ARTICLE

Frequency of Occurrence as a Factor in Testing Speech Discrimination in Non-Native English Speakers/Listeners

M. S. Malini
Department of Audiology
All India Institute of Speech and Hearing, Mysore, India

Abstract

Frequency of occurrence is considered to be an important factor that affects responses on a speech-discrimination test. This article is the outcome of the analysis of the error responses of normal-hearing subjects who were non-native English speakers/listeners. The analysis included determining the types of error responses and their relationship to the frequency of occurrence of the stimuli and to the sensation level used. In addition, the frequency of occurrence of the error responses was analyzed. The results of this analysis are presented and the findings discussed.

Introduction

Speech-discrimination tests form an integral part of the routine audiological test battery. Frequency of occurrence is one factor that affects the results of a speech-discrimination test. The effect of word frequency on speech recognition thresholds and speech intelligibility has been demonstrated by several investigators (Solomon & Postman, 1952; Rosenzweig & Postman, 1957; Savin, 1963). Word frequency effects on speech audiometry were first reported by Oyer and Doudna (1960).

Following an analysis of errors made by hearing-impaired subjects, Oyer and Doudna (1960) reported that error type was partly dependent upon the frequency of occurrence of test words. They also found that words with a high frequency of occurrence constitute the majority of error substitutions. Their test materials consisted of the CID W-22 lists (Hirsch, Davis, Silverman, Reynolds, Eldert, & Bensor, 1952). Their findings were substantiated later by Schultz (1964).

Another widely used speech-discrimination test is the NU Auditory Test No. 6 (Tillman & Carhart, 1966). This study will explore whether the NU 6 word lists differ from the CID W-22 lists in terms of the frequency of occurrence of the test words and will investigate if this factor, frequency of occurrence, influences the responses of non-native English speakers/listeners.

Method

Data was collected as part of a previous investigation by the author (Malini, 1979). Forty normal-hearing subjects took part in the study. All of them were non-native English speakers/listeners. Their English proficiency was determined prior to testing. Each subject's pure tone thresholds were determined using the Modified Hughson-Westlake Procedure (Carhart & Jerger, 1959). The speech-reception threshold was obtained using spondees from the CID W-1 list (Hirsch et al., 1952) and the Tillman and Olsen (1973) procedure. This was followed by speech-discrimination testing using Form A of the NU Auditory Test No. 6 (Tillman & Carhart, 1966). Discrimination scores were obtained at four of the five sensation levels employed: 8 dB SL, 16 dB SL, 24 dB SL, 32 dB SL, and 40 dB SL (re: SRT). The list-level combinations were randomized such that an equal number of subjects represented each combination. The order of presentation of the lists also was randomized. Responses were in writing.

Analysis

The frequencies of occurrence of the words in the NU 6 list were determined using the Thorndike and Lorge (1944) count. Words were categorized into three groups: *AA*, *A*, and *less-than-A*. Category *AA* included words that occurred 100 or more times per million. Category *A* words occured at least 50 times but less than 100 times per million. *Less-than-A* words occurred less than 50 times per million.

Number of errors and error type, that is, the substitution of one sound for another, the omission of a sound, or the addition of a sound (as in "train" for "rain"), were determined for words in each category of frequency of occurrence. The percentage of various errors as a function of the presentation level was also determined. Finally, the frequency of occurrence of the error response was determined using the Thorndike and Lorge (1944) count.

Results and Discussion

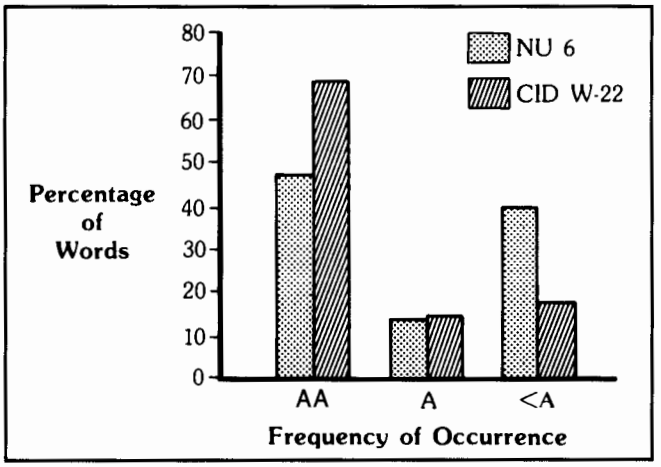
From Table 1 it can be seen that the NU 6 word lists differ from each other in terms of the percentage of words in any given category of frequency of occurrence. Considering the fact that List IV contains the highest percentage of AA words and the lowest percentage of less-than-A words, it should yield the maximum descrimination scores. Likewise, with a high percentage of less-than-A words, either List II or List I should be the most difficult of the four. These assumptions gain support from the results of previous investigation (Malini, 1979) in which the order of lists from easy to difficult was found to be IV, III, II, and I.

Table 1: Frequency of occurence of words (in percentage) in the NU Auditory Test No. 6 by test list.

List	*AA*	*A*	*Less-than-A*
List I	48	4	48
List II	44	12	44
List III	44	24	32
List IV	54	14	32
Total	47.5	13.5	39

When the frequency of occurrence of words in the NU 6 lists is compared with the CID W-22 word lists, as reported by Oyer and Doudna (1960), the latter is found to contain a greater number of AA words and fewer less-than-A words. Figure 1 illustrates this comparison. This difference could explain why differences are observed in the discrimination scores obtained using the two word lists (Jirsa, Hodgson, & Goetzinger, 1975; Orchik, Krygier, & Cutts, 1979).

Figure 1: A comparison of frequency of occurence of words in the NU 6 and CID W-22.



An analysis of error type as a function of word frequency indicated that substitution errors were by far the most common in all three frequency categories. The number of addition errors were negligible in all categories. Table 2 shows these data.

Table 2: Distribution of the three error types in the three categories of frequency of occurence (in percentage).

Error Type	*AA*	*A*	*Less-Than-A*	*Total*
Substitution	86.64	91.80	83.87	84.35
Omission	14.50	7.35	5.37	14.25
Addition	0.86	1.35	0.82	1.38

The difference in error type as a function of frequency of occurrence, if any, is marginal when the responses in the AA and less-than-A categories are considered. Oyer and Doudna's (1960) observations that "there is a slight increase in the substitutions as test words become familiar" (p. 82) and "there is a slight decrease in the familiarity values of the test words" (p. 352) also hold true for the outcome of this study when errors in the AA and A categories are considered. However, with further decrease in the frequency of occurrence (less-than-A), the trend reversed, resulting in fewer substitutions and more omissions than in the A category.

The analysis of error type as a function of sensation level is shown in Table 3. These data indicate that the number of substitutions increased with an increase in sensation level up to 24 dBSL. Beyond this, differences, if any, were marginal. At lower levels, the listener may be more uncertain of the sounds heard and may therefore give no response, which amounts to the omission of the sound. Further, because consonants are less audible at the lower intensities, this may contribute to the increase in the number of omissions. At higher levels, the stimulus being more audible, the probability of omissions may decrease, thereby increasing the percentage of substitution errors.

Table 3: Error type (in percentage) as a function of sensation level.

Sensation Level	Substitution	Ommission	Addition
8	80.50	18.64	0.66
16	86.85	12.04	1.11
24	95.36	4.40	0.24
32	95.73	2.66	1.61
40	95.28	3.77	0.95

The frequency of occurrence category was determined for substitution errors, and these data are presented in Table 4.

Table 4: The distribution of error responses in the three categories of frequency of occurence, at the five sensation levels.

Response Category	Total	8 dBSL	16 dBSL	24 dBSL	32 dBSL	40 dBSL
Same as the test word	40.53	39.56	36.76	43.49	47.71	40.46
Higher	39.70	39.19	43.25	37.86	35.14	39.88
Lower	19.72	21.24	19.97	18.64	17.14	19.65

Table 4 indicates that about 40% of the error responses are from the same frequency of occurrence category as the test word. An almost equal error rate exists for words from a higher frequency of occurrence category. Substituted words occurred either as frequently or more frequently than the test words. Very few responses were from a category of lower frequency of occurrence. This trend exists at all sensation levels except 16 dB SL in which more error words were from a higher frequency of occurrence category than from the same category as the test words.

This observation is slightly at variance with that made by Oyer and Doudna (1960) who reported that substituted words were mainly from the AA category. The differences, however, were insignificant when the stimulus was from the A category. In this study responses were from the same frequency category as often as from a higher frequency category. This difference may be attributed to two factors. First, frequency of occurrence may interact with other factors such as the specific phoneme being tested by the word and its frequency of occurrence in the listener's language. Secondly, the frequency of occurrence and usage of a word may not be the same for both native and non-native English speakers/listeners (the subjects in Oyer and Doudna's study presumably were native speakers). Results of both studies do concur in that, except for a few cases, error responses were not drawn from a category of lower frequency of occurrence.

Conclusions

The following conclusions may be drawn from this investigation. The NU 6 word lists consist of fewer AA words and more less-than-A words than the CID W-22 lists. Substitution is the most common type of error, irrespective of the category of frequency of occurrence. The number of substitution errors increases and omission errors decrease with an increase in sensation level up to 24 dB SL. In the case of substitution errors, the error response is selected from a higher category as often as from the same category of frequency as the test word. The frequency of occurrence of test words is thus an important variable in testing speech discrimination in non-native English speakers/listeners.

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Address all correspondence to:
M.S. Malini, M.Sc.
Department of Audiology
All India Institute of Speech & Hearing
Manasagangotri, Mysore 570 009

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