Distinctive Distributions: a New Look at the Sonority-Intensity Relationship

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The sonority hierarchy has long been recognized as a powerful force in phonology, although its abstract nature has generated controversy during efforts to quantify the hierarchy in relation to specific phonetic properties. Sonority is a factor in the formation of syllables; Blevins (1995) outlines the Sonority Sequencing Principle, by which "between any member of a syllable and the syllable peak, a sonority rise must occur" (210). Sonority is also a property of segments; generally speaking, those segments with high sonority (usually vowels) may appear in the nucleus or peak of a syllable, while those with lower sonority (i.e. consonants) are relegated to the margins of a syllable. Recent studies by Parker (2002, 2008) have championed intensity as an excellent correlate of sonority: low-sonority segments like voiceless stops have very low intensity, while vowels, at the opposite end of the sonority scale, have high intensity. Parker's methodology involves a) comparing the intensity of a target segment against a control segment in the frame sentence; b) treating segments as "sound level protrusions," and thus measuring the intensity "peak" for vowels but the lowest "trough" for consonants; c) taking multiple measures for stops and affricates, and averaging their values. This paper builds on Parker's work by presenting a new methodology for quantifying sonority in terms of intensity.

I propose that an empirically adequate and illustrative sonority hierarchy can be obtained by looking at the *distribution graph* of a segment's intensity, using an automated method of sampling intensity that treats all segments alike, without differentiating between consonants and vowels. Specifically, I hypothesize that the modal peak of intensity for a given segment correlates with the segment's place on the sonority hierarchy. In a pilot experiment, a total of 12 native speakers of English, Dutch, Italian, Spanish and Japanese were recorded reading declarative sentences in their native language. Using Praat speech analysis software (Boersma and Weenik: 2007), up to 12 sentences per speaker were labeled by phoneme, and a script was used to extract an intensity value every 5 milliseconds within those sentences. The phonemes of each labeled utterance, with their corresponding intensity values, were sorted into sonority levels based on Parker's (2002, 2008) hierarchies. Since the goal was to compare the intensity of different segments, intensity was re-scaled: each raw intensity value was converted into a percentage of the maximum intensity, per sentence. This permitted comparisons across sentences, and also across speakers. The intensity values for each sonority level were plotted, by language and by speaker, onto graphs showing their distribution (see tables).

These graphs show a good correlation of sonority level with the distributional peak; for example, in vowels, the modal peak appears in the range of 90-95% maximum intensity, with no low-intensity samples. Segments lower in sonority have lower-intensity peaks, and also show an increase in low-intensity samples outside the peak. Voiceless stops and some affricates have a bimodal intensity distribution, showing both the closure and burst periods of these consonants. The two main findings of this experiment are the following: first, that each sonority class has an "intensity signature," or a unique position on the distribution graph, with respect to other classes in the language. Secondly, it is not necessary to use different measurements for vowels and consonants in order to obtain these results. These findings simplify the experimental process, because the measurement of intensity is automated, and no single control segment is needed for comparison. The equal treatment of all segments is also advantageous, because in languages such as English, which allows non-vocalic segments in syllabic nuclei, we see a phonological treatment of consonants and vowels that places them on a continuum, not in two distinct categories.

References

Blevins, Juliette. 1995. The Syllable in Phonological Theory. In *The Handbook of Phonological Theory*, ed. John A. Goldsmith. Cambridge, MA: Blackwell.

Boersma, Paul and David Weenik. 2007. Praat: doing phonetics by computer, version 4.6.06. Available at http://www.praat.org

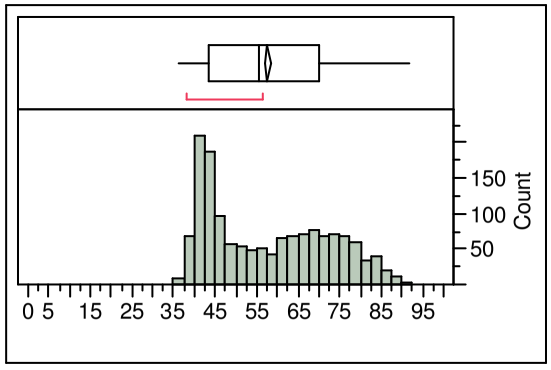
Parker, Stephen G. 2002. *Quantifying the Sonority Hierarchy.* Amherst, MA: University of Massachusetts Department of Linguistics.

Parker, Steve. 2008. Sound level protrusions as physical correlates of sonority. *Journal of Phonetics* vol. 36: 55-90.

Tables

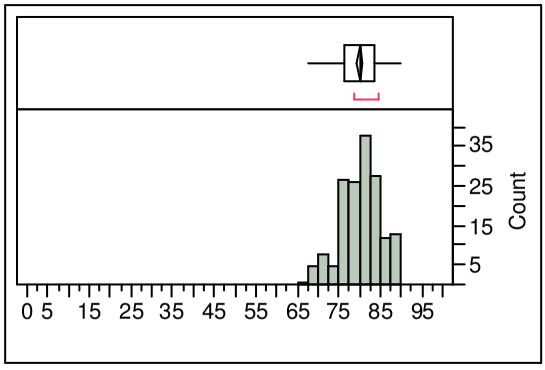
In the following tables, Percentage Maximum Intensity (calculated per sentence) occupies the X-axis; the count of intensity samplings occupies the Y-axis. They include data from 12 sentences read by female Italian speaker IF2.

A.



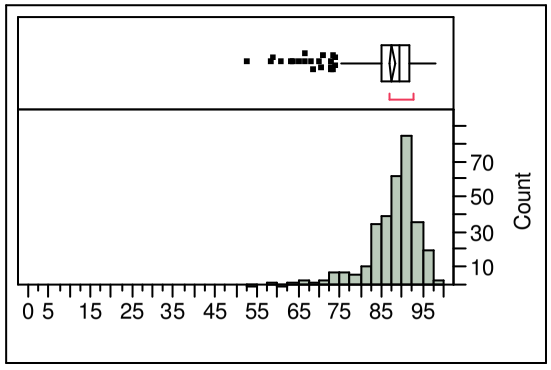
Italian voiceless stops (sonority level 1)

B.



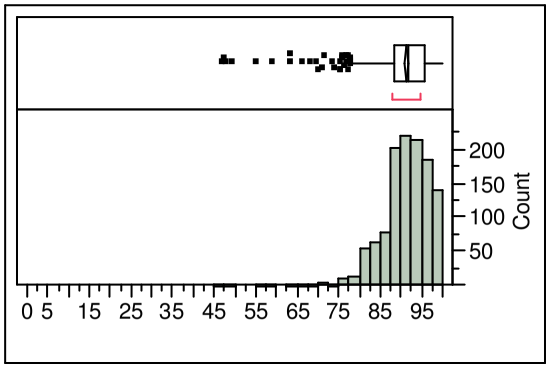
Italian voiced fricatives (sonority level 4)

C.



Italian laterals (sonority level 8)

D.



Italian low vowels (/a/) (sonority level 12)