COORDINATION OF SPEECH PERCEPTION ABILITY OF COCHLEAR IMPLANT PATIENTS IN DIFFERENT LANGUAGES

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ABSTRACT

This paper reports a strategy for coordinating the results of evaluation of speech perception ability of cochlear implant patients for speech sounds in different languages. The strategy consists of the derivation of correction rules and the conversion of test results to allow coordination among different languages. Complementary effects in the combined use of multi-sensory channels were analyzed on IPA charts, and the data thus obtained were utilized in editing the computer program for conversion.

STRATEGY OF COORDINATION

Test results of speech perception ability of patients using cochlear implants or artificial inner ears in different languages were coordinated in two stages: the derivation of correction rules; and the conversion of test results.

Derivation of Correction Rules

In the first stage, by comparing the common parts of the phonetic and phonemic systems, and syllabic, word and sentence structures between different languages, correction rules A for objective language in regard to the reference language are derived. Also, by comparing the characteristic parts of the systems and structures of each language, correction rules B are derived *(Left of Figure 1)*.

Conversion of Test Results

In the second stage, test results in the objective language are converted to equivalent results in the reference language, using the correction rules derived in the first stage for the common parts and characteristic parts of both languages *(Right of Figure 1)*. Differences in the speech materials and types of test adopted in the evaluation experiments are also adjusted in the process of conversion.

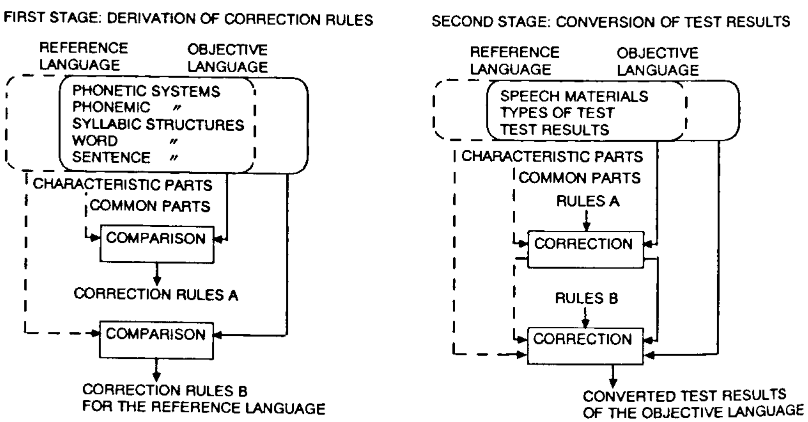

Figure 1.

MULTI-SENSORY PERCEPTION

An artificial inner ear is not sufficient in itself to enable for speech perception, but shows much better capability if combined with lip-reading. It is also necessary to evaluate the capability for speech perception through tactile sensation, as various types of tactile aids have been used in combination or substitutively with artificial inner ear or lip-reading.

Steps in Linguistic Processing

Information conveyed through each sensory channel can be analyzed commonly at the step of phonetic perception in the linguistic processing of speech. Outputs of optical analysis in visual organs and configurative analysis in tactile organs merge into the output of acoustical analysis in auditory organs at the step of the input of phonetic perception [1] *(Figure 2)*.

Analysis on the IPA Charts

The International Phonetic Alphabet (IPA) revised to 1989 was extended to include the classification of mouth shapes as well as speech sounds in the analysis of the transmission of speech information through auditory, visual or tactile sensory channels, so that the strategy is able to be applied to different languages in common.

Identifiable Groups of Phones

Auditory channel

For speech information transmitted auditorily, the amplitude-frequency ranges of the speech signal necessary for identifying each kind of consonant were derived from the data of an acoustical analysis and a perceptual test. Basic categories of consonants which are distinguishable from each other through the auditory channel were devised based on the consonant chart of the IPA *(Top of Table 1)*.

Visual channel

For visually transmitted speech information, identifiable groups of phones were predicted by taking into account the distinguishable places of articulation *(Middle of Table 1)*. The categorization was based on the stroboscopic observation of the mouth shape in the utterance [2]. Complementary effects between auditory and visual perceptions were estimated by referring to the data of hearing-impaired subjects using hearing aids or artificial inner ears [3].

Tactile channel

By using the same classification, groups of phones identifiable by tactile aids were predicted by referring to the speech perception data with a multi-channel vibro-tactile vocoder *(Bottom of Table 1)*.

EDITING COMPUTER PROGRAM

A computer program for converting results of evaluation experiments in different languages at various steps of linguistic processing is being developed by assembling the correction rules.

Reference and Objective Languages

In introducing the identifiable group of phones to the program, the speech sounds of Japanese is taken as the objective language, and that of English as the reference language, in the preliminary version.

Type of Cochlear Implant Devices

The computer program for converting the test results also accommodates data obtained from various types of cochlear implant devices, in order to compare their capabilities when combined with lip-reading or tactile aids.

REFERENCES

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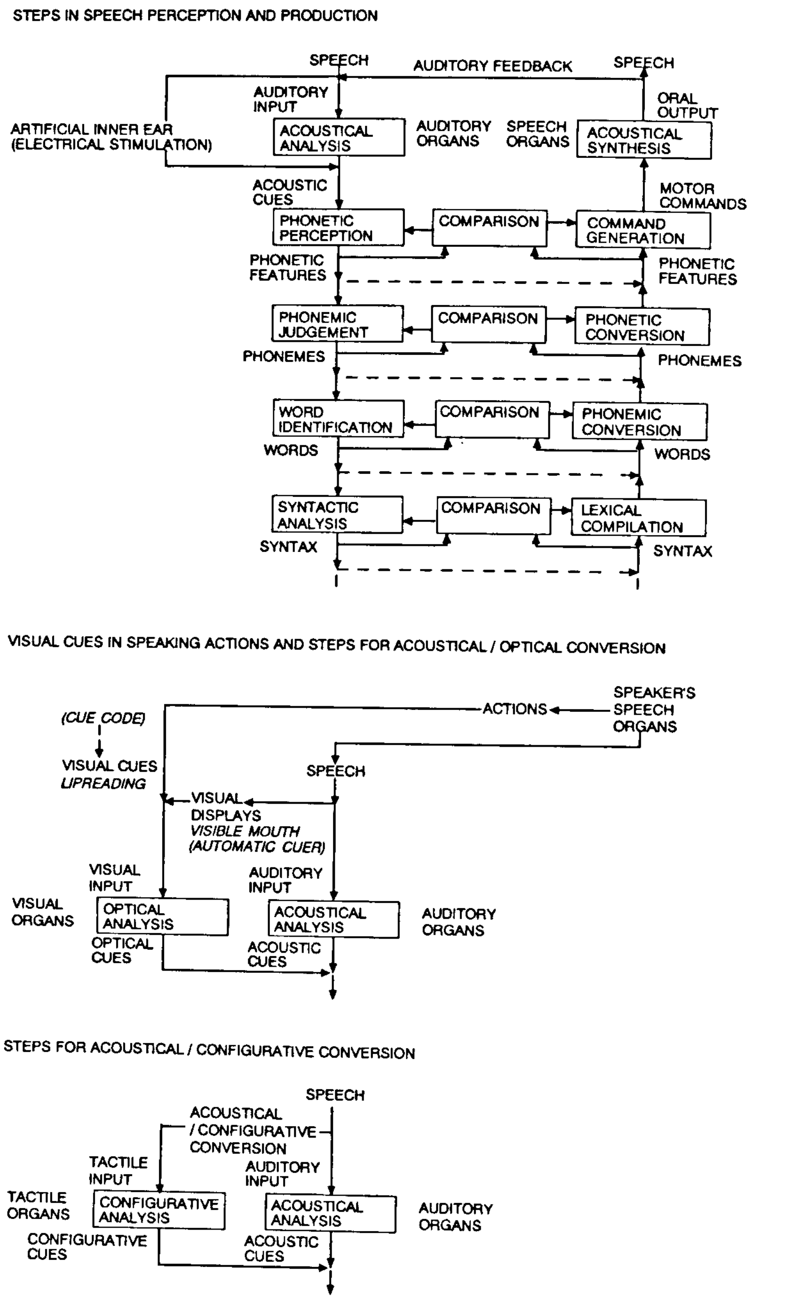

Figure 2.

Table 1.

AUDITORY

	Bilabial	Labiodental	Dental Alveolar Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b		t d	ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ	n	ɳ	ɲ	ŋ	ɴ		
Trill	ʙ		r				ʀ		
Tap or Flap			ɾ	ɽ					
Fricative	ɸ β	f v	θ ð s z ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative			ɬ ɮ						
Approximant	w	ʋ	ɹ	ɻ	j	ɰ			
Lateral approximant			l	ɭ	ʎ	ʟ			
Ejective stop	p'		t'	ʈ'	c'	k'	q'		
Implosive	ƥ ɓ		ƭ ɗ		ƈ ʄ	ƙ ɠ	ʠ ʛ		

VISUAL

	Bilabial	Labiodental	Dental Alveolar Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b		t d	ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ	n	ɳ	ɲ	ŋ	ɴ		
Trill	ʙ		r				ʀ		
Tap or Flap			ɾ	ɽ					
Fricative	ɸ β	f v	θ ð s z ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative			ɬ ɮ						
Approximant	w	ʋ	ɹ	ɻ	j	ɰ			
Lateral approximant			l	ɭ	ʎ	ʟ			
Ejective stop	p'		t'	ʈ'	c'	k'	q'		
Implosive	ƥ ɓ		ƭ ɗ		ƈ ʄ	ƙ ɠ	ʠ ʛ		

TACTILE

	Bilabial	Labiodental	Dental Alveolar Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b		t d	ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ	n	ɳ	ɲ	ŋ	ɴ		
Trill	ʙ		r				ʀ		
Tap or Flap			ɾ	ɽ					
Fricative	ɸ β	f v	θ ð s z ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative			ɬ ɮ						
Approximant	w	ʋ	ɹ	ɻ	j	ɰ			
Lateral approximant			l	ɭ	ʎ	ʟ			
Ejective stop	p'		t'	ʈ'	c'	k'	q'		
Implosive	ƥ ɓ		ƭ ɗ		ƈ ʄ	ƙ ɠ	ʠ ʛ		