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# QUANTIFICATION OF SIGNALS IN THE INTONATION OF AMERICAN ENGLISH BY HUMAN LISTENERS

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In this study, signal<sup>1</sup> detectability of native listeners in the intonation of American English was observed by statistically summarizing the psychophysical responses of three groups of 16 listeners each. Specific objectives of the present experiment were threefold: (1) to observe the signal detectability of a native listener, (2) to observe the ability of a native listener to quantify an intonational signal, and (3) to test the feasibility of the simple summation of component signal strengths to obtain the total signal strength of intonation in English sentences.

Twenty native American speakers and three groups of 16 native American listeners participated in this experiment. Each speaker recorded forty English sentences. Each sentence was paired with the same sentence spoken by a different speaker to make up 400 pairs of sentences. These 400 stimuli were presented to three groups of listeners for perception of intonational signals.

The first group of listeners reported whether the paired sentences were spoken with the same or different intonations. The listeners disagreed often in this apparently simple task. The average reliability of the responses of one listener was .62. Mean responses or majority decisions of 16 listeners, however, were sufficiently reliable. The reliability coefficient for this decision was .96.

The responses of each listener were then compared with the majority decisions to classify his responses into four categories: "HIT", "CORRECT REJECTION", "MISS", and "FALSE ALARM". Analysis of the responses of all listeners in the first group is presented in Table 1. The index of signal detectability<sup>2</sup> varied from 1.6 to 4.2, with an average of 2.4.

The second group of listeners reported the apparent magnitude of signal strength

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<sup>1</sup> A signal in intonation was defined in this study as any perceivable difference in the intonations of paired sentences.

<sup>2</sup> The index of detectability is a measure of the observer's sensory capabilities in a signal detection experiment and is obtained from the information of the HIT RATE and the FALSE ALARM RATE with reference to the table of cumulative normal distribution.

Table 1. The percentage of "HIT", "MISS", "CORRECT REJECTION", and "FALSE ALARM" in the responses of a signal detection experiment of native listeners in the intonation of American English. The index of signal detectability was obtained by referring to a published table of cumulative normal distribution.

Listeners	1	2	3	4	5	6	7	8
Hit	33.5	44.1	36.7	40.4	44.1	50.0	46.8	41.0
Miss	16.5	5.9	13.3	9.6	5.9	0	3.2	9.0
Correct Rejection	48.9	48.9	47.3	44.1	46.3	29.3	48.9	46.8
False Alarm	1.1	1.1	2.7	5.9	3.7	20.7	1.1	3.2
Hit Rate	67.0	88.2	73.4	80.8	88.2	100.0	93.6	82.0
F. A. Rate	2.2	2.2	5.4	11.8	7.4	41.4	2.2	6.4
Index of Signal Detectability	2.5	3.2	2.2	2.1	2.6	4.2	3.5	2.4

Listeners	9	10	11	12	13	14	15	16	Average
Hit	49.5	36.2	45.7	39.9	48.4	49.5	43.6	48.4	43.6
Miss	0.1	13.8	4.3	10.1	1.6	0.1	6.4	1.6	6.4
Correct Rejection	45.7	49.5	45.2	38.8	47.3	34.6	43.1	46.3	44.7
False Alarm	4.3	0.1	4.8	11.2	2.7	15.4	6.9	3.7	5.3
Hit Rate	99.0	72.4	91.4	79.8	96.8	99.0	87.2	96.8	87.2
F. A. Rate	8.6	0.2	9.6	22.4	5.4	30.8	13.8	7.4	10.6
Index of Signal Detectability	3.7	3.5	2.7	1.6	3.5	2.8	2.3	3.3	2.4

by assigning a number to each set of paired intonations by the method of equal-appearing intervals using a 9-point scale. The average reliability of the responses of one listener in this task was .47. The reliability of the mean responses of 16 listeners was .92. The measures of signal strength expressed by the mean responses of the listeners of this group were compared with measures<sup>3</sup> obtained from the responses of the listeners of the first group. The two measures correlated highly with each other with the coefficient of .90.

The third group listened only to those pairs of intonations which were unanimously reported either as similar or different by the listeners of the first group. The sentences they heard, however, had been truncated into each of the constituent words by an electronic switch device and randomized in the order before being presented to the listeners. Thus the listeners heard only a portion of the entire intonation and re-

<sup>3</sup> The number of listeners who reported that the pair of sentences were different in intonation was interpreted as the relative measure of signal strength for any pair of intonations.

ported the perceived magnitude of signal strength in these pairs. The listeners again used the 9-point scale of equal appearing intervals in reporting their responses. The average reliability of the responses of one listener in this task was .66. The reliability of mean responses of 16 listeners was .97. The mean response for each portion of the intonation was then reassembled in such a manner as to restore the entire pair of intonations. The average response of signal strength of all the constituent parts was compared with the mean response given by the listeners of the second group to the entire intonation. Twenty-eight pairs of intonations which were unanimously decided upon by the 16 listeners of the first group to be either different or similar (Figure 1, top) varied according to a measure of signal strength reported by listeners of the

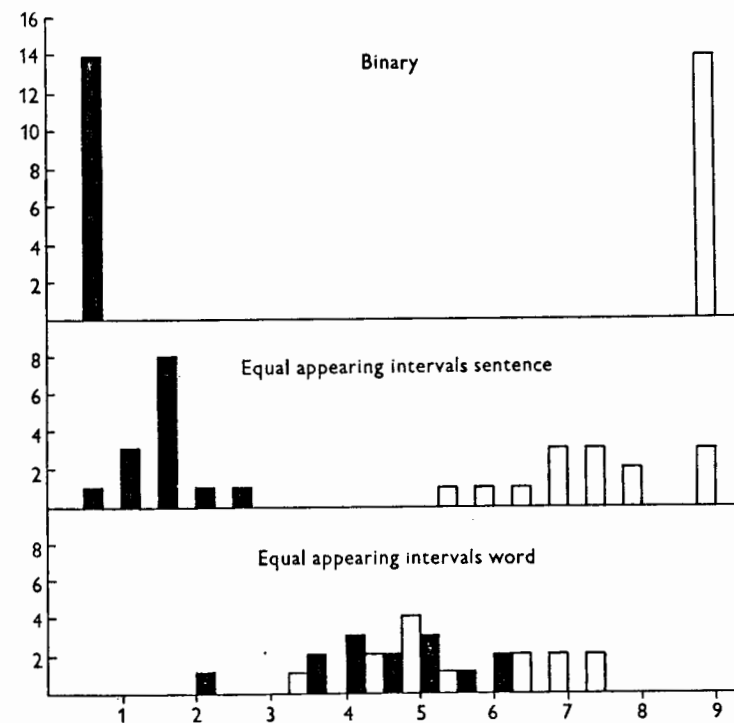


Fig. 1. Quantification of signals in the intonation of American English. The ordinate is the frequency and the abscissa is the 9-point scale of equal-appearing intervals. Twenty-eight sample pairs of intonations which were unanimously decided to be either different or similar (top) varied in the mean signal strengths estimated by the 9-point scale of equal-appearing intervals (middle). The average of the signal strengths of the constituent parts could not keep the dichotomy of the same samples (bottom).

second group. Dichotomy, however, of those sample stimuli was kept intact (Figure 1, middle). A simple summation or average of the measures of signal strength for all of the constituent parts of the intonation almost completely mixed the dichotomous samples (Figure 1, bottom).

## CONCLUSION

A native listener, as is shown by the coefficient of reliability and the indices of the signal detectability, was not very competent either in detection of the signals or in quantification of signal strength in the intonation of American English. Mean responses of 16 listeners, however, could reliably detect or quantify the signal. The signal strength of the entire intonation was found not to be a simple summation or the average of the signal strengths of the constituent parts of the intonation as perceived independently from other parts.

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