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Acquisition of /s/-initial Clusters: A Parametric Approach

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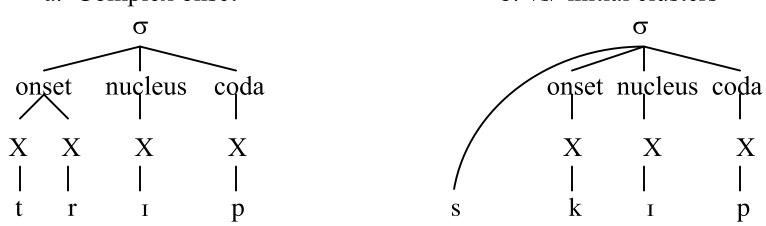
1. Introduction

The special status of word-initial /s/-consonant clusters has long been observed by researchers: Some /s/-initial sequences, such as /s/-stop clusters, violate the Sonority Sequencing Principle. In English, /s/ is the only word-initial consonant that may be followed by another homorganic consonant (e.g. /st-/, /sn-/), by either a nasal or a stop (e.g. /sm-/, /sn-/, /sp-/), or by a two-element consonant cluster (e.g. /spr-/, /spl-/, /str-/). It has also been noted that /s/-initial clusters are treated differently from other onset clusters by speakers of different ages and different languages (e.g. Fikkert 1994, Romani & Calabrese 1998, Barlow 2001). Yet, the structural status of /s/-initial clusters is still controversial. In recent studies of the acquisition of /s/-initial clusters, the initial /s/ has been analyzed as an element outside the initial syllable, termed either "extrasyllabic" (Fikkert 1994), an "adjunct" (Gierut 1999, Barlow 2001), or an "appendix" (Goad & Rose in press). Gierut (1999) provides the following structural comparison of obstruent-sonorant clusters and /s/-initial clusters:

(1) a. Complex onset b. /s/-initial clusters



(Gierut 1999:709)

According to this analysis, an obstruent-sonorant cluster is a true cluster – an actual branching onset. In contrast, an /s/-initial cluster is not a true cluster, but rather an /s/ adjoined to a simple onset. This analysis can account for the special

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status of /s/-initial clusters. Since /s/-initial clusters are not branching onsets, it explains why they do not obey the Sonority Sequencing Principle, or the phonotactic constraints against initial homorganic clusters and obstruent-nasal sequences. A three-element cluster is analyzed as a sequence of an adjunct /s/ followed by a true, two-element cluster. Because /s/-initial clusters and obstruent-sonorant clusters are structurally different, they are naturally treated differently by speakers.

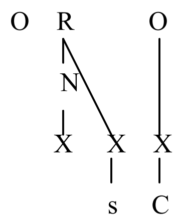
Nonetheless, many questions are left open. First, the markedness status of /s/-initial clusters is problematic. The special structure of /s/-initial clusters (1b) suggests that they are more marked than obstruent-sonorant clusters, and hence that they should be acquired later than obstruent-sonorant clusters. While some studies have found late acquisition of /s/-initial clusters, others have reported that /s/-initial clusters are acquired even earlier than obstruent-sonorant clusters (Fikkert 1994, Gierut 1999, Barlow 2001). Second, the evidence suggests that the acquisition of /s/-initial clusters is independent of the acquisition of obstruent-sonorant clusters. A natural question one may ask is whether the acquisition of /s/-initial clusters is related to other aspects of syllable acquisition. This question has never been addressed. Third, the adjunct account explains children's error of reducing /s/-initial clusters by deleting the adjunct /s/, but it cannot explain why some children insert a vowel before the initial /s/. Finally, the adjunct status of the initial /s/ is stipulated specifically for this case, which makes the account less satisfactory theoretically. In this paper, we propose a new analysis that answers these remaining questions.

2. A new analysis

The theoretical framework we adopt is Government Phonology (GP) (Kaye, Lowenstamm & Vergnaud 1990, Kaye 1990,1993). GP is a "principles and parameters" approach to phonology – Universal Grammar is taken to consist of a set of universal principles common to all languages, together with a series of parameters each with a limited set of values. This framework implies that a child's task in acquiring core grammar is one of setting the parameters correctly, based on the linguistic input. This model is rarely applied to the acquisition of phonology. Recently, however, we have applied GP to the study of syllable acquisition (Pan & Snyder 2003, 2004, in review).

We adopt Kaye's (1992) proposal for the structure of /s/-initial clusters, as shown in (2).

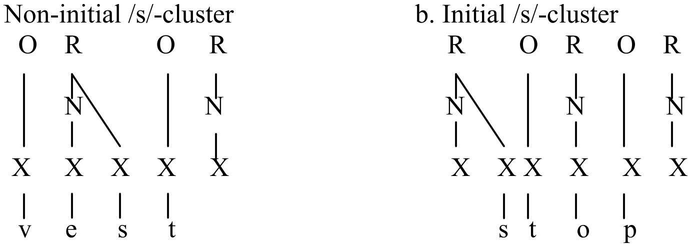
(2)



(Kaye 1992:293)

Much as in the adjunct account, Kaye takes /s/-initial clusters as structurally different from true branching onsets. Yet, rather than positing /s/ as an adjunct, he proposes that all /s/-clusters are rhymal complement-onset sequences. The initial /s/-clusters are then rhymal complement-onset sequences with an empty nucleus. The diagrams in (3) are structural illustrations of a non-initial /s/-cluster and an initial /s/-cluster. Their only difference lies in whether the nuclear position before /s/ is filled or empty.

(3) a. Non-initial /s/-cluster b. Initial /s/-cluster



(adapted from (Kaye 1992))

Under the proposal in (2), to produce /s/-initial clusters, a child must know (i) that rhymes can branch, and (ii) that the nuclear position before /s/ can be empty. More formally, we propose that the two parameters in (4) and (5) account for the acquisition of /s/-initial clusters.

(4) *Branching Rhyme Parameter (BR)*:
Rhymes may branch. [No/Yes]
(Kaye 1989, Harris 1994, Pan & Snyder, in review)

(5) *Magic Empty Nucleus Parameter (MEN)*:
Magic empty nuclei are allowed. [No/Yes]

The Branching Rhyme Parameter has two values – rhymes either can or cannot branch – and the negative value (underlined) is the default. It is widely observed that syllable systems differ in whether they allow rhymes to branch. The Branching Rhyme Parameter has been proposed specifically to capture this crosslinguistic variation (e.g. in Kaye (1989) and Harris (1994)). Examples of [+BR] languages are English, Dutch, and Arabic, while Desano, Hua, and

Hawaiian are examples of [-BR] languages. In Pan & Snyder (in review), this parameter is further supported through investigation of syllable acquisition.

According to GP's Empty Category Principle (Kaye, Lowenstamm & Vergnaud 1990, Kaye 1990), a *p*-licensed empty category receives no phonetic interpretation. Yet, it is unclear how the empty category before /s/-clusters is licensed. Kaye (1992) therefore proposes that in some languages, an /s/-cluster can serve as a *p*-licenser. This type of *p*-licensing is termed “Magic Licensing.” Following Kaye, we propose the Magic Empty Nucleus Parameter (MEN) in (5). A "magic empty nucleus" is the nucleus before an /s/-initial cluster that is magically licensed, and hence inaudible. The [MEN] parameter has two settings – either to allow or to disallow magic empty nuclei. When the setting is [+MEN], the language allows /s/-initial clusters, as in English, Dutch, and Italian. When the setting is [-MEN], /s/-initial clusters are forbidden, as they are in Spanish, Brazilian Portuguese. Another example of the effects of the [MEN] parameter comes from the adaptation of borrowed words in Spanish, as in (6).[1] Spanish is a [-MEN] language, and one can never find a Spanish word starting with an /s/-cluster. A vowel is therefore inserted at the beginning of any borrowed word that originally began with an /s/-cluster.

(6) *espagueti* ‘spaghetti’, *esprey* ‘spray’, *esfera* ‘sphere’

3. A prediction for acquisition

Based on the structure in (2), if a child can produce /s/-initial clusters, then she should have knowledge of both branching rhymes and magic empty nuclei. That is, production of /s/-initial clusters requires both [+BR] and [+MEN]. Hence, /s/-initial clusters should never be acquired prior to branching rhymes (with an overt nucleus). The latter require only the setting of [+BR], and the prerequisite for branching rhymes is therefore a proper subset of the prerequisites for /s/-initial clusters.

A point we have to note is that GP differs from other frameworks in its definition of branching rhymes. Mainstream phonology would consider a CVC syllable as in (7a) to contain a branching rhyme, but GP treats this as two onset-rhyme pairs with the final nuclear position empty. Thus, as shown in (7b), no branching rhyme is involved.

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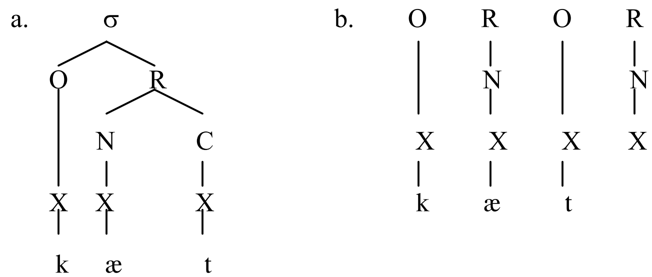
1. Thanks to an anonymous reviewer for pointing out these examples to us.

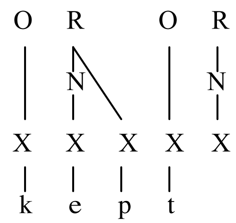
(7)



(σ=syllable, O=onset, R=rhyme, N=nucleus, C=coda, X=skeletal position)

GP limits use of the "coda" position. The Coda Licensing Principle (Kaye 1990:311) says post-nuclear rhymal positions must be licensed by a following onset. Hence, a branching rhyme structure looks like (8), where the post-nuclear rhymal position is followed by an onset. Note that there is an empty nucleus after /t/ in (8). This final empty nucleus is treated as distinct from the magic empty nucleus before /s/-initial clusters. For discussion of the acquisition of final empty nuclei, see (Pan & Snyder 2003).

(8)



(Kaye 1990:312)

Thus, our prediction that /s/-initial clusters will never be acquired prior to branching rhymes (i.e., with an overt nucleus) should be understood as follows: word-initial /s/-C sequences should never be acquired prior to CVCCV sequences.[2]

To test this prediction, we examined the Fikkert-Levelt corpora for 12 children acquiring Dutch (Fikkert 1994, Levelt 1994, MacWhinney 2000). Eight of the 12 children acquired /s/-initial clusters during their recording period, and all of these children acquired /s/-initial clusters either together with, or later than, branching rhymes ((C)VCC(V)). Three children (Eva, Enzo, Leonie) never produced /s/-initial clusters, but they did produce branching rhymes. Jarmo is

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2. Note that there are other sequences containing branching rhymes, such as CVCC, VCCV, VCC. However, since these sequences also involve marked settings of Empty Onset Parameter [+EO] or Empty Nucleus Parameter [+EN] (Pan & Snyder 2003) which may be set later than [+MEN] and [+BR], we do not predict that /s/-initial clusters are necessarily acquired later than these sequences.

the only child who failed to use branching rhymes by the end of his corpus. As predicted, Jarmo also failed to produce /s/-initial clusters. Crucially, none of the 12 children began producing /s/-initial clusters prior to branching rhymes. Our prediction is thus fully borne out. The details are provided in (9).

(9)

Child	Branching rhyme	Initial /s/+sonorant	Initial /s/+obstruent
Catootje	1;11	2;4	2.5
David	1;11(1st session)	1;11 (2nd session)	1;12
Elke	2;3	Not Found	2;4
Leon	1;10	1;11	2;4
Noortje	2;5	Not Found	2;8
Robin	1;6	2;3	2;2
Tirza	1;10	Not Found	2;7
Tom	1;6	1;10	Not Found
Eva	1;8	Not Found	Not Found
Enzo	1;11	Not Found	Not Found
Leonie	1;11	Not Found	Not Found
Jarmo	Not found	Not Found	Not Found

(Age of acquisition is taken here as the age of second clear use.)

More evidence comes from an intermediate grammar of Catootje. Fikkert (1994) notes that Catootje often inserted a vowel before /s/-initial clusters, as shown in (10), but not before other clusters. The fact that she syllabified the initial /s/ as a rhymal-complement position indicates that she could produce branching rhymes. Vowel epenthesis before the initial /s/, however, suggests that she could not yet produce magic empty nuclei. These examples support the view that Catootje's grammar during this stage was [+BR, -MEN].

(10)	*schapen*	/`sχaːpə[n]/	→	[əs`haːpə]	(2;5.8)
	schoen	/sχuːn/	→	[əs`huːn]	(2;5.8)
	staart	/staːrt/	→	[əstaːt]	(2;5.8)
	stoel	/stuːl/	→	[əstuː]	(2;5.22)
				(Fikkert 1994:112)	

4. A crosslinguistic prediction

The structure in (2) further predicts that any language with /s/-initial clusters will also allow branching rhymes with an overt nucleus. We have checked a number of languages with /s/-initial clusters, including Dutch, English, Isthmus Zapotec, Italian, Misantla Totonac, Serbo-Croatian, Seri, Wichita, Yatee Zapotec, and Yuchi.[3] Thus far, we have not found a

3. We thank Morelli (1999) for references to some of these languages.

counterexample. These languages, their /s/-initial clusters, and some example words with branching rhymes are given below.[4]

(11) *Dutch*
Language family: Indo-Eurpean (Germanic)
Data source: Trommelen (1984)
/s/-initial clusters: sp st sk sf sx sl
Branching rhymes: *slurf* 'trunk', *darm* 'bowel', *molm* 'mold'

(12) *English*
Language family: Indo-European (Germanic)
Data source: Harris (1994)
/s/-initial clusters: st sp sk sl sw sm sn str spr spl skr
Branching rhymes: *chapter*, *mist*, *winter*

(13) *Isthmus Zapotec*
Language family: Zapotec/Amerindian
Data source: Marlett and Pickett (1987)
/s/-initial clusters: st sk
Branching rhymes: *randa* 'able', *yanda* 'cold'

(14) *Italian*
Language family: Indo-European (Romance)
Data source: Davis (1990)
/s/-initial clusters: sp st sk sf sl sn sm
Branching rhymes: *scampo* 'rescue', *smalto* 'pavement'

(15) *Misantla Totonac*
Language family: language isolate
Data source: MacKay (1994)
/s/-initial clusters: st sk sp sq sm sn sl sw sy
Branching rhymes: *číškúʔ* 'man', *čukú̱ŋku̱* 'cold'

(16) *Serbo-Croatian*
Language family: Indo-European (Slavic)
Data source: Hodge (1946)
/s/-initial clusters: sp st sk sf sv sh sr sl sl' sm sn sn' sj spr str skr svr smr svj smj stv skv spl skl svl
Branching rhymes: *jèsti* 'to eat', *nòkta* 'fingernail', *krùmpiir* 'potatoes'

(17) *Seri*
Language family: Hokan

4. The lists of /s/-initial clusters in (11-20) are not necessarily exhaustive.

Data source: Marlett (1988)
/s/-initial clusters: st sk sp sɬ sn
Branching rhymes: *kapka* 'rain', *ʔast* 'stone', *ʔonk* 'duck'

(18) *Wichita*
Language family: Caddoan
Data source: Rood (1975)
/s/-initial clusters: sk
Branching rhymes: *iskʷa* 'go!', *ksaːrʔa* 'bed'

(19) *Yatee Zapotec*
Language family: Zapotecan
Data source: Jager and Van Valin (1982)
/s/-initial clusters: st sč sw
Branching rhymes: *gasx* 'black', *zápx* 'chayote vine'

(20) *Yuchi*
Language family: language isolate
Data source: Wolff (1948), Crawford (1973)
/s/-initial clusters: st sp sʔ sy stʔ skw sʔy
Branching rhymes: *dompa* 'hand', *ʔispi* 'black', *bʔaxte* 'horse'

5. Comparison with Fikkert's (1994) analysis

Fikkert (1994) also provides a parametric analysis of syllable acquisition in Dutch children. For her, the parameter relevant to /s/-initial clusters is the one given in (21).

(21) *Extrasyllabicity Parameter*
Can consonants at the left edge, which violate the Sonority Sequencing Principle, be extrasyllabic? Yes/No
(Fikkert 1994: 118)

The default setting of the Extrasyllabicity Parameter disallows initial extrasyllabic consonants. At first, children do not produce /s/-initial clusters. Only when the extrasyllabicity parameter is set to its marked value do /s/-initial clusters appear. This analysis is essentially an "adjunct" account, and it therefore treats the acquisition of /s/-initial clusters as unrelated to the acquisition of branching rhymes.

6. Advantages of the present analysis

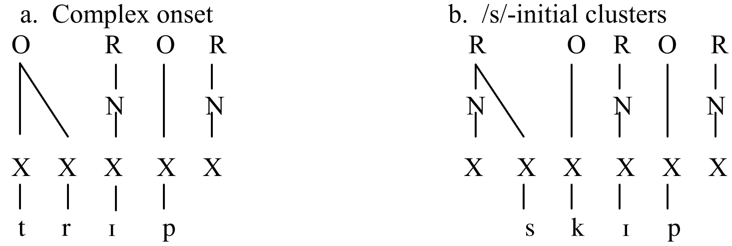
The present analysis, like the adjunct accounts, captures the special status of /s/-initial clusters. As (2) shows, /s/-initial clusters and branching onsets have completely different structures. This explains why /s/-initial clusters are so different from obstruent-sonorant clusters. Moreover, the present analysis answers the questions that the adjunct account does not.

Let us go back to the unsolved problems left by the adjunct account. First, the markedness status of /s/-initial clusters has long been a problem. As noted above, the early acquisition of /s/-initial clusters is not expected from the exceptional structure in (1b). In our analysis, although both obstruent-sonorant clusters and /s/-initial clusters are word initial consonant sequences, it is inappropriate to compare their markedness status, because they involve completely different structures. An obstruent-sonorant cluster forms a complex onset/branching onset, while an /s/-initial cluster involves a branching rhyme. Their structures are shown in (22).

In our parametric analysis of syllable acquisition, parameter settings are not ordered (Pan & Snyder, in review). Based on the input, some children may set the Branching Onset Parameter [BO] to its marked value earlier than [BR], while others may set [BR] earlier than [BO]. It is thus expected that some children acquire obstruent-sonorant clusters earlier, and others acquire /s/-initial clusters earlier — the latter happens if both [BR] and [MEN] are set to their marked values when [BO] still has its default value.

Crosslinguistic facts also support our claim that obstruent-sonorant clusters and /s/-initial clusters do not stand in a markedness relationship to one another. There are languages like Acoma (Miller 1965) that allow only /s/-initial clusters. There are also languages like Spanish (Harris 1969) that allow only complex onsets.

(22) a. Complex onset b. /s/-initial clusters



Second, the acquisition of /s/-initial clusters is both independent of the acquisition of branching onsets, and systematically related to (ordered after) the acquisition of branching rhymes. Only the present analysis offers an explanation for these facts.

Third, it has been observed that children either delete the initial /s/, or insert a vowel in front of the /s/, before they correctly produce /s/-initial clusters. These two strategies are easily explained by the present analysis. Before children acquire magic empty nuclei, they either delete a branching rhyme with a magic empty nucleus, or turn the empty nucleus into an overt nucleus by inserting a vowel. They insert a vowel before the /s/ precisely because there is a nuclear position there.

Finally, the present analysis is simple. It does not need to stipulate an additional adjunct position. The initial /s/ is not all that special. It is in a post-nuclear rhymal position, which is a part of branching rhymes more generally. As to the two parameters proposed for the acquisition of /s/-initial clusters, [BR] is needed independently to explain the two alternative choices of rhymes, branching and non-branching (Kaye 1989, Harris 1994, Pan & Snyder, in review). The [MEN] parameter, for its part, receives strong support from both acquisitional and crosslinguistic evidence.

7. Conclusion

In this paper we have examined the status of /s/-initial clusters within the framework of GP. Specifically, we have argued that the acquisition of /s/-initial clusters is related to the acquisition of branching rhymes. By treating /s/ as a rhymal-complement position preceded by an empty nucleus, we have shown that many problems unsolvable in the adjunct account are now satisfactorily resolved. Furthermore, this analysis correctly predicts an implicational relationship between /s/-initial clusters and branching rhymes, both in syllable acquisition and typology. In our analysis, the /s/-initial clusters are not in fact /s/-initial, because the so-called initial /s/ is always preceded by an empty nucleus.

References

Barlow, Jessica A. 2001. The structure of /s/-sequences: Evidence from a disordered system. *Journal of Child Language*, 28: 291-324.

Crawford, James M. 1973. Yuchi phonology. *International Journal of American Linguistics*, 39 (3): 173-179.

Davis, Stuart. 1990. Italian onset structure and the distribution of *il* and *lo*. *Linguistics*, 28: 43-55.

Fikkert, Paula. 1994. *On the Acquisition of Prosodic Structure*. Ph.D dissertation, Leiden University, The Netherlands.

Gierut, Judith A. 1999. Syllable onsets: clusters and adjuncts in acquisition. *Journal of Speech, Language, and Hearing Research*, 42: 708-726.

Goad, Heather and Yvan Rose. In press. Input elaboration, head faithfulness and evidence for representation in the acquisition of left-edge clusters in West Germanic. In Kager, René, Joseph Pater, and Wim Zonneveld, (eds.) *Fixing priorities: Constraints in phonological acquisition.* Cambridge: Cambridge University Press.

Harris, James W. 1969. *Spanish phonology*. Cambridge, MA: MIT Press.

Harris, John. 1994. *English Sound Structure*. Oxford: Blackwell.

Hodge, Carleton T. 1946. Phonemes of Serbo-Croatian. *Language*, 22: 112-120.

Jaeger, Jeri J. and Robert D. Van Valin. 1982. Initial consonant clusters in Yateé Zapotec. *International Journal of American Linguistics*, 48 (2): 125-138.

Kaye, Jonathan. D. 1989. *Phonology: A cognitive View*. Hillsdale, NJ: Lawrence Erlbaum.

Kaye, Jonathan. D. 1990. Coda licensing. *Phonology*, 7 (2): 301-330

Kaye, Jonathan. D. 1992. Do you believe in magic? The story of s+C sequences. *SOAS Working Papers in Linguistics*, 2: 293-313.

Kaye, Jonathan D. 1993. Derivations and interfaces. In Durand, Jacques and Francis Katamba (eds.) *Frontiers Of Phonology: Atoms, Structure, Derivation*, 289-332, London and New York: Longman

Kaye, Jonathan D., Jean Lowenstamm and Jean-Roger Vergnaud. 1990. Constituent structure and government in phonology. *Phonology*, 7 (2): 193-231.

Levelt, Clara. 1994. *On The Acquisition Of Place*. The Hague: Holland Academic Graphics.

MacKay, Carolyn J. 1994. A sketch of Misantla Totonac phonology. *International Journal of American Linguistics*, 60 (4): 369-419.

MacWhinney, Brian. 2000. *The CHILDES Project: Tools for Analyzing Talk*. Mahwah, NJ: Lawrence Erlbaum Associates.

Marlett, Stephen A. 1988. The syllable structure of Seri. *International Journal of American Linguistics*, 54 (3): 245-278.

Marlett, Stephen A. and Velma B. Pickett. 1987. The syllable structure and aspect morphology of Isthmus Zapotec. *International Journal of American Linguistics*, 53 (4): 398-422.

Miller, Wick R. 1965. *Acoma Grammar and Texts*. Berkeley, CA: University of California Press.

Morelli, Frida. 1999. *The Phonotactics and Phonology of Obstruent Clusters in Optimality Theory*. Ph.D. dissertation. University of Maryland at College Park.

Pan, Ning and William Snyder. 2003. Setting the parameters of syllable structure in early child Dutch. In Beachley, Babara, Amanda Brown and Frances Conlin (eds.), *Proceedings of the 27th Annual Boston University Conference on Language Development*, 615-625. Cascadilla, Somerville, MA.

Pan, Ning and William Snyder. 2004. Acquisition of phonological empty categories: A case study of early child Dutch. In Di Sciullo, A. M. and R. Delmonte (eds.), *UG and External Systems*. Amsterdam: John Benjamins.

Pan, Ning and William Snyder. In review. A parametric account of syllable acquisition and syllable typology.

Romani, Cristina and Andrea Calabrese. 1998. Syllable constraints in the phonological errors of an aphasic patient. *Brain and Language*, 64, 83-121.

Rood, David S. 1975. The implications of Wichita phonology. *Language*, 51 (2): 315-337.

Trommelen, Mieke. 1984. *The syllable in Dutch: with special reference to diminutive formation*. Dordrecht: Foris.

Wolff, Hans. 1948. Yuchi phonemes and morphemes, with special reference to person markers. *International Journal of American Linguistics*, 14: 240-243.