

A new method to assess the intelligibility in daily speech communication

--Towards the best fitting of hearing aids--

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- Nippon Telegraph and Telephone Corporation

To evaluate the hearing ability of hearing impaired listeners, a research group consisting of Research Institute of Electrical Communication, Tohoku University and NTT Communication Science Laboratories, has pursued their joint research since 1996. This joint research aims at developing new word lists, in which word difficulty and phonetic balance are well controlled, for word intelligibility tests. These lists are expected to show better performance in evaluating hearing ability of hearing impaired listeners than existing lists. Since September 10th, 2001, these lists are made available to the public on the Internet. These lists are provided free so long as they are used in academic and educational activities.

(<http://www.ais.riec.tohoku.ac.jp/lab/wordlist/index-j.html>)

When we started this project, we focused on the measurement of precise hearing ability in daily life using listening tests in clinics, especially for fitting hearing aids to a specific impaired listener. Today, in Japan, nonsense monosyllable tests have been widely used for evaluating hearing ability in clinics. However, hearing ability of continuous speech cannot be estimated from nonsense monosyllable tests. Moreover, since nonsense monosyllables rarely appear independently in our daily life, results often fail to reflect personal hearing ability in daily life. Therefore, we decided to develop new word lists for that purpose.

We think these lists are useful for evaluating the hearing ability of impaired listeners better reflecting daily life conversation in all clinical situations than nonsense monosyllable tests. These lists enable us to assess personal hearing ability from various viewpoints which are not measured by traditional measurements. For example, using lists with easy words, we are able to observe hearing abilities based on the understanding and prediction of senses as in our daily life. In contrast, using lists with difficult words, we are able to observe microscopic hearing abilities. We expect that audiologists will be able to fit the best hearing aids for their patients based on the results of these listening tests.

The characteristics of our lists are as follows: First, in these lists, the word difficulty is controlled appropriately. Since word intelligibility strongly depends on word difficulty, it is very important to control word difficulty in word lists. Previously, some word lists were proposed in Japan, but word difficulty was not taken seriously in these lists. In such word lists, word frequency was often used as the index of word difficulty. Word frequency shows how many times a specific word appears in a corpus. However, it is known that word frequencies do not correctly reflect subjective difficulties of words. For example, there are a lot of terms about politics in a newspaper but these words are not familiar in our daily life.

Therefore, we decided to use word familiarity as the index of word difficulty. Word

familiarity is the index of how subjectively familiar a specific word is and it is known to be a much better index of subjective difficulty than word frequency. No database on word familiarity of Japanese words had existed previously. Then, AMANO and KONDO researched the word familiarity of Japanese words over a number of years. As a result of their research, a word familiarity database of the Japanese language was recently published (Lexical Properties of Japanese, vol. 1, Sanseido, Tokyo, 1999). In this database, word familiarities of all words appearing in a Japanese dictionary were given for three presentation modes: audio only, visual only, and both. We used this database and we controlled word difficulty of our lists appropriately.

Moreover, in speech listening tests, it is also very important to balance the appearance of phonemes in the Japanese language. Therefore, in the proposed lists, we controlled the phonetic balance as well; phonemes at the beginning of words are balanced. Moreover, within words, all possible pairs of phonemes are also balanced (randomized) as far as possible. These processes were realized by maximizing the entropies.

The outline of the procedure for making our word lists is as follows:

1. From the familiarity database, we select words of four moras^{*} and low-high-high-high accent type.
2. Words with the highest familiarity value among homonyms were assigned for entry.
3. Words with a negative image such as words associated with disease and those associated with criminality, were excluded.
4. The population of words was then divided into four groups by arranging word familiarities.
5. Finally, we selected words so that every kind of phoneme could appear equally in each list.

Word intelligibility was then tested with normal listeners to evaluate the performance of these lists. The results indicated that word intelligibility, as expected, depends on word familiarity. This means that our new lists may be useful and powerful for assessing the personal hearing ability from various viewpoint, which are not measured by traditional measurements as mentioned above. For example, using high familiarity words, we are able to observe hearing abilities as reflected in daily life. In contrast, using low familiarity words, we are able to observe microscopic phoneme-by-phoneme hearing abilities.

By using these lists, we expect that rapid adjustment to the most appropriate hearing aid will become possible for each individual hearing impaired listener. We also expect that our lists can be used effectively not only in a clinical situation but also to evaluate various speech communication systems such as mobile telephones.

* A basic unit of rhythm (meter) in the Japanese language; often corresponds to a syllable.

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