

A Preliminary Typology of Word-Initial Clusters with an Explanation for Asymmetries in Acquisition*

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Abstract

Studies of normal and disordered phonological development have evidenced an asymmetry in the development of clusters in English, particularly the /s/ clusters relative to other clusters. An explanation for this asymmetry is found by appealing to differing structural representations. Some clusters may be represented as complex onsets, while others (e.g., /s/ clusters) may be represented as adjunct clusters. A typology of cluster production is presented based on data from normally developing and disordered phonologies. Several possible stages are posited, and it is argued that a grammar may allow for adjunct clusters only, complex onsets only, or both adjunct clusters and complex onsets. The typology is offered via optimality theory and involves possible constraint rankings for individual grammars and separate stages in development. Markedness constraints on syllable structure, sonority sequencing, and minimal distance are ranked in conflict with certain faithfulness constraints. Crucial to the account is the assumption that not all children pass through all the same stages in the same order. This explains the apparent asymmetries noted—within and across children’s grammars—in the acquisition of /s/ clusters relative to other clusters.

1. Introduction

The acquisition research, whether from normal or disordered development, has shown that there does not seem to be a true order of acquisition of specific word-initial consonant clusters in English. Children seem to differ in terms of which individual cluster is acquired first, and which is acquired last. This is not so surprising, since we have found the same to be true with the development of singleton sounds. Ideally, though, we should be able to make some general claims about the classes of sounds or clusters that are acquired earlier and those acquired later. Unfortunately, even such general claims are not easily made.

Consider for example the acquisition of the /s/ clusters relative to other clusters of the language shown in (1) and (2). According to some studies they are acquired relatively early, but according to others they are acquired relatively late. Looking in particular at case studies, we see, for example from normal development, that Amahl in (1d) acquired the /s/ clusters later than most other clusters. From disordered development we see that Subject 2, in (2a) acquired all the /s/ clusters before other clusters. The same happened for Subjects 3 and 8 in Gierut’s (1999) study, as referred to in (2b). Chin reported on a child who acquired non-/s/ clusters first, as in (2c), while in (2d) we see that Subject 25 acquired both types of clusters at the same time.

(1) Asymmetries in Cluster Development: Normal Development

- a) Stoel-Gammon and Dunn (1985) adapted from Templin (1957)
 pl bl kl gl pr br tr dr kr tw kw sm sn sp st sk > gr fl fr str > skw > spl spr skr sl sw jr θr
- b) Smit et al. (1990)
 tw kw > pl bl kl gl fl > sp st sk sm sn sw sl skw spl spr str skr > pr br tr dr kr gr fr jr > θr
- c) Smit (1993)—based on Smit et al. (1990) and Templin (1957)
 tw kw > pl bl kl gl > pr br tr dr kr gr fr jr > sp st sk sm sn sw > sl θr > skw > spl spr str skr
- d) Smith (1973): case study of Amahl
 pl bl kl gl > pr br kr gr > tr dr > fl fr > jr > sl > sm sn > sp st tw kw sw > st > C/j/

(2) Asymmetries in Cluster Development: Disordered Development

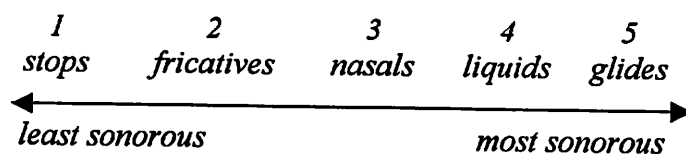
- a) Barlow (1997): Subject 2
 - pretreatment: no clusters
 - posttreatment: /s/ + approx, nasal, and stop clusters present
 - 2 mos. posttreatment: all clusters present
- b) Gierut (1999): Subjects 3 and 8: /s/ + (nasal) stop clusters only
- c) Chin (1996): Subject 6: obstruent + sonorant (non-/s/) clusters only
- d) Subject 25
 - pretreatment: no clusters (Barlow, 1997; Chin, 1996)
 - posttreatment: obstruent + sonorant and /s/ clusters present

Order of acquisition is one factor that determines relative markedness of sounds and clusters in language. Specifically, children are expected to acquire the unmarked properties of language first. Because of this unusual behavior of /s/ clusters, it is difficult to determine if they are marked or not. If /s/ clusters are early acquired, then it would be reasonable to assume that they are unmarked relative to other clusters. However, if they are later acquired, then we would assume they are marked relative to other clusters.

We may ask then, are /s/ clusters marked or unmarked? Gierut (1999) addresses this puzzle with a treatment study. She determined that treatment on /s/ + stop clusters resulted in within-class learning only, such that generalization was limited. This type of generalization is characteristic of learning patterns associated with treatment on unmarked aspects of sound systems. This has been shown in many other independent studies on a variety of aspects of sound systems, and it suggests that the /s/ + stop clusters are unmarked.

Another means for determining markedness in clusters involves an appeal to sonority. Accounts of consonant clusters in fully developed systems typically appeal to the sonority hierarchy, which ranks sounds according to their relative degree of sonority (a generic hierarchy is shown in (3)). There is also an appeal to the sonority sequencing principle or the SSP (shown in (4)) which states that onsets (or word-initial clusters) must rise in sonority and codas (or word-final clusters) must fall in sonority. Minimal distance constraints are also posited which appeal to the sonority distance between two sounds. Referring again to (3), numerical values are assigned to each sound class, and the distance between them can be calculated. The greater the sonority distance between two segments in a cluster, the less marked the cluster is. Typologically speaking, if a language has clusters with a smaller sonority distance, it is expected that the same language will also have clusters with a greater sonority distance. In acquisition, it is therefore expected that those clusters with greater sonority distance emerge first, while those with a smaller sonority distance emerge later. However, this prediction is not borne out in those cases where /s/ + stop and /s/ + nasal clusters, for example, which have a small sonority distance, emerge prior to any clusters with a greater sonority distance.

(3) Sonority Hierarchy (adapted from Clements, 1990)



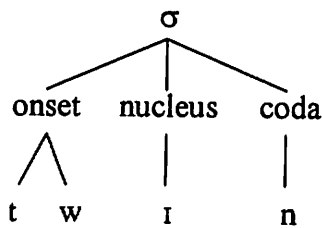
(4) Sonority Sequencing Principle (SSP): Onsets rise in sonority and codas fall in sonority.

In addition to the order of acquisition facts, the /s/ clusters are further problematic for theoretical accounts of English and other languages with /s/ clusters. First, /s/ + stop clusters violate the SSP in that they have a falling sonority slope. Second, clusters /sl-/, /sn-/ and /st-/ violate a phonotactic constraint on word-initial clusters in English which prohibits homorganic clusters. Third, /s/ is the only sound that may be followed by a nasal or a stop in word-initial clusters. Finally, /s/ is the only sound that may occur at the beginning of a three-element cluster such as /str-/ or /spl-/. All of these facts are revealing of the special status of /s/ clusters.

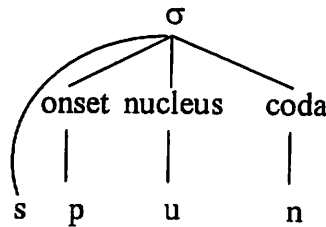
Many different accounts for the /s/ clusters have been proposed to address this special status, and some relate to their representational structure. For example, some accounts assume that /s/ clusters—in particular, the /s/ + stop clusters—are really adjunct clusters, where the /s/ is not syllabified directly under the onset portion of a syllable, but rather is a direct dependent of the syllable, thereby avoiding violation of the SSP. Under this analysis, all other clusters comprise complex onsets. A typical complex onset structure is shown in (5a), and (5b) illustrates this adjunct structure.

(5) Structural Differences Among Consonant Clusters of English

a) Clusters as Branching Onsets



b) /s/ Clusters as Adjuncts



Some notable studies that argue for the adjunct structure are listed in (6). Most accounts only include the /s/ + stop clusters as having this special structure. Other /s/ clusters are accounted for by appealing to, for example, a modified version of the sonority hierarchy and language-specific constraints related to sonority distance between segments in a cluster. What is most interesting is that some developing grammars are better explained by appealing to this adjunct status in (5b), whereas other developing grammars are better accounted for by assuming that all clusters are complex onsets as in (5a). Perhaps it is possible for different grammars to produce different types of clusters.

(6) Selected Accounts of /s/ Clusters as Adjuncts

- a) English (Giegerich, 1992; Kenstowicz, 1994)
- b) Dutch (Fikkert, 1994; Trommelen, 1983)
- c) Italian (Davis, 1990, 1992)
- d) Sanskrit and Gothic (Steriade, 1988)

2. A Typology of Grammars

If we assume that there exist such differing grammars, then, based on English developmental facts, there may be no markedness relationship between the true clusters that comprise complex onsets and the adjunct clusters. This would explain the differing patterns of acquisition of clusters that have been reported. This is illustrated with a possible typology listed in (7). Specifically, a grammar could exclude all types of clusters, as in grammar I. A different grammar could allow for adjunct clusters only, as in IIa. Yet another grammar could allow for complex

onsets only, as in IIb. Finally, a different grammar could allow for both complex onsets and adjuncts, as in grammar III.

(7) Typology of Cluster Production

Grammar	Examples
I. No clusters	Subject 2, pretreatment (Barlow, 1997) Subject 25, pretreatment (Barlow, 1997; Chin, 1996)
IIa. Adjuncts only	Subject 2, posttreatment (Barlow, 1997) Subjects 3 and 8 (Gierut, 1999)
IIb. Complex onsets only	Subject 6 (Chin, 1996) Subject 25, posttreatment Amahl (Smith, 1973)
III. Complex onsets and adjuncts	Subject 2, two months posttreatment (Barlow, 1997)

We can account for this typology with an appeal to the theoretical framework of optimality theory and a set of ranked constraints on output forms. There are three major relevant constraints that relate to cluster production, and these are competing markedness and faithfulness constraints shown in (8a) (see also Chin, 1996; Gnanadesikan, 1996; Barlow, 1997). There is the markedness constraint against complex onsets, which is *COMPLEX. This constraint is in conflict a faithfulness constraint prohibiting the deletion of segments from the input, which is MAX. There is another markedness constraint that prohibits adjuncts, which is *ADJUNCT.¹

Additional constraints must be appealed to in order to account for individual production patterns, and these are shown in (8b). There is a licensing constraint that shows a cross-linguistic preference for /s/ as an adjunct. This is the constraint ADJUNCT-/s/. To account for the preference for obstruents over sonorants in the pattern of cluster reduction, we appeal to two related markedness constraints that relate to the sonority hierarchy. The first is *M/SONORANT, which prohibits sonorants in the syllable margin and is universally ranked higher than the second constraint, *M/OBSTRUENT, which prohibits obstruents in the margin. This is a means for achieving a maximal rise in sonority between the onset and the nucleus (Clements, 1990), which results in the least marked syllable shape. Finally, there must be a constraint that licenses only a certain (language-specific) sonority distance between clusters, and that is MINDIST.

(8) Appeal to Optimality Theory

a) Core constraints

*COMPLEX: Avoid branching onsets (Prince and Smolensky, 1993).

MAX: Preserve underlying (input) segments in the surface (output) form (McCarthy and Prince, 1995).

*ADJUNCT: Adjuncts are prohibited (Barlow, 1997; adapted from Sherer, 1994).

b) Peripheral constraints

ADJUNCT-/s/: Only /s/ is licensed by the adjunct position (adapted from series of constraints on extrasyllabic segments proposed by Sherer, 1994).

*M/SON: Sonorants may not be parsed in syllable margins (adapted from Prince and Smolensky, 1993); universally ranked higher than *M/OBS.

*M/OBS: Obstruents may not be parsed in syllable margins (adapted from Prince and Smolensky, 1993); may be exploded into *M/FRIC and *M/STOP

MINDIST: Onsets have a minimal sonority distance of a language-specific value.

Our typology may now be considered in terms of different possible constraint rankings—in other words, different possible grammars—for the production of target clusters. Four different constraint rankings can predict our cluster typology, and these are shown in (9). For those grammars that disallow both types of clusters, *COMPLEX and *ADJUNCT would both be ranked higher than MAX, as in ranking I.

- (9) Typology of Core Constraint Rankings
- I. *COMPLEX, *ADJUNCT >> MAX
 - IIa. *COMPLEX >> MAX >> *ADJUNCT
 - IIb. *ADJUNCT >> MAX >> *COMPLEX
 - III. MAX >> *COMPLEX >> *ADJUNCT

This is illustrated in the tableau in (10) for Subject 25 pretreatment (Barlow, 1997; Chin, 1996). With *ADJUNCT and *COMPLEX undominated, all clusters are reduced to the least sonorous singleton segment. This is a common reduction strategy we see across most developing systems and it results in a maximal rise in sonority (Barlow, 1997; Chin, 1996; Gnanadesikan, 1996). (Note that a period is used to separate adjunct segments from onsets.)

(10) Subject 25, pretreatment: Ranking I (No clusters)

	*COMP	*ADJ	MAX	*M/SON	*M/FRIC	*M/STOP
'blow' /blo/						
a. blo	*!			*		*
b. b.lo		*!		*		
c. bo			*			*
d. lo			*	*!		
'stove' /stov/						
a. stov	*!				*	*
b. s.tov		*!				*
c. sov			*		*!	
d. dov			*			*
'snow' /snou/						
a. snou	*!			*	*	
b. s.nou		*!		*		
c. sou			*		*	
d. nou			*	*!		

For other grammars, *COMPLEX may remain ranked higher than MAX while *ADJUNCT is ranked lower, which would allow for only adjunct clusters, as in ranking IIa in (9). This is illustrated in the tableau in (11) for Subject 2's grammar posttreatment (Barlow, 1997). In this case, all non-/s/ clusters are reduced to the least sonorous segment because of high-ranking *COMPLEX, but all /s/ clusters, regardless of the segmental makeup, surface correctly because of low ranking *ADJUNCT. In this case, it is assumed that all /s/ clusters in Subject 2's grammar are adjunct clusters.

(11) Subject 2, posttreatment: Ranking IIa (Adjuncts only)

	*COMP	ADJ-/s/	MAX	*ADJ	*M/SON	*M/OBS
'blow' /blo/						
a. blo	*!				*	*
b. b.lo		*!		*	*	
c. bo			*			*
d. lo			*		*!	
'snow' /sno/						
a. sno	*!				*	*
b. s.no				*	*	
c. so			*!			*
d. no			*!		*	
'sky' /skai/						
a. skai	*!					**
b. s.kai				*		*
c. sai			*!			*
d. kai			*!			*

Then for other grammars, *ADJUNCT may remain ranked higher than MAX while *COMPLEX is ranked lower, allowing for only complex onsets, as in ranking IIb in (9). The tableau in (12) shows this for Subject 6's grammar in Chin (1996). In this case, obstruent + sonorant clusters—including the /sl-/ clusters—are produced correctly, but other /s/ clusters—specifically the /s/ + nasal and /s/ + stop clusters are reduced to the obstruent. This is accounted for by high-ranking *ADJUNCT and the MINDIST constraint that requires that clusters have a minimum sonority distance of 2, as based on the generic sonority hierarchy in (3).²

(12) Subject 6: Ranking IIb (Complex onsets only)

	*ADJ	MINDIS=2	MAX	*M/SON	*M/OBS	*COMP
'play' /pleɪ/						
☞ a. pleɪ				*	*	*
b. p.leɪ	*!			*		
c. peɪ			*!		*	
d. leɪ			*!	*		
'sleep' /slɪp/						
☞ a. slɪp				*	*	*
b. s.lɪp	*!			*		
c. sɪp			*!		*	
d. lɪp			*!	*		
'snow' /snoʊ/						
a. sno		*!		*	*	*
b. s.no	*!			*		
☞ c. so			*		*	
d. no			*	*!		
'sky' /skaɪ/						
a. skaɪ		*!			**	*
b. s.kɑɪ	*!				*	
☞ c. saɪ			*		*	
(☞) d. kɑɪ			*		*	

Finally, there will be grammars that demote both markedness constraints below MAX, allowing for both adjuncts and complex onsets at the same time, as in ranking III in (9). This is illustrated in the tableau in (13) with Subject 2's grammar two months posttreatment. In this case, low-ranking *COMPLEX and *ADJUNCT allow all clusters to be produced target appropriately, and it is assumed, for continuity purposes, that all /s/ clusters remain as adjunct clusters, while all other clusters are complex onsets.

(13) Subject 2, 2 months posttreatment: Ranking III (Complex onsets and adjuncts)

	ADJ-/s/	MAX	*COMP	*ADJ
'blow' /blo/				
☞ a. blo			*	*
b. b.lo	*!			*
c. bo		*!		
'snow' /sno/				
a. sno			*!	*
☞ b. s.no				*
c. so		*!		
'sky' /skai/				
a. skai			*!	*
☞ b. s.kai				*
d. kai		*!		

In this last ranking, Ranking III, *COMPLEX is ranked higher than *ADJUNCT, suggesting that adjuncts are, at least for Subject 2, less marked than complex onsets, which is consistent with Gierut's findings. In addition, the earlier emergence of /s/ clusters for this child's phonology would further support this claim. However, in the case of ranking IIb, complex onsets occur to the exclusion of any /s/ clusters, which would suggest that the /s/ clusters are generally marked. Therefore, it seems that, while we can hypothesize about markedness relationships *within* grammars, we cannot determine a markedness relationship between these two types of clusters *across* grammars.

3. Discussion and Conclusion

In summary, by appealing to the three constraints, MAX, *COMPLEX, and *ADJUNCT, we may account for the four different grammars. Of course, determining the specifics—that is, what kinds of clusters constitute allowable complex onsets—requires appealing to additional constraints such as ADJUNCT-/s/, MINDIST, and the margin sonority constraints, as shown in (8b). It appears then that some grammars allow /s/ + sonorant clusters to surface as adjuncts, while other grammars seem not to. Again, grammar-specific rankings of those particular constraints will determine how /s/ + sonorant clusters are analyzed within each grammar.

It is therefore possible that not all children will pass through all the stages. We of course assume that most will pass through a stage in which no clusters are produced, as in grammar I;

and we of course assume that most will reach a stage where all clusters are produced correctly. However, it is theoretically possible that a child could approximate the target system and represent all clusters as adjuncts, or all clusters as complex onsets.

As constraints are universal, we should see parallels between children's grammars and adult grammars. That is, if children's grammars may reflect each individual stage of the typology in (7), then we should also have evidence of fully developed grammars that exhibit each of these stages, and indeed we do. Fijian is a language with no clusters of any kind, supporting Stage I (Schütz, 1980); Acoma is a language with /s/ clusters but no complex onsets, supporting Stage IIa (Miller, 1965); Spanish is a language with complex onsets but no adjunct /s/ clusters, supporting Stage IIb (Harris, 1969); and Italian is a language with both complex onsets and adjunct clusters, supporting Stage III (Davis, 1990, 1992).

Because we are referring to an abstract structure, the individual differences in representation will not likely have an impact on the perception of speech. Clusters will always sound like clusters. Where we might find evidence of this differing structural representation is among error patterns of children, as in the present case, as well as speech errors and language games with both children and adults. That is, one speaker might show patterns with clusters that another speaker might not. Appealing to such external evidence will allow us to understand better phonological systems, both developing and fully developed.

This paper has looked at phonological patterns in both normal and disordered development. Ideally, the results of this research should have clinical implications for the remediation of phonological disorders, and indeed it does. What we have found is that treatment on /s/ clusters *may or may not* result in generalization to clusters other than /s/ clusters. Gierut has already found generalization following treatment on /s/ + stop clusters to be limited at best, but perhaps differing grammars would produce differing results, particularly with /s/ + sonorant clusters. Treatment on /s/ clusters is one common practiced strategy for facilitating singleton /s/ production as well as elimination of cluster reduction. In order to be able to determine whether treatment on /s/ clusters would be appropriate for widespread change on clusters, however, a characterization of the structural representation of /s/ clusters is necessary. This can be done by analyzing those clusters (if any) that are produced by a given child, as well as looking at all of the clusters produced in error. Consider the error patterns for Subjects 25 and 2 in (14) as an example.

(14) Error Patterns as Determiners of Structural Representation

- a) Subject 25 pretreatment: All clusters reduced in the same manner
 - obstruent + sonorant → reduce to obstruent: *play* [peɪ]
 - /s/ + sonorant → reduce to obstruent: *swim* [sɪm]
 - /s/ + stop → reduce to least sonorous obstruent: *stop* [tɒp]
- b) Subject 2 pretreatment: Clusters reduced differentially
 - obstruent + sonorant → reduce to obstruent: *play* [peɪ]
 - /s/ + sonorant → reduce to sonorant: *swim* [wɪm]
 - /s/ + stop → reduce to stop: *stop* [tɒp]

Pretreatment, Subject 25 showed error patterns that were the same across all cluster types: that is, reduction to the least sonorous singleton. This suggests that all clusters are treated in the same manner by the grammar. However, Subject 2's pretreatment data illustrate that /s/ clusters are reduced differently from other clusters. While the non-/s/ clusters are all reduced to

the least sonorous segment, all of the /s/ clusters are always reduced to the second segment, regardless of whether it is more or less sonorous than /s/. In other words, /s/ clusters are treated differently by the grammar. By looking for differential error patterns such as this, we can get a better understanding of how the clusters are organized within an individual child's grammar, and this might allow us to determine if treatment on /s/ clusters should be expected to cause change across all clusters. An obvious next step would be to look further at individual learning patterns in normal development and following treatment on children with phonological disorders who exhibit differing cluster errors.

Notes

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1. While not listed, a high ranking constraint against insertion (DEP) is also necessary (McCarthy and Prince, 1995); however, this constraint is not directly relevant to any of the analyses presented here.

2. Chin (1996) used a more detailed version of the sonority hierarchy in his analysis of this child's clusters.

References

- Barlow, J. A. (1997). The representation of on-glides in American English: Evidence from phonologically disordered systems. In S. Davis (Ed.), *Optimal viewpoints: In celebration of the 30th anniversary of the Indiana University Linguistics Club*. Bloomington, IN: Indiana University Linguistics Club.
- Chin, S. B. (1996). The role of the sonority hierarchy in delayed phonological systems. In T. W. Powell (Ed.), *Pathologies of speech and language: Contributions of clinical phonetics and linguistics*. New Orleans, LA: International Clinical Phonetics and Linguistics Association.
- Clements, G. N. (1990). The role of the sonority cycle in core syllabification. In J. Kingston and M. E. Beckman (Eds.), *Papers in laboratory phonology I: Between the grammar and physics of speech*. New York: Cambridge University Press.
- Davis, S. (1990). Italian onset structure and the distribution of *il* and *lo*. *Linguistics* 28: 43-55.
- Davis, S. (1992). The onset as a constituent of the syllable: Evidence from Italian. In M. Ziolkowski, M. Noske, and K. Deaton (Eds.), *Papers from the 26th Regional Meeting of the Chicago Linguistic Society, Vol. 2: The Parasession on the Syllable in Phonetics and Phonology*. Chicago: Chicago Linguistic Society.
- Dinnsen, D. A., and S. B. Chin (1993). Individual differences in phonological disorders and implications for a theory of acquisition. In F. R. Eckman (Ed.), *Confluence: Linguistics, L2 acquisition and speech pathology*. Amsterdam: John Benjamins.
- Dinnsen, D. A., S. B. Chin, M. Elbert, and T. W. Powell (1990). Some constraints on functionally disordered phonologies: Phonetic inventories and phonotactics. *Journal of Speech and Hearing Research* 33: 28-37.

- Elbert, M., D. A. Dinnsen, P. Swartzlander, and S. B. Chin (1990). Generalization to conversational speech. *Journal of Speech and Hearing Disorders* 55: 694-699.
- Fikkert, P. (1994). *On the acquisition of prosodic structure*. Doctoral Dissertation, Leiden University, Leiden, The Netherlands.
- Giegerich, H. J. (1992). *English phonology: An introduction*. Cambridge, England: Cambridge University Press.
- Gierut, J. A. (1999). Syllable onsets: Clusters and adjuncts in acquisition. *Journal of Speech, Language, and Hearing Research* 42: 708-726.
- Gnanadesikan, A. E. (1996). Child phonology in optimality theory: Ranking markedness and faithfulness constraints. In A. Stringfellow, D. Cahana-Amitay, E. Hughes, and A. Zukowski (Eds.), *Proceedings of the 20th annual Boston University Conference on Language Development*. Somerville, MA: Cascadilla Press.
- Harris, J. (1969). *Spanish phonology*. Cambridge, MA: MIT Press.
- Kenstowicz, M. (1994). *Phonology in generative grammar*. Cambridge, MA: Blackwell.
- McCarthy, J. J., and A. S. Prince (1995). Faithfulness and reduplicative identity. In J. N. Beckman, L. W. Dickey, and S. Urbanczyk (Eds.), *Papers in optimality theory (University of Massachusetts Occasional Papers 18)*. Amherst, MA: Graduate Linguistic Student Association, University of Massachusetts.
- Miller, W. R. (1965). *Acoma grammar and texts*. Berkeley, CA: University of California Press.
- Prince, A., and P. Smolensky (1993). *Optimality theory: Constraint interaction in generative grammar: Technical Report no. 2*. New Brunswick, NJ: Rutgers Center for Cognitive Science, Rutgers University.
- Schütz, A. J. (1980). *The Fijian language*. Honolulu, HI: University of Hawaii Press.
- Sherer, T. (1994). *Prosodic phonotactics*. Doctoral dissertation, University of Massachusetts, Amherst.
- Smit, A. B. (1993). Phonologic error distributions in the Iowa-Nebraska Articulation Norms Project: Word-initial consonant clusters. *Journal of Speech and Hearing Research* 36: 931-947.
- Smit, A. B., L. Hand, J. J. Freilinger, J. E. Bernthal, A. and Bird, (1990). The Iowa Articulation Norms Project and its Nebraska replication. *Journal of Speech and Hearing Disorders* 55: 779-798.
- Steriade, D. (1988). Reduplication and syllable transfer in Sanskrit and elsewhere. *Phonology* 5: 73-155.
- Stoel-Gammon, C., and C. Dunn (1985). *Normal and disordered phonology in children*. Austin, TX: Pro-Ed.
- Templin, M. C. (1957). *Certain language skills in children, their development and interrelationships (Institute of Child Welfare, Monograph Series 26)*. Minneapolis, MN: University of Minnesota Press.
- Trommelen, M. (1983). *The syllable in Dutch: With special reference to diminutive formation*. Dordrecht: Foris.