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Abstract "Prosodic cues of Repetitions in Spanish Spontaneous Discourse",

Pilar Munday
Sacred Heart University, mundayp@sacredheart.edu

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the fewest and shortest pauses, and child-directed speech in between the other two. Mean $F0$ was significantly higher for child-directed speech than for the other two registers, which did not differ from one another. The three registers did differ significantly from one another in terms of $F0$ range, with child-directed speech showing the greatest $F0$ range, native speech the smallest, and foreigner talk in between the other two. [Work supported by NIH Grant No. 1 R15 HD28173-01.]

5pSP13. Prosodic cues of repetitions in Spanish spontaneous discourse. Pilar Munday (Inst. for Speech and Lang. Sci., NYU, 719 Broadway, 5th fl., New York, NY 10003)

When Spanish speakers repeat words or phrases in discourse, some repetitions are due to false starts or hesitations while others are used for emphasis or clarity. These will be referred to as "hesitations" and "emphasis" repetitions, respectively. Although the purpose of the repetition can often be determined from discourse context or part of speech, this study shows that there are also prosodic cues that serve to distinguish the two types. The speech data consist of all repetitions uttered by a male Colombian speaker over the course of a 1-h spontaneous conversations. The following acoustic information was obtained for each utterance and its repetition: duration, peak amplitude, average amplitude, and duration of any intervening pause. Pauses occur more often and tend to be longer in hesitation repetitions. Contrary to previously reported findings for English, however, a pause is frequently not present. The first element of the hesitation repetition tends to be longer than the second. Amplitude does not appear to differentiate the two types of repetitions. The results suggest that durations is the most important cue for distinguishing between types of repetitions.

5pSP14. Perceptual centers as an index of speech rhythm. Charles Andrew Harsín and Kerry P. Green (Natl. Ctr. for Neurogenic Commun. Disord., Univ. of Arizona, Tucson, AZ 85721)

One of the obstacles to investigating speech rhythm has been the difficulty in locating the syllabic beat. This study attempts to address that difficulty by using perceptual centers (p-centers) as an index of speech rhythm. P-centers of syllables extracted from natural utterances were determined both by listeners using a method of adjustment procedure and by an acoustic p-center model. The phonetic structure (syllabic onset) and stress patterns of the syllables in the utterances were varied, and the effects of these manipulations on the utterances' rhythms were investigated. As expected, the p-centers of the syllables varied systematically with their own phonetic structure. Preliminary findings indicate that the p-center of the syllables also changes along with the p-center of the previous or subsequent syllable so as to maintain a relatively constant interval between the two p-centers. The study also examines the effects on rhythm of altering stress patterns, by determining whether unstressed syllables might influence p-centers. The results will be discussed in terms of dynamic constraints which might affect speech production. [Work supported in part by National Multipurpose Research and Training Center Grant No. P60 DC-01409 from the National Institute on Deafness and Other Communication Disorders.]

5pSP15. Perceptual centers are affected by stress location in English disyllables. Alan Bell and Debra Halperin Biasca (Dept. of Linguist., Box 295, Univ. of Colorado, Boulder, CO 80309)

The perceptual centers of English disyllables were investigated in two experiments. Six subjects participated in the first experiment, and five in the second. The first experiment compared initially stressed disyllables with five onsets whose duration varied from 4 (*batter*) to 180 ms (*flatter*). Its results demonstrated that initially stressed disyllables with longer onsets have perceptual centers that are displaced relatively further from the acoustic beginning of the word by about the same amount as the difference in the onset durations, in agreement with earlier research on English monosyllables [e.g., A. Cooper, D. Whalen, and C. Fowler, Percept. Psychophys. **39**, 187–196 (1986)]. The second experiment compared initially stressed disyllables with disyllables composed of a reduced first syllable and a stressed second syllable, e.g., *com'mute* vs *'comet*, holding the total duration of all items constant. Again, longer onsets produced later perceptual centers for both stress locations, but the perceptual centers of finally stressed disyllables were later than those of initially stressed ones by about 50 ms, or roughly half the duration from the beginning of the unstressed vowel to the beginning of the stressed vowel.

5pSP16. Perceptual centers in Japanese disyllables. Alan Bell (Dept. of Linguist., Box 295, Univ. of Colorado, Boulder, CO 80309) and Yasunori Morishima (Dept. of Psychol., Box 345, Univ. of Colorado, Boulder, CO 80309)

Most research on perceptual centers has been based on monosyllables in languages with stress; indeed the term "stress beat" is sometimes used for the same phenomenon. Accent in Japanese is mainly realized by pitch; amplitude and duration are relatively unimportant. Perceptual centers in disyllabic words perceived by four Japanese were used to investigate the characteristics of perceptual centers in the context of pitch accent. Perceptual centers occur later in disyllables with longer consonant onsets, by a magnitude comparable to that found for stressed monosyllables [e.g., Cooper *et al.*, Percept. Psychophys. **39**, 187–196 (1986)] and for Japanese monosyllables [Hoequist, Lang. Speech **26**, 367–376 (1983)]. The effect of lengthening the tail (the portion following the initial consonant) of disyllables also corresponded in magnitude to that found previously. Accent placement had little or no effect. The same effect of onset duration was found for initially accented and finally accented disyllables whose duration and amplitude contour were held constant. A small accent difference with respect to the effect of tail duration was found in words of the same duration but retaining differences in amplitude contour. The results are consonant with the greater prominence effects found for amplitude and duration than for pitch in rhythmic perception.

5pSP17. Spectral analysis of amplitude envelopes of bandpass filtered speech. King-Leung Kong (Dept. of Psychol., Univ. of Hong Kong, Hong Kong)

The amplitude envelopes of rectified bandpass filtered speech have been found to provide useful cues for speech perception [K. W. Grant, L. D. Braida, and R. J. Renn, J. Acoust. Soc. Am. **95**, 1065–1073 (1994)]. An analog terminal was built to yield 25 such envelopes from filters with center (carrier) frequencies from 150 to 4850 Hz. Each envelope was then subjected to another round of bandpass filtering and rectification to yield a modulation spectrum of up to nine channels with center (modulation) frequencies from half the carrier frequency to 700 Hz. The spectra were examined for cues for the identification of voicing, fundamental frequency, and consonants. Voicing was generally characterized by the concentration of formant energy at a single carrier and modulation frequency, corresponding to the formant and fundamental frequencies, respectively. The second formant of the front vowel /i/ and nasal release sometimes exhibited bimodal modulation spectra, suggesting multiple sources of modulation. Stop consonants and fricatives were characterized by elements scattered at high carrier and modulation frequencies whose occurrences might not coincide. Some consonants could be identified with elements at specific modulation frequencies: e.g., /g/ and /j/ suggested a 700-Hz source modulating carriers whose frequencies depended on the following vowel.

5pSP18. Prediction of speech transmission quality of wideband and narrow-band telephone handsets using short-time sub-band analysis and psychoacoustic models. Winfried Krebber (Inst. f. El. Nachrichtentechnik, Aachen Univ. of Technol. (RWTH), D-52056 Aachen Germany)

A predictor is presented which estimates the mean opinion score (MOS) for a given speech sample from speech and noise transfer characteristics of a specific handset applied to an artificial ear. The critical band rate excitation pattern is computed in 50-ms blocks for original and distorted speech signals and additive room noise. For each block three psychoacoustic parameters are computed: An intelligibility index (I) is evaluated using SNR analysis in each sub-band and considering simultaneous masking effects. Naturalness (N) is estimated by spectral distance between original and distorted speech. A loudness index (L) is derived from loudness (computed similar to ISO532) using a trapezoid function: L decreases if the loudness which is exceeded in 10% of time is lower than 15 sone or higher than 45 sone. The MOS is predicted as a weighted sum of I, N, and L. The prediction results were verified by an opinion test including totally 442 speech samples of several talkers which were filtered simulating typical transfer characteristics of handsets and presented in a noisy environ-

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