constraints. The possibility of independently controlled distinctive features raises many general issues for further research. One is the nature of phonological rules. For example, the present results raise the possibility that speakers produce English plurals by independent control of the voicing dimension for a plural archiphoneme, rather than by selection among fully integrated segments: /s/, /əz/, or /z/.

The present experimental technique seems useful for examining other aspects of segment organization, syllable structure, the nature of syllabic rules and the distinctive feature code that these rules employ as well as for testing the generality of the present results. Toward this latter goal, three further studies using /k/-/g/, /f/-/v/, and /s/-/z/ as critical consonants (see the Appendix for representative materials) have been undertaken which replicate the main results discussed above. In the /k/-/g/ study, for instance, "voicing switches" (*zag* transformed as *sack* rather than *sag*) resembled those of the /p/-/b/ study. Not so for place substitutions, however, e.g. *gad* transformed as *cag* rather than *cad*, which as often took a velar direction as a frontal one. Results for the /f/-/v/ and /s/-/z/ studies were also similar except that homorganic stops often replaced the critical fricatives, as when *file* was transformed as *bile* rather than *vile*. In contrast, fricatives rarely replaced the critical stops in the /k/-/g/ and /p/-/b/ studies. Both findings are reminiscent of the fact that children often replace fricatives or affricates with homorganic stops, e.g. *jump* mispronounced as *dup*, *fish* as *pis*, *suit* as *tut*, and *chase* as *tase* (Clark and Clark, 1977). For both children and adults, stops usually constitute "stronger" or more readily available phonological programs than fricatives.

The other theory of phonological retrieval of relevance to the present results is the model of serial order outlined in the introduction. Errors in the present study called for an extension of the theory to include diphthongization rules and a vowel nucleus unit which can be expanded as vowel+(glide)+(liquid). Such findings further reinforce Sapir's conclusion that speech sounds are not explicable in sinple sensory-motor terms but that a complex psychology underlies the utterance of even the simplest consonant or vowel.

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APPENDIX

Sample Materials: Main Experiment

Initial critical consonants

peg	beg	pegs	begs	perch	birch
puff	buff	puffed	buffed	poult	bolt
pout	bout	pouts	bouts	pund	bund
pun	bun	puns	buns	pearl	burl
pud	bud	pubs	buds	punt	bunt
pouf	bouf	poufs	boufs	punk	bunk
puck	buck	pucks	bucks	pounce	bounce
peak	beak	peaked	beaked	pound	bound
pug	bug	puged	buged	pard	bard
pail	bail	pails	bails	pork	bork
pit	bit	pits	bits		
pat	bat	pats	bats		
pack	back	packs	backs		
pan	ban	pans	bans		
pill	bill	pills	bills		

Noninitial critical consonants

gap	gab	gaped	gabed	chirp	serb
nap	nab	naped	nabed	carp	curb
lop	lob	loped	lobed	harp	herb
sop	sob	soped	sobed		
rip	rib	riped	ribed	galpe	galbe
cop	cob	cops	cobs	warp	verb
mop	mob	mops	mobs	tarp	corb
jip	jib	jips	jibs		
fop	fob	fops	fobs		
tap	tab	taps	tabs		
cup	cub	cups	cubs		
lip	lib	lips	libs		
cap	cab	caps	cabs		
lap	lab	laps	labs		
nap	nab	naps	nabs		

Sample Materials: Nonsense Syllable Experiment
(. indicates syllable boundaries)

Initial critical consonants

pung	bung	pungz	bundg	pung.zer	bung.zer
pake	buke	paket	bukes	pake.wor	buke.wor
pame	bame	pamed	bamez	pame.lan	bame.lan
pode	bowke	podz	bowkt	pod.sin	bowk.sin
powsh	bowsh	powsht	bowsht	powsh.ler	bowsh.ler
pag	bowg	pagd	bowgz	pag.wer	bowg.wer
paf	baf	paft	baft	paf.sack	baf.sack
pif	big	pift	bift	pif.mun	bif.mun
poug	boug	pougd	boudg	poug.lam	boug.lam
pij	bij	pijd	bijd	pij.tak	bij.tak

Noninitial critical consonants

hap	hab	hapt	habd	hap.ker	hab.ker
hayp	hayb	hayps	haybz	hayp.ker	hayb.ker
nipe	nibe	nips	nibez	nipe.zer	nibe.zer
lipe	libe	lipet	libed	lipe.ter	libe.ter
tuwp	towb	tuwpt	towbd	tuwp.man	towb.man
cipe	cibe	cipes	cibez	cipe.sak	cibe.sak
mape	mabe	mapet	mabed	mape.sig	mabe.sig
lape	labe	lapes	labez	lape.day	labe.day
cip	cib	cips	cibz	cip.ter	cib.ter
fipe	fibe	fipt	fibed	fip.lan	fibe.lan