THE STATUS OF SONORITY THEORY: EVIDENCE FROM SYLLABIFICATION IN APHASIC RECURRING UTTERANCES

*C. Code and M. J. Ball**
*University of Sydney, *University of Ulster*

ABSTRACT

The application of the sonority principle in syllabification is examined in non-lexical aphasic speech automatisms (recurring utterances). Syllabification was found to adhere to the sonority principle. These results are similar to those found with jargonaphasia. We discuss the location of syllabic sequencing principles in language organization, exploring the notion that sonority is either an artefact of the speech production process, or a hard-wired feature of phonological processing.

SONORITY

The term 'sonority' has had a long usage in phonology, and has in recent times been adopted by some syllable-based accounts of phonological theory. This concept has been used in three main ways: first in the description of sonority hierarchies (i.e. of segments), second in the description of sequencing within the syllable, and third in the ordering of segments within syllables.

Sonority has traditionally been defined from a perceptual viewpoint, in that the sonority of a sound is seen as its loudness relative to other sounds when length, stress and pitch are kept constant. Therefore, segments can be ordered along a sonority hierarchy, for example from least to most sonorant, stops, fricatives, affricates, nasals, liquids, glides, vowels.

The sonority sequencing principle (SSP) aims to account for segment ordering within syllables. This approach sees the syllable peak being highlighted by there being an increase of sonority from the syllable onset to the peak, and then a decrease from the peak to the coda. We expect, therefore, that in onsets, an initial obstruent would be followed by other segments increasing in sonority until we reach the peak (i.e. obstruent-nasal-liquid-glide-vowel, or O-N-L-G-V), while in syllable codas we expect the reverse ordering (V-G-L-N-O).

The syllable type with the greatest differentiation between onset and peak would be the OV type; the most favoured peak-coda type would be V-O, as here too there is the greatest sonority difference. The fact that some languages allow consonant clusters that do not follow the ordering set out above (e.g. OOV in "spy"), or allow syllables without onsets, etc., is accounted for by language specific phonotactic constraints.

SONORITY STUDIES IN APHASIA

The few previous studies of sonority and aphasia are reviewed in Christman [1]. The studies support the idea that there is an implicational hierarchy of syllable complexity, and that certain aspects of aphasic language breakdown may involve loss of control over more complex syllable structures.

Christman [1] notes that where the intended target is not clear, as with neologistic jargonaphasia, if neologisms still obey sonority constraints, "then we may find that they are not constructed with phonological abandon" (p225). She feels such results suggest that sonority is hard-wired in the brain in such a way that it survives extensive brain damage. Among other findings, her results showed that the overwhelming majority of both CV and VC patterns in the neologistic speech had an obstruent in the C position.

Christman comments that these results "support the notion of sonority as (1) a hard-wired component of the language system ...; (2) a mediator of phonological construction in all word forms, neologistic or otherwise ...; and (3) a useful metric in capturing the underlying phonological regularity of words that would otherwise appear to be somewhat randomly constructed ..." ([1] p.234).

RECURRING UTTERANCES

If we are to test the validity of the sonority approach further we need to explore other non-lexical forms in acquired neurological disorders. This study, therefore, examines aphasic non-lexical speech automatisms (recurring utterances).

While lexical speech automatisms are made up of recognizable words, and are syntactically correct structures in the majority of cases, non-lexical recurring utterances are mainly made up of reiterated and concatenated CV syllables (e.g. /bi bi/, /du du du/, /tu tu tu uuuu/). These utterances do not break the phonotactic constraints of the native language of the speaker.

The purpose of this study is to examine the syllable structure of non-lexical speech automatisms. Aphasics utilising speech automatisms tend to produce either one form only, or at the most very few different forms. For this study, therefore, we decided to make use of the data bases of British-English recurring utterances [2], and German recurring utterances [3]. The advantage of this approach is that we have immediate access to a relatively large amount of data from two different languages. As the majority of utterances recorded are of simple syllabic types, we are confident that the transcriptions are accurate enough for our analysis.

Method

The corpora for the study reported here were compiled from the studies noted above. This resulted in a total of 102 syllables for the English corpus, and 119 for the German corpus.

Our analysis requires the division of all syllables into demisyllables: that is the onset and peak of a syllable are assigned to an initial demisyllable, and the peak and coda (of the same syllable) are assigned to a final demisyllable. All demisyllables are further divided into utterance peripheral (initial or final), and embedded (initial or final), resulting in four categories: utterance initial (UI), embedded initial (EI), utterance final (UF), and embedded final (EF). Results of the analysis of the corpora are expressed in syllable shape (CV, CCV, V, VC), and demisyllable sonority profile (OV, NV, VO, etc.).

Results

The question we wished to address was the phonological make-up of demisyllables: both their phonological shape and their sonority profiles. Tables 1 and 2 show the demisyllable shapes for both the English and German recurring utterances, while Tables 3 and 4 show the sonority sequence patterns for the two groups.

Table 1. Syllable Patterns: English.

UI	EI	UF	EF
CV 20 69%	CV 60 82%	VC 4 14%	VC 5 7%
CCV 0	CCV 2 3%	V 25 86%	V 68 93%
V 9 31%	V 11 15%		
(n=29)	(n=73)	(n=29)	(n=73)

Table 2. Syllable Patterns: German.

UI	EI	UF	EF
CV 53 87%	CV 47 81%	VC 7 11%	VC 1 2%
CCV 1 2%	CCV 6 10%	V 54 89%	V 57 98%
V 7 11%	V 5 9%		
(n=61)	(n=58)	(n=61)	(n=58)

With the English recurring utterances, initial and embedded initial demisyllables were most frequently of the form CV. Of these CV types, OV was the most common demisyllable shape, with only NV scoring above 5% for both initial types, though GV occurred in a fair number of instances with embedded initial types. Only two initial consonant clusters occurred in the data, both of the OLV type. The V type occurred in 31% of the utterance initial, and 15% of the embedded initial demisyllables. Utterance final and embedded final demisyllables were overwhelmingly of the type V. The VO type was the only other variety found; no final clusters were found.

With the German recurring utterances, initial and embedded initial demisyllables were also most frequently of the form CV. For utterance initial this was followed by V and CCV, while for embedded initial the order was reversed. The most common type of CV was OV, followed by NV and LV. With clusters, the type found was OOV. These latter were phonetically /ts/, which could therefore be analysed alternatively as affricates (thus as further examples of OV). The choice of analysis does not alter the overall balance of sonority profiles in any significant way. With final demisyllables, the V type is again overwhelmingly the favourite for both varieties. Small numbers of VC types occurred: split between VO and VN.

Table 3. Sonority Patterns: English.

UI	OV	17 S14, F13	59%
	NV	2	7%
	V	9	31%
	GV	1	3%
EI	OV	40 S36, F4	55%
	OLV	2	3%
	NV	8	11%
	V	11	15%
	GV	11	15%
	LV	1	1%
UF	VO	4 S0, F4	14%
	V	25	86%
EF	VO	5 S0, F5	7%
	V	68	93%

Tables 3 and 4 show the breakdown of the obstruent category into stops and fricatives, and demonstrates that the least sonorous obstruents, stops, are favoured in initial position, with fricatives favoured in final position (though the numbers here are small). This might be thought to agree with Clement's [4] view that final demisyllables show a minimal decrease in sonority.

Table 4. Sonority Patterns: German.

UI	OV	46 S35, F11	75%
	NV	7	11%
	V	7	11%
	OOV	1	2%
EI	OV	44 S39, F5	76%
	NV	2	3%
	V	5	9%
	LV	1	2%
	OOV	6	10%
UF	VO	3 S1, F2	5%
	VN	4	7%
	V	54	88%
EF	VO	1 S0, F1	2%
	V	57	98%

DISCUSSION

The essential findings of this study are that: i) the syllable shapes used in these non-lexical speech automatisms are generally of the simplest types phonotactically; ii)the sonority patterns of the demisyllables adhere closely to those predicted in sonority theory; and iii) no examples were found of language specific phonotactic ordering that supersede the Sonority Sequencing Principle.

We can examine the implications these results have for both sonority theory and the neural representation of recurring utterances. Non-lexical recurring utterances are not arbitrary but concatenated syllables governed by phonotactic constraints which adhere to the sonority structure of normal speech production and avoid language specific phonotactic possibilities that breach the sonority principle (e.g. /sC-/ for English, and /ʃC-/ for German). The non-lexical utterances appear to reflect articulatory simplification where only high frequency and motorically unmarked articulations taken from the phonetic inventory of the speaker's language are produced to conform to phonotactic rules. The fact that they do not break phonotactic constraints may suggest that they access a phonological output module the first time they are produced, and do not involve limbic-right hemisphere input. This conceptualization gains support from Sussman [5] who suggests that the reason phonotactic constraints are not violated in even the most severely aphasic patients, and syllabification unaffected by extensive brain damage, is because syllabification is 'hard-wired' in the left hemisphere of the brain.

However, we can consider other possibilities for the locus of syllabification control. For some left hemispherectomy patients reported in Code [6], specifically patients E.C. and N.F., the surgery was sufficiently radical to eliminate the possibility of the involvement of the remaining left sub-cortical structures in speech production. The phonotactic constraints of the language are not broken in the speech of these subjects, and syllabification is organized according to normal sonority. That is to say, removal of the left hemisphere in adulthood, while devastating for speech and language processing, does not appear to impede the syllabification of speech production.

This may suggest that Sussman's left hemisphere model for syllabification cannot be correct and that syllabification, if hard-wired, is hard-wired either sub-cortically or is diffusely represented throughout the brain. Some support for this comes indirectly from Ohala [7] who suggests that sonority is not an integral feature of phonological processing but merely an artefact of speech production. Christman [8] suggests that sonority may be 'well-distributed' both neurologically and linguistically, and may be accessed not simply at lexical levels to organize word syllabification or at sub-segmental levels to organize phoneme sequencing, but during different stages in speech production, including at the motor instantiation level.

Such a diffuse representation may reduce the strength of Sussman's argument that sonority is hard-wired in the left hemisphere and has a fully abstract cognitive representation, but implies that sonority enjoys no mental reality and is simply an inevitable by-product of speech production, an epiphenomenon of neurophysiology and the mechanico-inertial constraints of the speech production mechanism. This assumes, perhaps incorrectly, that 'hard-wired' is synonymous particularly with more focal representation. This may be why it survives even the most serious brain damage and even complete left hemispherectomy. However, surviving speech in global and in left hemispherectomy subjects is essentially non-propositional, formulaic, over-learnt and highly automatic, and such speech is probably not newly generated and phonologically processed each time it is produced [2]. The sonority and syllabification frame of such utterances may therefore be established during earlier, pre-lesion, propositional usage.

REFERENCES

[1] Christman, S. (1992b), "Uncovering phonological regularity in neologisms: contributions of sonority theory", *Clinical Linguistics & Phonetics*, vol. 6, pp. 219-47.

[2] Code, C. (1991), "Speech automatisms and recurring utterances", in Code, C. (ed.), *The Characteristics of Aphasia*, Hove: Lawrence Erlbaum. Pp. 155-78.

[3] Blanken, G., Wallesch, C-W. and Papagno, C. (1990), "Dissociations of language functions in aphasics with speech automatisms (recurring utterances)", *Cortex*, vol. 26, pp. 41-63.

[4] Clements, G. (1990), "The role of the sonority cycle in core syllabification", in Kingston, J. and Beckman, M. (eds), *Papers in Laboratory Phonology I: Between the Grammar and the Physics of Speech*, Cambridge: CUP.

[5] Sussman, H. (1984), "A neuronal model for syllable representation", *Brain and Language*, vol. 22, pp. 133-54.

[6] Code, C. (in press), "Speech from the isolated right hemisphere? Left hemispherectomy cases", in Code, C., Wallesch, C.-W., Joanette, Y. and Lecours, A.-R. (eds), *Classic Cases in Neuropsychology*, Hove: Lawrence Erlbaum.

[7] Ohala, J. (1990), "Alternatives to the sonority hierarchy for explaining segmental sequential constraints", paper presented at the *Parasession on the Syllable in Phonetics and Phonology*, Chicago Linguistics Society.

[8] Christman, S. (1992a) "Abstruse neologism formation: parallel processing revisited", *Clinical Linguistics & Phonetics*, vol. 6, pp. 65-76.