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An Argument for Adjuncts: Evidence from a Phonologically Disordered System

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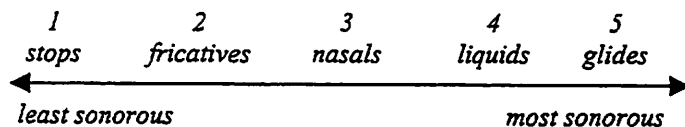
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1. Introduction

There have been numerous studies of early phonological development (that is, normal or disordered) that have looked into the production and acquisition of consonant clusters in English. These studies are interesting theoretically because they contribute to our understanding of consonant clusters of fully developed systems such as English. The goal of this paper is to further that contribution by looking at an asymmetrical pattern of cluster production by a child with a phonological disorder.

Accounts of consonant clusters in fully developed systems typically involve appealing to notions such as the sonority hierarchy, in which the sounds in languages are ranked according to their relative degree of sonority, as shown in (1).

(1) Sonority hierarchy (adapted from Clements, 1990)



Accounts also appeal to the sonority sequencing principle (shown in (2)) which states that onsets must rise in sonority and codas must fall in sonority (Clements, 1990). Sonority sequencing constraints are also posited which appeal to the sonority distance between two sounds (e.g., Davis, 1990; Steriade, 1982). That is, 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.

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

The sonority hierarchy has also been appealed to in accounting for children's erred productions of consonant clusters. In particular, a common error pattern among children is that of cluster reduction, where a target obstruent + sonorant cluster (such as /pl-/ in the word *play*) is reduced to the least sonorous sound of the target cluster, resulting in a production such as [peɪ] for *play* (Barlow, 1996, 1997; Barlow & Dinnsen, 1998; Chin, 1993, 1996; Edwards & Shriberg, 1983; Gnanadesikan, 1996). Several of the theoretical accounts of this sort of error pattern are listed in (3), all of which appeal to the notion of sonority. Most recently, this error pattern has been accounted for within the theoretical framework of optimality theory and this will be discussed more in detail in section 3.

(3) Selected accounts of cluster reduction: Appeal to sonority

- a. Nonlinear phonology (Chin, 1993; Chin, 1996; Lléo & Prinz, 1996)
- b. Optimality theory (Barlow, 1997; Barlow & Dinnsen, 1998; Gnanadesikan, 1996; Ohala, 1996)

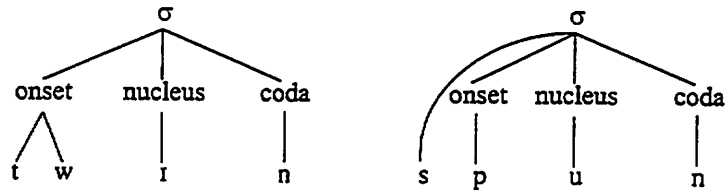
One rather puzzling area of cluster development by children is the development of the word-initial /s/ clusters, especially the /s/ + stop and /s/ + nasal clusters. Specifically, children's reduction patterns for these clusters are often different from the typical pattern for obstruent + sonorant clusters (e.g., Ingram, 1989; Smit, 1993; Smith, 1973; Stoel-Gammon & Dunn, 1985). That is, the /s/ may be deleted from the target cluster regardless of whether it is the least or most sonorous segment. Furthermore, whether or not /s/ clusters are produced in error often seems to be independent of the production patterns for other clusters.

The /s/ clusters are equally problematic, theoretically speaking, for accounts of fully developed English and other languages. The /s/ clusters have a special status in phonological accounts due to several factors. First, /s/ + stop clusters violate the sonority sequencing principle in that they have the opposite sonority slope of what is required by the principle. Whereas initial clusters are supposed to rise in sonority towards the following vowel, the /s/ clusters fall in sonority. Second, there is a phonotactic constraint on word-initial clusters in English which prohibit homorganic clusters such as /pw-/ and /tl-/; yet, the clusters /sl-/, /sn-/, and /st-/—all of which are homorganic coronal clusters—are allowed in English. Third, /s/ is the only sound that may be followed by a nasal in word-initial clusters.

Many different accounts of the /s/ clusters have been proposed for fully developed systems, and some relate to the representational structure of such clusters. For example, some accounts assume that /s/ clusters—in particular, the /s/ + stop clusters—are 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, thus avoiding the violation of the sonority sequencing principle. A typical branching onset structure is shown in (4a), and (4b) illustrates this

adjunct representational structure. Some notable studies that argue for this structure are listed in (5). Most accounts only include the /s/ + stop clusters as having this special representational structure. The remaining /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.

- (4) a. Clusters as branching onsets b. /s/ clusters as adjuncts



- (5) Selected accounts of /s/ clusters as adjuncts

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

In normative studies and in case studies, there is disagreement in terms of whether /s/ clusters are earlier or later acquired. While there is general agreement among the studies that /sl-/ and /sw-/ are acquired relatively late in development, some normative studies show the /s/ + stop clusters as acquired rather early, while others show them as emerging later (e.g., Smit, 1993; Smit, Hand, Freilinger, Bernthal, & Bird, 1990; Templin, 1957). Likewise, certain case studies show the /s/ + stop clusters as acquired first, and others show them as acquired much later (e.g., Gierut, in press; Smith, 1973).

Order of acquisition is one of several factors that determine relative markedness of sounds and clusters in languages of the world. Specifically, children are expected to acquire the unmarked properties of the language first (Jakobson, 1968). Furthermore, because of the unusual behavior of the /s/ clusters, both in terms of when they are to be acquired as well as the trouble we have in accounting for them, it is difficult to determine if /s/ clusters are marked or not. If we assume that /s/ clusters are adjunct clusters, then it would be reasonable to assume that they are marked relative to true complex onset clusters. Then again, we have studies that show that children sometimes acquire these /s/ clusters first, suggesting they might be unmarked.

Fikkert (1994) has addressed this seemingly asymmetrical development of clusters in Dutch by appealing to a parametric approach where the possibility of having extrasyllabic consonants (that is, /s/ as an adjunct) must be defined by a parameter, just as the possibility of having complex onsets must be defined by a

parameter. Fikkert assumes these parameters are independent: Thus, some children first set the extrasyllabic parameter to the marked value, while others first set the complex onset parameter to the marked value. Fikkert crucially assumes that the extrasyllabic status of certain consonants only arises with clusters that violate sonority sequencing. In other words, for target English clusters, only the /s/ + stop clusters could be assigned such a structural description. The /s/ + sonorant clusters, such as the /s/ + nasal clusters and /sl-/ and /sw-/, would not be considered adjunct clusters. Therefore, in development, the /s/ + sonorant clusters would not be expected to pattern in the same way as the /s/ + stop clusters.

These issues will be addressed as we consider data from an English-speaking child (Subject 2) who has a phonological disorder and who seems to treat /s/ clusters as separate from other clusters. The account of this child's productions will appeal to optimality theory. Part of the account will involve the well-known account of cluster reduction of the obstruent + sonorant clusters, as in previous work by Gnanadesikan (1996) and others listed in (3b). More importantly, an account will be offered for this child's production of /s/ clusters with the assumption that all /s/ clusters are adjunct clusters, rather than true clusters (complex onsets). It will be shown that this child's productions of clusters may be accounted for by appealing to certain ranked markedness constraints that relate to syllable structure and constraints that demand faithfulness to the input.

2. The Data

The data from Subject 2 are drawn from an archival study at Indiana University.¹ Relevant test scores and treatment methodology are provided in (6). The data that are presented in (7) are drawn from this child's productions immediately following treatment on singleton sounds.

(6) Subject 2 information

Male, age 3;6 pretreatment

GFTA: 3rd percentile; PPVT-R: 109

Treatment: Minimal pair singleton obstruents /θ z d/ word-initially

Pretreatment, this child produced no clusters correctly: All clusters were reduced to singletons. Immediately posttreatment, however, Subject 2 produced all two-element target /s/ clusters correctly (as shown in (7a)). This includes not only the /s/ + stop and /s/ + nasal clusters, but also the /sl-/ and /sw-/ clusters. The three-element target /s/ clusters are reduced to /s/ + stop clusters. Interestingly, all other target clusters are reduced to the least sonorous singleton obstruent, as shown in (7b).

(7) Subject 2: Immediately posttreatment (age 3;11)

a. Target /s/ clusters

swim	'swim'	swip	'sweep'
slip	'sleep'	smio	'smell'
sno	'snow'	spun	'spoon'
stovl	'stove (dim.)'	skai	'sky'
spei	'spray'	sku	'screw'

b. Target obstruent + sonorant clusters

pei	'pray'	bo	'blow'
din	'twin'	tihaus	'teehouse'
darn	'drum'	kin	'queen'
gav	'glove'	fai	'fly'
tag	'frog'	vu	'view'

c. Target singletons

/p b t d k g t v s z m n l w j h/ produced target-appropriately
 /θ / limited to word-initial position; /ð / ʃ dʒ ŋ r/ in error

Consider the asymmetry: Subject 2 produces both /s/ + stop and /s/ + sonorant clusters. Why aren't other obstruent + sonorant clusters produced? For example, if /s/- is produced, why isn't /t/-? If /s/- is occurring, why isn't /t/-? If we were to take into account sonority sequencing and minimal distance constraints, we would expect that a grammar would allow a supposedly less marked cluster such as /tʰw-/ before it allowed a supposedly more marked cluster like /sʰw-/, since /tʰw-/ has a greater sonority distance than /sʰw-/. However, for this child, the reverse is true. In addition, if we take into account results of normative studies, the markedness claims are furthermore called into question when we realize that /s/- and /tʰw-/—both of which are produced by this child at this point in time—are usually considered later acquired clusters, while /tʰw-/ and /kw-/ and certain other obstruent + sonorant clusters—which do not occur in this child's productions—are earlier acquired.

3. The Account

To account for Subject 2's data we may assume that all /s/ clusters are adjuncts (as in the structure in (4b)) rather than true clusters with branching onsets (as in (4a)). The argument against the true cluster analysis would relate to the fact that no other clusters are allowed to occur when we would otherwise expect them to. This goes against what is expected regarding the /s/ clusters.

That is, we have /s/ + sonorant clusters patterning with the /s/ + stop clusters rather than the other obstruent + sonorant clusters.

First, let us briefly discuss how we account for the reduction of the obstruent + sonorant clusters that do not include /s/ in the target. Similar to previous accounts (as referred to in (3b)), this involves the constraints listed in (8). The account first requires the high-ranking markedness constraint against complex onsets, that being *COMPLEX. We also must appeal to a faithfulness constraint prohibiting the deletion of segments from the input, that being MAX. Finally, we must be able to account for the preference for obstruents over sonorants in the pattern of cluster reduction, and this is accomplished by appealing to two markedness constraints that relate to the sonority hierarchy. The first constraint is *M/SONORANT, which prohibits sonorants in the syllable margin. This would be universally ranked higher than the second constraint, *M/OBSTRUENT, which prohibits obstruents in the margin.

(8) Constraints

- *COMPLEX: Avoid branching onsets (Prince & Smolensky, 1993).
- MAX: Preserve underlying (input) segments in the surface (output) form (McCarthy & Prince, 1995).
- *M/SON: Sonorants may not be parsed in syllable margins (adapted from Prince & Smolensky, 1993).
- *M/OBS: Obstruents may not be parsed in syllable margins (adapted from Prince & Smolensky, 1993).

Ranked in that order, these four constraints will yield our typical pattern of cluster reduction to the least sonorous segment, as shown in the tableau in (9).

(9) Tableau: Account of reduction to least sonorous segment

	*COMP	MAX	*M/SON	*M/OBS
'blow' /blo/				
a. blo	*!			
b. bo		*		
c. lo		*	*!	
'snow' /snou/				
a. snou	*!			
X b. sou		*		
c. nou		*	*!	

These constraints and their ranking do not account for the /s/ clusters. That is, if we were to assume that the /s/ clusters were also true clusters in Subject 2's grammar, then these four constraints ranked as such would incorrectly predict that the /s/ clusters would be reduced as well. For example, the /s/ + sonorant clusters would be reduced to the /s/, as shown for the target word *snow* in that

same tableau in (9). We know that this is not the case, however, and we must therefore assume a different structural representation for the /s/ clusters—that being the adjunct structure shown in (4b)—and we must furthermore appeal to constraints that relate to this type of structural representation. These are listed in (10).

(10) Additional constraints

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

First, there is a markedness constraint against adjuncts, that being *ADJUNCT, which prohibits adjuncts from surfacing. This would be ranked lower than the licensing constraint ADJUNCT-S, which licenses only /s/ as harmonic in the adjunct position. ADJUNCT-S is an abbreviation for a group of constraints, ranked in a particular order as proposed by Sherer (1994) in his account of word-final appendices. Sherer's account of appendices included a set of ranked constraints which incorporate the uniqueness of coronals cross-linguistically. Specifically, coronals tend to be the more favorable segments in extrasyllabic positions—such as the adjunct at the beginning of a word, or the appendix at the end of a word. In this case, /s/ in particular is the only segment that may surface in adjunct position. This is similar to accounts of clusters in fully developed English, where /s/ is the only extrasyllabic segment word-initially, but other coronals such as /t/ and /d/ may surface as extrasyllabic word-finally (Kenstowicz, 1994).

The overall ranking of the constraints is listed in (11), and this is first demonstrated in the tableau in (12), which shows how we account for the non-/s/ clusters. The high-ranking *COMPLEX constraint rules out any complex onset from surfacing in the output; thus, candidate (a) in each case is a failed candidate. The licensing constraint ADJUNCT-S rules out any segment other than /s/ from surfacing as an adjunct; thus, candidate (b) in each case is ruled out. (Notice that that the initial segment is represented as extrasyllabic by the period divisions between the two segments.) MAX ranked over *ADJUNCT ensures that it is worse to delete a segment than it is to have one of the segments surface as an adjunct. Finally, *M/SONORANT and *M/OBSTRUENT ensure that the least sonorous segment is the one that surfaces in the output, allowing candidate (c) with the obstruent in each case to win over candidate (d) with the sonorant.

(11) Ranking of constraints

*COMPLEX >> ADJUNCT-/s/ >> MAX >> *ADJUNCT >> *M/SON >> *M/OBS

(12) Tableau: Non-/s/ clusters

	*COMP	ADJ-/s/	MAX	*ADJ	*M/SON	*M/OBS
'blow' /blo/						
a. blo	*!				*	*
b. b.lo		*!		*	*	
☞ c. bo			*			*
d. lo			*		*!	
'fly' /flai/						
a. flai	*!				*	*
b. f.lai		*!		*	*	
☞ c. far			*			*
d. lai			*		*!	
'queen' /kwin/						
a. kwin	*!				*	*
b. k.win		*!		*	*	
☞ c. kin			*			*
d. win			*		*!	

Consider now the tableau in (13), which demonstrates the account for the /s/ clusters.

(13) Tableau: /s/ clusters

	*COMP	ADJ-/s/	MAX	*ADJ	*M/SON	*M/OBS
'snow' /sno/						
a. sno	*!				*	*
☞ b. s.no				*	*	
c. so			*!			*
d. no			*!			*
'sky' /skai/						
a. skai	*!				*	*
☞ b. s.kai				*	*	
c. sai			*!			*
d. kai			*!			*
'spray' /sprei/						
a. sprei	*!				*	*
b. s.prei	*!			*	*	
c. sp.rei		*!		*	*	
☞ d. s.pei			*			*
e. pei			**!			*

Again, high-ranking *COMPLEX rules out candidate (a) for each target word, as each contains a complex onset. This is also the case for candidate (b) for the

target word *spray*, which includes a three-element cluster, with /s/ as the adjunct but /pr-/ as a complex onset. Violation of ADJUNCT-S is only relevant for *spray*, again because of the three element cluster and the possible surface structure with /p/ in the adjunct position. For the target words *snow* and *sky*, candidate (b) in each case is the winning output, due to the fatal violations of MAX by candidates (c) and (d). For target *spray*, candidates (d) and (e) are left to compete, and candidate (e)'s two violations of MAX prove to be fatal; therefore, candidate (d) is chosen as the optimal candidate, as it violates MAX only once.

4. Discussion and Conclusion

To summarize the account, the constraint ranking shown in (11) has allowed for this asymmetrical pattern of cluster production exhibited by Subject 2. Specifically, the asymmetry concerned the /s/ clusters versus other clusters. It was argued that all /s/ clusters were surfacing with /s/ as an adjunct to the syllable. The fact that Subject 2's phonology allowed for adjunct clusters but not complex onsets was accounted for by the relative ranking of *COMPLEX, *ADJUNCT, and ADJUNCT-S.

Consistent with Fikkert's (1994) claims, it appears that there is no markedness relationship between the true clusters that comprise complex onsets and the adjunct clusters, and this would explain the differing patterns of acquisition of clusters that have been reported in the literature. This is illustrated with a possible typology listed in (14). For those children whose grammars disallow both types of clusters, *COMPLEX and *ADJUNCT would both be ranked higher than MAX, as in (a). For other children, *COMPLEX may remain ranked higher than MAX in a grammar while *ADJUNCT is ranked lower, which would allow for only adjunct clusters, as in (b). Then for other children, *ADJUNCT may remain ranked higher than MAX while *COMPLEX is ranked lower, allowing for only complex onsets, as in (c). Finally, there will be children whose grammars demote both markedness constraints below MAX, allowing for both adjuncts and complex onsets at the same time, as in (d).

(14) Cluster acquisition typology

- a. *COMPLEX, *ADJUNCT >> MAX: no clusters of any kind
- b. *COMPLEX >> MAX >> *ADJUNCT: adjunct clusters but no complex onsets
- c. *ADJUNCT >> MAX >> *COMPLEX: complex onsets, but no adjunct clusters
- d. MAX >> *COMPLEX, *ADJUNCT: both types of clusters allowed

Of course, determining the specifics—that is, which sounds can be allowed in the extrasyllabic position, and what kinds of clusters constitute allowable complex onsets—requires appealing to additional constraints such as ADJUNCT-S as shown in the present account, and, for example, the sonority sequencing principle. Additionally, it appears then that some grammars allow /s/ + sonorant clusters to surface as adjunct clusters, as in the present case, while other

grammars seem not to (as suggested by Fikkert's (1994) account of the phonological development of Dutch). Again, grammar-specific rankings of constraints related to sonority sequencing and minimal sonority distance will determine how the /s/ + sonorant clusters fit in with each developing grammar.

The next goal, then, in terms of future research, is to put this typology to further test and further establish all four patterns of cluster production in phonological development, all the while paying special attention to those /s/ + sonorant clusters.

Notes

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1. The subject in this study was drawn from an archival database of a study at Indiana University. Details of this study are discussed in Dinnsen & Chin, 1993; Dinnsen, Chin, Elbert, & Powell, 1990; Elbert, Dinnsen, Swartzlander, & Chin, 1990.

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