**This dissertation has been
microfilmed exactly as received**

66-6297

**SINGH, Sadanand, 1934-
A CROSS-LANGUAGE STUDY OF PERCEPTUAL
CONFUSION OF PLOSIVE PHONEMES IN TWO
CONDITIONS OF DISTORTION.**

**The Ohio State University, Ph.D., 1965
Speech**

University Microfilms, Inc., Ann Arbor, Michigan

A CROSS-LANGUAGE STUDY OF PERCEPTUAL CONFUSION OF PLOSIVE
PHONEMES IN TWO CONDITIONS OF DISTORTION

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the
Degree Doctor of Philosophy in the Graduate School of
The Ohio State University

By

Sadanand Singh, B.A. (Hons.), M.A., Ph.D.

* * * * *

The Ohio State University
1965

Approved by

Adviser
Department of Speech

PLEASE NOTE:

Table pages and Figure pages
are not original copy. Some
of them tend to "curl". Filmed
in the best possible way.

University Microfilms, Inc.

VITA

- January 2, 1934 .. Born - Saropatty, Saharsa, Bihar, India
- 1956 B.A. (Hons.), R.D. & D.J. College,
Monghyr, Bihar, India
- 1958 M.A., Hindi, L.S. College, Muzaffarpur,
Bihar, India
- 1958-1960 Lecturer in Hindi, Koshi College,
Khagaria, Bihar, India
- 1960-1963 Lecturer in Hindi, Ranchi College,
Ranchi, Bihar, India
- 1963 Ph.D. (Hindi), Ranchi University,
Bihar, India
- 1963-1965 Research Assistant Associate, The Ohio
State University, Columbus, Ohio

PUBLICATIONS

- 1962 "A Collection of Hindi Essays," Kamal
Prakashan, Ranchi, Bihar, India
- 1964 "A Study of Pauses in Oral Reading of
One's Native Language and English."
Co-authors, John W. Black, Oscar Tosi,
and Yukio Takefuta, 1964. Convention
Abstract, ASHA, A Journal of the American
Speech and Hearing Association, Vol. 6,
No. 10, Oct. 1964.
- 1965 "Speech and Aural Comprehension of
Foreign Students," The Journal of Speech
and Hearing Research, March 1965, Vol. 8,
No. 1. Co-authors: John W. Black,
Oscar Tosi, Yukio Takefuta, and Elizabeth
Jancosek.

- 1965 "An Audiovisual Pathway to Speech Improvement," Audiovisual Instruction, April 1965, Vol. 10, No. 4.
- 1965 "A Study of Nonsense Syllables Spoken by Two Language Groups in Varying Conditions of Sidetone and Reading Rate." Co-author, J. W. Black. In press.
- 1965 "Study of Twenty-six Intervocalic Consonants as Spoken and Recognized by Four Language Groups." Co-author, J. W. Black. In press.
- 1965 "The Effect of High- and Low-filtered Noise on Intelligibility of Filtered Speech." Co-authors, Sonia Brokaw and J. E. Fricke. Abstract of the 70th Meeting of the Acoustical Society of America.

FIELD OF STUDY

Speech and Hearing Science, Linguistics, and Psycholinguistics

CONTENTS

	Page
TABLES	v
FIGURES	viii
Chapter	
I. INTRODUCTION	1
II. BACKGROUND OF THE PROBLEM	9
III. EXPERIMENTAL PROCEDURE	32
IV. ANALYSIS OF THE RESULTS	46
V. DISCUSSION AND CONCLUSIONS	132
Appendix	
A. THE MULTIPLE-CHOICE RESPONSE SHEETS	143
B. TABLES 1-480, CONFUSION MATRICES	146
BIBLIOGRAPHY	187

TABLES

Table	Page
1. Classification of plosives used for the analysis of the confusion of distinctive features	87
2. Classification of consonants used for the analysis of the confusion of distinctive features	88
3. Frequencies of all correct responses for four distinctive features of the consonants spoken and recognized by three native speakers and ten native listeners of Hindi	90
4. Frequencies of all correct responses for four distinctive features of the consonants spoken by three native speakers of Hindi and recognized by ten native speakers of Hindi ...	91
5. Frequencies of all correct responses for the four distinctive features of the consonants spoken by three native speakers of English and recognized by ten native speakers of Hindi ...	92
6. Frequencies of all correct responses for the four distinctive features of the consonants spoken and recognized by three native speakers and ten native listeners of English .	93
7. Frequencies of all incorrect responses for the five distinctive features of the consonants spoken and recognized by three native speakers and ten native listeners of Hindi	95
8. Frequencies of all incorrect responses for the five distinctive features of the consonants spoken by three speakers of Hindi and recognized by ten native listeners of English.	96
9. Frequencies of all incorrect responses for the five distinctive features of the consonants spoken by three native speakers of English and recognized by ten native speakers of Hindi ...	97

Table	Page
10. Frequencies of all incorrect responses for the five distinctive features of the consonants spoken and recognized by three native speakers and ten native listeners of English	98
11. Information transmitted for four separate binary features when three native speakers and ten native listeners of Hindi are operating	101
12. Information transmitted for four separate binary features when three native speakers of Hindi are speaking and ten native speakers of English are listening	102
13. Information transmitted for four separate binary features when three native speakers of English are speaking and ten native speakers of Hindi are listening	103
14. Information transmitted for four separate binary features when three native speakers and ten native listeners of English are operating	104
15. Percent information transmitted for two distinctive features. Speakers and listeners, both, were of Hindi	106
16. Percent information transmitted for two distinctive features. Speakers were of Hindi and listeners of English.....	107
17. Percent information transmitted for two distinctive features. Speakers were of English and listeners of Hindi	108
18. Percent information transmitted for two distinctive features. Speakers and listeners, both, were of English	109
19. Information transmitted for four distinctive features. Responses of all four speaker-listener groups are pooled	114
20. Percent information transmitted for four distinctive features. Responses of all four speaker-listener groups are pooled	115

Table	Page
21. Information transmitted for all features (composite channel)	117
22. Percent information transmitted for all features (composite channel)	118
23. Information transmitted (observed) for all features (composite channel). The responses of all speaking-listening conditions are pooled	124
24. Transmission of information (expected) for all features (composite channel). Responses of all speaking-listening conditions are pooled	124

FIGURES

Figure	Page
1. A graphical representation of the gating procedure	35
2. A block diagram of gating instrumentation ...	39
3. A graphical representation of the experimental design	44
4-147. Graphical representation of the listener's response in six bandwidth conditions and at six points of temporal processing. Lower frequency of the bandwidth is stated at the bottom of each page. There are six such pages, each representing one of these lower frequencies: (1) 106 cps., (2) 212 cps., (3) 425 cps., (4) 850 cps., (5) 1700 cps., and (6) 3400 cps. The stimulus is written at the top and the responses close to the lines that represent them, bounded by slanted lines, e.g. /p/. A category of speakers is represented as Sp, listeners as Lis, Hindi as H, and English as E. There are six stimuli, four speaking-listening conditions, and six lower frequencies	50-67
148-218. A pictorial demonstration of the impact of gating phenomenon on the stimuli. Two speakers, one of Hindi and one of English, were arbitrarily selected for presentation. All stimuli they recorded were gated at six points. At the top of each page (that presents oscilloscopic pictures) gating at 120 msec. point is presented which is the maximum temporal gating. This follows 100, 80, 60, 40, and 20 msec. of gatings. Each stimulus was gated at all these six points. English, written at the bottom of each figure, indicates that the stimulus was spoken by a speaker of English, and Hindi indicates that the stimulus was spoken by a speaker of Hindi	78-83

219. A projection of a plane of the Y and X_1 axes. Ordinate (Y) is the information transmitted in bits per stimulus with a maximum information value of 2.584. Abscissa (X_1) represents the six points of processed time. The straight line at the top of the figure represents maximum possible information and the six squares are the six points that represent observed information. The fitted straight line represents the model of linearity 126
220. A projection of a plane on the Y and X_2 axes. Ordinate (Y) is the information transmitted in bits per stimulus. Abscissa (X_2) represents the twenty different widths of the frequency bands. The twenty squares are twenty points that represent observed information. The fitted straight line represents the model of linearity. Both width of the frequency bands and information, in this instance, have been drawn on a log-log paper. Information transmission, in terms of the width of the bandwidth, never surpassed one bit..... 128

CHAPTER I

INTRODUCTION

Speech recognition is a decoding of signals utilizing acoustic (segmental and suprasegmental), motor (tactile and proprioceptive), linguistic (diachronic and synchronic), probabilistic, and other learned cues. These cues equip the decoder with a set of distinctive patterns to recognize the on-going speech. Instantaneous decoding, presumably, takes place in absolute acoustic and articulatory terms. "For some sounds, however, distinctiveness is not so much an acoustic or even an articulatory factor, but a consequence of linguistic experience."¹

¹J. L. Flanagan, Speech Analysis, Synthesis, and Perception (New York: Academic Press, Inc., 1965), p. 236.

The present study manipulates acoustic stimuli spoken by two language groups in a non-meaningful speech context and investigates clues used by the listeners of two language groups when distortions on two dimensions, time and bandwidth, have been imposed. The study tests whether or not only a small amount of frequency in bandwidth and

time in msec. is necessary as input to perceive plosive consonants. It also tests whether the relative importance of the bandwidth and the time (msec.) may be established as acoustic-temporal cues which listeners need to distinguish phonemes and the inherent features in a cv nonsense syllable context, in both his own and a foreign language.

Much of the interest in the present study lies in finding a relation for predicting information transmission ratio in terms of time, width of the frequency band, and the lower frequency of the bandwidth. The theory of linear regression would be utilized in formulating models of prediction.

In case of the information transmission's being constant, we shall investigate the corresponding ratio in the times and frequency bandwidths.

A two-dimensional approach to the study of psycho-acoustic phoneme boundaries, i.e., frequency in cps and time in msec. has been adopted in this experiment. A third dimension, i.e., signal-to-noise ratio, is normal and held constant. Further extensions of this study would be (1) to keep time (msec.) constant and vary bandwidth and signal-to-noise ratio, and (2) to keep bandwidth constant and vary time (msec.) and signal-to-noise ratio. "Shannon has shown that it should be possible to exchange

bandwidth for power, so that by increasing bandwidth one should in principle be able to make up for the lack of transmitter power."²

²A. V. Balakrishnan, "Signal Selection Theory for Space Communication Channels," Advances in Communication Systems (New York: Academic Press, 1965), Vol. 1, pp. 1-31.

The acoustic properties of speech seem to have more than one dimension, namely time, frequency, and amplitude. There may be some critical points for speech perception on all these continua. A considerable amount of work on band-pass filtered speech indicates that there is an optimal frequency range for the recognition of a specific speech sound. There is a critical point of transition on the time and frequency dimensions which is crucial for perception.

Perception of consonants is categorical and hence discontinuous. Thus it is that categorical point which is important in regard to a particular consonant, not the whole speech spectrum. Such points of discrimination are termed as acoustic phoneme boundary. The motor theory of speech perception (Lieberman et al.) emphasizes the crucial importance of motor clues more than acoustic clues. Several experiments oriented to the 'motor theory of speech perception' have

reported that the perception of consonants is categorical and refers more to motor than to acoustic clues.³

³A. M. Liberman, F. S. Cooper, K. S. Harris, and P. F. MacNeillage, Proceedings of the Speech Communication Seminar, Speech Transmission Laboratory, R.I.T., Stockholm, Sweden, Session D (1963).

Distinctive feature theory handles the problem of speech perception in a somewhat different manner. Each sound of a language is characterized by some specific physio-acoustic properties unique to that sound. The presence of those properties affirms the incidence of that sound and the absence denies it. Thus, in so denying, it affirms the incidence of its opposite pair or cognate.⁴

⁴Roman Jakobson, C. G. M. Fant, and M. Halle, Preliminaries to Speech Analysis (Mass.: The M.I.T. Press, Mass. Institute of Technology, Cambridge, 39, 1952).

Phonemes have been widely accepted as a bundle of physio-acoustic properties called distinctive features. These features have been specified primarily by acoustic and secondarily by motor references. The theory utilizes a binary code of having or not having a particular acoustical or articulatory property which is crucial to the distinction of a given sound. The proponents of this theory propose its universal application.⁵

⁵R. Jakobson and M. Halle, "Phonology and Phonetics," Roman Jakobson Selected Writing (Gravenhage: I. Morton & Co., 1962), pp. 464-504.

Words [pæt], [bæt], and [mæt] are different because of the phonemes /p/, /b/, and /m/. /p/ and /b/ are different (among other things) because of the voicing, and /b/ and /m/ because of voicing and nasality. These features enable one to distinguish between [pæt], [bæt], and [mæt] in English and [pa:t̪], [ba:t̪], and [ma:t̪] in Hindi and are learned at an early stage of speech development. The difference between [pæt] and [bæt] is minimal whereas the difference between [pæt] and [mæt] is duple. "Wider differences may be termed duple, triple, etc., according to the number of minimal distinctions of which the total difference is composed."⁶ [pa:t̪] in Hindi

⁶D. Jones, An English Pronouncing Dictionary, 7th ed., New York, 1946.

means 'fall,' [ba:t̪] 'talk,' and [ma:t̪] 'defeat.' Distinctive features, thus, are differentiating semantic units and, therefore, "least dispensable among the sound function of language."⁷

⁷R. Jakobson, C. G. M. Fant, and M. Halle, op. cit.

When, because of some unavoidable physiological reason, the distinctive features are perceived in an altered manner, the listener becomes handicapped. In the experimental studies where these features are deliberately

altered, confusion occurs in the perception of speech sounds.^{8,9,10} Experimental evidences have shown that

⁸G. A. Miller and P. E. Nicely, "An Analysis of Perceptual Confusions Among Some English Consonants," Journal of the Acoustical Society of America, 27 (1955), pp. 338-352.

⁹W. A. Grimm, "The Perception of Segments of English-spoken Consonant-vowel Syllables," Ph.D. dissertation, The Ohio State University, 1965.

¹⁰S. Singh and J. W. Black, "Study of Twenty-six Intervocalic Consonants as Spoken and Recognized by Four Language Groups," in Press (1966).

certain features are preserved in error more than others.

In spite of the fact that each language has its own and unique phonological structure, there are some elements of commonality on the basic levels of incoding and decoding. A cross-linguistic study which included speakers and listeners of four languages demonstrated singular rank-order in regard to the relative amount of information per channel.¹¹ According to Jakobson and

¹¹S. Singh and J. W. Black, op. cit.

Halle,

The progress made in the phonemic investigation of the speech of infants and aphasics, along with the ever increasing number of discovered laws, moves into the foreground the problem of the universal rules underlying the phonemic patterning of languages. . . . The study of invariances within the phonemic pattern of one language must be supplemented by a search for

universal invariances in the phonemic patterning of language in general.¹²

¹²R. Jakobson and M. Halle, op. cit.

The present study includes three variables, time in msec., lower frequency, and width of the bandwidth; and one parameter, language groups. The purposes were the following:

1. To test the effect of filtering of frequency bandwidth and processing of time on the intelligibility of plosive consonants as spoken and recognized by native speakers of Hindi and English,
2. To determine the predictability of information transmitted in bits per stimulus as a function of time (acoustically segmented at six temporal points) and bandwidth (filtered at 20 frequency bands of six bandwidth conditions),
3. To estimate the preservation of distinctive features in error when speakers and listeners of two languages are experimental subjects and to assess the relevance and relative importance of these features, and
4. To search for universal invariances in the phonemic patterning of the plosives of the two languages.

Plans of the study. Chapter I introduces the subject and states the problems undertaken in this experiment. Chapter II is a review of previous experiments

pertinent to these problems. Chapter III is a statement of experimental procedures, and a description of instruments, experimental materials, and experimental subjects. Chapter IV states the results in four separate parts. The first deals with confusion matrices of plosive consonants in 20 bandwidths of six bandwidth conditions and at six points of processed time as spoken and recognized by the speakers and listeners of Hindi and English. The second part accounts for the frequencies of correct and incorrect responses added separately for four, in case of correct; and five, in case of incorrect, distinctive binary features. Part three deals with the information transmitted in bits per stimulus for the composite channel and for four separate channels (for four distinctive binary features). It also compares the information transmission values when phonemes were classified by four separate features with the values obtained when phonemes were classified by only two separate features. The fourth part is devoted to stating information as a function of bandwidth, lower frequency, and time. Chapter V is a discussion of the results.

CHAPTER II

BACKGROUND OF THE PROBLEM

The last fifteen years of study in the field of speech perception seem primarily devoted to the study of consonants. Vowels form a pattern relatively more convenient to analyze than the consonants. Modern technology, specifically electronics, provided ample facilities to design experiments that involve synthesis and analysis of consonants. Highly controlled experiments using synthetic and natural speech have been and are being conducted with several eliminating and distorting variables induced. Most of these efforts are directed towards the basic understanding of the inherent nature of speech and the process of speech perception.

Frequency bands in intelligibility and transformation of information testing. Kryter has reviewed the status of the articulation index and refers to it as 'the twenty band method' for predicting speech communication.¹ French and Steinberg have investigated twenty

¹K. D. Kryter, "On Predicting the Intelligibility of Speech from Acoustical Measures," Journal of Speech and Hearing Disorders, 21 (1956), pp. 208-217.

bands that contribute equally to speech intelligibility.

Such predictions of intelligibility of speech are of enormous value for further laboratory research and practical purposes.² Fletcher and Galt have developed

²N. R. French and J. C. Steinberg, "Factors Governing the Intelligibility of Speech Sounds," Journal of the Acoustical Society of America, 19 (1947), pp. 90-119.

functions as a relationship between articulation index and various measures of speech communication. Both Fletcher and Galt and French and Steinberg have used frequencies ranging from 200 to 6100 cps.³ Both were interested "in

³H. Fletcher and R. H. Galt, "The Perception of Speech and its Relation to Telephony," Journal of the Acoustical Society of America, 22 (1950), pp. 89-151.

the effects upon speech intelligibility of filtering and other type of frequency distortion of the speech signal."⁴

⁴K. D. Kryter, op. cit.

One of their propositions was that the masking of a band of speech by a band of noise would have a comparable effect on speech intelligibility as the suppression of the same band of speech by band-pass filtering.⁵

⁵K. D. Kryter, op. cit.

Since the octave band procedure is popularly used in the laboratories, Beranek and Strasberg have devised

methods to test intelligibility under maximally tolerable noise levels. The measures of noise are made by octave bands.

The twenty-band procedure was used by Black to investigate frequency bands that contribute equally to multiple-choice intelligibility scores and also to monosyllabic write-down scores over the same system of talkers, equipment and listeners.⁶ Thus the twenty-band

⁶J. W. Black, "Equally Contributing Frequency Bands in Intelligibility Testing," Journal of Speech and Hearing Research, Vol. 2, No. 1 (1959), pp. 81-83.

and octave-band methods have been effectively utilized to predict the effects of frequency distortion upon speech intelligibility.

Pollack has demonstrated that the intelligibility scores of a narrow band are not entirely independent.⁷

⁷I. Pollack, "Effects of High Pass and Low Pass Filtering of the Intelligibility of Speech in Noise," Journal of the Acoustical Society of America, 20 (1948), pp. 259-266.

The effects of selective narrow band filtering on the perception of phonetically balanced word-lists were observed. The findings are somewhat deviant from those that reported equally contributing bands. Extremely narrow bandwidth yielded 'demonstrably high' intelligibility

scores.⁸ Narrow bands centered at 1560 and 1920 cps.

⁸W. E. Castle, "Effects of Selective Narrow-band Filtering on the Perception by Normal Listeners of Harvard PB-50 Word Lists," National Institute of Neurological Diseases and Blindness, BPD-15 (1963), in conjunction with NIH Grant #62-4616-20 (1964).

yielded better intelligibility scores than those centered at 1080 cps. Several narrow bands did not contribute equally to the intelligibility scores. Speech tends to remain highly intelligible even after several of the equally contributing bands are eliminated.

Miller and Nicely have reported five independent acoustic features to characterize sixteen English consonants in the eliminating frequency and distorting signal-to-noise ratio conditions. An important difference reported between low- and high-pass filtered speech was that "low-pass filters affect several linguistic features differentially, leaving the phonemes audible but similar in predictable ways, whereas high-pass filters remove most of the acoustic power in the consonants, leaving them inaudible, consequently, producing quite random confusions." Using the traditional method, the authors have demonstrated that low- and high-pass curves cross each other at 1550 cps.⁹ Five female subjects served as speakers and

⁹G. A. Miller and P. E. Nicely, op. cit.

listeners. Sixteen English consonants were recorded with

the vowel /a/. Frequency and signal-to-noise ratio distortions were imposed. All sixteen consonants were characterized by binary distinctive features: nasality, voicing, duration, affrication, and place. A covariance measure of intelligibility indicated that masking affects the characteristic distinctive features of the sixteen phonemes in the following order of ranking: (1) nasality, (2) voicing, (3) affrication, (4) duration, and (5) place. Low-pass filtering and noise were found to have similar effects on speech perception, while high-pass filtering yielded different results. "With a minor exception for duration, all features deteriorate in about the same way as the low frequencies are removed . . . even without noise, audibility is the problem for high-pass systems and confusibility is the problem for low-pass systems."¹⁰

¹⁰G. A. Miller and P. E. Nicely, op. cit.

Formant transition, acoustic loci, and other cues.

Formant transition, a state of rapid change in the vowel formant to the consonant, is known to be an important cue for the perception of consonants. Experiments by Haskins Laboratories using synthetic speech, and others using both synthetic and natural speech, have demonstrated that formant transitions contain crucial cues for the perception of consonants.

In an experiment with synthetic speech, the first formant was kept constant and the second formant transition was varied in a controlled manner. The gradual change in the acoustic properties of the stimuli did not result in a gradual change in the perception of the sounds. There were distinct points of significantly higher scores for the perception of /b/, /d/, and /g/ with articulation as the referent. This indicates that the crucial domain of psycho-acoustical boundaries for each sound was more important than the rest of the input spectrum. The change from /b/ to /d/ and from /d/ to /g/ was abrupt rather than gradual. "For equal physical differences acuity was greater across phoneme boundaries than within the phoneme classes."¹¹ The researches of the Haskins Laboratories

¹¹A. M. Liberman, K. S. Harris, H. S. Hoffman, and B. C. Griffith, Journal of Experimental Psychology, 54 (1957), pp. 358-368.

indicated that the feedback of a speaker's own articulatory movement is decisive in the perception of plosive sounds. Because there is no intermediate articulation between /b/ and /d/, there is no intermediate perception.

There seems to be a basis of disagreement with the present argument regarding speech perception. Experimenters have no means of knowing that listeners perceive anything intermediary between /b/ and /d/ because they have no

intermediary symbols and, hence, do not have any choice between them.

The motor theory of speech perception lacks a uniform theoretical explanation for all speech sounds. The perception of consonants has been reported to be discontinuous and of vowels continuous.¹²

¹²F. S. Cooper, A. M. Liberman, K. S. Harris, and P. M. Grubb, Proceedings of the Second International Congress on Cybernetics, Namur, Belgium (1958).

The motor theory of speech perception was put to a direct experimental verification in a somewhat simplified manner.¹³ Speech spectra of 180 to 4500 cps. were split

¹³P. B. Denes, "On the Motor Theory of Speech Perception," Symposium on Models for the Perception of Speech and Visual Forms, Boston, Mass. (1964).

into eleven bands. The hypothesis was based on a corollary of motor theory that an essential part of the process of learning to recognize speech is the learned way of producing speech. According to the motor theory of speech perception, speech input is not directly and exclusively interpreted by auditory mechanisms but with continuous reference to articulatory movements.

Experimental subjects were divided into two groups: (1) those who received visual stimuli only and (2) those who spoke the words they were asked to respond. No significant difference between the learning progress of

the two groups was found. This finding did not "support" the motor theory of speech perception. Some doubts, however, were posed to favor motor theory. The basis was the different patterns of curves: the marked oscillations in the speakers' progress curve as compared with the relative smoothness of the listeners' progress curve.

Two acoustical cues have been reported to be important for the perception of consonants: (1) the position of noise on the frequency scale and (2) the transitions of the second and third formants. Each consonant has been reported to have a characteristic frequency position which has been described as the locus for the second formant. For the voiced plosives /b/, /d/, and /g/ there seems to be a fixed second formant foci at 720 cps., 1800 cps., and 1200 cps., respectively. The first formant has the same locus for all three of these voiced plosives.¹⁴ The effect of the third formant

¹⁴P. C. Delattre, A. M. Liberman, and F. S. Cooper, "Acoustic Loci and Transitional Cues for Consonants," Journal of the Acoustical Society of America, Vol. 27, No. 4 (1955), pp. 769-773.

transition on the perception of the voiced plosive consonants was observed two years later and cues independent of the two-formant patterns were found.¹⁵ Up and

¹⁵K. S. Harris, H. S. Hoffman, A. M. Liberman, P. C. Delattre, and F. S. Cooper, "Effect of Third-formant Transition on the Perception of the Voiced Stop Consonants," Journal of the Acoustical Society of America, Vol. 30, No. 2 (1958), pp. 122-126.

down shifts of the third formant usually affected the perception of consonants. "This reinforces and extends the observations already noted and provides more general evidence for the assumption that there are F_3 loci analogous to those we have already found for F_2 ." However, the data are not considered sufficient by the experimenters to be able to speak of the third formant loci.¹⁶

¹⁶K. S. Harris, H. S. Hoffman, A. M. Liberman, P. C. Delattre, and F. S. Cooper, op. cit.

A burst of noise in the relatively high frequency region is crucial for the perception of dentals and a relatively low frequency position is indicative of the labial or velar place cues of the consonant. Two acoustical cues are relevant for the perception of the consonantal place of production: the position on the frequency scale of noise and the transition of the second and third formants.^{17,18}

¹⁷F. S. Cooper, P. C. Delattre, A. M. Liberman, J. M. Borst, and L. Gerstman, "Some Experiments on the Perception of Synthetic Speech Sounds," Journal of the Acoustical Society of America, 24 (1952), pp. 629-639.

¹⁸A. M. Liberman, P. C. Delattre, and F. S. Cooper, "The Role of Selected Stimulus-variables in the Perception of Unvoiced Stop Consonants," The American Journal of Psychology, 65 (1952), pp. 497-517.

The traditional way of categorizing phonemes in terms of voiceless/voiced has been declared "somewhat

inappropriate." Instead, tense/lax (or fortis/lenis) have been used to refer to /ptk/ and /bdq/ respectively.^{19,20}

¹⁹M. Halle, G. W. Hughes, and P. Radley, Jr., "Acoustic Properties of Stop Consonants," Journal of the Acoustical Society of America, 29 (1957), pp. 107-116.

²⁰R. Jakobson and M. Halle, "Tenseness and Laxness," Roman Jakobson: Selected Writings, I, Phonological Studies (The Hague, 1962), pp. 554-555.

To determine a single best measure for these two phoneme categories, a cross-linguistic study was designed. While introducing the problem, the authors expressed disagreement with the ambiguous status of the terms fortis and lenis (or tense and lax). Fant's view that there is no need of pointing out an independent fortis/lenis difference is in agreement with the present work.²¹ Spectrographic

²¹G. G. M. Fant, Acoustic Theory of Speech Production (The Hague, 1960), pp. 224-225.

evidences regarding the two phoneme categories have been cited. They indicate that in the case of plosives in English, voicing and aspiration correlate with the periodic pulsing at the frequency range of higher formants. There is a prominence of one feature in the absence of another; where voicing is present, noise is absent or less prominent; and where noise is present, voicing is

absent or less prominent.²² This study concludes that

²²L. Lisker, and A. S. Abramson, "A Cross-language Study of Voicing in Initial Stops, Acoustic Measurements," Word, 20 (1964), pp. 384-422.

the difference in voicing not only distinguishes voiced from voiceless plosives, but also distinguishes aspirated from unaspirated. One of the purposes was to see how the plosive categories of a number of languages differ. The study included eleven languages, English being the two-category language and Hindi the four-category language. The findings generally support the view that the voice-onset-time is an important acoustic differentiator of plosive categories across a wide variety of languages. The following rationale has been used to classify the languages into two, three, and four categories of acoustic description. English is a two-category language because of the duple variation of voiced and voiceless. Eastern Armenian is a three-category language because of the triple phonetic-phonemic variations of voiced, voiceless-unaspirated and voiceless-aspirated. Hindi and Marathi are four-category languages because of quadruple phonetic-phonemic variations of voiced-unaspirated, voiced-aspirated, voiceless-unaspirated, and voiceless-aspirated.

Voice onset time serves as a basis for separating the manner and to a certain extent place categories in all the plosives of the eleven languages that were examined

in the Lisker and Abramson study. Two-category languages, for example Dutch, Spanish, Hungarian, and Tarnil, were similar in having one set of plosives with similar values of voice onset time. English and Cantonese are also two-category languages, but different from the rest in regard to the voice onset time. However, "the over-all similarity among these six languages is striking."²³

²³L. Lisker and A. S. Abramson, op. cit.

The case of three-category language was a departure in terms of voice onset time because of the peculiarity of Korian. The four-category languages, Hindi and Marathi, showed clear inadequacies of the voice onset time to distinguish among all the plosive categories of a language.

An interesting observation made in this study (Lisker and Abramson) about all the eleven languages was that in regard to the measures of voice onset time, the distribution of values was essentially tri-modal, each corresponding to one of the three points of centering (-100, +10, and 75 msec.).

Processing of time. Psychophysical-acoustic-temporal phoneme boundaries have been achieved by processing of time, i.e., acoustically segmenting speech signals. This helped eliminate temporal redundancies, economize channels, and understand cues to speech perception.

Ascertaining phoneme boundaries determined by varying formant transition and the point of acoustic locus has been one of the focal points of the work of the Haskins Laboratories. Segmentation of acoustic stimuli on absolutely temporal dimensions has been a relatively recent endeavor to investigate crucial acoustic correlates for speech perception. All such processes of elimination are carefully designed to minimize the amount of time, frequency band, stress, intonation, etc., without jeopardizing the useful information necessary to operate the voice-communication network.

Duration, the length of speech signal heard, plays an important role in speech perception. Steady state segments were synthesized on the temporal dimension to test the hypothesis that is based on the perceptual analysis of speech.²⁴ Fricatives /f/ and /s/ when

²⁴A. Cohen and J. Hart, Proceedings of the Speech Communication Seminar, Vol. II, Speech Transmission Lab., R.I.T., Stockholm/Sweden, Session F (1962).

presented in short temporal segments consistently sounded like /p/ and /t/ respectively. Thus, duration, in this case, seems to be an important cue to separate plosives from fricatives. Such acoustic correlates to the phonemic class of distinction were 'arbitrarily adopted' by Miller and Nicely who thought "it is their extra duration that is

most effective in setting them apart."²⁵ The study by

²⁵G. A. Miller and P. E. Nicely, op. cit.

Cohen and t'Hart provides the information that variation of time contributes significantly to discovering cues for perception of speech and that "the proper dimensioning of the time parameter makes it possible to neglect quite a number of the details of formant information, which is usually claimed to be of paramount importance by other investigators."²⁶

²⁶A. Cohen and J. t'Hart, op. cit.

Natural speech was used in a similar experiment in our own laboratory which yielded similar perceptual findings. Fourteen consonants were truncated at thirteen points at 10 msec. intervals in a monosyllabic nonsensical speech context. Analysis of confusion matrices indicated that error responses of plosives stayed within plosive groups whereas the error responses of fricatives invariably crossed the class limit. Rises in curves representing plosive sounds occurred between 60 msec. and 100 msec. /f/ and /v/ were confused as /b/, /s/ as /t/, /z/ as /d/, /ʃ/ as /t/, and /ʒ/ as /d/. Thus duration, again, was a distinctive acoustical property between plosive and fricative classes.²⁷

²⁷William A. Grimm, op. cit.

Öhman reported the contribution of duration as a variable in the study of Swedish consonants.²⁸ Electronic

²⁸Sven Öhman, On the Perception of Swedish Consonants in Intervocalic Position, R.I.T., Stockholm/Sweden, Report No. 25 (1962).

grating equipment was used to acoustically segment bisyllabic nonsense words spoken by a speaker of Swedish in such a way that the following processing of time occurred 20 msec. later than the preceding. Acoustically recorded stimuli, for example /aba/, were bisected into two monosyllabic segments. Thus vcv became vc and cv as designated by /ab/ and /ba/. The conclusion was that an extension of a stimulus by a certain temporal amount causes a change in listeners' identification. The magnitude of the importance of the added segment depends of its contribution to the identification score.

A tape-cutting and slicing experiment on the Swedish vowel indicated that length is a distinctive feature. It was concluded in the report that "there were a few cases in which the consonant after a short vowel was the same as, or even shorter than, the consonant after the corresponding long vowel."²⁹

²⁹K. Hadding-Koch and S. Abramson, "Duration Verses Spectrum in Swedish Vowels: Some Perceptual Experiments," (to appear in Studia Linguistica), Status Report on Speech Research, S-R--2 (1965), Haskins Laboratories, New York.

A close relationship has been demonstrated between the physical and perceptual phoneme boundaries. Physical boundaries are marked by the most noticeable change in the over-all intensity. The perceptual boundary is marked by the maximum identification score. The perceptual and physical boundaries coincide within a duration limit of only 20 msec.

Two major cues for plosive consonants: (1) the release of the burst on the plosive and (2) the formant transition in the adjacent vowel, have been considered important. Plosive bursts and the transition from the consonant to the vowel were studied by varying the plosive burst on time, and transiting from the consonant to vowel on the frequency continua individually. Common acoustical properties of burst and formant transitions were found.³⁰

³⁰M. Halle, G. W. Hughes, and J. P. A. Radley, "Acoustic Properties of Stop Consonants," Journal of the Acoustical Society of America, Vol. 29 (1957), pp. 107-116.

The study introduces the concept of silence as an important cue for the perception of consonants adjacent to vowels. Two other cues, transition and burst, are subsidiary. A question asked in this experiment was, "Is a listener able to identify stop bursts isolated from their context as /p/, /t/, or /k/?" The first 20 msec. of all plosives were gated in order to eliminate the burst part and then the phonemes were re-recorded and presented to the listeners

in a closed response environment of /p/, /t/, and /k/. With a mean percentage of 77 percent of the identification score, it was concluded that the bursts in isolation are identifiable and therefore the presence of the first 20 msec. seems more important for the identification of these voiceless plosive consonants than the rest of the acoustical remains.

The second experimental step included the filtering of the bursts with the following findings:

/p/ and /b/, the labial stops, have a primary concentration of energy in the low frequency (500-1500 cps.). /t/ and /d/, the post dental stops, have either a flat spectrum or one in which the higher frequencies (above 4000 cps.) predominate aside from an energy concentration in the region of 500 cps. /k/ and /g/, the palatal and velar stops, show strong concentration of energy in intermediate frequency regions (1500-4000 cps).³¹

³¹M. Halle, G. W. Hughes, and P. A. Radley, Jr., op. cit.

Distinctive features. Before Jakobson, Fant, and Halle formulated a unified theory of the distinctive features and their correlates with somewhat 'universal application'; Saussure emphasized that the differential qualities among phonemes are more basic speech elements upon which the structure of a language rests than the phonemes themselves.^{32,33} The theory proposed by the trio

³²R. Jakobson, C. G. M. Fant, and M. Halle, op. cit.

³³Ferdinand de Saussure, Courses in General Linguistics, ed., Charles Bally and Albert Secheaye (New York Philosophical Library, 1959).

utilizes a very useful concept of binary oppositions. Information theory is based on similar binary selection. This "dichotomous scale is the pivotal principle of the linguistic structure." Speech perception, as they propose, is absolutely dependent on discrimination of features. They realize, however, that speech perception does not only involve the distinctive features. "Other types of coded information-bearing features should not be disregarded."³⁴ Thus the distinctive features are the primary

³⁴R. Jakobson and M. Halle, op. cit.

elements of perception and then there are secondary elements which speakers and listeners of a speech community acquire and use.

Twaddell thought that phonemes are abstract and fictitious.³⁵ So long as there is a constant physical

³⁵Twaddell, "On Defining the Phoneme," Supplement to Language, XVI (1935).

correlate of the phonemes marked by the appropriate distinguishing features at all speech events, perception is identical in all conditions (except when some distortion is present). Phonemes are not fictitious but are the real units of language. The hierarchy of such reality is marked by certain distinctive features forming phonemes, phonemes forming syllables, syllables forming words, and words

forming sentences; all guided by certain probabilistic, phonological, and syntactic rules.

Instead of taking the unified hierarchial approach to the distinctive feature theory, Mol and Ulenbeck think:

It is by the whole of its soundshape that in actual speech the word is recognized and at the same time marked off from the word forms of the surrounding words. . . . The most elementary aspect of the phonemes is that they are characteristic parts of the word forms, which distinguish the words from each other by the whole of their form. . . . The phoneme characterizes the word form in speech via the whole of the word form, i.e., via its place and sequence, that is to say on the syntagmatic level and not on the paradigmatic level.³⁶

³⁶H. Mol and E. M. Ulenbeck, "The Analysis of the Phoneme in Distinctive Features and the Process of Hearing," Lingua, Vol. IV (1954-1955), pp. 167-193.

Mathematical theory of information. Mathematical theory of information has proved to be a very useful tool in establishing stimulus-response relationships in precise quantitative terms.³⁷ Shannon treated information and

³⁷C. E. Shannon, and W. Wever, The Mathematical Theory of Communication (Urbana: University of Illinois Press, 1949).

uncertainty as synonymous and declared everything that was predictable a priori as redundancy. "Following Shannon, we can define redundancy as one minus the relative uncertainty of a source, where the relative uncertainty is the ratio of the uncertainty of the source

to the maximum value it could have with the same set of symbols."³⁸

³⁸W. R. Garner and D. H. Carson, "A Multivariate Solution of the Redundancy of Printed English," Psychological Reports, 6 (1960), pp. 123-141.

Uncertainty or information is symbolized as H or U, as a function of the variable x in a univariate analysis where x can take any value, x_i , $i=1$ to K. Shannon's measure of average information or uncertainty associated with a discrete probability distribution is given by:

$$H(x) = - \sum P(x_i) \log P(x_i) \quad (1)$$

In a bivariate uncertainty measure two variables, x and y, are involved where x can take any value x_i and y can take any value y_j . Thus, in terms of two variables the equation would write:

$$H(x,y) = - \sum P(x_i, y_j) \log P(x_i, y_j) \quad (2)$$

Such analysis has been extended up to the multivariate measure of uncertainty where more than two variables, as for example, x,y,w, are involved.³⁹

³⁹W. R. Garner, Uncertainty and Structure as Psychological Concepts (New York: John Wiley and Sons, Inc. (1962)).

H(x) is the uncertainty of the stimulus transmitted, H(y) the uncertainty of the response received, and H(x,y) the uncertainty of the stimulus (x) which

will be transmitted, and response (y) which will be received. The following formula is known to hold:

$$T = H(x) + H(Y) - H(x,y) \quad (3)$$

where T is the transformation of information or the transmission of information in bits per stimulus. Note that for a noiseless channel,

$$H(x,y) = H(y) = H(x),$$

Hence,

$$T = H(x)$$

Miller and Nicely applied the procedure (3) of covariance measure to analyze the perceptual confusions among some English consonants.⁴⁰ Sixteen English

⁴⁰G. A. Miller and P. E. Nicely, op. cit.

consonants were categorized into five binary linguistic codes, as five separate channels and one composite channel. The results indicated five distinctive features which characterized consonants in five separate channels with a negligible "cross-talk." Nasality and voicing were much less affected by a random masking noise than were affrication, duration, and place. Place of articulation was hardest to hear correctly.

Similar procedure was used in a cross-linguistic study of twenty-six intervocalic consonants.⁴¹ Four

⁴¹S. Singh and J. W. Black, op. cit.

language groups served as speakers and listeners, resulting in sixteen speaking-listening conditions. There were twenty-six intervocalic consonants characterized by seven binary distinctive features, presumably each independent of the others. There was one composite channel labeled as 'all.' The consonants represented the majority for all four languages and were characterized in a single string of phonological analysis; that is to say, each of the twenty-six phonemes differed because one or more features varied from the rest of the twenty-five phonemes.

The singular and striking outcome of the present study lies in the rank order of the seven channels in the relative amounts of information per channel: the "importance" of the channels. A singular rank order in this regard occurs for all of the listening groups: (1) nasality, (2) place, (3) liquid, (4) voicing, (5) duration, (6) fricatives, and (7) aspiration. Such perceptual consistencies on the basic structure level of distinctive articulatory and acoustic features among sixteen speaker-listener conditions of four languages seem to support the hypothesis of language universals,

or, more specifically, a universal phonetic theory.^{42,43,44}

⁴²Noam Chomsky, "Current Issues in Linguistic Theories," The Structure of Language (ed.) Jerry A. Foder and Jerrold J. Katz (New Jersey: Prentice-Hall, Inc. (1964), Chapter 3, pp. 50-118.

⁴³M. Halles, "On the Basis of Phonology," The Structure of Language (ed.) Jerry A. Foder and Jerrold J. Katz (New Jersey: Prentice-Hall, Inc. (1964), pp. 324-333.

⁴⁴C. F. Hockett, "The Problem of Universals in Language," Universals of Language (Mass.: M.I.T. Press, 1963), pp. 1-22.

In summary, studies pertinent to this which deal with the effect of high-, low-, and band-pass filters, the contribution of formant transition and shift of locus, and the effect of time processing on the perceptions of speech have been presented in this chapter. The chapter also includes a description of the distinctive feature theory and enumerates the features according to their respective "importance." By importance is meant the relative degree of success with which the listeners perceived the intended distinctive features of the speakers. Additionally, a quantitative procedure of handling stimulus-response, an application of information theory to speech and hearing, is briefly discussed.

CHAPTER III

EXPERIMENTAL PROCEDURE

Six plosives /p t k b d ɡ / were acoustically recorded prevocally with the vowel /a/ in a nonsense monosyllabic form. Three male speakers of each of two languages, Hindi and English, acoustically recorded the syllables on an Ampex Model 300 SSU tape recorder in a sound-isolated room. The speakers, graduate students at The Ohio State University, were trained to read the randomized stimuli in a natural manner, and, to the best of their ability, to maintain a single level of loudness. Subsequently the acoustically recorded stimuli were re-recorded at approximately a single level by adjusting the recording level for each syllable. The principal interest in the study, however, lay in durational properties, not ones of level.

The thirty-six acoustically recorded monosyllables were each processed at six points of gating so that the preceding gated segment of each monosyllable was 20 msec. less than the following gated segment. With the moment of maximum sound pressure of the vowel as a reference, zero gate was determined by a pilot project in which the four

listeners of Hindi and English (two of each) reported 100 percent agreement in identifying consonants. This zero, then, represented a temporal distance of 120 msec. prior to the maximum peak of the vowel (Figure 1). However, the reference point or zero gate was not included in the experiment. Rather the maximum duration of the consonant in the monosyllable was 20 msec. less than this and the values were so that successive segments, early to late, were distinguished by 20 msec. decrement in duration. Thus, the successive points at which gating was introduced were 20, 40, 60, 80, 100, and 120 msec. subsequent to the arbitrarily determined zero. The first 20 msec. beyond the psychophysically determined zero and the rest of the five gatings were obtained following the procedure stated below.

Preparatory to the gating procedure the stimulus was copied from a master recording on one channel of a multichannel tape recorder/reproducer (Ampex, Model 55 SSU). This unit permits a recording to be reproduced from either the recorder or playback head of each channel. In the present case, the record head was used to reproduce the copied stimulus which was then fed to the trigger terminals of a waveform generator (Tektronix, Type 162). This generator provided a constant voltage reference pulse (Figure 1) which was fed through a

Figure 1. A graphical representation of the gating procedure employed in the temporal processing of the signals. The stimulus is a consonant-vowel syllable. The maximum peak of vowel is the reference for the reference pulse of constant voltage. Once the reference pulse is recorded it is then displaced by 120, 100, 80, 60, 40, and 20 msec. from the original. The reference pulse supplies a trigger voltage necessary to initiate a sawtooth waveform generator which represents a linear change in voltage with respect to time. The gated stimuli that are recorded are bounded by two pulses, one a reference pulse and another displaced from it.

- voltage divider to the input of a second channel on the multichannel tape recorder/reproducer, and recorded.

From other research¹ it was learned that the peak

¹W. A. Grimm, op. cit.

pressure of the vowel provided a convenient reference point on a consonant-vowel stimulus. Before recording the reference pulse, it was necessary to adjust the playback level on the stimulus channel to a point that triggered the waveform generator as close to the peak of the vowel as possible. Once this point was determined for a syllable, the reference pulse was recorded. The stimulus channel was reset to reproduce from the normal reproduce head and the reference pulse channel set to reproduce from the record head. On this recorder/reproducer, the distance between the record and reproduce head is approximately two inches. It follows that at a tape speed of 7-1/2 inches per second, the reference pulse would be reproduced approximately 366 msec. earlier. This temporal repositioning of the reference pulse causes it to precede the stimulus and thus serve as a trigger for the gating system described below (Figure 1).

The gating system consisted of a Tektronix waveform generator (Type 162), two Tektronix pulse generators (Type 162), and a Grason-Stadler electronic

switch (Figure 2). The reference pulse described above supplies the trigger voltage necessary to initiate a sawtooth waveform generated by the waveform generator. This sawtooth waveform represents a linear change in voltage with respect to time, and is connected to the inputs of three Tektronix pulse generators. The inputs of these pulse generators are voltage comparator circuits that compare the sawtooth voltage with an adjustable comparison voltage and initiate a pulse when the two are equal. The control used to adjust the comparison voltage is calibrated in percentage of delay, the percentage of delay being a function of the instantaneous voltage of the sawtooth waveform. Two of the pulse generators are connected to the Grason-Stadler electronic switch and provide the on and off pulse necessary to operate and control it. The third pulse generator provides a delayed external pulse for the oscilloscope, used to measure the gate width. Thus, the electronic switch is opened and closed by a sequence of two pulses. The stimulus is permitted to pass for a fixed period, controlled by the relative position of the pulse generator "pulse-delay" controls, and is recorded on another tape recorder/reproducer (Ampex, PR10-2).

The timed segments were passed through the following band-pass conditions of filtering: 196-425 cps.; 106-850 cps.; 106-1700 cps.; 106-3400 cps;

Figure 2. A block diagram of gating instrumentation. It consists of two Ampex recorder/reproducers, stimulus and control channels. A waveform generator initiates a sawtooth waveform which represents linear change in voltage with respect to time. This is connected to the inputs of three Tektronic pulse generators. An electronic switch provides on and off pulses. The third pulse generator provides a delayed external pulse for the oscilloscope used to measure the gate width. Thus the electronic switch is opened and closed by a sequence of two pulses. The stimulus is permitted to pass for a given unit of time, depending on the relative position of the pulse generator "pulse delay" controls, and is recorded on another tape-recorder/reproducer.

FIG. 2.

BLOCK DIAGRAM OF GATING INSTRUMENTATION

106-6800 cps.; 212-425 cps.; 212-850 cps.; 212-1700 cps.; 212-3400 cps.; 212-6800 cps.; 425-850 cps.; 425-1700 cps.; 425-3400 cps.; 425-6800 cps.; 850-1700 cps.; 850-3400 cps.; 850-6800 cps.; 1700-3400 cps.; 1700-6800 cps.; 3400-6800 cps. The filter-set used was the Gertsch Model BP one-half octave filter with 80 dB roll-off per octave.

The acoustically recorded 4320 stimuli were presented via earphones (Model TDH 39) to ten native listeners of Hindi and ten of English at a three-second interval between stimuli. The level of recording the stimuli to be presented to the listeners was 79 dB (re .0002 dyne sq. cm.) with the full spectrum of the speech signal. Thus, the level of presentation for each filter and time-processing condition was characteristic of that condition. For example, the signal accompanying the 3400-6800 cps. filtering condition was very soft relative to the level of the recording accompanying 106-425 cps. (characteristic, again, to the frequency band with a constant referent of 79 dB for the full spectrum).

The listeners identified the consonant in a multiple-choice formant. The answer sheets were in English for the listeners of English and in Hindi for the listeners of Hindi. Listeners were asked to respond to all stimuli with the informal instructions to make the best approximation in case they were not sure what they heard. The listening

task took five hours of volunteered time which was divided among four or five sessions, depending on the convenience of the listening subjects. None of the speaking subjects was included in the listening group.

Listeners heard the stimuli in gradually additive acoustic-temporal segments. Thus, in the time-processing domain, the stimuli presented first were those gated at the 120 msec. point; then followed the presentation of stimuli gated at 100 msec.; 80 msec.; 60 msec.; 40 msec.; and finally 20 msec. points. In the frequency-bandwidth domain, efforts were made to present the five bandwidths having 106 cps. as the lower frequency at one session, five bandwidths having 212 cps. as the lower frequency at the second session, four bandwidths having 425 cps. as the lower frequency at the third session, three bandwidths having 850 cps. as the lower frequency at the fourth session, and finally two bandwidths of lower frequencies of 1700 cps. and 3400 cps. at the fifth session. The bandwidths of lowest frequencies, e.g. 106-425 cps. etc., were presented first and then the following ones. Thus, at the onset the listeners were presented a minimum of acoustic properties in both the temporal and frequency bandwidth domains. Each session that lasted for more than one hour included a twenty-minute break after one hour of listening.

Listeners of English were graduate and undergraduate students in Speech Science and had training in phonetics. They were asked to distinguish aspirated from unaspirated plosives which the listeners of Hindi were able to do on account of their linguistic experience. The listeners of English were provided the response-sheets marked in Roman script and the listeners of Hindi in Devanagari script. Thus, all listeners responded to the stimulus-sounds they heard in their respective graphemes (Appendix A).

Figure 3 depicts the representation of the experimental design graphically.

The response sheet included twelve choices for a heard stimuli, six of which were included in the stimuli, and six were never correct choices. The false choices were the aspirated counterparts of the voiceless and voiced plosives. The purpose of including the false choices was to investigate aspiration as one of the possible cues to speech perception (Appendix A).

The data were tabulated for both correct and incorrect responses. Four hundred eighty confusion matrices were prepared as the basic data for the computation of intelligibility and information. Each table consisted of one hundred eighty responses, three speakers speaking six consonants, identified by ten listeners.

Figure 3. A graphical representation of the experimental design. L_1 and L_2 represent the two input "boxes" each containing three speakers. All inputs, then, are processed at six points of temporal gating represented as T_1-6 . The time processed stimuli are, then, passed through twenty different bandpass filters (BW_1 to BW_{20}). Finally, ten listeners of L_1 and ten of L_2 (L_1 represents speakers and listeners of Hindi and L_2 , English) identified the stimuli (plosive consonants) in all conditions of T_1-6 and BW_1-20 .

Fig.3

GRAPHICAL REPRESENTATION OF EXPERIMENTAL DESIGN.

Summary. Six plosives acoustically recorded prevocally with the vowel /a/ by the three speakers of each Hindi and English were filtered through 20 frequency band-pass and temporally processed at six points of gating. The stimuli were presented for listening to the ten listeners of each Hindi and English to identify consonants in a multiple-choice format in their respective graphemes. The possible choices for responses were twelve; six were the same as the stimuli and the remaining six were the aspirated counterpart of the stimuli.

CHAPTER IV

ANALYSIS OF THE RESULTS

The present chapter is devoted to the analysis of the results of this experiment. A three-fold analysis of results is presented. Each of these is dependent on the same source but independent in its implications. (1) Intelligibility and confusion of plosive consonants are presented by using phonemes as a unit of analysis; (2) importance of the features that characterize the consonants is presented by using the consonant-characterizing binary distinctive features as the unit of analysis; and (3) the effect of two experimental variables, frequency bandwidth and processed time on intelligibility and on preservation of feature in error, has been determined on one hand and information transmission as a predictable function of frequency bandwidth and time on the other hand. The study includes the speakers and listeners of two languages, Hindi and English. One of the focal points of the cross-linguistic involvement, in this study, is to predict intelligibility and confusability of consonants in cross-linguistic speaking-listening conditions. The study further determines preservation in error of the

distinctive features that characterize plosive consonants. The effect of the two-dimensional distortions (processed time and filtered bandwidths) on the four speaking-listening conditions of two language groups in terms of intelligibility, preservation of features that characterize the consonants, and prediction of information transmission under the conditions of distortion and the four speaking-listening conditions of two language groups entail the third interest in the experiment.

Intelligibility measure of consonants. There were six stimulus consonants and twelve response consonants. Tables 1-480 (Appendix B) enumerate the responses associated with four speaking and listening conditions, namely native listeners of Hindi listening to the native speakers of Hindi and to the native speakers of English; and native listeners of English listening to native speakers of English and native speakers of Hindi. The stimuli presented were processed at six temporal intervals and filtered in 20 bandwidths of six lower frequencies. Points of temporal processings were 20 msec., 40 msec., 60 msec., 80 msec., 100 msec., 120 msec. (re zero gate determined at 120 msec. from the highest peak of the vowel toward the consonant). Frequency bandwidths consisted of 106-425 cps., 106-850 cps., 106-1700 cps., 106-3400 cps., 106-6800 cps., 212-425 cps., 212-850 cps., 212-1700 cps., 212-3400 cps., 212-6800

cps., 425-8500 cps., 425-1700 cps., 425-3400 cps., 425-6800 cps., 850-1700 cps., 850-3400 cps., 850-6800 cps., 1700-3400 cps., 1700-6800 cps., and 3400-6800 cps. Lower frequencies were 106 cps., 212 cps., 425 cps., 850 cps., 1700 cps., and 3400 cps.

Figures 4-147 represent the identification pattern of the four speaker-listener conditions. Figures 4-11, 52-59, and 100-107 represent the lower frequency 106 cps.; Figures 12-19, 60-67, and 108-115 represent the lower frequency 212 cps; Figures 20-27, 68-75, and 116-123 represent the lower frequency 425 cps.; Figures 28-35, 76-83, and 124-131 represent the lower frequency 850 cps.; Figures 36-43, 84-91, and 132-139 represent the lower frequency 1700 cps.; and Figures 44-51, 92-99, and 140-147 represent the lower frequency 3400 cps. The lower frequency represents the lower frequency of the bandwidth without consideration to the width and the higher frequency. For example when 850 cps. is the lower frequency of the bandwidth the frequency bands included are 850 cps.-1700 cps., 850 cps.-3400 cps., and 850 cps.-6800 cps. When lower frequency of the bandwidth is 212 cps. the frequency of the bandwidth is 212 cps., the frequency bands included are 212 cps.-425 cps., 212 cps.-850 cps., 212 cps.-1700 cps., 212 cps.-3400 cps., and 212 cps.-6800 cps. Thus, where there are five bandwidths with the lower frequency

Figures 4-147. Graphical representation of the listeners' response in six bandwidth conditions and at six points of processed time. The ordinate represents the average identification score and the abscissa the six points of temporal processing. The average maximum identification score for a bandwidth is 30 (ten listeners listening to three speakers). Lower frequency of the bandwidth is stated at the bottom of each page. There are six such pages, each representing one of these lower frequencies: (1) 106 cps., (2) 212 cps., (3) 425 cps., (4) 850 cps., (5) 1700 cps., and (6) 3400 cps. The stimulus is written at the top and the responses close to the lines that represent them, bounded by slanted lines, e.g. /p/. Speakers are represented as Sp, listeners as Lis, Hindi as H, and English as E. There are six stimuli, four speaking-listening conditions, and six lower frequencies. Therefore, there are $(6 \times 4 \times 6)$ 144 figures. Maximum identification (on ordinate) is 20 because this limit was never surpassed.

LOWER FREQUENCY OF BANDWIDTH IS 425 CPS.

of 212 cps., the total score has been divided by five and where there are only two bandwidths of lower frequency of 1700 cps. (1700 cps.-3400 cps. and 1700 cps.-6800 cps.) the total score has been divided by two. The maximum average score for a bandwidth, thus, is 30, that is, 10 listeners of a language listening to three speakers of a language. The observed score, however, never surpasses the $3/4$ limit of identification and, therefore, the ordinate of each figure represents a maximum score of twenty. Those responses that do not exceed the chance level have not been represented. But any response that surpasses the chance level at any one of the six points of temporal processing (as represented on the abscissa of the figures) has been included in the figures. In each figure the stimulus phoneme has been written at the top and the response phoneme close to the curve that represents it, all bounded by slanted lines, e.g. /p/. Speakers are denoted by Sp, listeners by Lis; Hindi by H and English by E. In Figure 4, for example, the speakers and listeners both belong to Hindi, and in Figure 5, the speakers belong to Hindi and the listeners to English.

Determining the crucial lower frequency of the bandwidth and the point of processed time for each stimulus phoneme. When the stimulus phoneme is /p/: the most relevant lower frequency of bandwidth is 850 cps.,

i.e. the maximum correct responses are obtained when the lower frequency of the bandwidth is 850 cps. The point of the time continuum that yields maximum intelligibility is 60 msec. A comparison of Figures 24, 29, 30, and 31 with the rest of the figures representing the responses to the same phoneme shows the relevance of the lower frequencies of 850 cps., as compared to the responses to the phoneme /p/ having the lower frequency of bandwidths of 106, 212, 425, 1700, and 3400 cps. All four listening conditions, that is listeners of Hindi listening to the speakers of Hindi and the speakers of English and the listeners of English listening to the speakers of English and the speakers of Hindi, demonstrate similar trends. The average highest point of the curve is at 60 msec.

When the stimulus phoneme is /b/: the most relevant lower frequency of a bandwidth is 3400 cps., i.e., the maximum correct responses to the stimulus phoneme are obtained when the lower frequency of the bandwidth is 3400 cps. The time processing point on which maximum intelligibility was achieved is 20 msec. All four listening-speaking conditions, i.e., listeners of Hindi listening to the speakers of Hindi and the speakers of English and the listeners of English listening to the speakers of Hindi and the speakers of English, are in

agreement relative to the critical lower frequency of bandwidth and the critical point of temporal processing.

When the stimulus phoneme is /t/: the most relevant lower frequency of the bandwidth is 1700 cps., as shown in the curves representing correct response to the phoneme /t/ in the figures (84, 85, 86, and 87) and their comparison with the rest of the curves which also represent correct response to the stimulus phoneme /t/ in the conditions of lower frequencies other than 1700 cps. The processed time where stimulus phoneme /t/ is perceived most successfully falls on some uninvestigated point between 20 and 40 msec. Both points of 20 and 40 msec. contribute maximally and approximately equally to the correct identification of the stimulus phoneme /t/. All speaking and listening conditions, except the listeners of English listening to the speakers of Hindi (in which case the lower frequency with maximum intelligibility was 850 cps.), are in agreement.

When the stimulus phoneme is /d/: the most relevant lower frequency of the bandwidth is 3400 cps. as shown in Figures 96, 97, 98, and 99. The correct response to the stimulus phoneme /d/ represented in these figures can be compared with the correct response to the same phoneme in Figures 56, 57, 58, 59, 64, 65, 66, 67, 72, 73, 74, 75, 80, 81, 82, and 83. There is a gradual rise in

the designated correct response curve as the lower frequency rises. The critical points of temporal processing for the best perceptibility of the stimulus phoneme are 60 and 80 msec., or somewhere on an uninvestigated point between 60 and 80 msec. Any point before or after 60 and 80 msec. does not yield superior or even equivalent intelligibility.

When the stimulus phoneme is /k/: the most relevant lower frequency of the bandwidth is 425 cps., as shown in Figures 116, 117, 118, and 119. The correct response to the stimulus phoneme /k/ can be compared with the correct response to the same phoneme in Figures 100, 101, 102, 103, 108, 109, 110, 111, 124, 125, 126, 127, 132, 133, 134, 135, 140, 141, 142, and 143. The critical temporal processing point to yield the maximum intelligibility is 40 msec. All speaking and listening conditions except listeners of English listening to speakers of Hindi (in which case the critical lower frequency of the bandwidth is 850 cps.) are in agreement.

When the stimulus phoneme is /g/: the most relevant critical lower frequency of the bandwidth to yield maximum intelligibility score is 425 cps. All speaking and listening conditions, namely listeners of Hindi listening to the speakers of Hindi and English, and listeners of English listening to the speakers of English and Hindi are

in agreement. The graphical representation of the correct response to the stimulus phoneme /g/ shown in Figures 120, 121, 122, and 123 can be compared with the graphical representation of the correct response to the same stimulus phoneme in Figures 104, 105, 106, 107, 112, 113, 114, 115, 128, 129, 130, 131, 136, 137, 138, 139, 144, 145, 146, and 147. The critical point of temporal processing is 40 msec.

Phonemic substitutions. When the stimulus phoneme is /p/ and the speaking and listening subjects are both native speakers of Hindi, irrespective of the lower frequency of the bandwidth, the error responses are distributed either among voiceless plosives, /t k/, or the voiced counterpart of /p/ (Figures 4, 12, 20, 28, 36, and 44).

When the stimulus phoneme is /t/ and the speaking and listening subjects are both the native speakers of Hindi, irrespective of the lower frequencies of the bandwidth the error responses are distributed either among voiceless plosives, /p k/, or the voiced counterparts of /t/ /d/ (Figures 52, 60, 68, 76, 84, and 92).

When the stimulus phoneme is /k/ and the subjects are both native speakers of Hindi, the error responses primarily are distributed between the voiceless plosives /p t/ or the voiced counterpart of /k/ /g/ (Figures 100, 108, 116, 124, 132, and 140).

When the stimulus phoneme is /p/ and the speaking and listening subjects are both native speakers of English, the error responses to /p/ fall preponderantly on its aspirated counterpart /p^h/ (Figures 7, 15, 23, 31, 39, and 47).

When the stimulus phoneme is /p/ and the speaking subjects are the native speakers of Hindi and the listening subjects are native speakers of English, the error responses are distributed among the voiceless plosives /t k/, the voiced counterpart /b/, the aspirated counterpart /p^h/, and the voiced-aspirated counterpart /b^h/ (Figures 5, 13, 21, 29, 37, and 45).

When the stimulus phoneme is /t/ and the speaking subjects are the native speakers of Hindi and the listening subjects are native speakers of English, the error responses are distributed among the aspirated counterpart /t^h/, voiced counterpart /d/, and voiced aspirated counterpart /d^h/ (Figures 53, 61, 69, 77, 85, and 93).

When the stimulus phoneme is /k/ and the speaking subjects are native speakers of Hindi and the listening subjects are native speakers of English, error responses are distributed among the aspirated counterpart, /k^h/, voiced counterpart /g/, voiceless plosive /t/, and unexpectedly /b/ (Figures 101, 109, 117, 125, 135, and 141).

When the stimulus phoneme is /p/ and the speaking subjects are native speakers of English and the listening subjects are native speakers of Hindi, error responses are distributed among the voiceless plosive /t k/, and preponderantly the aspirated counterpart of phoneme /p/ /p^h/ (Figures 6, 14, 22, 30, 38, and 46).

When the stimulus phoneme is /t/ and the speaking subjects are native speakers of English and the listening subjects are native speakers of Hindi, error responses are distributed among the voiceless plosive /p k/, and preponderantly the aspirated counterpart of the stimulus phoneme /t/ /t^h/ (Figures 54, 62, 70, 78, 86, and 94).

When the stimulus phoneme is /k/ and the speaking subjects are native speakers of English and the listening subjects are the native speakers of Hindi, the errors are distributed among the voiceless plosives /p t/ and preponderantly the aspirated counterpart /k^h/ (Figures 103, 111, 119, 127, 135, and 143).

When the stimulus phoneme is /b/ and the speaking and listening subjects are both native speakers of Hindi, the error responses are distributed primarily between /b/ and /p^h/, and secondarily between /t/ and /k/ (Figures 8, 16, 24, 32, 40, and 48).

When the stimulus phoneme is /d/ and the speaking and listening subjects are native speakers of Hindi, the

error responses are divided primarily between /t/ (the voiceless counterpart of the stimulus) and /g/ (phonemically different because of place of articulation) (Figures 56, 64, 72, 80, 88, and 96).

When the stimulus phoneme is /g/ and the speaking and listening subjects are both native speakers of Hindi, the error responses are divided primarily between /k/ (the voiceless counterpart) and /d/ (phonemically different because of place) (Figures 104, 112, 120, 128, 136, and 144).

When the stimulus phoneme is /b/ and the speaking subjects are native speakers of Hindi and the listening subjects are native speakers of English, error responses are distributed among: /p/ (the voiceless counterpart), /p^h/ (the voiceless aspirated counterpart), /b^h/ (the aspirated counterpart), and /d/ (which is phonemically different because of place of articulation) (Figures 9, 17, 35, 33, 41, and 49).

When the stimulus phoneme is /d/ and the speaking subjects are native speakers of Hindi and the listeners are native speakers of English, error responses are distributed among: /g/ (the voiceless counterpart of the stimulus phoneme) /t^h/ (which is phonemically different because of its voicelessness and aspiration), /d^h/ (the aspirated counterpart of the stimulus phoneme) and /b/

(which is phonemically different because of the place of articulation) (Figures 57, 65, 73, 81, 89, and 97).

When the stimulus phoneme is /g/ and the speaking subjects are native speakers of Hindi and the listening subjects are native speakers of English, error is distributed among: /g^h/ (the aspirated counterpart of the stimulus), /d/ (which is phonemically different because of place of articulation), and /d^h/ (because of its place and aspiration) (Figures 105, 113, 121, 137, and 145).

Psychophysical and acoustic phoneme boundaries.

An examination of the curves representing correct identification in Figures 4-147 reveals that the correct identification of the stimuli /p t k d b g / decreases sharply between the 60 and 80 msec. points of temporal processing. This part of the analysis deals primarily in establishing relationships between the acoustical components of the stimuli and the listeners' responses to them. The procedure includes a search for the critical domains on temporal (msec.) and frequency (cps.) continua that yield optimal intelligibility.

The psychophysical phoneme boundaries are remarkably coherent with acoustic phoneme boundaries. Figures 148-218 without any exception indicate that there is no trace of the presence of the consonants at the points of 120 and 100 msec. Some consonantal color is evident at the

Figures 148-218. A pictorial demonstration of the impact of gating phenomenon on the stimuli. Two speakers, one of Hindi and one of English, were arbitrarily selected for presentation. All stimuli they recorded were gated at six points. At the top of each page (that presents oscilloscopic pictures) gating at 120 msec. point is presented which is the maximum temporal gating. This follows 100, 80, 60, 40, and 20 msec. of gatings. Each stimulus was gated at all these six points. English, written at the bottom of each figure, indicates that the stimulus was spoken by a speaker of English, and Hindi indicates that the stimulus was spoken by a speaker of Hindi.

Fig.
148

ENGLISH / Pa / 120 MSEC

Fig.
154

ENGLISH / ba / 120 MSEC.

Fig.
149

ENGLISH / Pa / 100 MSEC.

Fig.
150

ENGLISH / Pa / 80 MSEC

Fig.
155

ENGLISH / ba / 80 MSEC.

Fig.
151

ENGLISH / Pa / 60 MSEC

Fig.
156

ENGLISH / ba / 60 MSEC.

Fig.
152

ENGLISH / Pa / 40 MSEC.

Fig.
157

ENGLISH / ba / 40 MSEC.

Fig.
153

ENGLISH / Pa / 20 MSEC

Fig.
158

ENGLISH / ba / 20 MSEC.

Fig.
159

HINDI / Pa / 120 MSEC.

Fig.
165

HINDI / ba / 120 MSEC.

Fig.
160

HINDI / Pa / 100 MSEC.

Fig.
166

HINDI / ba / 100 MSEC.

Fig.
161

HINDI / Pa / 80 MSEC.

Fig.
167

HINDI / ba / 80 MSEC.

Fig.
162

HINDI / Pa / 60 MSEC.

Fig.
168

HINDI / ba / 60 MSEC.

Fig.
163

HINDI / Pa / 40 MSEC.

Fig.
169

HINDI / ba / 40 MSEC.

Fig.
164

HINDI / Pa / 20 MSEC.

Fig.
170

HINDI / ba / 20 MSEC.

Fig.
171

ENGLISH /ta/ 120 MSEC.

Fig.
177

ENGLISH /da/ 120 MSEC.

Fig.
172

ENGLISH /ta/ 100 MSEC.

Fig.
178

ENGLISH /da/ 100 MSEC.

Fig.
173

ENGLISH /ta/ 80 MSEC.

Fig.
179

ENGLISH /da/ 80 MSEC.

Fig.
174

ENGLISH /ta/ 60 MSEC.

Fig.
180

ENGLISH /da/ 60 MSEC.

Fig.
175

ENGLISH /ta/ 40 MSEC.

Fig.
181

ENGLISH /da/ 40 MSEC.

Fig.
176

ENGLISH /ta/ 20 MSEC.

Fig.
182

ENGLISH /da/ 20 MSEC.

Fig.
183

HINDI/ta/ 120 MSEC.

Fig.
184

HINDI/ta/ 100 MSEC.

Fig.
185

HINDI/ta/ 80 MSEC.

Fig.
186

HINDI/ta/ 60 MSEC.

Fig.
187

HINDI/ta/ 40 MSEC.

Fig.
188

HINDI/ta/ 20 MSEC.

Fig.
189

HINDI/da/ 120 MSEC.

Fig.
190

HINDI/da/ 100 MSEC.

Fig.
191

HINDI/da/ 80 MSEC.

Fig.
192

HINDI/da/ 60 MSEC.

Fig.
193

HINDI/da/ 40 MSEC.

Fig.
194

HINDI/da/ 20 MSEC.

Fig.
195 Fig.
201 Fig.
196 Fig.
202 Fig.
197 Fig.
203 Fig.
198 Fig.
204 Fig.
199 Fig.
205 Fig.
200 Fig.
206

Fig.
207

HINDI /ka/ 120 MSEC

Fig.
213

HINDI /ga/ 120 MSEC.

Fig.
208

HINDI /ka/ 100 MSEC

Fig.
214

HINDI /ga/ 100 MSEC.

Fig.
209

HINDI /ka/ 80 MSEC.

Fig.
215

HINDI /ga/ 80 MSEC.

Fig.
210

HINDI /ka/ 60 MSEC

Fig.
216

HINDI /ga/ 60 MSEC

Fig.
211

HINDI /ka/ 40 MSEC

Fig.
217

HINDI /ga/ 40 MSEC.

Fig.
212

HINDI /ka/ 20 MSEC.

Fig.
218

HINDI /ga/ 20 MSEC.

80 msec. point which becomes obvious at the 60 msec. point. Transition at the 80 msec. point is evidently not sufficient for the identification of plosive consonants. However, the 60 msec. point is by far the best one for the identification of the plosives. Thus, a transition (at 80 msec. point) plus a few more msec. of consonant (some point between 60 and 80 msec.) or maximally an addition of 20 msec. of consonant to that transition yields maximum identification of plosive consonants and reasonably correct perception of distinctive features.

A bivariate measure of intelligibility. This part of the analysis of the confusion matrices draws heavily on a quantitative procedure applied by Miller and Nicely¹ and adopted in a cross-linguistic study by Singh and Black.²

¹G. A. Miller and P. E. Nicely, op. cit.

²S. Singh and J. W. Black, op. cit.

Miller and Nicely used sixteen consonants and characterized them by five distinctive features. Singh and Black used twenty-six consonants and characterized them by seven distinctive features. All twenty-six consonants were phonemic and therefore different by at least one feature. They represented the majority of the consonants of four languages, namely Hindi, English, Arabic, and Japanese.

The matter of handling place posed some problems. In the Miller and Nicely study, voicing, nasality, affrication, and duration are represented by binary codes of 0 and 1, but place has been represented by a code of 0, 1, and 2. This was inevitable because of the tri-dimensionality of the place category, namely bilabial, alveolar, and velar. Singh and Black used quadruple variability of place, namely bilabial, alveolar, palatal, and velar.

The manner of handling place was a departure. If one were to treat place as four separate channels as designated here, he would locate /k/ as (i) not front of mouth, (ii) not mid-front of mouth, and (iii) not mid-back of mouth. Obviously, these four channels would be quite overlapping. Thus, the way of handling place, here, is a compromise. /k/ has been located in the back of the mouth in contrast with any of the sounds that are placed in the mid-back, mid-front, and front of the mouth. This treatment results in one 'multi-channel' instead of four separate channels for place and leads to the use of a 4 x 4 instead of a 2 x 2 contingency table.³

³S. Singh and J. W. Black, op. cit.

The present experiment handles place in both of these manners: place as represented in a multi-channel, and place as represented in three separate channels. Such dual treatment of the place category was specifically designed to test the overlapping of cross-talk between the

channels. Miller and Nicely with five separate channels have a cross-talk of .89 bit: .

The degree of redundancy in the input is indicated by the fact that the sum of the transmission for the five channels is 4.890 bits, whereas the composite channel can transmit only 4 bits.⁴

⁴G. A. Miller and P. E. Nicely, op. cit.

Such redundancy was greater in the Singh and Black study and was attributed to the greater number of channel and language groups.

The dual handling of place may be (1) when place is represented in a traditional manner as multichannel, and (2) when place is represented as one of three separate channels. These distinctions were drawn to test the validity of the attributed redundancy to the greater number of channels in the voice communication network.

Tables 1 and 2 present the dual classifications of consonants used to analyze confusions. Table 1 has characterized consonants by the five binary distinctive features, (1) voicing, (2) bilabial place, (3) alveolar place, (4) velar place, and (5) aspiration. Table 2 has characterized the consonants by three categories only: (1) voicing, (2) place, and (3) aspiration. Aspiration, however, in both cases is an unaccounted feature in predicting information because it is present only in responses, and not in the stimuli. The maximum possible

TABLE 1. Classification of plosives used for the analysis of the confusion of distinctive features.

	Bilabial Place	Alveolar Place	Velar Place	Voicing	Aspiration
p	1	0	0	0	0
p ^h	1	0	0	0	1
b	1	0	0	1	0
b ^h	1	0	0	1	1
t	0	1	0	0	0
t ^h	0	1	0	0	0
d	0	1	0	1	0
d ^h	0	1	0	1	1
k	0	0	1	0	0
k ^h	0	0	1	0	1
g	0	0	1	1	0
g ^h	0	0	1	1	1

TABLE 2. Classification of the consonants used for the analysis of the confusion of distinctive features.

	Voicing	Place	Aspiration
p	0	1	0
p ^h	0	1	1
b	1	1	0
b ^h	1	1	1
t	0	2	0
t ^h	0	2	1
d	1	2	0
d ^h	1	2	1
k	0	3	0
k ^h	0	3	1
	1	3	0
h	1	3	1

information in bits per stimulus for four channels separately, as characterized by Table 1, is 3.75^4 bits (maximum possible information for bilabial place is .918 bit, for alveolar place .918 bit, for velar place .918 bit, and for voicing 1.000 bit) and maximum possible information for a composite channel is 2.58^4 bits. Thus, there is a cross-talk of 1.170 bits. Maximum possible information for the two separate channels, i.e. place and voicing, strikingly, is also 2.58^4 bits (for place it is 1.58^4 bits and for voicing 1.000 bit). This finding reveals that if there is a precise classification of consonants into the component features, the component channels yield bits per stimulus information equal to the bits per stimulus information for a composite channel. A comparison of the sum of the maximum possible information when the voice communication network was sub-divided by four separate channels with the voice communication network of two channels indicates that when there are more numbers of channels involved in the voice communication network there are more possibilities of cross-talk or redundancy than when there are fewer numbers of channels.

Interest now focuses on the confusions in Tables 1-480 (Appendix B) in relation to Tables 3, 4, 5, and 6, and especially in the extent to which features of the stimuli were preserved in the responses made by the

TABLE 3.-Frequencies of all correct responses for the four distinctive binary features in Tables 1 through 480, as spoken and recognized by three native speakers and ten native listeners of Hindi.

		SN ₁	SN ₂	SN ₃	SN ₄	SN ₅	SN ₆	SN ₇	SN ₈	SN ₉	SN ₁₀	SN ₁₁	SN ₁₂	SN ₁₃	SN ₁₄	SN ₁₅	SN ₁₆	SN ₁₇	SN ₁₈	SN ₁₉	SN ₂₀	Mean
20 msec.	BP	112	121	157	161	141	112	139	199	153	171	125	168	175	180	162	172	174	132	137	167	150.9
	AP	109	125	129	157	136	108	122	123	143	162	120	127	168	173	132	160	160	113	130	154	137.5
	VP	107	110	112	166	151	118	113	122	150	167	115	125	171	173	120	160	160	127	137	141	137.5
	VO	101	133	158	151	138	111	142	148	133	156	115	142	145	155	105	115	112	115	111	120	130.3
40 msec.	BP	100	148	146	157	143	106	126	141	161	161	124	163	177	175	174	172	155	131	132	165	147.8
	AP	112	117	124	151	142	107	123	126	146	153	114	125	167	172	127	160	150	117	132	150	135.7
	VP	108	100	98	164	147	116	113	99	153	156	94	112	170	173	127	164	157	120	138	135	132.2
	VO	102	113	128	133	134	96	130	140	133	136	116	138	149	131	103	110	112	118	121	119	123.1
60 msec.	BP	95	93	135	145	139	104	111	148	154	154	125	158	159	168	173	165	163	121	120	164	139.7
	AP	95	114	123	117	128	104	115	123	138	131	121	120	140	144	128	143	152	112	107	142	124.8
	VP	114	115	100	138	131	104	126	101	140	137	132	113	149	148	127	142	147	129	134	128	127.7
	VO	91	107	115	120	124	92	118	125	132	131	115	128	132	133	100	106	108	113	104	111	117.2
80 msec.	BP	104	79	121	123	111	97	99	126	125	133	72	138	126	143	133	146	152	110	94	159	119.5
	AP	97	106	110	110	120	86	118	127	132	126	110	130	136	128	103	126	118	96	109	136	116.2
	VP	105	117	115	111	115	103	125	123	121	127	126	130	124	131	102	132	128	126	115	123	119.9
	VO	101	94	104	113	108	92	111	118	118	113	114	127	134	90	94	113	104	98	103	93	107.1
100 msec.	BP	106	76	109	105	100	105	77	96	95	92	90	102	97	100	108	116	110	95	98	124	100.0
	AP	82	102	99	95	109	96	113	92	106	109	107	94	108	102	97	101	107	90	104	115	101.4
	VP	112	98	106	88	89	105	96	86	95	91	105	92	85	88	101	107	107	109	98	101	97.9
	VO	88	97	98	99	87	95	101	90	93	100	95	114	100	104	106	94	94	94	107	103	97.9
120 msec.	BP	108	91	108	102	98	100	99	100	110	92	93	102	94	109	105	108	102	111	108	115	102.7
	AP	93	94	96	103	60	92	100	101	103	110	99	97	91	101	106	91	104	91	94	115	97.0
	VP	107	105	80	85	84	102	97	89	93	82	106	101	105	100	93	95	92	100	104	84	95.2
	VO	84	86	93	96	90	84	93	92	109	92	95	97	90	92	100	93	105	93	92	96	93.6

TABLE 4. Frequencies of all correct responses for the four distinctive binary features in Tables 1 through 480 as spoken by three native speakers of Hindi and recognized by ten native speakers of English.

		EW ₁	EW ₂	EW ₃	EW ₄	EW ₅	EW ₆	EW ₇	EW ₈	EW ₉	EW ₁₀	EW ₁₁	EW ₁₂	EW ₁₃	EW ₁₄	EW ₁₅	EW ₁₆	EW ₁₇	EW ₁₈	EW ₁₉	EW ₂₀	Mean
20 msec.	BP	123	108	153	162	170	124	136	163	164	172	124	154	159	168	171	176	171	119	131	175	151.1
	AP	115	89	136	152	159	108	120	144	148	161	108	134	145	151	133	169	151	114	122	158	135.8
	VP	126	123	125	166	165	126	114	137	164	169	104	120	164	155	128	171	154	119	141	157	141.4
	VO	144	142	147	148	144	126	140	153	152	153	110	126	132	133	104	103	98	106	110	119	109.5
40 msec.	BP	118	120	152	157	159	122	127	153	163	173	126	152	148	168	159	173	170	110	124	173	147.3
	AP	101	115	124	149	147	100	108	129	142	162	107	130	138	150	134	164	152	118	113	151	131.7
	VP	115	123	108	166	164	122	119	110	157	167	109	112	158	160	125	169	158	128	133	154	137.8
	VO	116	126	120	128	148	123	134	137	148	151	100	124	141	139	91	96	95	116	109	113	122.7
60 msec.	BP	111	122	158	145	163	120	121	152	147	163	128	154	156	145	157	157	167	111	117	167	143.0
	AP	98	106	137	125	139	111	109	123	113	134	104	128	126	134	136	144	145	107	116	141	123.8
	VP	119	128	131	138	150	117	130	131	136	143	118	136	140	127	133	145	144	130	135	138	133.4
	VO	101	112	127	114	130	112	121	117	120	124	90	114	126	128	90	91	92	104	108	101	111.1
80 msec.	BP	108	90	110	106	107	90	97	124	124	113	100	125	115	119	146	149	157	87	95	142	115.2
	AP	96	112	114	108	114	89	105	122	114	122	100	123	115	114	127	129	124	90	106	122	112.3
	VP	116	114	122	126	129	111	112	130	128	131	110	132	126	133	127	128	125	117	125	124	123.3
	VO	91	110	112	99	111	92	108	143	111	90	118	107	114	97	92	89	82	92	102	101	103.0
100 msec.	BP	107	93	102	84	98	109	81	84	93	77	89	88	104	95	97	114	116	98	91	121	97.0
	AP	91	95	97	87	102	84	98	104	92	100	94	89	92	103	93	117	100	106	120	102	97.8
	VP	102	108	107	103	100	101	107	100	103	101	107	105	108	104	108	107	110	110	113	111	105.7
	VO	81	90	90	94	96	90	97	81	95	83	96	95	95	94	92	93	87	80	95	101	91.2
120 msec.	BP	94	99	103	106	102	107	99	108	104	99	101	93	100	103	105	112	109	108	87	101	102.0
	AP	82	89	89	98	105	91	100	97	105	89	93	98	95	109	85	90	99	91	95	105	95.2
	VP	116	98	94	96	111	114	97	103	109	106	106	95	105	112	104	114	106	113	106	100	105.2
	VO	93	80	89	89	95	98	93	99	86	88	93	91	92	99	94	113	101	95	97	97	94.1

TABLE 5. Frequencies of all correct responses for the four distinctive binary features in Tables 1 through 480 as spoken by three native speakers of English and recognized by ten native speakers of Hindi.

		BN ₁	BN ₂	BN ₃	BN ₄	BN ₅	BN ₆	BN ₇	BN ₈	BN ₉	BN ₁₀	BN ₁₁	BN ₁₂	BN ₁₃	BN ₁₄	BN ₁₅	BN ₁₆	BN ₁₇	BN ₁₈	BN ₁₉	BN ₂₀	Mean
20 msec.	BP	97	134	158	164	149	111	136	162	153	172	124	164	171	172	160	162	165	121	126	152	147.6
	AP	98	123	125	150	140	113	116	127	143	166	116	128	174	174	127	160	162	133	137	129	137.0
	VP	108	105	115	148	137	112	98	111	138	162	98	124	165	168	119	154	151	108	125	117	128.1
	VO	105	121	142	139	144	115	134	148	140	156	90	157	154	161	126	132	131	121	126	120	133.1
40 msec.	BP	92	127	148	159	149	102	127	153	161	157	126	159	166	162	162	162	162	111	120	154	142.9
	AP	94	114	127	144	137	104	124	125	140	154	114	127	159	155	124	151	151	132	141	118	131.7
	VP	110	89	101	143	165	104	97	106	151	149	100	118	159	153	118	149	153	97	117	110	124.4
	VO	89	126	141	153	144	101	136	147	150	157	142	154	157	155	130	133	120	129	136	126	136.3
60 msec.	BP	101	90	136	140	136	109	95	141	135	149	94	156	143	139	148	149	147	100	104	106	127.9
	AP	108	111	111	132	126	105	118	108	127	137	120	118	129	138	114	138	134	117	134	119	122.2
	VP	107	111	97	122	122	110	97	99	128	132	102	116	132	125	112	141	135	103	113	107	115.5
	VO	99	104	128	134	124	94	130	132	141	138	138	150	137	150	114	113	113	119	110	126	124.7
80 msec.	BP	114	84	112	112	124	115	75	95	122	124	75	109	123	134	121	129	129	104	99	133	111.6
	AP	107	109	99	116	112	101	113	108	111	112	108	95	116	124	101	115	111	106	118	117	109.9
	VP	99	99	89	106	98	100	101	87	111	108	101	102	113	110	96	112	118	114	97	112	103.6
	VO	96	101	103	111	114	91	105	123	121	115	108	119	122	125	115	113	107	89	104	121	110.1
100 msec.	BP	105	90	117	111	108	106	85	102	102	109	88	115	113	104	111	123	111	96	98	109	105.1
	AP	98	94	92	116	118	100	108	102	105	111	107	118	116	102	106	96	103	86	95	111	104.2
	VP	109	96	99	97	98	104	97	106	97	100	101	109	101	104	103	107	106	104	110	104	102.6
	VO	87	99	90	95	102	91	95	94	102	106	89	100	101	103	95	93	87	91	92	98	95.5
120 msec.	BP	102	112	107	105	109	103	106	109	105	112	99	109	107	110	101	111	101	102	112	112	106.7
	AP	86	101	110	103	108	84	112	116	93	100	97	99	103	103	111	88	91	90	99	98	99.6
	VP	102	97	89	90	77	97	88	89	94	88	60	68	94	93	90	97	100	102	99	90	90.2
	VO	85	91	89	90	82	86	88	93	94	92	88	100	95	95	89	88	101	88	94	91	90.9

TABLE 6. Frequencies of all correct responses for the four distinctive binary features in Tables 1 through 480 as spoken and recognized by three native speakers and ten native listeners of English.

		BN ₁	BN ₂	BN ₃	BN ₄	BN ₅	BN ₆	BN ₇	BN ₈	BN ₉	BN ₁₀	BN ₁₁	BN ₁₂	BN ₁₃	BN ₁₄	BN ₁₅	BN ₁₆	BN ₁₇	BN ₁₈	BN ₁₉	BN ₂₀	Mean
20 msec.	BP	134	138	163	168	172	124	145	165	165	167	105	162	164	171	163	173	139	119	134	169	132.0
	AP	111	118	127	155	164	93	112	127	148	156	105	131	148	160	121	168	126	123	124	141	132.9
	VP	125	118	126	163	166	125	111	124	159	159	88	125	160	163	118	167	155	116	120	142	136.5
	VO	150	158	170	167	166	132	153	162	169	163	130	154	162	162	126	121	115	141	140	159	150.0
40 msec.	BP	131	133	159	160	170	119	140	159	162	165	119	153	160	157	150	173	168	113	124	167	149.1
	AP	88	110	116	150	146	103	115	122	148	157	105	118	139	141	119	155	142	127	125	130	127.8
	VP	111	119	111	150	146	112	111	125	148	154	102	115	151	148	117	154	146	122	119	135	129.8
	VO	124	155	155	164	168	126	152	146	164	172	109	155	163	161	116	114	119	137	146	155	145.0
60 msec.	BP	114	114	149	140	149	108	103	148	138	140	113	136	135	139	141	149	136	94	101	140	129.3
	AP	100	109	115	128	126	95	116	114	125	122	109	115	121	126	123	129	128	122	112	116	117.5
	VP	118	117	120	128	129	113	115	116	131	130	102	121	130	129	114	130	132	110	115	116	120.8
	VO	106	142	159	149	156	102	140	142	148	157	131	150	151	148	117	97	92	111	129	123	132.5
80 msec.	BP	115	87	118	102	100	110	89	101	111	106	96	113	101	89	126	129	136	74	92	131	106.3
	AP	96	107	94	105	101	105	119	113	107	110	97	105	105	88	111	116	105	106	101	98	104.4
	VP	111	106	104	119	103	107	108	110	114	110	103	116	108	99	119	113	125	116	113	113	110.8
	VO	100	119	120	125	119	81	113	112	119	126	102	121	120	79	117	100	107	106	107	115	110.4
100 msec.	BP	98	93	104	98	109	104	92	100	97	107	93	97	103	92	135	124	111	105	91	109	103.1
	AP	84	93	99	96	60	104	104	97	112	103	101	101	109	107	85	106	97	94	93	92	96.8
	VP	110	104	89	110	106	94	102	105	109	106	106	112	104	99	105	110	110	121	116	105	106.1
	VO	89	97	94	100	100	90	92	99	104	106	94	101	100	97	95	99	104	93	92	100	97.3
120 msec.	BP	106	113	107	113	103	104	104	94	99	97	96	100	97	100	97	115	104	103	92	107	102.5
	AP	82	99	95	103	102	93	88	94	96	85	103	102	81	99	97	108	95	87	90	93	94.6
	VP	110	96	100	108	115	107	96	102	105	102	103	108	102	103	106	111	109	102	108	98	104.5
	VO	88	92	100	84	104	90	88	95	101	102	85	96	96	76	85	83	90	101	99	99	92.5

listeners. These four tables are comparable to Table 20 of Miller and Nicely and Table 21 of Singh and Black.^{5,6}

⁵G. A. Miller and P. E. Nicely, op. cit.

⁶S. Singh and J. W. Black, op. cit.

The bivariate measure of intelligibility can be obtained separately for the characteristic linguistic features of the stimulus consonants in the same manner as the articulation score for each feature has been obtained in Tables 3, 4, 5, and 6. The process for computing correct responses for voicing, for example, was to compute all the voiced responses for all the voiced stimuli. Similarly, the correct responses for the bilabial place was computed by adding all the responses for bilabial place to all the stimuli for bilabial place.

Tables 7, 8, 9, and 10 enumerate frequencies of all incorrect responses for the five distinctive binary features in Tables 1-480 (Appendix B) in four conditions of speaking and listening. Thus, these features of the stimuli were not preserved in the responses made by the listeners. There are five such binary feature categories for errors as compared with four in the case of the correct responses. The reason for such irregularity is that there are only six consonantal stimuli whereas there are twelve choices for response. The aspirated counterparts of all

TABLE 7. Frequencies of all incorrect responses for the five distinctive binary features in Tables 1 through 480, as spoken and recognised by three native speakers and ten native listeners of Hindi.

		BN ₁	BN ₂	BN ₃	BN ₄	BN ₅	BN ₆	BN ₇	BN ₈	BN ₉	BN ₁₀	BN ₁₁	BN ₁₂	BN ₁₃	BN ₁₄	BN ₁₅	BN ₁₆	BN ₁₇	BN ₁₈	BN ₁₉	BN ₂₀	Mean
20 msec.	BP	68	59	23	19	39	68	41	21	27	9	55	12	5	0	18	8	6	48	43	13	29.1
	AP	71	55	51	23	44	72	58	57	37	18	60	53	9	7	48	20	20	67	50	26	42.3
	VP	73	70	68	14	29	62	67	58	30	13	65	55	9	7	60	20	20	53	43	39	42.7
	VO	79	47	22	29	42	69	38	32	47	24	65	38	35	25	75	65	68	65	69	60	49.7
	AS	40	20	22	17	21	21	16	15	21	10	19	18	23	13	89	80	80	34	28	29	30.8
40 msec.	BP	80	71	34	23	37	74	54	39	19	19	56	17	3	5	6	8	25	49	48	15	34.1
	AP	68	63	56	29	38	73	57	54	34	27	66	55	13	8	53	20	30	63	48	30	44.2
	VP	72	80	82	16	33	65	67	81	27	24	86	68	10	7	53	16	23	60	42	45	47.8
	VO	78	67	52	47	46	84	50	40	47	43	64	42	31	49	77	70	68	62	59	61	56.8
	AS	55	38	15	13	16	27	12	7	11	2	19	5	11	11	89	81	73	18	18	18	26.9
60 msec.	BP	85	87	45	35	41	76	69	32	26	26	55	22	21	12	7	15	17	59	59	16	40.2
	AP	85	66	57	63	52	76	65	57	42	49	59	59	40	36	52	37	28	68	72	38	55.0
	VP	66	65	80	42	49	72	54	79	40	43	48	67	31	32	53	38	33	51	45	52	52.0
	VO	89	73	65	60	56	88	62	55	48	49	65	52	48	47	80	74	72	67	75	69	64.7
	AS	64	28	6	7	11	28	12	3	8	8	9	5	7	5	80	77	74	11	19	12	23.7
80 msec.	BP	76	101	59	57	69	83	81	54	55	47	108	42	54	37	47	34	28	70	86	21	60.4
	AP	83	74	70	70	60	94	62	53	48	54	70	50	44	52	77	54	62	84	71	44	63.8
	VP	75	63	65	69	65	77	55	57	59	53	54	50	56	49	78	48	52	54	65	57	60.0
	VO	79	88	78	69	72	88	69	62	62	67	66	53	46	53	86	67	76	82	77	87	71.0
	AS	71	40	28	19	20	38	19	14	15	7	18	20	8	17	47	49	55	22	16	16	26.9
100 msec.	BP	74	104	71	75	80	75	103	84	85	88	90	78	83	80	72	64	70	85	82	56	79.9
	AP	98	78	81	83	71	84	67	88	74	71	73	86	72	78	83	79	73	110	76	65	79.6
	VP	68	82	74	82	91	75	84	94	85	89	75	88	95	92	79	73	73	71	82	79	82.0
	VO	92	83	82	81	93	85	79	90	87	80	85	66	80	76	74	86	86	86	73	77	82.0
	AS	62	33	44	44	40	40	35	36	26	23	26	29	27	31	37	49	43	26	32	24	35.3
120 msec.	BP	72	89	72	78	82	80	81	80	70	88	87	78	89	71	75	72	78	69	72	65	77.4
	AP	87	88	84	77	80	88	80	79	77	70	81	83	89	79	74	89	76	89	86	65	80.9
	VP	73	75	100	93	96	78	83	91	87	98	74	79	75	80	87	85	88	80	76	96	84.8
	VO	96	94	87	84	92	96	87	88	81	88	85	83	90	88	80	87	75	87	88	84	87.0
	AS	68	52	52	45	51	89	33	33	37	32	23	22	27	37	53	30	46	32	30	31	38.1

TABLE 8. Frequencies of all incorrect responses for the five distinctive binary features in Tables 1 through 480 as spoken by three speakers of Hindi and recognized by ten native listeners of English.

		EW ₁	EW ₂	EW ₃	EW ₄	EW ₅	EW ₆	EW ₇	EW ₈	EW ₉	EW ₁₀	EW ₁₁	EW ₁₂	EW ₁₃	EW ₁₄	EW ₁₅	EW ₁₆	EW ₁₇	EW ₁₈	EW ₁₉	EW ₂₀	Mean
20 msec.	BP	57	72	27	18	10	56	44	17	16	8	56	26	21	12	9	4	9	61	49	5	28.8
	AP	65	91	44	28	21	72	60	36	32	19	72	46	35	29	47	11	29	66	58	22	44.1
	VP	54	57	55	14	15	54	66	43	16	11	76	60	16	25	52	9	26	61	39	23	38.6
	VO	36	38	33	32	36	54	40	27	28	27	70	54	48	47	96	77	82	74	70	61	51.5
	AS	108	87	81	71	81	82	110	75	84	72	88	95	91	65	104	99	96	70	72	88	85.9
40 msec.	BP	62	60	28	23	21	58	53	27	17	7	54	28	32	12	21	7	10	70	56	7	32.6
	AP	79	65	56	31	33	80	72	51	38	18	73	50	42	30	46	16	28	62	67	29	48.3
	VP	65	57	72	14	16	58	61	70	23	13	71	68	22	20	55	11	22	52	47	26	42.1
	VO	64	54	60	52	32	57	46	43	32	29	80	56	39	41	89	84	85	64	71	67	57.2
	AS	110	85	77	74	67	90	101	68	88	79	100	83	105	79	84	100	88	66	83	89	85.8
60 msec.	BP	69	58	22	35	17	60	59	28	33	17	52	26	24	35	23	23	13	69	63	13	36.9
	AP	82	74	43	55	41	69	71	57	67	46	76	52	54	46	44	36	35	73	64	39	56.2
	VP	61	52	49	42	30	63	50	49	44	37	62	44	40	53	47	35	36	50	45	42	46.5
	VO	79	68	53	66	50	68	69	63	60	56	67	66	54	52	90	89	88	76	72	79	68.2
	AS	78	81	8	101	107	74	98	87	88	88	77	76	78	79	106	98	80	49	76	83	80.6
80 msec.	BP	72	90	70	74	73	90	83	56	56	67	80	88	65	61	34	31	23	93	85	38	66.4
	AP	84	68	66	72	66	91	75	58	66	58	80	123	65	66	53	51	56	90	74	58	71.0
	VP	64	66	58	54	51	69	68	50	52	49	70	48	54	47	53	52	55	63	55	56	56.7
	VO	89	70	68	81	69	88	72	67	69	82	62	73	66	83	88	91	98	88	78	79	78.0
	AS	76	77	73	77	107	54	92	69	83	67	95	77	94	83	89	95	76	61	86	83	80.7
100 msec.	BP	73	87	78	96	82	71	99	96	87	103	91	92	80	85	83	66	64	82	89	59	83.1
	AP	89	85	83	93	78	96	82	76	88	80	86	91	88	77	87	63	80	74	70	78	82.2
	VP	78	72	73	77	80	79	73	80	77	79	73	75	72	76	72	73	70	70	67	69	74.2
	VO	99	90	90	86	74	90	83	99	85	97	84	85	85	86	88	87	93	100	85	79	88.2
	AS	63	63	51	83	76	60	76	68	77	63	79	84	82	80	80	80	100	82	65	95	75.3
120 msec.	BP	86	81	77	74	78	73	81	72	76	81	79	87	80	77	75	68	71	72	93	79	78.0
	AP	98	91	91	82	75	89	80	113	75	91	87	82	85	71	95	90	81	89	85	75	86.2
	VP	64	82	86	84	69	66	83	77	71	74	74	85	75	68	66	66	74	67	74	80	74.2
	VO	87	100	91	91	85	82	87	81	94	92	87	89	88	81	86	67	79	85	83	83	85.9
	AS	59	66	52	68	67	43	33	75	72	49	86	63	85	84	69	76	87	65	63	66	66.4

TABLE 9. Frequencies of all incorrect responses for the five distinctive binary features in Tables 1 through 480 as spoken by three native speakers of English and recognized by ten native speakers of Hindi.

		BW1	BW2	BW3	BW4	BW5	BW6	BW7	BW8	BW9	BW10	BW11	BW12	BW13	BW14	BW15	BW16	BW17	BW18	BW19	BW20	Mean
20 msec.	BP	83	46	22	16	31	69	44	18	27	8	56	16	9	8	20	18	15	59	54	28	32.3
	AP	81	57	55	30	40	67	64	53	37	14	64	52	6	6	53	20	18	47	43	51	42.9
	VP	72	75	65	32	43	68	82	69	42	18	82	56	15	12	61	26	29	72	55	63	51.8
	VO	75	59	38	41	36	65	46	32	40	24	54	23	26	19	54	48	49	59	54	60	45.1
	AS	53	33	47	81	59	38	39	60	70	72	56	75	88	86	113	101	105	73	68	57	68.7
40 msec.	BP	88	53	32	20	31	78	53	27	19	23	54	21	14	18	18	18	18	69	60	26	37.0
	AP	86	66	53	36	43	76	56	55	40	26	66	53	21	25	56	29	29	48	39	62	48.2
	VP	70	91	79	37	48	76	83	74	29	31	80	62	21	27	62	31	27	83	63	70	57.2
	VO	91	54	39	27	36	79	44	33	30	23	38	26	23	25	50	47	60	51	44	54	43.7
	AS	53	40	22	39	43	24	25	34	51	57	36	49	59	68	84	90	90	44	49	46	50.1
60 msec.	BP	79	90	44	40	44	71	85	39	45	31	86	24	37	41	32	31	33	80	77	34	52.1
	AP	72	69	69	48	54	75	62	72	53	43	60	62	51	42	66	42	46	63	47	61	57.8
	VP	73	69	83	58	58	70	83	81	52	48	78	64	48	55	68	39	45	97	68	73	64.5
	VO	81	76	52	46	56	86	50	48	39	42	42	30	43	30	66	67	67	61	71	54	55.3
	AS	92	48	30	28	24	31	68	36	33	24	44	26	28	31	61	71	70	25	18	23	40.5
80 msec.	BP	66	96	68	68	56	65	105	65	58	56	105	71	57	46	59	51	51	76	81	47	67.3
	AP	73	71	81	64	68	79	66	72	69	68	72	85	64	56	79	65	69	74	62	63	70.0
	VP	81	81	91	74	82	80	79	93	69	72	79	78	67	70	84	68	52	66	83	68	75.8
	VO	84	79	77	69	66	89	75	57	59	65	72	61	58	55	65	67	73	91	76	59	69.8
	AS	66	47	40	37	41	34	36	42	36	19	28	35	34	33	59	60	58	37	39	26	40.3
100 msec.	BP	75	90	63	69	72	74	95	78	78	71	92	65	67	76	69	57	69	84	81	71	74.8
	AP	82	86	88	64	62	80	72	78	75	69	73	62	64	78	74	84	77	94	85	69	75.8
	VP	71	84	81	83	82	66	83	74	83	80	79	71	79	76	77	73	74	76	70	76	79.9
	VO	93	81	90	85	78	57	85	86	78	74	91	80	79	77	85	87	93	90	88	82	82.9
	AS	46	58	59	47	45	49	40	47	29	32	24	47	41	45	49	45	43	30	39	36	42.5
120 msec.	BP	78	68	73	75	71	77	44	71	75	68	81	71	73	70	79	69	79	78	68	68	71.8
	AP	94	79	70	77	72	96	68	64	87	80	83	81	77	77	69	92	89	90	81	82	80.4
	VP	68	83	91	90	103	83	92	91	86	81	78	92	86	87	90	83	80	78	81	90	85.6
	VO	95	89	91	90	98	94	92	87	86	88	92	80	88	85	91	92	79	92	86	89	89.2
	AS	44	63	62	57	42	43	34	39	46	26	25	28	35	39	60	39	34	43	40	33	42.6

TABLE 10. Frequencies of all incorrect responses for the five distinctive binary features in Tables 1 through 480 as spoken and recognized by three native speakers and ten native listeners of English.

		EW ₁	EW ₂	EW ₃	EW ₄	EW ₅	EW ₆	EW ₇	EW ₈	EW ₉	EW ₁₀	EW ₁₁	EW ₁₂	EW ₁₃	EW ₁₄	EW ₁₅	EW ₁₆	EW ₁₇	EW ₁₈	EW ₁₉	EW ₂₀	Mean
20 msec.	BP	46	42	17	12	8	46	35	15	15	13	75	18	16	9	17	7	41	61	46	11	28.0
	AP	69	62	53	25	16	87	68	53	32	24	75	49	32	20	59	12	54	57	56	39	47.1
	VP	55	62	54	17	16	55	69	56	21	21	92	55	20	17	62	13	25	64	60	38	43.6
	VO	30	22	10	13	14	48	27	18	11	17	50	26	18	18	54	59	65	39	40	21	30.0
	AS	97	80	95	89	94	66	90	74	88	88	88	71	82	107	95	99	104	71	69	90	86.8
40 msec.	BP	49	47	21	20	10	61	40	21	18	15	61	27	20	23	30	7	12	67	56	13	30.9
	AP	92	70	64	30	34	77	65	58	32	23	75	62	41	39	61	25	38	53	55	50	52.2
	VP	69	61	69	30	34	68	69	55	32	26	79	65	29	32	63	26	34	58	61	45	50.2
	VO	56	25	25	16	12	54	28	34	16	8	71	25	17	19	64	66	61	43	34	25	34.9
	AS	102	78	82	84	90	55	81	70	98	94	87	99	82	89	73	92	96	63	77	96	84.4
60 msec.	BP	66	66	31	40	31	72	77	32	42	40	67	44	45	41	39	31	44	86	79	40	50.6
	AP	80	71	65	52	54	85	64	67	55	58	71	65	59	54	57	51	52	58	68	64	62.5
	VP	62	63	60	52	51	67	65	64	49	50	78	59	50	51	66	50	48	70	65	64	59.2
	VO	74	38	21	31	24	78	40	38	32	23	49	30	29	32	63	83	88	69	51	57	47.5
	AS	83	77	99	103	100	54	75	76	86	89	96	83	92	102	73	106	97	62	75	75	85.1
80 msec.	BP	65	75	62	78	80	70	91	79	69	74	84	67	79	91	54	51	44	106	88	49	72.8
	AP	84	73	86	75	79	75	61	67	73	70	83	75	75	92	69	64	75	74	79	82	75.5
	VP	69	74	76	61	77	73	72	70	66	70	77	64	72	81	61	67	55	64	67	67	69.1
	VO	80	61	60	55	61	89	67	68	61	54	78	59	60	101	63	80	73	74	73	65	69.1
	AS	76	68	76	73	95	35	75	68	77	63	86	79	78	70	85	109	84	81	80	81	76.9
100 msec.	BP	82	87	76	82	71	76	88	80	83	73	87	83	77	88	68	56	69	75	89	71	78.0
	AP	96	87	81	84	83	76	76	83	68	77	79	79	71	73	95	74	83	86	87	88	81.3
	VP	70	76	91	70	74	86	78	75	71	74	74	68	76	81	75	70	70	59	64	75	73.8
	VO	91	83	86	80	80	90	88	81	76	74	86	79	80	83	85	81	76	87	88	80	82.7
	AS	81	70	75	84	71	49	54	52	72	52	79	55	79	74	82	96	94	67	88	73	72.3
120 msec.	BP	74	67	73	67	77	76	76	86	81	83	84	130	83	80	83	65	76	77	88	73	79.9
	AP	98	81	85	77	78	87	92	86	84	95	77	78	99	81	83	72	85	93	90	87	85.4
	VP	70	84	80	72	65	73	84	78	75	78	77	72	78	77	74	69	71	78	72	82	75.4
	VO	92	88	80	96	76	90	92	85	79	78	95	84	84	104	95	97	90	79	81	81	87.3
	AS	69	48	53	69	74	34	49	68	69	50	76	68	72	68	71	85	99	61	71	70	66.2

plosive consonants are included in the responses but not presented in the stimuli. Thus, there is no point of agreement between stimulus and response regarding aspiration and, therefore, in no place is aspiration a potent category, except where the frequencies of incorrect responses have been enumerated. Computations of the frequencies of incorrect responses were made by adding all incorrect responses for all incorrect stimuli. Incorrect responses for voicing, for example, in Tables 1-480 (Appendix B), were computed by adding all voiced responses to the voiceless stimuli, and voiceless responses to the voiced stimuli. This procedure is the reverse of what has been done in computing the frequencies of correct responses presented in Tables 3, 4, 5, and 6.

The tables representing the incorrect responses under four speaking-listening conditions reveal that aspiration is an important feature for the listeners of Hindi, more so than for the listeners of English, and that the listeners of Hindi make less errors in regard to aspiration as compared to the three place and one voicing categories. The frequencies of incorrect responses to aspiration are minimum when Hindi-speaking subjects are listening. On the contrary, when English-speaking subjects are listening, the frequencies of incorrect responses for aspiration are maximum. Bilabial place yields the fewest error responses when English-speaking

subjects are listening, the bilabial place being second only to aspiration in terms of discarding errors when Hindi-speaking subjects are listening. The error distribution of alveolar place, velar place, and voicing is not very consistent across the four speaking-listening conditions and almost equal in magnitude. All these results are based on the mean values mentioned in the last columns of Tables 7, 8, 9, and 10.

The manner in which the articulation score (correct and incorrect) has been enumerated in Tables 3-10, naturally follows a fourfold contingency table for the computations of information transmitted in bits per stimulus for each feature separately. For example, for voicing, the fourfold contingency table consisted of (1) voiced stimuli and voiceless responses, (2) voiced stimuli and voiced responses, (3) voiceless stimuli and voiceless responses, and (4) voiceless stimuli and voiced responses. For bilabial place, similarly, the contingency table consisted of (1) bilabial stimuli and bilabial responses, (2) bilabial stimuli and non-bilabial responses, (3) non-bilabial stimuli and non-bilabial responses, and (4) non-bilabial stimuli and bilabial responses, etc.

A comparison of Tables 11, 12, 13, and 14 reveals the relative importance of the features in terms of information transmitted in bits per stimulus. BP represents bilabial place, AP alveolar place, VP velar

TABLE 11. Information transmitted in bits per stimulus in Tables 1 through 40 for four separate binary features (four separate channels) when three native speakers and ten native listeners ~~estimated~~ of that are operating.

	W ₁	W ₂	W ₃	W ₄	W ₅	W ₆	W ₇	W ₈	W ₉	W ₁₀	W ₁₁	W ₁₂	W ₁₃	W ₁₄	W ₁₅	W ₁₆	W ₁₇	W ₁₈	W ₁₉	W ₂₀	W ₂₁	W ₂₂	W ₂₃	W ₂₄	W ₂₅	W ₂₆	W ₂₇	W ₂₈	W ₂₉	W ₃₀	W ₃₁	W ₃₂	W ₃₃	W ₃₄	W ₃₅	W ₃₆	W ₃₇	W ₃₈	W ₃₉	W ₄₀	W ₄₁	W ₄₂	W ₄₃	W ₄₄	W ₄₅	W ₄₆	W ₄₇	W ₄₈	W ₄₉	W ₅₀	W ₅₁	W ₅₂	W ₅₃	W ₅₄	W ₅₅	W ₅₆	W ₅₇	W ₅₈	W ₅₉	W ₆₀	W ₆₁	W ₆₂	W ₆₃	W ₆₄	W ₆₅	W ₆₆	W ₆₇	W ₆₈	W ₆₉	W ₇₀	W ₇₁	W ₇₂	W ₇₃	W ₇₄	W ₇₅	W ₇₆	W ₇₇	W ₇₈	W ₇₉	W ₈₀	W ₈₁	W ₈₂	W ₈₃	W ₈₄	W ₈₅	W ₈₆	W ₈₇	W ₈₈	W ₈₉	W ₉₀	W ₉₁	W ₉₂	W ₉₃	W ₉₄	W ₉₅	W ₉₆	W ₉₇	W ₉₈	W ₉₉	W ₁₀₀	W ₁₀₁	W ₁₀₂	W ₁₀₃	W ₁₀₄	W ₁₀₅	W ₁₀₆	W ₁₀₇	W ₁₀₈	W ₁₀₉	W ₁₁₀	W ₁₁₁	W ₁₁₂	W ₁₁₃	W ₁₁₄	W ₁₁₅	W ₁₁₆	W ₁₁₇	W ₁₁₈	W ₁₁₉	W ₁₂₀	W ₁₂₁	W ₁₂₂	W ₁₂₃	W ₁₂₄	W ₁₂₅	W ₁₂₆	W ₁₂₇	W ₁₂₈	W ₁₂₉	W ₁₃₀	W ₁₃₁	W ₁₃₂	W ₁₃₃	W ₁₃₄	W ₁₃₅	W ₁₃₆	W ₁₃₇	W ₁₃₈	W ₁₃₉	W ₁₄₀	W ₁₄₁	W ₁₄₂	W ₁₄₃	W ₁₄₄	W ₁₄₅	W ₁₄₆	W ₁₄₇	W ₁₄₈	W ₁₄₉	W ₁₅₀	W ₁₅₁	W ₁₅₂	W ₁₅₃	W ₁₅₄	W ₁₅₅	W ₁₅₆	W ₁₅₇	W ₁₅₈	W ₁₅₉	W ₁₆₀	W ₁₆₁	W ₁₆₂	W ₁₆₃	W ₁₆₄	W ₁₆₅	W ₁₆₆	W ₁₆₇	W ₁₆₈	W ₁₆₉	W ₁₇₀	W ₁₇₁	W ₁₇₂	W ₁₇₃	W ₁₇₄	W ₁₇₅	W ₁₇₆	W ₁₇₇	W ₁₇₈	W ₁₇₉	W ₁₈₀	W ₁₈₁	W ₁₈₂	W ₁₈₃	W ₁₈₄	W ₁₈₅	W ₁₈₆	W ₁₈₇	W ₁₈₈	W ₁₈₉	W ₁₉₀	W ₁₉₁	W ₁₉₂	W ₁₉₃	W ₁₉₄	W ₁₉₅	W ₁₉₆	W ₁₉₇	W ₁₉₈	W ₁₉₉	W ₂₀₀	W ₂₀₁	W ₂₀₂	W ₂₀₃	W ₂₀₄	W ₂₀₅	W ₂₀₆	W ₂₀₇	W ₂₀₈	W ₂₀₉	W ₂₁₀	W ₂₁₁	W ₂₁₂	W ₂₁₃	W ₂₁₄	W ₂₁₅	W ₂₁₆	W ₂₁₇	W ₂₁₈	W ₂₁₉	W ₂₂₀	W ₂₂₁	W ₂₂₂	W ₂₂₃	W ₂₂₄	W ₂₂₅	W ₂₂₆	W ₂₂₇	W ₂₂₈	W ₂₂₉	W ₂₃₀	W ₂₃₁	W ₂₃₂	W ₂₃₃	W ₂₃₄	W ₂₃₅	W ₂₃₆	W ₂₃₇	W ₂₃₈	W ₂₃₉	W ₂₄₀	W ₂₄₁	W ₂₄₂	W ₂₄₃	W ₂₄₄	W ₂₄₅	W ₂₄₆	W ₂₄₇	W ₂₄₈	W ₂₄₉	W ₂₅₀	W ₂₅₁	W ₂₅₂	W ₂₅₃	W ₂₅₄	W ₂₅₅	W ₂₅₆	W ₂₅₇	W ₂₅₈	W ₂₅₉	W ₂₆₀	W ₂₆₁	W ₂₆₂	W ₂₆₃	W ₂₆₄	W ₂₆₅	W ₂₆₆	W ₂₆₇	W ₂₆₈	W ₂₆₉	W ₂₇₀	W ₂₇₁	W ₂₇₂	W ₂₇₃	W ₂₇₄	W ₂₇₅	W ₂₇₆	W ₂₇₇	W ₂₇₈	W ₂₇₉	W ₂₈₀	W ₂₈₁	W ₂₈₂	W ₂₈₃	W ₂₈₄	W ₂₈₅	W ₂₈₆	W ₂₈₇	W ₂₈₈	W ₂₈₉	W ₂₉₀	W ₂₉₁	W ₂₉₂	W ₂₉₃	W ₂₉₄	W ₂₉₅	W ₂₉₆	W ₂₉₇	W ₂₉₈	W ₂₉₉	W ₃₀₀	W ₃₀₁	W ₃₀₂	W ₃₀₃	W ₃₀₄	W ₃₀₅	W ₃₀₆	W ₃₀₇	W ₃₀₈	W ₃₀₉	W ₃₁₀	W ₃₁₁	W ₃₁₂	W ₃₁₃	W ₃₁₄	W ₃₁₅	W ₃₁₆	W ₃₁₇	W ₃₁₈	W ₃₁₉	W ₃₂₀	W ₃₂₁	W ₃₂₂	W ₃₂₃	W ₃₂₄	W ₃₂₅	W ₃₂₆	W ₃₂₇	W ₃₂₈	W ₃₂₉	W ₃₃₀	W ₃₃₁	W ₃₃₂	W ₃₃₃	W ₃₃₄	W ₃₃₅	W ₃₃₆	W ₃₃₇	W ₃₃₈	W ₃₃₉	W ₃₄₀	W ₃₄₁	W ₃₄₂	W ₃₄₃	W ₃₄₄	W ₃₄₅	W ₃₄₆	W ₃₄₇	W ₃₄₈	W ₃₄₉	W ₃₅₀	W ₃₅₁	W ₃₅₂	W ₃₅₃	W ₃₅₄	W ₃₅₅	W ₃₅₆	W ₃₅₇	W ₃₅₈	W ₃₅₉	W ₃₆₀	W ₃₆₁	W ₃₆₂	W ₃₆₃	W ₃₆₄	W ₃₆₅	W ₃₆₆	W ₃₆₇	W ₃₆₈	W ₃₆₉	W ₃₇₀	W ₃₇₁	W ₃₇₂	W ₃₇₃	W ₃₇₄	W ₃₇₅	W ₃₇₆	W ₃₇₇	W ₃₇₈	W ₃₇₉	W ₃₈₀	W ₃₈₁	W ₃₈₂	W ₃₈₃	W ₃₈₄	W ₃₈₅	W ₃₈₆	W ₃₈₇	W ₃₈₈	W ₃₈₉	W ₃₉₀	W ₃₉₁	W ₃₉₂	W ₃₉₃	W ₃₉₄	W ₃₉₅	W ₃₉₆	W ₃₉₇	W ₃₉₈	W ₃₉₉	W ₄₀₀	W ₄₀₁	W ₄₀₂	W ₄₀₃	W ₄₀₄	W ₄₀₅	W ₄₀₆	W ₄₀₇	W ₄₀₈	W ₄₀₉	W ₄₁₀	W ₄₁₁	W ₄₁₂	W ₄₁₃	W ₄₁₄	W ₄₁₅	W ₄₁₆	W ₄₁₇	W ₄₁₈	W ₄₁₉	W ₄₂₀	W ₄₂₁	W ₄₂₂	W ₄₂₃	W ₄₂₄	W ₄₂₅	W ₄₂₆	W ₄₂₇	W ₄₂₈	W ₄₂₉	W ₄₃₀	W ₄₃₁	W ₄₃₂	W ₄₃₃	W ₄₃₄	W ₄₃₅	W ₄₃₆	W ₄₃₇	W ₄₃₈	W ₄₃₉	W ₄₄₀	W ₄₄₁	W ₄₄₂	W ₄₄₃	W ₄₄₄	W ₄₄₅	W ₄₄₆	W ₄₄₇	W ₄₄₈	W ₄₄₉	W ₄₅₀	W ₄₅₁	W ₄₅₂	W ₄₅₃	W ₄₅₄	W ₄₅₅	W ₄₅₆	W ₄₅₇	W ₄₅₈	W ₄₅₉	W ₄₆₀	W ₄₆₁	W ₄₆₂	W ₄₆₃	W ₄₆₄	W ₄₆₅	W ₄₆₆	W ₄₆₇	W ₄₆₈	W ₄₆₉	W ₄₇₀	W ₄₇₁	W ₄₇₂	W ₄₇₃	W ₄₇₄	W ₄₇₅	W ₄₇₆	W ₄₇₇	W ₄₇₈	W ₄₇₉	W ₄₈₀	W ₄₈₁	W ₄₈₂	W ₄₈₃	W ₄₈₄	W ₄₈₅	W ₄₈₆	W ₄₈₇	W ₄₈₈	W ₄₈₉	W ₄₉₀	W ₄₉₁	W ₄₉₂	W ₄₉₃	W ₄₉₄	W ₄₉₅	W ₄₉₆	W ₄₉₇	W ₄₉₈	W ₄₉₉	W ₅₀₀	W ₅₀₁	W ₅₀₂	W ₅₀₃	W ₅₀₄	W ₅₀₅	W ₅₀₆	W ₅₀₇	W ₅₀₈	W ₅₀₉	W ₅₁₀	W ₅₁₁	W ₅₁₂	W ₅₁₃	W ₅₁₄	W ₅₁₅	W ₅₁₆	W ₅₁₇	W ₅₁₈	W ₅₁₉	W ₅₂₀	W ₅₂₁	W ₅₂₂	W ₅₂₃	W ₅₂₄	W ₅₂₅	W ₅₂₆	W ₅₂₇	W ₅₂₈	W ₅₂₉	W ₅₃₀	W ₅₃₁	W ₅₃₂	W ₅₃₃	W ₅₃₄	W ₅₃₅	W ₅₃₆	W ₅₃₇	W ₅₃₈	W ₅₃₉	W ₅₄₀	W ₅₄₁	W ₅₄₂	W ₅₄₃	W ₅₄₄	W ₅₄₅	W ₅₄₆	W ₅₄₇	W ₅₄₈	W ₅₄₉	W ₅₅₀	W ₅₅₁	W ₅₅₂	W ₅₅₃	W ₅₅₄	W ₅₅₅	W ₅₅₆	W ₅₅₇	W ₅₅₈	W ₅₅₉	W ₅₆₀	W ₅₆₁	W ₅₆₂	W ₅₆₃	W ₅₆₄	W ₅₆₅	W ₅₆₆	W ₅₆₇	W ₅₆₈	W ₅₆₉	W ₅₇₀	W ₅₇₁	W ₅₇₂	W ₅₇₃	W ₅₇₄	W ₅₇₅	W ₅₇₆	W ₅₇₇	W ₅₇₈	W ₅₇₉	W ₅₈₀	W ₅₈₁	W ₅₈₂	W ₅₈₃	W ₅₈₄	W ₅₈₅	W ₅₈₆	W ₅₈₇	W ₅₈₈	W ₅₈₉	W ₅₉₀	W ₅₉₁	W ₅₉₂	W ₅₉₃	W ₅₉₄	W ₅₉₅	W ₅₉₆	W ₅₉₇	W ₅₉₈	W ₅₉₉	W ₆₀₀	W ₆₀₁	W ₆₀₂	W ₆₀₃	W ₆₀₄	W ₆₀₅	W ₆₀₆	W ₆₀₇	W ₆₀₈	W ₆₀₉	W ₆₁₀	W ₆₁₁	W ₆₁₂	W ₆₁₃	W ₆₁₄	W ₆₁₅	W ₆₁₆	W ₆₁₇	W ₆₁₈	W ₆₁₉	W ₆₂₀	W ₆₂₁	W ₆₂₂	W ₆₂₃	W ₆₂₄	W ₆₂₅	W ₆₂₆	W ₆₂₇	W ₆₂₈	W ₆₂₉	W ₆₃₀	W ₆₃₁	W ₆₃₂	W ₆₃₃	W ₆₃₄	W ₆₃₅	W ₆₃₆	W ₆₃₇	W ₆₃₈	W ₆₃₉	W ₆₄₀	W ₆₄₁	W ₆₄₂	W ₆₄₃	W ₆₄₄	W ₆₄₅	W ₆₄₆	W ₆₄₇	W ₆₄₈	W ₆₄₉	W ₆₅₀	W ₆₅₁	W ₆₅₂	W ₆₅₃	W ₆₅₄	W ₆₅₅	W ₆₅₆	W ₆₅₇	W ₆₅₈	W ₆₅₉	W ₆₆₀	W ₆₆₁	W ₆₆₂	W ₆₆₃	W ₆₆₄	W ₆₆₅	W ₆₆₆	W ₆₆₇	W ₆₆₈	W ₆₆₉	W ₆₇₀	W ₆₇₁	W ₆₇₂	W ₆₇₃	W ₆₇₄	W ₆₇₅	W ₆₇₆	W ₆₇₇	W ₆₇₈	W ₆₇₉	W ₆₈₀	W ₆₈₁	W ₆₈₂	W ₆₈₃	W ₆₈₄	W ₆₈₅	W ₆₈₆	W ₆₈₇	W ₆₈₈	W ₆₈₉	W ₆₉₀	W ₆₉₁	W ₆₉₂	W ₆₉₃	W ₆₉₄	W ₆₉₅	W ₆₉₆	W ₆₉₇	W ₆₉₈	W ₆₉₉	W ₇₀₀	W ₇₀₁	W ₇₀₂	W ₇₀₃	W ₇₀₄	W ₇₀₅	W ₇₀₆	W ₇₀₇	W ₇₀₈	W ₇₀₉	W ₇₁₀	W ₇₁₁	W ₇₁₂	W ₇₁₃	W ₇₁₄	W ₇₁₅	W ₇₁₆	W ₇₁₇	W ₇₁₈	W ₇₁₉	W ₇₂₀	W ₇₂₁	W ₇₂₂	W ₇₂₃	W ₇₂₄	W ₇₂₅	W ₇₂₆	W ₇₂₇	W ₇₂₈	W ₇₂₉	W ₇₃₀	W ₇₃₁	W ₇₃₂	W ₇₃₃	W ₇₃₄	W ₇₃₅	W ₇₃₆	W ₇₃₇	W ₇₃₈	W ₇₃₉	W ₇₄₀	W ₇₄₁	W ₇₄₂	W ₇₄₃	W ₇₄₄	W ₇₄₅	W ₇₄₆	W ₇₄₇	W ₇₄₈	W ₇₄₉	W ₇₅₀	W ₇₅₁	W ₇₅₂	W ₇₅₃	W ₇₅₄	W ₇₅₅	W ₇₅₆	W ₇₅₇	W ₇₅₈	W ₇₅₉	W ₇₆₀	W ₇₆₁	W ₇₆₂	W ₇₆₃	W ₇₆₄	W ₇₆₅	W ₇₆₆	W ₇₆₇	W ₇₆₈	W ₇₆₉	W ₇₇₀	W ₇₇₁	W ₇₇₂	W ₇₇₃	W ₇₇₄	W ₇₇₅	W ₇₇₆	W ₇₇₇	W ₇₇₈	W ₇₇₉	W ₇₈₀	W ₇₈₁	W ₇₈₂	W ₇₈₃	W ₇₈₄	W ₇₈₅	W ₇₈₆	W ₇₈₇	W ₇₈₈	W ₇₈₉	W ₇₉₀	W ₇₉₁	W ₇₉₂	W ₇₉₃	W ₇₉₄	W ₇₉₅	W ₇₉₆	W ₇₉₇	W ₇₉₈	W ₇₉₉	W ₈₀₀	W ₈₀₁	W ₈₀₂	W ₈₀₃	W ₈₀₄	W ₈₀₅	W ₈₀₆	W ₈₀₇	W ₈₀₈	W ₈₀₉	W ₈₁₀	W ₈₁₁	W ₈₁₂	W ₈₁₃	W ₈₁₄	W ₈₁₅	W ₈₁₆	W ₈₁₇	W ₈₁₈	W ₈₁₉	W ₈₂₀	W ₈₂₁	W ₈₂₂	W ₈₂₃	W ₈₂₄	W ₈₂₅	W ₈₂₆	W ₈₂₇	W ₈₂₈	W ₈₂₉	W ₈₃₀	W ₈₃₁	W ₈₃₂	W ₈₃₃	W ₈₃₄	W ₈₃₅	W ₈₃₆	W ₈₃₇	W ₈₃₈	W ₈₃₉	W ₈₄₀	W ₈₄₁	W ₈₄₂	W ₈₄₃	W ₈₄₄	W ₈₄₅	W ₈₄₆	W ₈₄₇	W ₈₄₈	W ₈₄₉	W ₈₅₀	W ₈₅₁	W ₈₅₂	W ₈₅₃	W ₈₅₄	W ₈₅₅	W ₈₅₆	W ₈₅₇	W ₈₅₈	W ₈₅₉	W ₈₆₀	W ₈₆₁	W ₈₆₂	W ₈₆₃	W ₈₆₄	W ₈₆₅	W ₈₆₆	W ₈₆₇	W ₈₆₈	W ₈₆₉	W ₈₇₀	W ₈₇₁	W ₈₇₂	W ₈₇₃	W ₈₇₄	W ₈₇₅	W ₈₇₆	W ₈₇₇	W ₈₇₈	W ₈₇₉	W ₈₈₀	W ₈₈₁	W ₈₈₂	W ₈₈₃	W _{884</}
--	----------------	----------------	----------------	----------------	----------------	----------------	----------------	----------------	----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	------------------	-----------------------

TABLE 14. Information transmitted in bits per stimulus in Tables 1 through 440 for four separate binary features (four separate channels) when these include speakers and ten native listeners of English are operating.

	EW1	EW2	EW3	EW4	EW5	Total EW5	EW6	EW7	EW8	EW9	Total EW9	EW10	Total EW10	EW11	EW12	EW13	Total EW13	EW14	EW15	Total EW15	EW16	EW17	Total EW17	EW18	Total EW18	EW19	Total EW19	EW20	Total EW20
BP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
AP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	467	569	661	1,977	.063	819	506	506	1,831	633	1,273	.000	449	493	1,273	467	645	1,112	467	819	1,288	1,444	688	688	139	688	1,463
VP	135	145	4																										

place, and VO voicing. Table 11 represents the transmission of information in bits per stimulus where there were both Hindi speakers and Hindi listeners. The column at the right-hand end represents the grand total and indicates the following rank order: (1) bilabial place, (2) velar place, (3) alveolar place, and (4) voicing. This rank-order is maintained throughout 60 msec. of processed time. The grand total column at the right-hand end of Table 12 indicates that when three native speakers of Hindi are speaking and ten native speakers of English are listening, bilabial place is the most difficult to obliterate.

Table 13 represents information transmitted in bits per stimulus for the three native English speakers, with the ten native speakers of Hindi listening. Bilabial place of articulation, again, is by far the most difficult feature to obliterate.

A reversal from the finding mentioned above is noted in Table 14 where the speakers and listeners both belong to the English language group. Voicing, in this instance, is more difficult to obliterate than any other category. Second, in the rank-order, is bilabial place.

Tables 15, 16, 17, and 18 present the values that are comparable in the case of the place category and identical in the case of voicing with Tables 11, 12, 13, and 14. The former, however, is the percent information

TABLE 15. Percent information transmitted in bits per stimulus in Tables 1 through 480 for two distinctive features, place and voicing, in 20 bandwidths of 6 bandwidth conditions at 6 points of processing time. Speakers and listeners, both, were of Hindi.

		BW ₁	BW ₂	BW ₃	BW ₄	BW ₅	BW ₆	BW ₇	BW ₈	BW ₉	BW ₁₀	BW ₁₁	BW ₁₂	BW ₁₃	BW ₁₄	BW ₁₅	BW ₁₆	BW ₁₇	BW ₁₈	BW ₁₉	BW ₂₀	Mean Percent
20 msec.	Place	1	6	29	53	25	2	12	28	32	63	6	39	77	86	32	61	64	10	18	49	34.65
	Voicing	1	20	47	39	23	4	30	33	19	47	7	26	31	46	2	6	5	7	6	11	20.50
40 msec.	Place	1	2	17	34	26	1	7	13	40	50	2	32	75	77	49	63	45	10	20	47	30.55
	Voicing	1	6	15	19	19	0	20	27	19	22	6	24	38	19	2	4	6	7	10	8	13.60
60 msec.	Place	0	1	8	19	15	0	1	17	29	26	12	28	36	45	44	37	42	11	9	40	21.10
	Voicing	0	3	6	10	11	0	8	12	18	16	6	13	17	18	1	3	3	5	2	4	7.80
80 msec.	Place	0	1	4	6	5	0	5	10	15	13	4	16	18	18	2	19	22	3	1	33	9.75
	Voicing	1	0	2	6	3	0	5	8	8	5	7	13	19	12	0	5	2	0	1	0	4.85
100 msec.	Place	1	1	2	3	0	0	0	1	0	1	1	4	4	2	0	1	1	0	0	6	1.40
	Voicing	0	1	1	1	0	0	1	0	0	1	0	6	1	2	3	0	0	0	2	1	1.00
120 msec.	Place	1	1	0	0	1	0	0	0	0	0	0	0	3	1	1	0	0	0	1	1	.50
	Voicing	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	2	0	0	0	.30

TABLE 16. Percent information transmitted in bits per stimulus in Tables 1 through 480 for two distinctive features, place and voicing, in 20 bandwidths of 6 bandwidth conditions at 6 points of processing time. Speakers were of Hindi, and listeners of English.

		BW ₁	BW ₂	BW ₃	BW ₄	BW ₅	BW ₆	BW ₇	BW ₈	BW ₉	BW ₁₀	BW ₁₁	BW ₁₂	BW ₁₃	BW ₁₄	BW ₁₅	BW ₁₆	BW ₁₇	BW ₁₈	BW ₁₉	BW ₂₀	Mean Percent
20 msec.	Place	6	8	30	56	62	6	10	44	58	67	3	26	50	49	44	79	53	6	16	63	36.80
	Voicing	28	26	33	34	32	12	24	42	40	40	4	12	16	17	0	2	1	2	3	8	18.80
40 msec.	Place	4	5	22	40	50	4	7	26	49	68	4	25	36	56	28	71	55	10	10	57	31.35
	Voicing	7	12	9	14	33	10	18	22	32	36	1	10	24	23	0	0	0	6	3	5	13.25
60 msec.	Place	1	6	30	21	43	6	6	22	21	39	5	25	30	23	28	37	46	6	12	42	22.45
	Voicing	1	4	17	6	18	5	4	7	9	11	5	6	13	14	0	0	0	2	4	1	6.35
80 msec.	Place	1	1	4	3	7	1	1	12	10	9	1	12	6	10	19	22	25	1	2	15	8.10
	Voicing	0	3	4	1	4	0	3	5	4	3	7	3	6	0	0	0	0	0	1	1	2.25
100 msec.	Place	0	1	1	2	2	2	1	2	1	2	1	1	0	1	0	3	2	1	0	4	1.35
	Voicing	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	.20
120 msec.	Place	3	0	1	1	1	1	0	0	0	0	0	1	0	1	1	1	0	2	1	1	.75
	Voicing	0	1	0	0	0	0	1	1	0	0	0	0	0	1	0	5	1	0	0	0	.50

TABLE 17. Percent information transmitted in bits per stimulus in Tables 1 through 400 for two distinctive features, place and voicing, in 20 bandwidths of 6 bandwidth conditions at 6 points of processing time. Speakers were of English and listeners of Hindi.

		BW ₁	BW ₂	BW ₃	BW ₄	BW ₅	BW ₆	BW ₇	BW ₈	BW ₉	BW ₁₀	BW ₁₁	BW ₁₂	BW ₁₃	BW ₁₄	BW ₁₅	BW ₁₆	BW ₁₇	BW ₁₈	BW ₁₉	BW ₂₀	Mean Percent
20 msec.	Place	0	9	26	42	25	2	8	31	28	65	4	34	75	77	28	48	51	10	16	24	30.15
	Voicing	2	10	27	29	28	6	20	37	25	48	15	47	43	66	13	21	20	11	17	10	24.75
40 msec.	Place	0	4	18	48	23	0	5	21	39	39	5	30	55	46	29	41	43	6	13	26	24.55
	Voicing	0	13	26	42	29	1	21	33	37	47	27	43	51	45	17	20	11	15	20	13	25.55
60 msec.	Place	1	0	9	17	11	11	5	13	13	23	1	24	20	18	16	26	24	2	7	22	13.15
	Voicing	0	1	2	4	5	0	2	11	10	7	3	8	10	11	6	5	0	0	2	9	4.80
80 msec.	Place	3	1	1	3	5	1	2	4	5	6	1	1	8	11	2	6	7	1	2	10	4.00
	Voicing	0	1	2	4	5	0	2	11	10	7	3	8	10	11	6	5	2	0	2	9	4.90
100 msec.	Place	0	1	0	1	2	0	0	1	1	1	0	3	2	0	1	3	1	0	1	1	.95
	Voicing	0	1	0	0	2	0	0	0	2	4	0	1	1	1	0	0	0	0	0	0	.60
120 msec.	Place	0	0	1	0	0	1	0	1	1	1	0	0	0	1	1	1	0	0	0	0	.40
	Voicing	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	.25

TABLE 18. Percent information transmitted in bits per stimulus in Tables 1 through 480 for two distinctive features, place and voicing, in 20 bandwidths of 6 bandwidth conditions at 6 points of processing time. Speakers and listeners were, both, of English.

		BW ₁	BW ₂	BW ₃	BW ₄	BW ₅	BW ₆	BW ₇	BW ₈	BW ₉	BW ₁₀	BW ₁₁	BW ₁₂	BW ₁₃	BW ₁₄	BW ₁₅	BW ₁₆	BW ₁₇	BW ₁₈	BW ₁₉	BW ₂₀	Mean Percent
20 msec.	Place	12	11	33	56	65	8	14	33	50	51	3	31	50	60	30	69	36	8	12	44	33.80
	Voicing	35	48	74	69	64	16	41	61	72	58	19	45	61	58	21	16	10	29	27	48	43.60
40 msec.	Place	8	9	26	50	46	5	11	31	40	47	2	21	37	34	19	56	43	8	8	39	27.00
	Voicing	10	42	42	57	68	12	31	33	59	78	3	44	62	54	8	8	13	21	31	42	35.90
60 msec.	Place	2	3	22	18	24	1	2	20	20	22	3	15	16	17	14	23	16	2	2	14	12.80
	Voicing	2	25	48	34	44	1	23	26	33	45	16	36	38	33	7	0	0	5	15	12	22.15
80 msec.	Place	1	0	3	1	1	1	3	2	4	3	1	3	2	1	6	8	11	3	0	6	3.00
	Voicing	1	8	9	11	8	0	5	4	8	12	1	9	9	1	6	1	2	2	2	7	5.30
100 msec.	Place	1	1	0	0	0	2	0	0	2	1	0	1	1	1	2	5	2	3	1	1	1.20
	Voicing	0	0	0	0	0	0	0	0	1	2	0	1	1	0	0	0	2	0	0	1	.40
120 msec.	Place	2	1	0	1	1	2	1	1	0	1	0	0	2	1	0	2	0	2	0	1	.90
	Voicing	0	0	1	0	2	0	0	0	0	1	0	0	0	1	0	0	0	1	1	1	.40

transmitted in bits per stimulus instead of information transmitted in bits per stimulus. Percent information for each feature was computed by dividing each value that represented information transmission in bits per stimulus for that feature by the maximum possible information for the same feature. Maximum possible information for place in this instance was 1.584 bits and for voicing, 1.000 bit. Thus, each value that represented information transmission for the place category was divided by 1.584 bits, and for the voice category by 1.000 bit.

A single rank-order was obtained in all the conditions of processed time (20, 40, 60, 80, 100, and 120 msec.) for the importance of the features in Tables 15 and 16 (when speakers and listeners both belonged to Hindi and when speakers were of Hindi and listeners of English). Table 17 shows native English speakers and Hindi-speaking listeners and indicates preponderantly that place was more important than voicing. A reversal, as mentioned earlier, regarding the importance of features was noted in Table 18, where speakers and listeners both were the speakers of English. Voicing was more important than place.

Rank-order of bandwidths. Rho was computed to determine the degree of agreement between the four speaking-listening conditions in terms of the importance of bandwidths. The bottom column of Tables 11, 12, 13,

and 14 show the sum of the information transmitted in each bandpass filter condition. Table 11 represents the values obtained from the speakers and listeners of Hindi; Table 12, speakers of Hindi and listeners of English; Table 13, speakers of English and listeners of Hindi; and Table 14, both speakers and listeners of English. The following rank-order correlation values were obtained: (1) when speakers of Hindi heard by listeners of Hindi was correlated with speakers of English heard by listeners of Hindi, $\rho = .95$; (2) when speakers of Hindi heard by the listeners of Hindi was correlated with the speakers of Hindi heard by the listeners of English, $\rho = .83$; (3) when speakers of Hindi heard by the listeners of Hindi was correlated with the speakers of English heard by the listeners of English, $\rho = .77$; (4) when speakers of Hindi heard by the listeners of English was correlated with the speakers of English heard by the listeners of Hindi, $\rho = .77$; (5) when speakers of Hindi heard by the listeners of English was correlated with the speakers of English heard by the listeners of English, $\rho = .78$; and when speakers of English heard by the listeners of Hindi was correlated with the speakers of English heard by the listeners of English, $\rho = .88$. Thus, when the values obtained from the listeners of Hindi have been correlated with the values obtained from the listeners of Hindi (in the one

case listening to their peers, and in the other listening to the speakers of English), $\rho = .95$. Similarly, when the values obtained from the listeners of English were compared with the values obtained from the listeners of English (in one case listening to their peers, and in the other listening to the speakers of Hindi), $\rho = .88$. These two are the highest ρ values. The second two highest ρ values are when speakers of Hindi are correlated with the speakers of Hindi and the speakers of English are correlated with the speakers of English. In both cases, in one condition they are heard by their peers, and in the other by non-peers. The ρ values are .83 and .78 respectively. The remaining two ρ values are identical (.77) where neither speakers nor listeners belong to the same group. Finally, the concordance among the four speaking-listening conditions has been described by finding the average value of all six possible pairs, denoted by $\overline{\rho} = .83$.⁷

⁷G. A. Ferguson, Statistical Analysis in Psychology and Education (New York: McGraw-Hill Book Company, 1959), p. 187.

The average value of .83 indicates a high degree of concordance among the four speaking-listening conditions.

A good deal of concordance among the four speaking-listening conditions for both importance of channels (i.e.

bilabial place, alveolar place, velar place, and voicing) and of 20 bandwidths in Tables 3, 4, 5, and 6, led to a pooling of the values for the four speaking-listening conditions (speakers and listeners of Hindi, speakers of Hindi and listeners of English, speakers of English and listeners of Hindi, and speakers and listeners of English). Table 19 presents the mean values of information transmitted in bits per stimulus derived from Tables 11, 12, 13, and 14. The overall mean of the channels (bilabial place, alveolar place, velar place, and voicing) indicates the following rank order: (1) bilabial place, (2) voicing, (3) alveolar place, (4) velar place. In terms of the importance of bandwidths the following rank order for the six highest band channels was obtained from the bottom column of Table 19: (1) BW₁₀ and BW₁₄ (212-6800 cps. and 425-6800 cps. respectively), (2) BW₁₃ (425-3400 cps.), (3) BW₁₆ (850-3400 cps), (4) BW₄ and BW₉ (106-3400 cps. and 212-3400 cps. respectively), (5) BW₅ and BW₁₇ (106-6800 cps. and 850-6800 cps. respectively), and (6) BW₂₀ (3400-6800 cps.).

Table 20 is the percent of information transmitted in bits per stimulus in Tables 1-480 (Appendix B) for four binary distinctive features in 20 bandwidths of six bandwidth conditions and at six points of processed time. Responses of all four speaker-listener groups are pooled.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80																				

TABLE 20. Percent information transmitted in bits per stimulus in Tables 1 through 480 for four binary distinctive features in 20 bandwidths of 6 bandwidth conditions and at 6 points of processing time. Responses of all four speaker-listener groups are pooled.

			BW ₁	BW ₂	BW ₃	BW ₄	BW ₅	Mean	BW ₆	BW ₇	BW ₈	BW ₉	BW ₁₀	Mean	BW ₁₁	BW ₁₂	BW ₁₃	BW ₁₄	Mean	BW ₁₅	BW ₁₆	BW ₁₇	Mean	BW ₁₈	BW ₁₉	Mean	BW ₂₀	Over- all Mean
20 sec.	BF	05	10	44	53	47	32	05	20	51	45	68	38	03	50	63	76	48	54	70	57	60	03	09	06	60	41	
	AF	05	08	07	41	37	18	08	08	09	34	51	20	01	07	53	58	30	07	59	37	34	12	19	15	33	23	
	VF	05	09	24	49	41	30	03	06	22	37	56	25	04	21	58	60	36	14	54	38	35	04	11	07	21	26	
40 sec.	BF	04	06	33	43	40	25	03	93	33	50	55	47	04	41	54	58	39	50	68	54	57	02	04	03	57	38	
	AF	01	01	03	33	24	12	01	08	04	29	42	16	01	04	38	40	21	05	46	36	29	10	15	12	25	19	
	VF	00	04	11	42	31	18	01	05	16	34	43	20	02	15	47	49	28	14	46	36	32	05	12	08	11	19	
60 sec.	BF	01	03	26	21	30	16	01	03	28	26	38	19	08	37	33	32	27	41	39	41	40	01	02	01	40	24	
	AF	01	01	06	08	15	06	02	02	04	14	17	08	02	04	16	19	10	27	25	25	19	06	08	07	17	11	
	VF	01	08	05	10	13	06	00	04	05	13	14	07	03	10	15	12	10	09	17	18	15	04	04	04	06	08	
80 sec.	BF	01	00	02	03	03	02	00	01	07	09	09	05	00	10	06	13	07	13	19	25	19	01	00	00	22	09	
	AF	00	00	02	01	02	01	01	01	04	05	04	03	00	06	06	06	05	04	09	04	06	01	01	01	11	04	
	VF	01	03	04	02	05	02	00	01	03	02	04	05	01	04	03	05	03	02	05	06	04	01	01	01	02	03	
100 sec.	BF	00	01	00	01	00	00	00	00	00	00	01	00	00	01	00	00	00	00	03	01	01	00	00	00	03	01	
	AF	00	00	00	01	01	00	00	00	00	00	01	00	00	01	04	00	01	00	02	01	01	00	00	00	02	01	
	VF	00	00	00	01	00	00	00	00	00	01	00	01	00	00	01	01	01	01	00	00	00	01	00	00	00	00	
120 sec.	BF	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
	AF	01	00	00	01	01	00	00	00	00	00	01	00	00	00	02	00	00	00	01	00	00	00	00	00	00	00	
	VF	00	00	01	00	01	00	00	00	00	00	00	00	00	00	00	00	00	00	01	00	00	00	00	00	00	00	

The percent information was computed by dividing the obtained information by the maximum possible information for each binary classification. The maximum possible information for bilabial place was .918 bit, for alveolar place .918 bit, for velar place .918 bit, and for voicing 1.000 bit.

In terms of importance of the features, the rank order indicated that bilabial place is by far the most important feature, i.e. hardest to obliterate. The remaining three (voicing, alveolar place, and velar place) are almost equal.

Tables 21 and 22 are comparable to the first column under the heading all in Table 21 of Miller and Nicely⁸ and in Tables 22 and 23 of Singh and Black.⁹

⁸G. A. Miller and P. E. Nicely, op. cit.

⁹S. Singh and J. W. Black, op. cit.

Table 21 in the present experiment is the information transmitted in bits per stimulus by a composite channel in the 20 frequency bands and at the six points of temporal processing. The values representing the grand total of the points of temporal processing (20, 40, 60, 80, 100, and 120 msec.) in all four speaking-listening conditions clearly indicate that there is a perfect concordance between the four speaking-listening conditions

TABLE 22. Percent information transmitted in bits per stimulus in Tables 1-480 for all features (composite channel) in 20 bandwidths of 6 bandwidth conditions, at 6 points of processing time, and under 4 conditions of speakers and listeners.

	EW ₁	EW ₂	EW ₃	EW ₄	EW ₅	Mean	EW ₆	EW ₇	EW ₈	EW ₉	EW ₁₀	Mean	EW ₁₁	EW ₁₂	EW ₁₃	EW ₁₄	Mean	EW ₁₅	EW ₁₆	EW ₁₇	Mean	EW ₁₈	EW ₁₉	Mean	EW ₂₀	Overall Mean
20 msec.	09	21	41	60	39	34	11	27	40	37	67	36	12	39	66	77	48	32	47	49	43	18	23	20	43	38
40 msec.	09	14	23	32	39	28	09	21	27	38	45	28	20	36	71	61	47	40	46	43	43	21	24	22	40	34
60 msec.	08	13	16	25	24	17	07	14	23	33	32	22	13	29	39	48	32	34	38	42	38	17	16	16	34	25
80 msec.	10	11	16	18	17	14	08	14	19	22	17	16	10	26	31	24	23	14	22	25	21	10	08	09	29	18
100 msec.	10	09	11	10	09	10	09	12	10	09	10	10	08	26	31	24	23	14	22	25	21	10	08	09	29	18
120 msec.	10	10	07	07	06	08	03	07	07	08	08	07	07	07	11	08	08	13	06	13	11	07	08	07	08	08
Mean	09	13	19	28	22		08	16	21	24	30		12	25	38	38		24	28	30		14	14		28	22
20 msec.	24	27	42	56	39	37	16	28	53	57	63	43	11	32	47	46	34	32	55	40	42	15	19	17	47	37
40 msec.	15	16	27	50	39	29	16	20	35	53	68	37	11	31	44	54	35	24	47	40	27	17	16	16	45	33
60 msec.	10	14	34	26	24	21	16	36	27	22	37	28	17	27	31	37	28	29	31	36	32	13	18	15	33	26
80 msec.	09	09	16	15	17	13	09	09	16	17	18	14	11	18	19	14	15	19	30	26	25	09	11	10	19	15
100 msec.	08	08	09	10	09	09	07	07	11	07	12	09	09	08	19	14	15	19	30	26	25	09	11	10	19	15
120 msec.	10	08	07	08	08	08	10	05	07	07	07	07	08	10	07	07	08	08	13	06	05	08	08	08	08	08
Mean	13	13	23	27	22		12	17	25	27	33		11	21	26	19		20	31	26		12	13		27	21
20 msec.	09	20	40	54	43	33	16	27	42	40	66	38	18	50	75	80	56	33	49	49	44	28	31	29	30	40
40 msec.	07	15	32	45	40	28	09	19	36	50	57	34	23	49	66	60	49	38	47	42	42	18	29	21	33	36
60 msec.	08	12	21	30	24	19	07	17	25	31	36	23	23	44	34	47	37	6	30	35	10	14	18	16	31	26
80 msec.	09	08	11	16	16	12	07	12	16	21	18	15	10	18	21	23	18	15	16	15	13	09	11	10	19	14
100 msec.	10	09	08	08	11	09	09	06	06	09	11	08	09	09	11	10	09	08	10	07	08	08	08	08	08	09
120 msec.	09	08	06	06	07	07	10	07	05	05	09	07	06	08	09	06	07	07	07	09	08	10	08	09	08	07
Mean	09	12	20	27	24		10	15	22	26	33		15	30	36	38		21	26	26		14	17		21	22
20 msec.	30	35	56	67	70	52	19	32	51	64	62	46	20	43	60	65	46	34	55	45	45	24	27	25	36	46
40 msec.	20	33	41	57	61	42	18	38	45	56	67	45	16	38	57	52	41	21	46	39	15	25	25	25	50	40
60 msec.	13	22	41	36	46	32	12	22	35	35	42	29	19	38	38	38	33	20	24	23	12	17	17	17	26	28
80 msec.	09	14	13	19	13	14	09	12	09	17	17	13	11	14	13	12	12	20	13	18	11	12	10	11	13	13
100 msec.	10	10	08	08	08	09	08	08	08	13	08	09	07	07	08	09	07	08	13	11	11	09	10	09	10	09
120 msec.	08	11	10	07	10	11	11	06	08	09	10	09	07	07	12	09	09	07	12	08	08	10	10	10	10	10
Mean	15	21	28	32	36		13	20	26	32	34		13	24	31	31		18	27	24		16	16		27	24
Overall Mean	11	15	18	28	26		11	17	23	27	32		12	25	33	31		22	28	26		14	15		26	

for each point of processed time in terms of the information transmitted in bits per stimulus. The 20 msec. point yields the maximum value and 40, 60, 80, 100, and 120 msec. points yield gradually decreasing information transmission values.

Table 22 is the percent of information transmitted in bits per stimulus by a composite channel in the 20 frequency bands and at the six points of processed time. Each of the observed information transmission values in Table 21 has been divided by 2.584 bits, the maximum possible information for the composite channel, in order to compute the percent of information transmitted in bits per stimulus. The extreme right-hand column in Table 22 presents the mean values for all the points of processed time computed by adding the information transmission values for all 20 bandwidths for each time condition and dividing it by 20. The 20 msec. point yields the highest percentage of information transmitted in all four speaking-listening conditions and the 40, 60, 80, 100, and 120 msec. points yield the gradually decreasing amount.

The six frequency bandwidths that yielded the maximum observed values of information transmission, in the order of priority, are the following: (1) BW₁₃ (425-3400 cps), (2) BW₁₀ (212-6800 cps.), (3) BW₁₄ (425-6800 cps.), (4) BW₄ and BW₁₆ (106-3400 cps. and 850-3400 cps.

respectively), (5) BW₉ (212-3400 cps.), and (6) BW₅, BW₁₇, and BW₂₀ (106-6800 cps., 850-6800 cps., and 3400-6800 cps. respectively). The same frequency bandwidths with almost similar rank order were stated to indicate the importance of frequency bands, that is the six frequency bands that yield six higher values of information transmission when the voice communication network was subdivided into four binary distinctive features, i.e. four separate channels, instead of "all" in a composite channel (compare the bottom line, overall mean, of Tables 19 and 22).

Information y as a function of (1) time X₁, (2) width of the frequency band X₂, and (3) lower frequency of the frequency band X₃. The remaining of the present experiment draws heavily on the mathematical derivations of predictable functions. Transmission of information is shown as a predictable function of the three acoustical variables (time, width of the bandwidth, and the lower frequency of the bandwidth) present in this experiment. It is assumed that y is a linear function of X₁, X₂, and X₃ and the relation is given by the following model:

$$y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \quad (1)$$

The fitted model obtained is:

$$y = 1.09 - 9.10^{-3}X_1 + 6.10^{-5}X_2 - 3.10^{-5}X_3 \quad (2)$$

This equation gives information for a given set of values of X₁, X₂, and X₃, i.e. for a given set of values of

time, width of the frequency band, and the lower frequency of the frequency band.

A multiple correlation of 0.83 and a corresponding F-value of 86.87 with 3. and 117 degrees of freedom indicate that the linear assumption is valid. That is, the differences between time, width of the frequency band, and the lower frequency of the bandwidth in any one situation bears a constant ratio to the difference between the time, width of frequency bandwidth, and the lower frequency of the bandwidth in any other situation.

We considered another model for information transmission. In this case we consider information transmission as a linear function of X_1 and X_3 , i.e. time and lower frequency of the frequency band only. We are removing in this model the dependence on width of the frequency bandwidth. The model considered is:

$$y = b^1_0 + b^1X_1 + b^1X_3. \quad (3)$$

The fitted model is:

$$y = 1.24 - 9.10^{-3}X_1 - 8.10^{-6}X_3 \quad (4)$$

In this case the multiple correlation coefficient is 0.77 and the corresponding F value is 84.90 with degrees of freedom of 2 and 117. Thus, the difference between time and the lower frequency of the frequency band in any one situation bears a constant ratio to the difference between the time and lower frequency of the frequency

band in any other situation. Notice that the correlation value and the corresponding F value in this case are not as high as in the preceding one. Therefore the predictability in this case is also not as confident as in the preceding one.

The analysis has also been extended by considering information as a linear function of X_1 and X_2 , i.e. time and width of the frequency bandwidth. We are removing in this model the dependence on the lower frequency of the frequency band. The model considered is:

$$y = b^{11}_0 + b^{11}_1 X_1 + b^{11}_2 X_2. \quad (5)$$

The model fitted is:

$$y = 1.08 - 9.10^{-3} X_1 + 6.10^{-5} X_2 \quad (6)$$

In this case the multiple correlation coefficient is 0.83 and the corresponding F value is 129.4 with degrees of freedom of 2 and 117. It is evident that the predictability in the present case (with two variables, time and width of the frequency band) is as strong as in the first one (with three variables, time, width, and lower frequency of the frequency band).

The situation in which the information transmission remains unchanged while time and width of the frequency band simultaneously vary can be seen as follows:

Let y be the information transmission corresponding to the time X_{11} and width of the frequency band

X_{22} on one hand and let the same information transmission be obtained in time X_{12} with width of the frequency band X_{22} on the other hand. Then we will have the following equations:

$$y = \begin{cases} 1.08 - 9.10^{-3}X_{11} + 5.10^{-5}X_{21} & (7) \\ 1.08 - 9.10^{-3}X_{12} + 5.10^{-5}X_{22} & (8) \end{cases}$$

Now, subtracting equation (8) from (7) we obtain:

$$0 = 9.10^{-3} (X_{12} - X_{11}) + 5.10^{-5}(X_{21} - X_{22}) \quad (9)$$

or

$$\frac{X_{11} - X_{12}}{X_{21} - X_{22}} = \frac{5.10^{-5}}{9.10^{-3}} = \left(\frac{5}{9}\right) .10^{-2}.$$

That is, the difference between time and width of the frequency band in any one situation bears a constant ratio to the difference between the time and width of frequency band in any other situation.

Tables 23 and 24 are the representation of the transmitted information (for a composite channel, with responses of all speaking-listening conditions pooled) for the two best predicting variables (time and the width of the frequency band). Width of the frequency band is in cps. computed by subtracting the lower frequency of the bandwidth from the higher frequency of the bandwidth. For example, the width of the first row in the tables is 213 cps. which represents 212-425 cps. frequency band (425 cps. - 212 cps. = 213 cps.). The frequency bandwidth

which has the minimum width is put in the extreme left-hand column of the tables and the one which has the maximum width in the extreme right-hand column. The remaining widths of the frequency bands are put from lower to the higher widths subsequently.

The linear relation of the two variables has been graphically presented in Figures 219 and 220. These two are the projections of a plane. Figure 219 is the projection of the variable X_1 (time) and Figure 220 is the projection of variable X_2 (width of the frequency band). Straight lines in both cases represent predicted values and the squares represent the observed values. Ordinates represent the transmission of information and the abscissa represent temporal processing in Figure 219 and width of the frequency band in Figure 220. In Figure 220 the maximum information observed does not surpass one bit and therefore the ordinate represents maximum of one bit only.

Summary. Four hundred eighty confusion matrices (20 bandwidths x 6 points of temporal processing x 4 speaking-listening conditions) are prepared from the listeners' response to the stimulus phonemes /p t k b d ɣ/. The intelligibility of these consonants in relation to four speaking-listening conditions have been stabilized and the relationship of intelligibility of consonants

Figure 219. A projection of a plane on the Y and X_1 axes. Ordinate (Y) is the information transmitted in bits per stimulus with a maximum information value of 2.584. Abscissa (X_1) represents the six points of processed time. The straight line at the top of the figure represents maximum possible information and the six squares are the six points that represent observed information. The fitted straight line represents the model of linearity.

Figure 220. A projection of a plane on the Y and X_2 axes. Ordinate (Y) is the information transmitted in bits per stimulus. Abscissa (X_2) represents the twenty different widths of the frequency bands. The twenty squares are twenty points that represent observed information. The fitted straight line represents the model of linearity. Both width of the frequency bands and information, in this instance, have been drawn on a log-log paper. Information transmission, in terms of the width of the bandwidth, never surpassed one bit.

FIG. 220

with the transition of vowel to consonant in a CV monosyllable is determined. Also, the psychophysical phoneme boundaries are determined to demonstrate that there is a critical point of temporal processing and there is also a crucial lower frequency of the bandwidth which are of great importance to yield the maximum intelligibility. A bivariate measure of intelligibility is obtained in terms of information transmitted in bits per stimulus for four and two separate channels and for a composite channel. The separate channels are characterized by the distinctive linguistic features. The relative importance of these features is established. Through a comparison of the information transmitted by a composite channel, by two component channels, and by four component channels, cross-talk or redundancy is discussed in quantitative terms. Concordance among all speaking-listening conditions in terms of information transmitted in bits per stimulus at six points of temporal processing and in twenty different bandwidths is shown. There is also a great deal of similarity among all four speaking-listening conditions in terms of the importance of the channels. Finally, a model of linearity is set to find information as a predictable function of (1) time, (2) width of the frequency band, and (3) lower frequency of the frequency band. Multiple correlations of 0.83 in the case of (1),

(2), and (3), of 0.83 in the case of (1) and (2), and 0.77 in the case of (1) and (3) are found. The findings indicate that the difference among (1), (2), and (3), or between (1) and (2) or (1) and (3) in any one situation bears a constant ratio to the difference among (1), (2), and (3), or between (1) and (2), or (1) and (3), in any other situations respectively.

CHAPTER V

DISCUSSION AND CONCLUSIONS

The purpose of this study was to investigate cues used by the speakers of Hindi and English for the perception of plosive consonants. Consonants were characterized in terms of distinctive features in a binary manner. Six plosive consonants were used as stimuli; twelve plosive consonants, as allowable responses; two variables of speech (temporal processing and filtering in frequency bands) as distortions; and four combinations of speaking-listening language groups, as conditions of language.

An analysis of the confusion matrices, Tables 1-480 (Appendix B), of six stimulus and twelve response consonants reveals consistency in the distribution of correct as well as error responses of speakers and listeners of Hindi and English. The graphical representation of the listeners' responses in Figures 4-147 on the phonemic levels shows that where the stimulus phoneme is a voiceless plosive, the response phonemes are more of the voiceless category than of the voiced counterpart of the stimulus. In such instances voicing is preserved more

in the errors than the place categories. This does not hold true when the confusion is analyzed on the distinctive feature levels. When responses to all stimulus phonemes are pooled, place is a more potent category and preserved more in errors than voicing. This is true in all speaking-listening conditions except when both speakers and listeners are English-speaking.

Place of articulation was treated in two different manners: place as represented by three different channels, and a multiple channel. This reveals two important findings. (1) The dual treatment of the place category introduces some clues for speech perception. Bilabial place is the best category, that is better than alveolar place and velar place categories in regard to both the frequency of correct responses and the amount of information transmitted in bits per stimulus for all the speaking-listening conditions. It is least affected and therefore hardest to obliterate in the conditions of distortion (temporal processing and bandpass filtering). (2) When the voice communication network was subdivided into two channels, place and voicing, the outcome of the maximum possible information of these channels were the same as the outcome of the maximum possible information transmitted by a composite channel. To the contrary, when the voice communication network was subdivided into

four channels, three place and one voice categories, a cross-talk or redundancy of 1.17 was discovered.

Aspiration was an ambiguous category. Including it in the experiment doubled the number of choices of responses for the listeners and thus decreased the probability of responding to each stimulus by chance by one half. Aspiration is phonemic in Hindi, and one degree or another of aspiration is allophonic in English. The results indicate that the native speakers of Hindi, when listening, make less than one half of the errors as compared to native speakers of English, listening. No aspirated phonemes were included in the stimuli, and therefore any aspirated response was a wrong choice. However, speakers of English when saying voiceless plosives use one or another degree of aspiration and this was perceived as an aspirated counterpart of the voiceless stimulus phoneme by the listeners of the Hindi-speaking group. The English-speaking group, when listening, is also affected by the aspiration in their responses. Aspiration, then, is an acoustic characteristic of a plosive phoneme and in both phonemic and allophonic capacities it influences a listener's response.

The two variables, processing of time in msec. and bandpass filtering, were introduced primarily to determine: (1) the phoneme boundaries on the two continua, frequency,

and time; (2) to predict information as a function of frequency bandwidth; and (3) as a corollary of frequency bandwidth, to assess the importance of the lower frequency of the bandwidth. The responses of the listeners of both language groups (four speaking-listening conditions) determine crucially important lower frequencies of bandwidth and the points of temporal processing that yield the optimal intelligibility of the plosive consonants. For most plosive consonants 40 and/or 60 msec. points seem to be critical. In regard to the lower frequency of the bandwidth, it is striking to note that for some consonants 1700 cps. or 3400 cps. are the most facilitating lower frequencies of the bandwidth for intelligibility. These results suggest that it is necessary to discard the first 60 msec. from the point of onset of the plosive consonant in order to obtain maximum/optimum intelligibility. Similarly, when maximum intelligibility accompanies 1700 cps. or 3400 cps. lower frequency of a band, it is beneficial to filter out lower frequencies. Thus, for the perception of the plosive consonants, it is conducive to intelligibility to discard certain temporal portions (in msec.) and to filter out certain frequencies (in cps.) in order to obtain the maximum intelligibility with the system employed here. In other words, there are particular lower frequencies of the bandwidth and points on the time continuum which are

more important for intelligibility than the full frequency spectrum and the full duration. Thus, we are led to believe that for the perception of plosive consonants, at least two psychophysical phoneme boundaries are determinable. This finding was supported by photographs of oscilloscopic displays of the temporally processed stimuli. The transition can be seen at the 80 msec. point of temporal processing. The 60 msec. point yields maximum intelligibility. Thus, the phoneme boundaries may be established by adding a maximum of 20 msec. of consonantal element beyond the transition of the vowel to the consonant.

There is a contradiction in the results on the two levels of analysis. On the phonemic level the mean intelligibility of the plosive consonants seems to be maximum at the 40 and/or 60 msec. points of temporal processing which indicates a skewed distribution of responses. When instead of phonemes, distinctive features that characterized consonants were the unit of analysis to yield the information transmission (instead of intelligibility), the distribution is linear, as may be observed in Figure 219. A possible explanation seemed to be that when the phoneme, a bundle of characteristic and redundant features, is a unit, some amount of temporal processing is beneficial to intelligibility. In other words, when the redundant as well as characteristic features are present, some amount of temporal processing is conducive

to intelligibility. On the contrary, when only the characteristic features are present, any amount of loss in the time domain of the stimuli would affect the responses. In that case the temporal processing of 20, 40, 60, 80, 100, and 120 msec. showed a linear distribution. Thus, it did not seem feasible to eliminate successfully redundant features on the one hand and process temporally on the other, simultaneously.

The four speaking and listening conditions are strikingly similar. They are almost in perfect agreement in determining crucial lower frequency of the bandwidth and the point of temporal process that yields maximum intelligibility. In terms of the importance of features, except with speakers of English both speaking and listening, all speaking-listening conditions are indicative that the place of articulation is preserved more in errors than voicing and that bilabial place is harder to obliterate in error than any other feature.

In terms of the percent information transmitted in bits per stimulus, the overall mean for the temporal process in the right-hand end of Table 22 indicates striking similarities among the four speaking-listening conditions. The overall mean for the speakers and listeners of Hindi is 22 percent; for the speakers of Hindi and listeners of English, 21 percent; for the speakers of

English and listeners of Hindi, 22 percent; and for the speakers and listeners of English, 24 percent.

The rank order correlation among all six possible pairs of four speaking-listening conditions regarding the importance of bandwidth is 0.83. This indicates that in spite of the linguistic barriers the speakers and listeners of two languages (Hindi and English) respond to distortions imposed by filtering of frequency bands similarly.

There are some differences between the speakers and listeners of the two languages. They differ significantly in terms of the number of error responses assigned to the aspirated counterparts of the voiced and voiceless plosives. But there are some remarkable similarities between them on the inherent or basic (and therefore more important) levels of linguistic categories.

A high degree of concordance between the speakers and listeners of two languages (Hindi and English) were found: (1) in choosing the similar error responses; (2) in determining the lower frequency of the bandwidth that yielded maximum intelligibility; (3) in establishing the respective importance of the different points of the processed time determined both acoustically and psychophysically; (4) in determining the importance of the distinctive features that characterize the consonants by using dual classification; (5) in determining the mean

percentage of overall information transmitted; and (6) in the rank ordering of the bandwidths for their importance.

The hypothesis of the universal phonetic theory or the universality of language was supported on the phonological basis when speakers and listeners of Hindi, English, Arabic, and Japanese participated in an experiment.^{1,2,3,4} Sixteen speaking and listening conditions

¹S. Singh and J. W. Black, op. cit.

²Noam Chomsky, "Current Issues in Linguistic Theories," The Structure of Language (ed.) Jerry A. Fodor and Jerrold J. Katz (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964), pp. 50-118.

³Morris Halle, "On the Basis of Phonology," The Structure of Language (ed.) Jerry A. Fodor and Jerrold J. Katz (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964), pp. 324-333.

⁴C. F. Hockett, "The Problem of Universals in Language," Universals of Language (Massachusetts: M.I.T. Press, 1963), pp. 1-22.

obtained a single rank-order in terms of the importance of features. With one exception of English-speaking speakers and listeners, the findings of the present experiment are also in agreement with our previous study where twenty-six (instead of six in the present experiment) intervocalic (instead of cv in the present experiment) consonants (only plosives in the present experiment) were used. Thus, on some basic levels of incoding and decoding (distinctive feature level in this case) there seems to be some

predictable commonality in the cross-linguistic situation. That is to say, some basic element of speech and perceptual behavior of one language group is predictable by the speech and perceptual behavior of another language group. Also, the high order rank order correlation between all pairs of four speaking-listening conditions indicates that the perceptual behavior of one language group is predictable by the perceptual behavior of the other language group in the condition of distortion (bandpass filtering in the present instance). There is a perfect agreement among all the four speaking-listening conditions in terms of the percent information transmitted at 20, 40, 60, 80, 100, and 120 msec. cut points which in turn, again, concludes that the perceptual behavior of one language group is predictable by the perceptual behavior of another language group when the present kind of distortion (temporal processing at an interval of 20 msec.) has impaired the nature of the stimuli.

The lower frequency of the bandwidth, the width of the bandwidth, and the time in msec. were the three acoustic variables included in this experiment. Psycho-physical responses of the listeners were the basis of all predictions. One of the focal points of this experiment was to predict information as a function of time, width of the frequency bandwidth, and the lower frequency of the

bandwidth. A model equation of linearity was adopted to predict the functions. Functions were derived. Information was predictable by all the three acoustic variables together. It was predictable best by the three variables with a multiple correlation of 0.83 or with the two variables time and width of the frequency bandwidth with a multiple correlation of 0.83 again. The predicted and observed values for the two variables time and width of the frequency bandwidth are presented in Tables 23 and 24 respectively. The values representing twenty different widths of the frequency bandwidths have been arranged in a progressive manner. The minimum width (213 cps.) is in the first column and the maximum width (6694 cps.) is in the last column. Notice that there is a gradual growth in the amount of the observed information transmitted from the first to the twentieth columns. This has been graphically presented in Figure 220 and is comparable in terms of linearity to Figure 219 which depicts the linearity of the six points of processed time. Figures 219 and 220 are the two projections of the plane, one on the X_1 and Y axes, and the other on the X_2 and Y axes.

Thus, information transfer is a predictable function of the width of the frequency bandwidth, lower frequency of the frequency bandwidth and the time. It is also a predictable function of any two of these foci of interests.

The models set for establishing predictable relationships reveal that the difference between time and width of the frequency band in any one situation bears a constant ratio to the difference between the time and width of frequency band in any other situation.

APPENDIX A

The multiple-choice response sheets. There were twelve choices for response to one stimulus. The Hindi- and English-speaking listeners were provided the response sheets in their respective graphemes. The instruction was to circle one of the twelve choices that the listener thought he heard. There were 4320 such boxes containing twelve choices because there were 4320 stimuli (6 plosives x 3 speakers x 2 language groups x 6 temporal processings x 20 frequency bands = 4320).

p	p ^h	b	b ^h
t	t ^h	d	d ^h
k	k ^h	g	g ^h

क	ख	ग	घ
ट	ठ	ड	ढ
प	फ	ब	भ

APPENDIX B

Tables 1-480. Confusion matrices for twenty frequency bands of six bandwidth conditions (106-425 cps., 106-850 cps., 106-1700 cps., 106-3400 cps., 106-6800 cps., 212-425 cps., 212-850 cps., 212-1700 cps., 212-3400 cps., 212-6800 cps., 425-850 cps., 425-1700 cps., 425-3400 cps., 425-6800 cps., 850-1700 cps., 850-3400 cps., 850-6800 cps., 1700-3400 cps., 1700-6800 cps., and 3400-6800 cps.) and for six points of temporal processing (20, 40, 60, 80, 100, and 120 msec.). Stimulus consonants were /p t k b d ɟ / and response /p p^h t t^h k k^h b b^h d d^h ɟ ɟ^h/. Speakers and listeners were of Hindi and English.

TABLES 1-12

BW - 106 - .425 OPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	5	2	6		6		3	2	5		1	
	b	5	1	4	4	3	2	1		4	1	4	1
Hin.	t	4	1	3		9	2	5		3		2	1
List.	d	2	3	4	2	2		10		4	1	1	1
to Hin.	k	3		2	1	8	2	3		7	2	1	1
	g	2	1	7	3	3	1	4	1	4	1	1	2
	p	3	3	2	2	6	1	4	1	6	1	1	
	b	4		8	4	4		1	2	5		2	
Hin.	t	1	3	5	4	6	1	1	1	4	3		1
List.	d	3	1	7	3	4	3	3		5		1	
to Eng.	k	4	3	4	2	5	2	2		4	1	2	1
	g	3		3	3	2	5	4	1	3		5	1
Stimuli	p	4	5	3	1	8	4	1	3				1
	b		4	5	8			1	4	1		3	4
Eng.	t	3	5			7	6	3	1	1	2	1	1
List.	d		1	1	3	2	1	8	12			1	1
to Hin.	k	1	8			2	4		4	3	5		3
	g	2	1	1	1	1		5	8		1	4	6
	p	6	8	1		2	2	2	1	2	4	1	1
	b	1	4	7	12			4	1				1
Eng.	t	4	4	1		8	10			2	1		
List.	d		2	6	1	2	4	6	6			2	1
to Eng.	k	2	1			4	9	2	3	3	5	1	
	g	1	1	1	1	1		6	8		1	5	5
Time:													

20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	6	3	5	3	3	3			5	1		1
b	4	1	5	3	4	2	5	1	4			1
t	1		3	4	10	2	3		5		2	
d	1	4	1	6	7	2	3	1	2	1	1	1
k	4	1	5	4	9	1	1		4		1	
g	3	2	8	3	3	2	1	1	4		2	1
P	2		5	3	7		4	2	6			1
b	6	1	4	4	3	2	4	1	4			1
t	7	3	3	2	2	1	3	1	5		1	2
d	5	3	2	4	4	2	4		4	1	1	
k	3	1	5	2	3	2	2	1	7	2	1	1
g	4	3	4	2	5	3	3	1	2		2	1
P	5	4		2	3	3	3	4	1	1	2	2
b		2	5	6	3	3	2	3	1		3	2
t	1	3	1	2	5	1	6	7	1	2		1
d	1	1	3	2		3	9	11				
k	1	5	1	3	1	5	2	8	1	2	1	
g	2			1	2	5	13				2	5
P	6	7	1	1	2	2	2	5		1	2	1
b		3	8	9		1	3	4		1		1
t	5	1	1		6	4	2	6	1	3	1	
d	1	4	1	4	5	2	3	4		1	2	3
k	1	4		1	5	4	3	4	3	3	1	1
g				1	2	4	11	12				

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	3	2	4	3	7	2	1	4	4			
b	8		5	6	2	2		3	1	2	1	
t	7	2	3	4	3	3	4		3			1
d	2	2	3	5	6	1	2	1	4	1	2	1
k	3	2	2	5	5	1	1	1	5		1	4
g	2	2	2	4	7	1	3	2	3		3	1
P	5	1	4	4	3	3		2	3	2		3
b	3	2	1	7	1	1	1	2	5	2	3	2
t	4	3	4	5	2	3	2		3	3	1	
d	5	1	3	3	3	5	1	4	4	2		1
k	3	2		4	4	1	2	3	6	3	1	1
g		2	3	6	3	1	3	2	3	4	1	2
P	4	1	2	2	3	3	8	3		2	2	
b	1	2	6	4	1	3	6	1	2		3	1
t	2	1	2	4	5	5	5	3	1	1	1	
d	2	1	3	2	3	1	8	6	1	1	2	
k	1	2	3	3			3	7	1	6	3	1
g		1	2	2	2	5	11	2		1	3	1
P	5	3	5	2	1	4	4	2	2	2		
b		5	3	5	3	2	6	2	1	1	2	
t	4	3	2	1	4	6	6	3				1
d	2	1	2	3	4		6	7		2	3	
k	1	1	4	5	4	1	4	5	2		1	2
g			2	3	3	2	8	5	1		2	4

60 msec.

TABLES 13-24

BW - 106 - 425 CBS.

Resp.

Hin.
List.
to Hin.Hin.
List.
to Eng.Eng.
List.
to Hin.Eng
List.
to Eng.

Time: 1 E.

Stimuli

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	5	1	1	1	5	3	2	3	5	2	1	1
b	4	3	2	2	2	3	3	2	6	1		2
t	4	2	3		2	8	2		7	1		1
d	4	2	1	3	7	1	2	2	4	1	2	1
k	2	5			5	4	3		7	2		2
g	5		2	2	1	8	3		7			2

P	5	3	5	3	5	1	2		4	1		1
b	3	4	6	2	4	1	1		4		3	2
t	4	1	1	1	7	2	1	1	5	4	2	1
d	3	4	1		6	6	2	1	3	1		3
k	4	4	1	4	6	3		1	5		1	1
g	2	1	3	3	8	4	1	2	4		2	

P	4	4	2		3	3	5	4	1	2	2	
b	2	2	7	2	2	3	4	3	3		2	
t	2	5	2	2	2	1	6	5	1	2	2	
d	4	1	2	1	7	3	4	3		2	3	
k	2	2	2	2	1	5	6	3	1	3	1	2
g	4		1	3	1	3	7	2	4	2	2	1

P	4	3	2	2	3	3	6	3	2	2		
b	3	2	6	2	1	4	3	2	2	1	4	
t	3	1	2	2	4	9	1	3	2		3	
d	1	1	3	2	8	5	3	1			3	3
k	2		3	1	2	7	4	4	2	2	3	
g	2		5	1	3	5	4	4	2	1	3	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	1	6	5		5	1	3	3	4	1		1
b	2	3	3	1	8	2	6	2	1	1		1
t	6	3	6	1	3	2	2	1	2	1	2	1
d	3	2		1	10	2	3		3	2	3	1
k		2	1	2	6	5	2	2	6	2	1	1
g	1	3	2	2	8	3	4	1	4		2	

P	7	2	3	2	5	2	3		4		2	
b	7	1	2	2	8	1	1	2	5			1
t	8	2	1	1	5	2	4	1	4		1	1
d	1	2	3	3	6	2	1	2	6		3	1
k	3	2	1	2	6	1	3	2	7	1	2	
g	1	2	5	1	4	3	4		6	1	1	2

P		3	3	1	5	3	3	3		6	1	
b	1	2	4	2	3	5	6		2	2	3	
t	1	1	5		3	4	5	1	2	1	4	3
d	4		3		4	3	3	3	4	2	3	1
k	1	3	2	2	1	1	8	1	3	2	5	1
g		2	3	2	5	4	6	1	2	1	2	2

P	1	1		2	1	5	11	4	1		2	2
b	1	2	4	3	2	5	2	3	1	1	5	1
t	2	4	3	2	3	3	4	1	2		1	5
d	1	2	2	5	3	2	6	2	2		3	2
k	4		4			4	8	3		2	4	1
g	3	1	2	1	1	2	6	3	1	4	3	3

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	6	2		1	2	5	7	1	3	1	1	1
b	5	2	2	1	3	3	2		7	2	1	2
t	3	3	4	3	5	2		1	6		2	1
d	5		2		5	7	3	1	2	2	1	2
k		1	2	2	5	5	3		8	1	1	2
g	2	3		1	5	6	2	2	4	1	3	1

P	3		2		8	4	3	2	5		2	1
b	5	3	1	1	8	1	2	2	4		1	2
t	4	1	4	1	6	3	2		7	1		1
d	6		1		7	5	3		5		2	1
k	4		1		8	3	5	1	2		3	3
g	7		2	2	4	4	5		3	2	1	

P	3	3	2		6	4	6	1	1	1	1	2
b	1	2	4	1	4	3	5	3	1	1	4	1
t	5	2	4	4	2		5	2	1	2	3	
d	5	2	4	2	1	4	5	1	3		2	1
k	2		4	3	1	2	6	3	2		5	2
g	1		3	1	5	1	5	3			9	2

P	1		6		3	5	3	4	1	2	3	2
b	1	3	4	3	4	3	4	2	1		3	2
t	5	2	3	2	2	1	5	4	1		3	2
d	1	2	7	1	3	1	4	4	2		4	1
k		1	1	2	4	1	8	4	2	1	5	1
g	1	1	3		5	3	6	4		3	3	2

80 msec.

100 msec.

120 msec.

TABLES 25-48

BW - 106 - 850 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	4				4	2	1		17	1	1	
	b			12	1	2		1		11	2	1	
Hin.	t	3		2		13	1			8	2	1	
List.	d	1	1	4	1	2	1	5		8	1	6	
to Hin.	k	1	1			2		1	1	14	3	2	
	g			2				2	1	9		15	1

Hin.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	1	3	3		1	1			1	9	7	3
to Eng.	b		1	20			1			8			
	t		1	4		1		1		20	1	2	
	d	1		4		3	2	2		9	2	6	1
	k	1								24	5		
	g			3		2				13	2	6	4

Eng.	Stimuli		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	4	1	1		4	5	1	2	2	5	3	2	
to Hin.	b			11	7		1	3	3		2	3		
	t	3				6	3	3	3	4	6		2	
	d	1	1	1	2	2	2	7	9		1	2	2	
	k		1			2	6	1		8	5	3	4	
	g			1		1	2	3	6			13	4	

Eng.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	8	6		1	5	1			3	4	1	1
to Eng.	b		1	14	4			2	3		3	2	1
	t	4	2		1	5	2			7	9		
	d	2			1	2	1	7	2		1	6	8
	k	1	2	1		2	2			11	11		
	g	1		1		2	1	1	2	2	1	10	9

Time

20 msec.

		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	4				6	2			11	4	2	1
	b	4	2	4		4	3			7	2	3	1
	t	3		3	1	10	1			10		2	
	d	3		1	1	1	1	4		7	4	5	2
	k	1		2	1	1				22	1	2	
	g	3	1	4	1	2	1	1		5	2	5	5

		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	2	1	6	1	1				15	3	1	
	b	2		16	1	2	2			5	1	1	
	t			3		2	2			18	4		1
	d	2		4			1		1	10	2	8	2
	k	1	2	2		1	2			15	5	1	1
	g	1	1	6		1	2		1	4	2	10	2

		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	5	2	1	1	2	5	4	3	2	2	2	1
	b	1	2	9	3	1	2	3	3	1	2	1	2
	t	2	2	1	2	6	6		3	3	2	1	2
	d	1	2	1		3	2	7	6		2	5	1
	k	2	3	1	1	4	4			6	3	3	3
	g	3		3			1	3	3		2	8	7

		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	8	9	1		5	1			2	4		
	b			13	8	2	1	2		1		1	2
	t	7	4			4	1	2	1	2	7		2
	d	2		3	1	1	3	6	1		1	6	6
	k	5	3			3	2	2	2	4	8	1	
	g					1		7	2	1	2	11	6

40 msec.

		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	15		1	3	5		1	1	2		2	
	b	13	3	4		3		1		4			2
	t	9	2	3	2	6	1			3	1	3	
	d	6	3	8		2	1	3		2		5	
	k	9	5	3		3				8		2	
	g	7		9		3	1	1		2	2	4	1

		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	10	4	5	2	3		1	2	1	1		1
	b	8	1	7		4	1	1	1	2	3	1	1
	t	11	3	3		2	2	1	2	2		4	
	d	5	4	6		3	3	3		1		5	
	k	13	2	2			3	1	2	3	2	2	
	g	5	1	11	1	2	3	1		2		1	3

		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	8	2	3	3	2	2	4	5			1	
	b	1	2	6	3	5	2	4	4	1		1	1
	t	3	2	2		6	5	3	5	1		2	1
	d	1	2	2		2	5	10	6			2	
	k	3	1		5	3	8	2	2	2	2	2	
	g	1	1	3			3	5	5	2		6	4

		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	8	9	1		2	2	1	1	1	3	2	
	b		5	10	3	2	1	2	2	1		2	2
	t	9	8	1		2	1	4	1		3		1
	d	1	2	3		1	1	10	6			4	2
	k	4	5	2	2	6	5			2	2	2	
	g		1	4			1	8	4	3	1	5	3

60 msec.

TABLES 49-60

BW - 106 - 850 CPS.

Resp.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	9	2	3		7	4			1	1	1	2
b	12	2	1	1	8				5	1		

Hin.
List.
to Hin.

t	11	4		1	5	4	1		3	1		
d	15	4	2		3	1	2		3			
k	16				2	3	1		5		1	2
g	11	2	2	3	3	2			2		5	

Hin.
List.
to Eng.

p	10	3	1	1	3	2		1	6		1	2
b	8	1	4		5	1			5	2	1	3
t	11	1	4		4	3			3	3	1	
d	8	2	5		6	3	2		1		2	1
k	9	2	3		5	3		1	3	1	1	2
g	10	1	7	1	2	5		1	1		1	1

Eng.
List.
to Hin.

Stimuli

p	7	7	6	1	4		1			2	1	1
b	4	2	8	4	1		3	2	1	3	2	
t	5	5	4	4	3	2		2	1	2	2	
d	2	4	7	4	2	1	3	5			1	1
k	5	3	7	3	1	3	2	1		2	3	
g	4	5	4	3	2		3	3	1		3	2

Eng.
List.
to Eng.

Time

80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	11	1	1		5	1	1	1	5	2	2	
b	8		1		5	4	1	1	7		3	

t	10	3	1		4	2	1		7	1	1	
d	11	3	3		4	2			3	1	2	1
k	12	1		1	7	1			5	2	1	
g	17	3		1	4				1		3	1

p	7	3		1	7	2	1	2	4	2		1
b	9	2		3	2	2	2	1	5	2	1	1
t	8	4	1		1	1	1	1	9	1	1	2
d	9	3	2		1		3	1	6	2	1	2
k	9	3	1	1	3	3		1	3	3	2	1
g	11	1	2		4	4			1		4	2

p	3	1	5	3	7	1	3		2	3	2	
b	3	3	4	3	3	3	5		4	1	1	
t	3	3	8	2	3	4	3	1	1		1	1
d	1		7	4	6	2	4	2	4			
k	1	1	7	2	3	5	3	3	2	2		1
g	1	4	6	2	6	2	3	3	1	1	1	

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	6	4			5	5	2	1	4	2	1	
b	5	1			10	4	1		1	3	3	2

t	9	1		1	2	4	1		4	3	2	3
d	8	3			8	4			5	1	1	
k	6		2		7	1	2		10	1	1	
g	10	2	2	1	5	2			4	2	1	1

p	8	3	1		6	1	2		2	5	1	1
b	7	2			6	3	1		6	1		4
t	4	1			3	5	3	1	8	3	1	1
d	5	2		1	7	1		1	6	2	1	4
k	7	1	2		3	3	3		2	5	1	3
g	5		1		7	3	2		4	2	2	4

p	4	2	1	2	5	1	4	2	5	3	1	
b	3	3	5	1	3	2	7	2	1	2	1	
t	1	2	3	3	4	3	5	1	3	2	3	
d	2	4	1	1	4	2	3	5	6		1	1
k	4		7	1	2	1	2	4	3	3	2	1
g	1	2	3	1	4	2	5	4	4	1	1	2

120 msec.

TABLES 61-72

BW - 106 - 1700 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	14	3			2				9	1	1	
	b	2	2	16		1				3	1	4	1
	t					9				15	3	3	
	d							4	1		1	24	
Hin. List. to Hin.	k					1				23	4	2	
	g								1	4	2	21	2
	P	7	9		1					5	4	1	3
	b	4	3	19	1	1				1		1	
	t	1		1		1		1		14	11	1	
Hin. List. to Eng.	d		1	2		6				1	20		
	k					2				17	10	1	
	g		1							10	1	17	1
	P	1	4	4	1	3	1	1	1	10	3		
	b		3	11	9	1		1		3	2		
Eng. List. to Hin.	t					4	3	2	1	6	5	3	6
	d							12	5			10	3
	k					1				10	15	4	
	g								2			19	9
	P	8	14			2				1	5		
Eng. List. to Eng.	b		4	12	11	1			1				1
	t	2	1			1	3			6	17		
	d				1			6	3		3	12	5
	k	1	1							15	12		
	g							1		1	1	16	11

Time

20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	12	1			1				12	1	3	
b	9	1	5			1			8	2	4	
t			2		4				17	2	5	
d					1		1		6	1	20	1
k									25	2	3	
g									10		17	3
P	7	1	1						12	6	1	2
b	5	1	17	1	1				4			1
t	1				1				24	2	2	
d			1		4		3		4	1	17	
k									23	4	3	
g	2								7		18	2
P	3	1	5	3		2	2			4	7	3
b	2	7	8	4	1					2	4	2
t		1			4	1	3		4	5	8	4
d							4	2			13	11
k					2	1			7	10	8	2
g							2			3	14	9
P	10	9		1		2		2	2	4		
b	3	4	9	7					1	1	1	3
t	2				2	8	1		8	7	2	
d		1					1		3	1	18	6
k	1				1	4	1	1	10	10	2	
g							3	1	1		14	11

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	14				3				11		2	
b	7		3		3				13		2	2
t	1		2		11		1		10	2	3	
d	2				4		2		9	1	12	
k			1		2		1		20		6	
g	2		1		3		3		5		15	1
P	11	3				1	1		5		4	
b	10	1	8	1	1	1	1		5		2	
t	5	3	1		6	1			8		3	
d			1		3	1	3		8		14	
k	5	1			7				12	3	2	
g	1		1		4	2	5		3	1	10	3
P	6	4	6	4		1	3			3	2	1
b		2	13	8		1	2	1				3
t					2	5	7	9	3	1	3	
d							13	5			6	6
k		1		1	4		1	2	7	6	6	2
g			1	2	1		3	5	1	1	10	6
P	9	16	2			1				1	1	
b		5	12	10		1					1	1
t	4	10	1		1	5	2	1	2	3	1	
d				1		1	10	7	1		6	4
k	3	5			5	4	1	2	2	5	2	1
g				1			11	7			4	7

60 msec.

TABLES 73-84

BW - 106 - 1700 CPS.

Resp.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	15	2		11	3	1	2		5			
b	8	1	1		8	1	2	1	4	2		2
t	6	2	4		10	2	1		2	2	1	
d	1	1			13	1	9		3		2	1
k	10		1		3	3	2		8	2		
g	1	1	1		12	1	7		4		3	

Hin.
List.
to Hin.

p	5	1	1		3	4	1		10	3	1	1
b	3	2	2		3	2	3		6	4	5	
t	2	2	2	1	6				11	2	4	
d	4		2		10	3	4		2	1	4	
k	5	1		1	6	2	1	1	6	3	3	1
g	2				10	3	5		4		4	2

Hin.
List.
to Eng.

Stimuli

p	1	7	2	4	3		4	1	2	5	1	
b	5	1	4	4	3	4	4	1		3	1	
t	5	3	1	2	5	3	5	2	2	1	1	
d		1	5	2	4		12	5		1		
k	3	3	5		1	3	1	3	4	2	3	2
g	3	3	1	1		1	10	3		2	6	

Eng.
List.
to Hin.

p	6	5	2	1	2	1	5	1	3	2	1	1
b	2	1	6	6	1	2	5	1	2	2	1	1
t	2	3	4	3	3		5	3	3	2	1	1
d		1	4	1		2	8	8		1	3	2
k	2	1	4	1	5	3	4	6	1	3		
g			5			1	11	7	1	1	2	2

Eng.
List.
to Eng.

Time

80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	2	2	1	1	7	3			6	3	4	1
b	6		2		8	1	1	1	7	1	1	2
t	4	3	1	1	10	2	2		2	4	1	
d	6	2	1		9		4		5	2		1
k	2	1			9		1		10	7		
g	2		2		8	5	4		6	1	2	

p	2	3	1		12	2	1		2	4	2	1
b	3	2			7	4	2		5	3	4	
t		1	2		10	4		1	8	1	1	2
d	3	1			8	5	2		5	6		
k	2	1		1	11	1	2		5	5	1	1
g	1	2			11	2	3		2	4	3	2

p	2	1	3	1	7	3	2	1	3		6	1
b	5	1	2	1	4	3	6		3	1	3	1
t	3	1	6	1	4	6	4		3		1	1
d	4	1	2		7	3	4	5	1	1	1	1
k		1	6	3	6	3	3		3		3	2
g	2		4		2	5	10	1	2	1	2	1

p	2	2		3	3	2	4		4	3	5	2
b	1	2	2	3	4	3	2		5	3	3	2
t		3	3	1	4	1	2	2	5	2	2	5
d		1	6	1	3	2	6	3	2	2	2	2
k	1	1	1	3	4	1	7	2	4	4		2
g	3	1	4	2	4	2	3	3	2	2	2	2

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	5	1			6	1	1		8	6		2
b	4		1		6		2		11	3	2	1
t	1	1	1		6	2	1		11	6	1	
d	6	2	1		4				8	8		1
k	3	2	2		7	2	1	1	8	3		1
g	2	2			7	1			8	4	2	2

p	5	2		1	5	1	1	1	7	4	1	2
b	3	2		1	4	3	1		9	5		2
t	5	1			5	5	1		6	4	3	
d	2	2			8	2			7	5	2	2
k	6	1	1		7	1	1		7	5		1
g	5	3		1	4	1	1		10	3	1	1

p	2	2	3		6	6	3	2	1	1	2	2
b	3	1	4		3	3	4	1	3	3	5	
t	1	2	1	1	5	2	8	2	2		5	1
d	3	1	3	1	5		4	3	4	1	4	1
k	3	2	5		4	4	5	2	2		3	
g	4	3	2		6	2	7	2		1	3	

p	2	1	5		5	3	2		2	3	7	
b		1	4	1	4	1	8	2	1	3	5	
t	1	1	3		5	3	5		4	4		4
d	3	1	3	2	6	2	8			1	3	1
k	3	2	3		4	2	7		4	2	3	
g	1	1	3		6	3	5	2	1	6	1	1

120 msec.

TABLES 85-96

BW - 106 - 3400 CPS.

Resp.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	18	4			4	1	1		2			
b	8	2	13		3	1	1		1	1		
t			3	25		1			1			
d					3	1	20	1			5	
k			1		2	1			24	2		
g									2	1	25	2

Hin.
List.
to Hin.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	17			1	1	2	2		3		
b	3		21	2					2		2	
t	1				8	18			3			
d			1		5		16	1		1	6	
k		1			3	5			9	12		
g		2			1		1		3	2	21	

Hin.
List.
to Eng.

Stimuli

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	8	4	6	3	4	3	1			1		
b			14	8	2	4	1	1				
t					13	8	6	2			1	
d						1	17	11			1	1
k		1			2	3		1	10	9	3	
g						1	2	1			19	7

Eng.
List.
to Hin.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	7	17			4	2						
b	3	2	10	11	1	1	1				1	
t					12	18						
d		1				2	15	7			3	2
k		1			3	2			12	12		
g					1	1	1	2		1	17	7

Eng.
List.
to Eng.

Time

20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	19				7	1	1		2			
b	13	3	5		14	1			1	1		
t			3	20		1			3	3		
d					10		18				2	
k			1		1				25	1	1	1
g						1	1		3	23	2	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	11	12			3				2	2		
b	8	2	14	1	1		1		1		2	
t	2	2			10	7			1	7	1	
d			1		3		14	2		1	8	1
k	1				3	3			19	2	2	
g	2	1			1		1		3	20	2	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	1	8	2	2	5	6	3	2	1			
b	3	5	14	5	1	1			1			
t	1				10	12	5	1			1	
d					1		15	12			2	
k		1			4	1			7	14	1	2
g					1		2	3	1	1	11	10

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	11	14			1	2			1			1
b	3	1	10	11		2	1				1	
t		2			13	13			1	1		
d		1				2	16	7			1	3
k	2	2	1	1	7	3			1	7	6	
g	1					1	1	2			18	7

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	18				9		1		1		1	
b	11		4	1	9		1	1	2		1	
t	1	1	3	20		2			2		6	
d	2				8	1	11	1	1		6	
k			1		7		1		18		3	
g		1			9		7	1	3		9	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	14	5	1	2	1	1	1		4	1		
b	15	1	10		1				1		2	
t	7	2			11	4	1		3		1	1
d			2		5	1	16		1		5	
k	5	3	1	3	13		1		3	1		
g	3	1			1	2	1	5		2	15	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	3	6	6	6	4	1	2	2				
b	3	5	6	5	3	1	1		4	1		
t		2			3	6	3	6	9			1
d					1			13	15			1
k	1	2	1	2	2	4	2	4		4	5	3
g			1	2			10	7			3	7

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	10	15			1	3						1
b	5	5	9	11					1		1	2
t	5	10			3	2	3	3	1	1	2	
d					1	1	1	13	12			1
k	2	8	1	2	2	5			3	3		2
g					2		3	5	8			7

60 msec.

TABLES 97-108

BW - 106 - 3400 cps.

Resp.		p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	9	1	3	1	2		2		2			1
	b	1	1	4		5		1		4	2		2
Hin.	t	1	3			1	2			2	1	1	
List.	d	3	1	2		10		4	1	4		4	1
to Hin.	k	7		1		9	1	2	1	8			1
	g	4	2	3		5		10				6	

Hin.		p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	9	3			4	1	2		5	3		3
to Eng.	b	1		3	1	3		1		4	2	2	3
	t	6	1	2		6	1	4		4	3		3
	d	5		4		7		10	1			3	
	k	6	3	3	1	5	2			4	2	2	2
	g	2		2		9	1	4	1	3		8	

Eng.		p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	4	4	8	3	5	2	2	1			1	
to Hin.	b	3	4	8	4	4	3		1	1	1		1
	t	5	8	4	1	1	1	3	3		1	2	1
	d		6	3	1	1		10	7			2	
	k	2	4	8	2			3	2	3	2	2	2
	g	3	3	2		1	2	6	6	1		5	1

Eng.		p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	4	7		3	8	2	4	1	1			
to Eng.	b	1	2	10	5	1	1	2	1	2	3	1	1
	t	4	4	8	1	1	1	2	2	2	4	1	
	d	1	3	3	2	1	1	12	4			1	2
	k	6	6	3			1	4	2	4		4	
	g	1	1	5	2	1	1	4	6			5	4

Time

80 msec.

	p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	9		1	1	2	3	2		5	5	2	
b	10	3	3	1	3	2			4	1	2	1
t	9	1			4	2			8	2	2	2
d	9	2		1	3		2		6	4	2	1
k	9	1	1	1	8	1	1		5	3		
g	7	1	1		9		4	1	1	3	2	1

	p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	12	1	2	1	4	1	1		4	3	1	
b	6		4	1	4				8	4	2	1
t	4	3	1	1	7	2			7	2	2	1
d	5		1		8		1	1	5	5	3	1
k	5	3	1	1	5				8	2	2	3
g	6	2	3		4	2	1	1	5	4	1	1

	p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	3	3			8	5	4	1	2	1		3
b	2	3	3		3	5	5	4	2		1	2
t	3	3	2	2	7	3	1	2	2	4		1
d	2	3	3	3	9	3		1	3	2		1
k	3	6	7	1	2	1	3	3	2			2
g	3	3	5	1	3	5	3	4	1	2		

	p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	6	4	2	1	4	3	5	2	1	1		1
b	1	4	7	3	1	2	3	1	2	2	2	2
t	2	3	4	3	4	2	2		1	2	5	2
d	6	3	5	1	2	2	3	3	2		2	1
k	3	3	3	3	3	5	2		3	1	1	3
g	4	2	4	1		4	6	1	2	2	3	1

100 msec.

	p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	5	1	1	1	5	1	1		9	4	1	1
b	2	1			7	2			12	2	2	2
t	3	2	1		6	3	1		11	2	1	
d	4	4			6	3			5	3	4	1
k	8	1	1		6	1			10	3		
g	2		3		10	2	1		6	4	1	1

	p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	3	4			6		2		10	3	1	1
b	3	4		1	7	1			7	6		1
t	2	6			9	3			6	3	1	
d	8	2			6	2	1		6	3	1	1
k	3	2			9	1			8	4	1	2
g	4	2	1		6	1	1		10	4	1	

	p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	3	2		2	2	1	5	1	6	3	4	1
b	3	4	3		5	2	3	2	1	3	4	
t	4	5	2		6	3	1	1	2	3	3	
d	2	2			5	6	6	2	3	2	1	1
k	3	4	2		4	2	5	4	1	2	3	
g	1	3	2	1	8	2	4	2	3	2	2	

	p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	3	4	4	1	1	3	4	1	2	1	5	1
b	2	4	3	2	3	3	2	2	2	3	4	
t	1	3	2	2	4	4	5	1	3	1	2	2
d	4	3	1	1	6	1	2	3	5		3	1
k	3	2	1	1	3	2	3	4	3	2	6	
g	1	1	2	2	1	6	4	1	5	1	6	

120 msec.

TABLES 109-120

BW - 106 - 6800 CPS.

Resp.		P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	4	3			7	4			2			
	b	4	2	12	2	2		4		3		1	
Hin.	t			3		21	1			3	2		
List.	d	6	1			6	1	13		1		2	
to Hin.	k	2	1	2		2			1	15	3	4	
	g	1				4				1		22	

Hin.		P	6	12	2	1	1	1		2	5		
List.	b	1	3	14	2	7						3	
to Eng.	t	2	1			4	13		1	6	1	2	
	d	2				4	1	13				9	1
	k	3					1			8	12	6	
	g	1		3		2		4		3		13	4

Eng.		P	6	7	6	4		2	1	3	1		
List.	b	1	3	15	9					2			
to Hin.	t					11	9	5	4			1	
	d					1		17	11			1	
	k					1	3			9	10	5	2
	g			1				1	6			16	6

Eng.	t				12	18							
List.	d				1	2	11	12			3	1	
to Eng.	k	4			2	4			13	10			
	g				1				1	2	14	12	

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	16	1	1		5	3			2		2	
b	10	3	5	1	1	1	2	1	3	1	2	
t	1		2		19	2	2		4			
d	5				4		13		3		5	
k	2		4					1	19	1	3	
g							4				25	1

p	9	12	1		3				2	2		1
b	6	1	12	1	6						4	
t	2	2			2	11			12		1	
d					4	3	14		2		6	1
k	3	1				3	1		13	4	5	
g	1		3	1	2		2		2		19	

p	8	5	4	1	3	3	3	1		2	
b	1	2	14	5	4	2	1	1			
t					11	12	4	3			
d	1				2		17	5			1 4
k					4	2			12	9	2 1
g						1	1	1			20 7

	P	13	13			1	1				1	1	
b		4	12	11			2					1	
t		1			15	11				1	2		
d					4	9	5	1			5	6	
k	1	1			5	7			8	8			
g					1	1				1	13	14	

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	13	1	1		7	1	1		2		4	
b	6	4	9		5		1		4		1	
t	2		1		19	2	1		4		1	
d	3			1	5		11		4		6	
k	3	1	3		3			1	13		6	
g	1				3		8		2		16	

	P	10	4	3	1	4	1			5	1	1	
b	8		11		7					2		2	
t	4	2	1	1	9	3	1	2	4		2	1	
d					4		18		2		5	1	
k	4	2	2		4		3	1	6		6	2	
g	2	1	2		2		9		1		12	1	

	P	4	10	2	6	2	2	1	3				
b	1	3	11	10		1		4					
t		1			7	6	6	9			1		
d					1	1	9	17			2		
k		2	1			2	4	3	6	5	5	2	
g						6	9				4	11	

	P	10	15		1		2			1			1
b		4	13	12				1					
t	4	9	1		1	7	3	1	2			2	
d					2	1	11	14			2		
k		8	2	1	7	4	3	1		3		1	
g			1				7	9			8	5	

Time

20 msec.

40 msec.

60 msec.

TABLES 121-132

BW - 106 - 6800 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	12	1	2	3	4		1		3		4	
	b	6	2	4		6				7	3	2	
Hin.	t	8	2	1		10	1	3		2	2	1	
List.	d	4		6		6	1	10		3			
to Hin.	k	8	1	2	2	2		2	1	7		5	
	g	2		3		4		10	1	1		9	

Hin.	p	13	5	2	1	1		1		4	1		2
List.	b	5	1	5		5		3		5	3	1	2
to Eng.	t	5	1	1		9	1		1	2	3	4	3
	d	3		1		5	1	10	1	4		3	2
	k	6	1		2	7	2	1		5	3	2	1
	g	7		1		3	2	10	1	1		4	1

Eng.	p	7	7	3	5	1	1	1	3			1	1
List.	b	3	6	7	5	1	3		1				4
to Hin.	t	2	8	4	4	3	2	2	4				1
	d	1	5	5	4		2	5	8				
	k	2	6	3	2	1	1	2	4	2	2	2	3
	g		2	4	4	1		7	5			3	4

Eng.	p	5	5	1		1	3	3	2	1	5	2	2
List.	b	2	2	3	4	1	2	4	3	2	5	1	1
to Eng.	t	4	3	3	2	2	1	2	3	2	4	1	3
	d		2	3	5	1		9	8	1			1
	k	2	2	4	2		3	3	3	7	3	1	
	g	2	2	3	3		2	9	6				3

Time 80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	7	1	2		3		1	1	6	1	5	3
b	10	1	2	2	5				7	2		1
t	8				3	1	3	1	6	4	3	1
d	10		1	1	3	1	1	1	6	3	3	
k	11		4		2	1	1		6	4		1
g	5	2	2	1	5	1	4	1	3	3	2	1

p	6	5	2	1	3	1			5	3	1	1
b	7	1	3		5	2		1	8	1		2
t	6	1			5	1			10	2	2	3
d	5	1		1	5	1	6	1	6	2	2	
k	9	3		1	2				10	3	1	1
g	6	2	4		6				5	2	2	2

p	5	4	1	1	5	1	2	3	4	1	2	1
b		1	4		6	4	4	2	5	2	1	1
t	1	4		2	8	1	3	4	4	2		1
d	1	4	1		7	3	6	1	1	4	1	1
k	5	6	3	2	1	1	4	2	4	2		
g	2	4	2	1	2	3	5	6	3	1	1	

p	4	3	3	2	5	2	2	4	1	2	1	1
b	1	3	3	3	1	2	7	2	4	2	2	
t	2	2	2	3	5	1	4	3	2	2	3	1
d	1	1	2	2	3	1	9	2	4		3	2
k	3		1	2		3	6	2	3	4	3	3
g	3	1	6	2	3	2	5	5	1	1	1	

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	5	4	2		5	3	1		3	2	4	1
b	4	1	1	1	5		1		10	4	2	1
t	5	3			3	1	1		9	4	2	2
d	7	2	1		5	1			6	2	5	1
k	7	1	1	1	5	3	1		7		2	2
g	8	2	1	1	4	3			4	4	2	1

p	7		2		3	1			11	2	3	1
b	3	2	1		3	1			12	5	1	2
t	5		1	1	3				10	4	4	2
d	4	1			3	1	1		14	5	1	
k	3	1	2		2	2	1		12	4	2	1
g	5	2		1	7				8	2	4	1

p	4	2	2	2	4	4	4	2	2	1	2	1
b	3	2	5		3	5	5	1	1	2	2	1
t	5		1	1	6	3	5	5	1	1	2	
d	3	1	2	1	3	5	5	3	2	2	3	
k	3	2	5	4	3	2	5	1	2	1	2	
g	1	1	7	1	2	2	3	4	2	1	3	3

p	1	3	2	2	5	3	2	2	3	2	3	2
b		2	5	3	3	5	5	2	2	1	2	
t	3	2	1		1	2	5	8	5	1	2	
d	2	3	5	2	1	2	7	2	3		3	
k	2	2	1	2	2	2	5	2	4	5	2	1
g	2	1	5	2		4	3	1	2	1	7	2

120 msec.

TABLES 133-144

BW - 212 - 425 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	7	2	7		6		2		3	1	2	
	b	3		9		7	1	2	2	3	2	1	
Hin.	t	7	1	1		14		2		2	2	1	
List.	d	4	2	4		6		8	2	2	1	1	
to Hin.	k	6		2		7	2	3		5		5	
	g	4		5		7	1	3	1	1		7	1

Hin.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	7	3	6	2	2	1	1	1	5			2
to Eng.	b	5	1	13	1	2	1	3		3		1	
	t	4	4	2	1	4	4		1	6	3	1	
	d	5		7		6		7				5	
	k	5	2	2		6	3	1		6	1	3	1
	g	11	1	1	2	3	1	3		2		4	1

Eng.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	3	5	3	1	2	4	2	5	3		2	
to Hin.	b	2	2	9	8	1	1	3	2	1		1	
	t	2	3	1	1	6	7	5	2	2		1	
	d	2	1	4	3	4	1	6	6	1		1	1
	k	2	3		1	5	6	2		3	3	3	2
	g	2	1	1	2	4		5	7			4	4

Eng.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	2	5	4		4	5	5	2	1	1	1	
to Eng.	b	2	2	13	4	1	1	3	1			2	1
	t	4	7			5	6	4			1	3	
	d	1	1	8	1	4	1	8	4	1		1	
	k		1	1		7	7	1	1	5	4	2	1
	g			4		4	4	10	3	1		2	2

Time

20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	10	1	3		7				7	1		
b	7	2	4		10		1		4	1	1	
t	2	5	2		11		5		4			1
d	6	3	4		6	2	4		5			
k	4	3	4		9	1	1		6		1	1
g	4	2	1	1	9	1	1		4		6	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	10		3		6				4	2	1	3
b	5		5		8	1	3		6		1	1
t	9	2	1		4		5	1	5		2	1
d	6	1	1		4		9	1	4	1	3	
k	7	2	1		6	2	1		5	1	4	1
g	8		3		5	2	4	1	3		4	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	6	3	1	5	2	2	5			2	
b	2	4	6	6	2	3	4	3				
t	3	1	2	1	4	6	5	4	1	1	2	
d	1		4	2	1	2	8	9	1	2		
k	2	7			7	5	2	1		4	2	
g	3	1		3		1	9	8	1	1	2	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	2	4	4		4	1	4	1	3	1	4	2
b	1	2	15	5		2	3				2	
t	4	4	3		4	4	4	3	2	1	1	
d		1	7	1	5	1	11	3		1		
k	6	1	2		6	4	3	3	1	1	2	1
g		1	3	1	1	1	13	6		1	3	

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	9	3	2	1	6	1	2		4		1	1
b	6	1	2	2	12	1			4		1	1
t	5	2	2		8	1	1	1	7		3	
d	6	1	2		9	2	4	2	4			
k	11	1			8	1	1	1	4		3	
g	9	1	2		4	3	3	1	6		1	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	7	3	3		5	1	2	1	7	1		
b	9	2		3	6	2	1		7			
t	6	3	1	2	9		2		6	1		
d	5	1	1	1	11	1	2	1	5		1	1
k	5	1	1	1	10	1	2		7	1	1	
g	6		3	1	6	1	3		8		1	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	2	4		2	2	2	7	2		3	2
b	1	3	10	2	2	1	2	3		2	4	
t	1	1	5		6	6	6	3		1	1	
d	3		1	1	3		10	11			1	
k	5	4			2	3	5	5	2		1	3
g	1	1	3		1	1	10	6		2	4	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	3	3	2		4	2	4	3	4	1	3	1
b	1		10	4	3	3	6	1	1		1	
t		5	2	3	5	1	8	2	1		2	1
d	2	3	4		4	3	9	2		1	2	
k		4	4	1	4	1	6	2	1	1	6	
g	1	1	5		1	3	15	1		1	2	

60 msec.

TABLES 145-156

BW - 212 - 425 OPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	5	3	1		9	1	3	1	6	1		
	b	7	2	2	1	8	1	4		3	2		
Hin.	t	7		4	1	8		2	1	6			1
List.	d	5	3	2	1	9	2	2		3		2	1
to Hin.	k	5	3	2	1	12		2	2	3			
	g	5	2	1	2	7	4	2	2	4		1	

Hin.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.		5		3	1	6	2	1		7	1	2	2
to Eng.	b	1	1	3	1	8		1	2	11	1	1	
	t	4		2	1	10	2	1	1	8		1	
	d	3		2		8	3	2	2	7		2	1
	k	1		1	1	7	1	4	1	10	2		2
	g	1		3	1	10	1	3	1	7	3		

Eng.	Stimuli		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.			2		2	2	1	5	13	1	1		2	1
to Hin.	b		2	3	2	1	3	3	10	1	1	1	3	
	t		6	4	1	2	3		7	1		1	3	2
	d		2	1	2	1	1	1	16	1		2	2	1
	k		5	3	5	2	1	1	6	1	1	2	2	1
	g		4	1	4	1	3	3	5	4	3		2	

Eng.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.			1	4		6	1	5	1	6	1	5	
to Eng.	b		2	1	8			2	6	1	6	3	
	t		3		4		6	1	7	3	2	1	2
	d		2		5		4	2	9	1	2	3	1
	k			1	4		1	1	8	2	4	2	6
	g		1		7		1	3	10		1	1	4

Time

80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	3		3	2	10	5	2		4		1	
b	2	3	3		8	3	1		7	1	2	
t	3		2	1	15	1		2	4		1	1
d	3		1	3	9	2	4	1	5	1	1	
k	7	1		1	9	2	2	1	5			2
g	3		3	3	8	3	3	1	6			

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	5	1	4		7	2	2	3	4	1		1
b	2		3	2	7	4		2	5	1	1	3
t	3	2	2		8	4	2	3	5			1
d	4	1			11	2	4	3	4	1	1	2
k	4	1	1		10	1	1	3	4	1	4	
g	8		4	1	6	1	4	1	4	1		

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	1	3	6	1	3	2	5	3	3		2	1
b	2	3	3	1	4	3	4	1	2	2	5	
t	1	2	4	1	7	2	6		1	3	1	2
d	4		3	4	6	2	4	2	1	1	2	1
k	2	2	1	1	6	2	9	3	1	1	1	1
g		1	4	1	6	3	8	3	1	1	1	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	1	1	5		2		7	1	1	4	7	1
b	3	1	12	1			1	2	1	2	4	3
t	3	2	6	1	3		3	1	3	3	5	
d	1	2	5		7	1	5	2		3	2	2
k	2	2	7		2		7	2	1	1	2	4
g	2	1	6		4	1	6	3	1	1	4	1

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	3	3	1		13	1	1		4	1	1	2
b	4	1	3		11	1	1		7	1	1	
t	4	2	3		12		2		5	1	1	
d	5	2	1		11	1	1		7	1	1	
k	4	1	4		9	2	1		5	1	1	2
g	3	3	3		12	2	1		4	1	1	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	4	2	2		10	1	1	3	6			1
b	3		2		10	1	1		10	2		1
t	6	1	1	1	5	4	1	2	5	3	1	
d	4	4	1		5	3		2	10	1		
k	3	2	1		9		3		7	4		1
g	2	2	2		13	1	4	1	5			

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	7		3	2	6	1	5	3	1		2	
b	1	3	4	1	4	2	4	1	2	2	5	1
t	4	2	2		4	2	8	1	1	1	4	1
d	6	2	6		2		5	3	3	1	2	
k	2	2	1	1	5	3	7		1	2	4	2
g	1		5		6		5	2	1		8	2

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	8		3		6		1	2	5		4	1
b	3	3	3	3	5	1	4	2	4	2		
t	7	1	6	1	3	1	6	1	1	1	2	
d	5		4		7	1	9		3	1		
k	6	1		1	4	2	10	2	2	1	1	
g	1		5	1	6	3	6	1	3	1	3	

120 msec.

TABLES 157-168

BW - 212 - 850 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	8	3	2		2	1		1	12	1		
	b	1		15	2		1	1		8		1	1
Hin.	t	4	1			10	1			14			
List.	d	1		4		1	1	3		8		11	1
to Hin.	k	1				3				23	1	2	
	g	1				1		3	1	10		14	

	p	3	5	2	2	1		1		8	7		1
	b	2		17				1		8		2	
Hin.	t		1			1				21	7		
List.	d	3	3	3				4		8		9	
to Eng.	k	2	1	1				2		15	9		
	g			1		1	1	1	1	11		13	1

Eng.	p	4	1			6	2	1			13	1	2
List.	b		1	11	5	1	1	2	2		6		1
to Hin.	t	1		1		3	3	5	2	2	12		1
	d		1	1			1	10	8		5	1	3
	k				2	2	6			4	14		2
	g					1	1	6	1		5	7	9

Eng.	p	10	5	1		1	2	1		5	4	1	
List.	b	1	1	11	11		1	2			2	1	
to Eng.	t	4	1				2	1		8	13	1	
	d	1	1	1	2	1	2	2	3	1	4	8	4
	k	2	1			2	3		1	11	10		
	g				2		1	2	3	1	4	10	7

Time

20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	9	1			4	2			12	2		
b	5	1	5		6		2		7	2	2	
t	2	1			16				10		1	
d	3		2		2		4	2	10		6	1
k	1		1		5		1		21		1	
g	2		3				1		8		16	

p	4	3	1	2					11	6	3	
b	2		16				1		6		5	
t	5	1	1		1				20		2	
d	2	1	2		1	1	4		7	1	10	1
k	3	1					1		19	3	3	
g	2		2	1			1		6	2	14	2

p	2	1	1	2	6	3			2	8	2	3
b	1	1	6	4	3	2	4	4		3	1	1
t	2	3	1		6	7	3	3		1	1	3
d			2	2		1	7	6	1	3	3	5
k	1				7	2		1	1	11	2	5
g					1	1	7	4		2	6	9

p	12	7			3	1			3	3		1
b	1		13	7			1	1	2	3		2
t	5	4			4	2	1		4	6		4
d			3		1	4	5	1	1	2	6	7
k		7		1	4	2	1		9	4		2
g							5	5	1	3	14	2

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	15	1	1		8	2			1		2	
b	13	1	4		4	1	1		3	1	2	
t	8	2	1		15		1		2	1		
d	6	1	6		4		6		4		3	
k	9		4		5		3		8		1	
g	3		4		5		2		3		11	2

p	16	3	3	2					4	2		
b	6	2	15		1				2	1	3	
t	10	5	3		2	2	1		5	1		1
d	5	1	7		3		2	1	3		7	1
k	12	5	3	3	4	1	1					
g	5	1	11	1	2		3	1	1		5	

p	1	2	7	5		4	4	3	1	2		1
b	3	2	3	4	1	2	8	4		1	1	1
t	1	3	1	2	5	6	5	6		1		
d	1	2	1	3	1		10	8	1	1	1	1
k		2	3	1	5	3	1	5	2	4	1	3
g	2	1	1	2	1	1	7	3		1	3	8

p	10	11	1	1	1		3		1	2		
b	1	1	8	10	1		5	1	1	1		1
t	14	5	3		1	1	1	1	1	1	1	1
d	1	2	1	1	3	3	9	5			1	4
k	9	7	4	2	3	1		1	1		1	1
g	1	2	6	2			7	5	1	1	4	1

60 msec.

TABLES 169-180.

BV - 212 - 850 CPS.

Resp.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	22	2	2						1			1
b	14		6		3	1			5		1	

Hin.
List.
to Hin.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	12	1	4	1	2				7	1	1	1
b	10	2	3		3	1	2		4	3		2
t	10	3	4		4		2	1	3	2	1	
d	6	3	1	1	2		2	2	3			
k	9	5	1	1	3	1	3		3		2	2
g	11		1	2	1		2	1	2			

Hin.
List.
to Eng.

Stimuli

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	2	5	5	2	3	3	1	2		2	2	3
b	2	4	1	4		1	3		1	2		2
t	3	5	6	3	1	4	2	4	1	1		
d		6	8	1		1	5	3		2		4
k	2	6	6	2	2	3	2	1	1	1	1	3
g	1	3	5	1	1	2	7	4	1		3	2

Eng.
List.
to Hin.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	6	8	1		1	2	2		5	1	1	3
b	6	3	7	5		1	1	1	1	1	3	1
t	2	6	6	2	1	4	4	2	1		2	
d	2	3	7	4	1		7	3			3	
k	4	4	7	4		4	2	1	2		2	
g	1	4	8	3	1	2	4	1		2	4	

Eng.
List.
to Eng.

Time

80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	11	2	2		2	1	1	1	6	1	3	
b	9	1		8	1			2	6	2	1	
t	12	2	1	4	1		2		5	2	1	
d	14	1	1		4		1		4	2	3	
k	17	1	2		3		1		6			
g	11	1	8	1	1	1	1		2		2	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	8	5	1	1	2	1			8	2	1	1
b	7	1	3		6		3		8		1	1
t	9	2	2	1	3			1	6	1	2	3
d	9	1	4	2	3	1	1		5	2	1	1
k	8	4	2	2	3	1	1		5		3	1
g	9	1	3	2	2	1	1		7		3	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	4	4	1	2	6	2	5	3		1	1	1
b	5	4	5	3	3	2	3	1		2	2	
t	5	4	3	2	4	4	1	2	2		3	
d	3	5	5	2	3	2	3	3	2	1	1	
k	3	6	7	4	5	1	1	2				1
g	3	3	9	3	3	2	2	3		1	1	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	5	1	6	4	3		4	2	3	1	1	
b	2	2	5	5	1		3	1	5	1	4	1
t	3	1	4	2	1		6	2	5	3	2	1
d	3	5	10	1	1	1	3		3	2	1	
k	3	2	8	3		1	2	2	7	1	1	
g	1	2	8	2	4	2	3	2	3		2	1

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	7	2	2	1	6	2			9	1		
b	7	1	1	2	10			1	6		1	1
t	7	2	1		6	1	1		10	1		1
d	6	1	1	2	9	2	1		6			2
k	8	1		2	8		1		7			3
g	9	1	3		10				4	1		

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	6	1	1		3	1	3		12	3		
b	6		1	1	4				15		2	1
t	6			1	5	1		1	10	2	1	3
d	6	1	1		4	1		1	9	3	2	2
k	5		1	1	5	2	1		11	2	2	
g	8				4	1		1	10	3	2	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	3	4	2	1	3	6	1	3	4	1	1	1
b	2	5	2		3	2	2	2	3	2	6	1
t	4	6	1		3	2	3	4	2	2	3	
d	1	5	3	1	5	2	4	3	1	2	1	2
k	3	5	2	1	3	3	4	3	2	2	1	1
g	3	3	3		3	3	4	4	2	2	1	2

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	2	1	2		6	1	6	2	3	2	3	2
b	4	1	6	1	4		3	2	4		2	3
t	1	2	6	1	1	2	4	1	4		4	4
d	2	1	5		2	3	3	2	6	1	3	2
k	2	1	5		2	4	4	3	3		4	2
g	2	1	4		4		7	2	3	1	5	1

120 msec.

TABLES 181-192

BY - 212 - 1700 CPS.

Resp.		p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	15	2	2		3	2			3	2	1	
	b	10		14	1			2		3			
Hin.	t			1		8				16	1	4	
List.	d	2				1		5		3		19	
to Hin.	k	2				2				20	4	2	
	g					1	1			2		24	2
	p	6	11	2						3	8		
	b	6	1	17	2					2		1	1
Hin.	t		1			1				12	15	1	
List.	d					3		3		5		18	1
to Eng.	k									13	16	1	
	g		1	1						8	2	18	
Eng. List. to Hin.	p	6	7	3	1		3	1		4	3	2	
	b	1	1	16	8			1		1	2		
	t					3	2	3	1	7	4	4	6
	d							12	8			5	5
	k									20	9	1	
	g											15	15
Eng. List. to Eng.	p	10	15			1				2	2		
	b	2	4	15	5		1	1			1	1	
	t		3			3	3			13	8		
	d					3	5	2	2	1	14	3	
	k	3				1	2			16	8		
	g					1			2	3		14	10
Time		20 msec.											

	p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	10	1			1				17		1	
b	9		7	1					11		2	
t	1		1		4		1		22		1	
d	3						2		5	1	14	
k	2								24	1	3	
g									4		23	3
p	7	6			1	1			5	9		1
b	7	3	13	1					2		4	
t	1	1			1	1			19	5	1	1
d					1		5		7	2	15	
k					1				22	3	4	
g			2						4		24	
p	6	3	2			1			5	5	6	2
b	3	3	10	6	1	1	1		1	2	1	1
t					1		3	2	7	6	6	5
d							4	4	2		12	8
k							1		14	12	2	1
g											24	6
p	8	20							1	1		
b	2	1	12	11	1			1			2	
t		2			5	5			13	2	3	
d					1		2	2	1	1	18	5
k	2	1				3			13	8	1	2
g											22	8
	40 msec.											

	p	ph	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	15		3		1		1		9	1		
b	11		4		1		1		11		2	
t					7				20		2	1
d	1				2		1		7		19	
k	1				1				20		8	
g	1		2				2		6		18	1
p	9	5		1	1	1			7	4	1	1
b	12	1	9	1	1				3		2	1
t	6	4	1		3				1	9	3	3
d	1				1		2		7	2	16	1
k	3			1	7	1	1		10	4	2	1
g	1					1	5	1	4	1	17	
p	8	4	7	2	1	4		2			2	
b	3	3	7	6	1	4	2	1		1		2
t		1		2	6	3	3	10	1		3	1
d					1		9	10		1	6	3
k			1		4	2	2	3	4	5	5	4
g			1	3	1		7	5		1	8	4
p	14	11	2			1				2		
b	3	4	9	10		1	2			1		
t	6	3		3	3	2	5	3	2	2	1	
d	1				1	1	13	7	2		5	
k	3	3	3	2	5	6	1		3	2	1	1
g	1				1	1	17	7			1	3
	60 msec.											

TABLES 193-204

BW - 212 - 1700 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	16	1	5		2		1		5			
	b	16	1	4		1			2	4		1	1
Hin.	t	9	1	2		12				3	2	1	
List.	d	3	2	2		10		8	2	2		1	
to Hin.	k	10		2		5	1	1	1	10			
	g	3		3		2		9		5		8	
	p	8	1	1		4				9	4	1	2
	b	7	2	3	2	3		1	2	7		2	1
Hin.	t	8	1			4		3	1	7	4	1	1
List.	d			3		7		6	4	1	2	6	1
to Eng.	k	8	1	2	1	7	2		2	5	1		1
	g	2		3		5	2	7	2	3		4	2
Eng.	p	6	6	7	3	2	1	1	1	2	1		
List.	b	3	5	10	6	1		1	1	3			
to Hin.	t	2	4	5	1	5	4	5	3	1			
	d	1	4	5	2	5		9	3		1		
	k	1	4	3	2	4	1	4	1	3	5	2	
	g		3	4	1	2		9	3	1		4	3
	p	9	7	2	2		1	2	1	3	1	2	
	b	3	3	6	4	1	2	4	1	2		4	
Eng.	t	5	4	6	3	1	1	3	2	3			2
List.	d	4	2	6	2	1	2	7	2		1	1	2
to Eng.	k	3	4	3	2	6	3	3	2	3		1	
	g	3	1	3	4	1	3	8	2	2	1	1	1

80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	8	2			5	2			9	3	1
	b	2	4			10	2	1		7	4	
	t	7	1	1	1	6				9	2	1
	d	7	1	1		10	1	1		6	3	
	k	8	1	2		9	3	2		2	2	1
	g	6		4		8	1	3		7		1
	p	7		1	1	5	1	1	1	9	2	1
	b	6		1		8		2	2	5	2	1
	t	8	2	1		7	1	2	1	4	1	1
	d	5	2	3		4	1	2	2	6	1	2
	k	3		1	2	5	1	1	1	9	2	1
	g	5	1		1	5	2	2	1	9	1	3
	p	3	3	4	1	3		5	3	5	2	1
	b	2	5	3		9	1	3		3	2	1
	t	3	5	2		5	3	6		1	2	2
	d	4	3	2	3	4	5	4		1	2	2
	k	2	5	9	5	2		3	1	1	1	1
	g	2	4	6	2	4	1	6	2	1	2	
	p	3	4	3	1	5		5	1	4	1	2
	b	3	3	4	3	3	1	5		3	1	3
	t	3	1	3	1	4	1	7	1	2	1	3
	d	6	2	7	1	1		6	1	2		2
	k	1	2	3	2	3	2	5	1	4	2	3
	g	1	2	7	2	3	1	7	2		2	2

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	6		1		6	3			11	2	1
	b	2	1		1	8	2			11	2	1
	t	8				8	1	1		7	3	2
	d	6	1			9	2		1	8	3	
	k	10	1	1		7	1	1		6	2	1
	g	4				8	2	1	2	10	1	2
	p	5	1	1		6				11	4	2
	b	1	2	1		5	1	1		12	5	1
	t	4	2			7	2	2	1	6	3	2
	d	3				6	2	2		10	4	2
	k	5	1	1		5	1			13	2	2
	g	4	1	1		5	1	1		10	3	4
	p	3	1	2	3	8	2	1	2	2	3	2
	b	2	3	2	4	8	1	1	1	2	1	3
	t	3	2	2	2	4	4	2	2	4	2	3
	d	2	1	2	1	6	3	5	1	3	3	2
	k	2	3		2	6	3	2	3	4	4	1
	g		4	5	1	5	2	4	1	3	2	2
	p	1	3	4	2	6	3	2	2	4		2
	b	2	4	7	5	3	2	2		4	1	
	t	4	3	5	1	4	3	1	2	2		3
	d	3	4	4	3	2	1	3	1	3		3
	k	1	2	8	4	2	1	5	1	4	1	1
	g		3	5	4	3	2	7	2	1	1	1

120 msec.

TABLES 205-216

BW - 212 3400 CPS.

o - 66

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	18	2			4	1	1		2		2	
	b	7	1	10	3	4	1	2		1		1	
Hin.	t			1		20	1	3		3	2		
List.	d	2		1		5	3	15		3		1	
to Hin.	k	1		3		1				18	5	2	
	g					4	1	5		2	1	17	

Hin.		p	b	t	d	k	g
List.		6	14	1		2	2
to Eng.		4	1	14	2	4	
	t	2	1		2	20	1
	d		1		4	1	16
	k	1	1		1	4	3
	g	2	1		3	1	2

Eng.		p	b	t	d	k	g
List.		2	8	5	2	5	4
to Hin.			3	13	11	1	1
	t				10	11	5
	d				1	17	12
	k				5	3	
	g					4	4

Eng.		p	b	t	d	k	g
List.		8	13			5	4
to Eng.		1	2	14	10		1
	t				14	16	
	d	1			2	1	13
	k	1	1		5	5	
	g				1	4	

Time 20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	20	2	1		4	1			2			
b	12	2	10		2		3		1			
t	1		1		21	1	1		3		2	
d	1				9	1	15		2		2	
k		1	2		3	1	1		20		2	
g					2	1	4		4		18	1

	p	b	t	d	k	g
p	7	15	1		1	2
b	6	1	16	2	2	
t	2	5		5	10	1
d				5	18	
k				4	3	1
g				2	1	

	p	b	t	d	k	g
p	5	8	3	1	2	8
b	4	7	12	3	1	2
t				13	11	5
d					14	15
k				6	4	
g				1	3	4

	p	b	t	d	k	g
p	9	17			3	
b	2	4	9	13		1
t	1	3		10	15	
d				1	4	13
k	3	4		4	6	
g	1			6		1

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	18	2	2		6		1		1			
b	14		6		3		1	1	4		1	
t					25	1	1	1	2			
d	2				7		14		2		3	
k	4		1		4	2	1		15		3	
g	1				3	1	10		1		14	

	p	b	t	d	k	g
p	11	8	1		4	
b	7	1	16	2	2	
t	5	6	1	1	7	
d	2			3		
k	8	3		1	9	
g	3			4	5	

	p	b	t	d	k	g
p	6	5	4	4	1	4
b	4	4	5	5	2	2
t	3			7	5	7
d		1	1	2	14	10
k	1	3		4	4	4
g	1			2	9	8

	p	b	t	d	k	g
p	14	11	1		1	1
b	2	4	9	12		1
t	8	8	2		2	4
d	1			1	2	16
k	5	6	2	2	3	5
g	1			1	11	7

60 msec.

TABLES 217-228

BV - 212 - 3400 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	15	3	2	1	1				5		3	
	b	13		9		2				6			
Hin.	t	6	1	3		14	3	1		2			
List.	d	4		5		8	1	10		1		1	
to Hin.	k	10	1	1		3		4	1	8		2	
	g	1	2	2	2	5		9		1		8	

Hin.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	11	4			4	3			5	3		
to Eng.	b	8	1	6		4	2			5	3		1
	t	6	3	2		4	1	3	2	7	1	1	
	d	4		1		5		15	1	1		1	2
	k	8		2		2	2	1	1	8	4	2	
	g	1		1		8	2	11		1		6	

Eng.	Stimuli	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	3	8	10	2		2	3	1		1		
to Hin.	b	5	9	7	4	1	1	1				1	1
	t	3	5	4	3	5	5	1	2		1	1	
	d	1		6	4		2	11	4	1	1		
	k	1	4	3	3	2	2	4	1	3	3	2	2
	g	2	1	2	2		2	13	3		1	1	3

Eng.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	11	3	3	3	1	2	2		2	3		
to Eng.	b	2	3	13	3	3	1	1	2		2		
	t	5	5	2	4	1		2	7		2	1	1
	d	1	2	6	1		3	9	7		1		
	k	3	2	7	2	3	3	4	2	2	1	1	
	g		1	5	4		1	11	6			2	

Time 80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	11		1		6		1		10		1	
b	12		2		4	1	1		7	3		
t	11	2			5	1	1		6	1	2	1
d	9	2			6	1	3		7	2		
k	8	4	3		5	2	3		2	2	1	
g	9		3		2	1	4	1	5	2	3	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	13	1	3	1	3		1	1	5	2		
b	5	1	3		9	1	1		5	2	1	2
t	7	1	1		4		1	1	11	3	1	
d	6	1	3		3	1	6		6	2	2	
k	7		2		7		1		10	2	1	
g	10	3	4		1	2	3	1	5	1		

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p		2	4	1	3	3	2	5	7	1	1	1
b	3	4	2	3	4	3	5	2	1		1	2
t	2	3	4	3	2	1	4	4	6			1
d	1	3	4	2	5	2	6	4	1		1	1
k	1	3	6	5	5	3	3	1	1	1	1	
g	1	2	4	2	4	3	7	3	1	1		2

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	5	3	3		2	5	1	3	4	1	2	1
b	2	3	6	3	1	2	2	3	2	2	1	3
t	6	1	4	2		3	4	4		1	1	4
d		1	4	3	6	2	9	2			2	1
k	3	2	4	2		3	4	3	7		1	1
g	4		10	2	3	2	1	3	1	1	3	

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	7	2	1		8		2		5	5		
b	7		2		5		2		10	1	3	
t	4	1			9	1	3		8	4		
d	8				7		1		7	5	1	1
k	6	1			8	2	2		6	6		
g	6		3		5	2	2		5	5		2

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	3	1			11	1	1		8	3		2
b	3	1			8	1	1	1	9	4		2
t	7	1			6			1	11	3		1
d	6				6	3	1		8	3	2	1
k	4				7	2	2		10	3		2
g	4	1			7	1	1		7	5	1	3

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	5	2	2	3	6	1	3	1	2		1	4
b	5	3	1	1	5	1	4	1	4	2	1	2
t	6	2	1	3	5	2	1	2	5	1		2
d	1	4	1		9	2	4	4	3	1		1
k	2	4	1	2	3	1	1	5	7	2		2
g	3	3	2	3	7	2	1	2	5		1	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	3	1	3	2	1	2	7	3	2	4	2	
b	2	3	6	2	3	4	2	1	4		3	
t	4	1	4	4	3	1	3	3	5	1	1	
d	2	1	3	3	3	1	5	5	2	1	4	
k	3	5	3		7		3	3	2	1	1	2
g	2	2	4	2	2	1	3	6	1	1	3	3

120 msec.

TABLES 229-240

BW 212 - 6800 GPS.

Resp.	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	24	2			2	2						
	9		18				2		1			
Hin.			1		25				4			
List.					10		20					
to Hin.			1		1	1			21	5	1	
							5		1		24	

Hin.	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	7	20							1	2		
to Eng.	7	2	16	2	2						1	
					4	22			2	2		
					5	1	18				6	
	1	1				1			7	18	2	
									4	1	24	

Eng.	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	7	9	7	2	4	1						
to Hin.		5	18	6			1					
	1			1	13	11	4					
						2	18	7			1	2
					1	2			10	13	3	1
							4	1	1	1	15	8

Eng.	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	9	18			1	2						
to Eng.	1	4	10	9	1	1	1		1		2	
	1				13	15					1	
	1				1	1	14	6			5	2
	1	1			1	3		1	13	10		
					1		2		1	2	14	10

Time 20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	21		2		3		1		2		1	
b	16		9				2		1	1	1	
t			2		25				3			
d	3				9		12		1		5	
k			2		3				22	1	2	
g							4		2		24	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	7	14			1				1	7		
b	10	1	13	2	2				1		1	
t	2	3	1		3	14			4	3		
d					1		23		1		4	1
k	2				1	1			13	10	3	
g	2						2				25	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	8	10	5	1	3	3						
b	2	5	14	9								
t					11	12	4	3				
d						2	15	10			3	
k	1				1	4			11	8	5	
g						1	2	1		1	17	8

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	9	18					1			1	1	
b	1	3	12	11		2	1					
t	1	1			10	17				1		
d						1	11	9		1	8	
k	2	5			2	3			10	8		
g							1	1			17	11

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	19		3		4	1	1		1		1	
b	11		10		4		3		2			
t	2		1		19	4	1		1		2	
d					10		11		2		7	
k	1	1	2		5		3		18			
g	2				3		10		1		12	2

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	13	7	1		1	1	1		1	4	1	
b	12	1	15		1				1			
t	4	4	1		9		5		4	1	2	
d					6	1	19				4	
k	6	3	1		8		1		9		1	1
g	1				3	1	6				19	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	7	8	7	3	1	3	1					
b	2	5	10	6	1	3	1	2				
t	1				3	10	9	7				
d						1	13	14	1		1	
k		1	2	1	5	1	2	5	5	4	1	3
g						1	12	5	1		6	5

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	14	15					1					
b	1	3	12	12			2					
t	7	10	3	1	4	2	1	1		1		
d						1	2	15	10		2	
k	4	9	2	1	4	5	1	2			1	1
g						1		8	10		7	4

60 msec.

TABLES 241-252

BW - 212 - 6800 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	15	2	6		1		1		2	1	2	
	b	13		7		4	1			4		1	
	t	7	1	1		14		3		2		2	
	d	2		6		8		11		1		2	
Hin.	k	7		1	1	4		5		7	1	4	
List.	g	1		3		5		9		2		10	
to Hin.													

Hin.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	17	4	1		4				3	1		
	b	9		4	1	5				6	3	2	
	t	12		1		6		1		3	1	4	2
	d	2		1	1	9	2	10		1		4	
List.	k	3	2	2		9		2		8	2	2	
to Eng.	g	4		4		6		10		3		3	

Eng.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	8	7	9	2	2			2				
	b	3	8	8	5	4				1		1	
	t	4	6	6		4	1	2	5	1		1	
	d	2	2	9	1			8	7			1	
List.	k		5	10	2	1		1	2	2	1	5	1
to Hin.	g		2	7	1			8	5	2		5	2

Eng.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	10	8	1		5	1	1		2		1	
	b	6	3	9	4			2		3	1	2	
	t	6	5	3	1	4	1	3		2	2	2	1
	d	1	3	7	1	3	1	9	4				
List.	k	5	5	5	1	4	1	3	3			2	1
to Eng.	g	1	2	7	2			10	4			1	3

Time 80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	9	3	3		5				8	1	1	
b	10		1		5	1			10	1	1	1
t	11	2	2		5	1	1		6	1	1	
d	8	1			5	2	3		9	2		
k	15	1	2		5				3	3	1	
g	6	1	5		4		7	1	4		1	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	11	3			5	1			9		1	
b	6	1	4		5		1		6	6	1	
t	5	4	1		4		2		11	3		
d	7		1		6		6		9	1		
k	6	3		1	6	1			12		1	
g	5	1	2		3	1	4		7	4	1	2

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	4	2	1	6	1	1	2	3		4	2
b	6	2	2	3	2	2	5	1	4		1	2
t	5	7	2	4	2	1	3	1	4		1	
d	5	4	3	2	4	2	5	1	2	1	1	
k	1	1	13	4		2	5	1	1		2	
g	5	6	3	2	3		7	1		1		2

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	10	3	2	1	1		3	1	3	1	3	2
b	1	2	7	3	4	1	5	1	3		3	
t	5	2	4	1	3	2	3	2	3		4	1
d	1	2	6	1	2	1	9	3	2	1	1	1
k	1	2	3	1	4	1	6	2	3	2	3	2
g	4	2	6	1	1	2	6	4	1		2	1

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	8				5				8	5	3	1
b	8	1			3		1		11	4		2
t	6	1			4	1	2		10	4	2	
d	11	2	1		2		1		9	1	1	2
k	8	1	3	1	4	1			8	4		
g	9		2		3		3		11	1	1	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	8	1	2		9				8			2
b	8	3			5	1			11		1	1
t	5	1			8	1			13	1	1	
d	7				6				10	5	2	
k	6	4			6				10	3	1	
g	6		1		10	1	3		7	2		

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	2	2	2		6	2	4	3	6		2	1
b	6		4	2	4	1	6	2	2		2	1
t	5	3	3		4	1	4	4	3		3	
d	4	3	3		4	1	3	3	5	2	1	1
k	3	2	4	1	3	1	8	2	3		2	1
g	1	3	3	1	6		2	5	5	1	3	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	1	2	1	2	2	6	2	4	1	4	1
b		3	7	3	3	2	7	2		2	1	
t	3	2	5	2	1		4	3	4	1	4	1
d	2	1	8	1	2		3	2	4		7	
k	1	5	4	2	4		7		3	1	1	2
g	1	2	2	3	2		10	1	2	1	6	

120 msec.

TABLES 253-264

BF - 425 - 850 CPS.

Resp.

	p	ph	b	bh	t	th	d	dh	k	kh	g	gh
p	6	4	5		1	1	1		10	2		
b	5	1	8		2	1	4		5	3	1	
t	5	2	2		6		2		13			
d	3		3		2		6		11		5	
k	3	1	1		1		1		18	3	2	
g	2		2		1	1	2		14		8	

Hin.
List.
to Hin.

p	2	9			3	2			1	7	4	2
b	1	3	8		1				8	5	3	1
t	1	3	1		1	2			14	6	2	
d	1	1	5				3		12		7	1
k		1	1		1				13	13	1	
g			5		1		1		11	2	10	

Hin.
List.
to Eng.

Stimuli

p	1	1		1	8	2	2		3	11		1
b	1	1	3	1	7		4	1		11	1	
t	1			1	9	2	3	2	1	10		1
d					7	2	6	2	1	10	1	1
k	2				7	3	1		3	11	2	1
g			1		4	1	5		3	7	5	4

Eng.
List.
to Hin.

p	3	6			7	2			5	6		1
b	2	1	2	1	3	3	4	3	3	5	2	1
t	2	3			3	3	1	2	7	8		1
d			2		3	3	4	1	2	9	3	3
k	3	2			5	2			7	8	1	2
g	2				1	2	5	3	4	1	6	6

Eng.
List.
to Eng.

Time

20 msec.

	p	ph	b	bh	t	th	d	dh	k	kh	g	gh
p	10	1	1		5	1	1		6			
b	5		8	1	3		3		8		2	
t	4		1		4		4		16		1	
d			1		3		3		10		13	
k			1		3		2		20	2	2	
g			2		1		2		7		15	1

p	7	5				4	1		6	4	2	1
b	4	1	15						4	1	4	1
t	5	3	1			2			12	4	2	1
d	3		3		1		3		9	1	10	
k	2	2				3			19	3	1	
g	3		4				4		2		17	

p	2	1		1	5	3	5	2	2	6	1	2
b	2	4	1	1	3	5	4			9	1	
t					7	6	4	4		6	1	2
d	1				3	5	8	4		5	2	2
k	1	2			8	3	3	1	2	9		1
g			2		3	2	4	3	4	7	1	4

p	7	7			4	1		1	4	5		1
b	3	1	4	2	2	2	3	4	2	4	2	1
t	5	2	1		5	3		1	5	3	1	4
d	2	1		1	3	1	4	2	2	4	6	4
k	2	6			8	1	1	1		6	3	2
g			1		2	4	2	2	2	2	7	8

40 msec.

	p	ph	b	bh	t	th	d	dh	k	kh	g	gh
p	14	4	4		3							
b	13	1	8		5		1		1		1	
t	10	1	1	1	9		2		3		3	
d	8	1	2		3		6		3		7	
k	10	1	1		4		1		9		4	
g	4		4		3		2		6		11	

p	7	12			1				4	5		1
b	12	2	11		1				1		3	
t	11	10				1	2		3	1	2	
d	3	1	7		2		2		3		12	
k	11	7	4			2			3		2	1
g	1		15			1	2		3		8	

p	3	4	4		3	2	7	3	1	2		1
b		5	3	2	3		6	2	4	3	1	1
t	1	4		2	4	6	5	2	2	1	2	1
d					3	2	18	5	1	1	1	4
k	4	1			4	1	4	2	4	5	1	4
g	1				4		7	8		2	7	1

p	6	10	1		3	3			3	3		1
b	2	4	7	7		3	3		2	1		1
t	4	8	1	1	4	2	3	1		2		4
d		2	2			2	6	6	3	2	4	3
k	7	7	2	3	3	3	2	1	1	1		
g	1	1	2	3		2	8	4	2	2	2	3

60 msec.

TABLES 265-276

BV - 425 - 850 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	17	3	3		3	2			1	1		
	b	12	2	4		5		3		2		2	
	t	18	6	2		3						1	
Hin.	d	14	1	8		3		4					
List.	k	16	1	3		3	1	1		3		2	
to Hin.	g	11	1	8		1		1		2		6	

	p	10	5	3		1		1		6	1	3	
	b	9	2	8	1	3	1			5			1
	t	14	4	4				1		6			1
Hin.	d	11		10				1		2	1	4	1
List.	k	8	6	5		2	1	1		5	1		1
to Eng.	g	12	1	8		2		2		3		2	

Eng.	p	4	5	4	3	1	4	2	2	1	3	1	
List.	b	2	3	6	9	2	1	3	1			2	1
to Hin.	t	5	3	4	4	1	4	3		1	2	2	1
	d	2		5	6	3	2	3	5		2		2
	k	3	3	4	3	2	6	2	2	2		1	2
	g	1	1	9	3	1	2	3	7				3

	p	2	4	2	1	1	4	3		1	4	5	3
	b	4	2	5	5	4	3	1	1	1		1	3
Eng.	t	5	5	4	3	2	1	2	1	2	3	1	1
List.	d	3	1	4	3	1	1	7	4		2	2	2
to Eng.	k	1	3	6	1	3	1	3	8	1	3		
	g	1	1	6	2	2	4	2	2	2	2	4	2

Time 80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	13	2	2	2	5	2		1	3		
	b	13	2	3	1	3		2		5		1
	t	11	2	1		2	1	1	2	8		1
	d	14		3		4	1	1		4	2	1
	k	13	1	3		5		1	1	5		1
	g	11	1	8		2	2		1	4		1

	p	10	1	4		6				3	3	3	
	b	10		7		3	1		1	5	3		
	t	8	2	5	1	3		3		6	1		1
	d	10		6		7				6		1	
	k	10	2	2		5	1	3		3	2		2
	g	11	1	6		5			1	4	1	1	

	p	3	3	2	2	5	2	7	1		2	2	1
	b	4	6	2	2	4	1	5			3	2	1
	t	5	4	2	2	4	3	2	2	2	2	2	
	d	3	3	5	3	2		3		3	4	1	3
	k	4	4	6		1	2	2	4	2	4	1	
	g	1	5	6	2	3	1	2	2	1	2	2	3

	p	2	3	5	1	5		1	4		3	3	3
	b	4	2	5	3	4		3	2		3	2	2
	t	2	2	6	2	2	1	2	2	3	3	1	4
	d	3	1	8	3	1	2	2	3	1		3	3
	k	1	2	6	3		1	3	3	5	1	2	3
	g	2	2	6	3	2	1	3	2	1	3	2	3

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	10	1	1		10	1			5		1
	b	6	1			8	1	4		8	1	1
	t	11		1		11		1		3	3	
	d	7	3			10	3			5	1	1
	k	9	1	1		8	2	1		6	2	
	g	10		3		8	1	1		4	1	2

	p	7	2			10	1	2	1	4	2		1
	b	7	3			16	2			6	1		1
	t	6	1	1		12		1		8	1		
	d	7	1	1		10		2		7	1	1	
	k	11	1	1		9		2		4	1		1
	g	8	1	1		16			1	6	2	1	

	p	3	2	4		4	5	3	3	1	4		1
	b	3	3	1	3	2	2	7	2	2	3	2	
	t	3	1	6	1	4	5	1	3	1	2	1	2
	d	1	4	1	1	6	2	2	2	4	4	1	2
	k	6	4	1	1	4	1	3	2		4	1	3
	g		3	4	1	5	2	3	4	2	3	2	1

	p	4	3	3	2	2	1	2	2	2	1	6	2
	b	2	4	6	2	2	3	2	2	2	3	2	
	t	3	3	4	3	1	1	3	3	4	3	2	
	d	2	4	5	2	4	2	1	1	4	3	1	1
	k	5	3	2	3	1	1	4	2	5	3		1
	g	1	4	4	2	2	4	3		3	2	5	

120 msec.

TABLES 277-288

BW - 425 - 1700 CPS.

Resp.

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	17	6	3		2				1		1	
b	8	4	14		1				1		2	
t					5				17	2	6	
d	1		1		2		4		2		19	1
k	1								20	5	4	
g	1						1		4		24	

Hin.
List.
to Hin.

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	5	16			2				1	1	5	1
b	5	9	15						1			
t		2			5				10	12	1	
d			1		1		6		1		21	
k	1	1							4	23	1	
g							1		2		27	

Hin.
List.
to Eng.

Stimuli

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	4	6	5	4		2			2	5	2	1
b	3	3	7	6	1	2			2	4		2
t					3	3	1	2	10	9	2	
d			1		1		5	8		2	8	5
k		1						1	12	13	2	1
g		1						1	1	3	15	9

Eng.
List.
to Hin.

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	13	12				1			1	3		
b	7	5	6	5			1	1	1	2	1	1
t	1	1			3	6	1	1	10	6	1	
d	1						4	2	2		17	4
k	1	2			1	2			16	8		
g									3	2	18	7

Eng.
List.
to Eng.

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	23		1		2				4			
b	16	2	5						3	2	2	
t					3				21		6	
d					1		4		3		22	
k	3								24	1	2	
g	1						1		5		23	

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	3	12				3			1	3	6	2
b	11	5	12						1		1	
t	1	1			1	7			16	4		
d					1		2		3		24	
k	1	1							20	6	1	1
g											28	2

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	2	7	5			1	1	2	4	4	3	1
b	2	8	8	1		1			2	5	2	1
t					1	4	1		1	7	13	3
d							4	6	2	1	12	5
k		1				1			12	13	3	
g										3	19	8

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	12	11			1	2				3		1
b	2	4	8	6		3			1	1	2	2
t	2	3			2	8			5	10		
d					1	2			1	4	13	9
k	2	2		1	3	3			7	9	1	2
g					1	1			1	16	11	

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	18	1	1		2		1		7			
b	11		8		2		1		6		2	
t					4	1	1		12		11	1
d			1		1		3		3		22	
k									22		8	
g							3		5	1	20	1

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	16	6			1	1			2	4		
b	12		16	1								1
t	3	5	1		6	1	3		5	1	5	
d					1		4		4		20	1
k	3	2	1		4	2	3		14	1		
g							6				24	

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	5	3	9	2	1	3	4	1		1	1	
b	2	7	8	3		1	2	2	2	1	1	1
t	2	1			3	4	7	6		1	4	2
d					1		11	9			7	2
k		1	1		2	1	1	2	2	9	6	5
g							8	5		1	14	2

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	12	15			1			1	1			
b	1	2	14	9		1	2			1		
t	7	9	4		1		4	3		2		
d						1	8	7		2	9	3
k	6	5	3	1	3	1	3	2	3	3		
g		2			1	7	7			6	7	

Time

20 msec.

40 msec.

60 msec.

TABLES 289-300

BW - 425 - 1700 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	17	2	4		3		1		1	1		1
	b	15	2	7		1		3		1		1	
Hin.	t	5	1		1	15	2	2		3			1
List.	d	2		4		6	2	15				1	
to Hin.	k	9	2	1		2	1	2	2	10		1	
	g	3		1		3	2	12				9	
	p	9	3	4		3		1	1	5	2	1	1
	b	9	2	9		3		1		5			2
Hin.	t	8	2	3		3		7		4	1	1	1
List.	d	2		1		4	3	15		1		4	
to Eng.	k	9	3	2		8	1	1		2	2	1	1
	g	1		1		7	2	15		1	1	2	
Stimuli	p	2	6	14	3	1	2	1					1
	b	4	4	9	5	1	3	1	2		1		
Eng.	t	4	4	3	1	4	5	3	4	1		1	
List.	d	1	2	6		3	1	9	8				
to Hin.	k	1	5	7		4			3	3	2	3	2
	g	1	3	3	1	1	2	9	4			3	3
	p	9	10	2		2	2	3				1	1
	b	1	2	8	8	3	1	3	1	1	1		1
Eng.	t	3	3	5	2	4	2	3	3	2	1	1	1
List.	d		2	5	4	2	1	10	4	2			
to Eng.	k	3	5	1	5	5	1	3	2	1		1	3
	g		2	4	3	1	2	10	5	1		1	1

Time

80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	10	1	1		5	1			7	1	2	2
b	10	1	4	1	3	1	1		5	1	1	2
t	11	2	1		5	1			5	2	3	
d	6	3	3	1	4	1	6		3	1	2	
k	7	2	3		9	1	3		2	2	1	
g	3	1	3		5	1	13		1		3	
p	7	5	6		4			1	4	2	1	
b	8	3	3	2	5		1		4		2	2
t	5	2	2	2	6	1	1	3	5	2	1	
d	3	1	2		6	3	6	1	4	1	1	2
k	5	2	2	1	5	1	2		7	1	2	2
g	4	1	6	1	3	1	5	1	4	3	1	
p	2	4	2	1	5	4	3	1	4	3	1	
b	2	4	3	1	7	3	4	1	4	1		
t	1	4	5	1	6	4	3	3	2	1		
d	2	5	5	3	4	3	2	1		4	1	
k	1	5	6	3	3	5	1	2	1	1	2	
g		5	3	2	4	3	6	5			1	1
p	7	2	3	3	3	2	3	2	3	1	1	
b	2	2	5	4	7	3	3		2	1	1	
t	3	2	5	2	7	1	5	1	3	1		
d	3	3	5	1	8	1	4	4		1		
k	6	1	3	3	7	2	3	2	2		1	
g	5		6	3	2	1	5	5		1	2	

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	9	2			6	2	1		7	2		1
b	11	1			10		1		4	1	2	
t	9		1		8	1			10			1
d	10		1		8		2		6	2		1
k	9		1		6	1	1		9	1		2
g	8		1	1	8	1	5		4	1		1
p	3	1	1		9	1			9	2	2	2
b	7		2		8	1			7	1	2	2
t	4				11	1	1		9	2		2
d	6		1		7		4		8	1	2	1
k	6	1			11	1			6	4		1
g	4	1		2	12		2		7	1	1	
p	3	4	2		7	1	3	2	6	1		1
b	2	5	6		5	2	1	2	3	1	1	2
t	6	4	2	1	5	1	2	2	5	1	1	
d	2	3	1		8		1	2	6	2	2	3
k	2	5	8	5	4	1		1	3			1
g	1	5	3	1	5	3	6		5			1
p	4	4	6		2	2	3	4	3	2		
b	6	2	5	3	3	3	1	1	2	1	2	1
t	2	5	5	1	2	2	6	2	3	2		
d	1	1	5	4	2	3	7	1	3	1	2	
k	2	2	5	2	1	2	7	4	4	2	2	
g	3	2	8	2	3	3	4	3	1			1

120 msec.

TABLES 301-312

BW - 425 - 3400 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	2	5	5									
	b	11	5	13		1							
Hin.	t	1				25	2		1	1			
List.	d		1	1		7	18		1	2			
to Hin.	k								19	11			
	g	1					2	1			26		
	p	3	18							7	2		
	b	7	10	12	1								
Hin.	t					3	24		2	1			
List.	d					3		23			4		
to Eng.	k								4	25	1		
	g						1		1		28		
Stimuli	p	3	2	5	7	4	6	2	1				
	b	1	7	8	7	1	3	1	1	1			
	t			1		11	12	4	2				
Eng.	d					3	2	13	10			2	
List.	k					2	1			9	14	2	2
to Hin.	g						3	2	5		1	14	5
	p	11	11			4	4						
	b	3	4	8	9	2	2		1			1	
Eng.	t		1			15	14						
List.	d					2	4	14	6			4	
to Eng.	k		1			7	3			11	8		
	g					1		3				12	14

Time

20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	22	1			1							
b	16	5	8	1								
t	1				25	1		1	1	1		
d	1				4	1	21			3		
k					2			27	1			
g						2				28		
p	7	15				1			1	6		
b	11	8	10	1								
t	2	4			8	11			1	3	1	
d					1	2	23				4	
k					2	4			19	5		
g											30	
p	1	4	8	2	4	6	1	2			1	1
b	3	3	7	7	1	5	2	2				
t	1	1			8	15	3	2				
d	1				1	1	13	12			2	
k	1	2			1	3			7	15	1	
g			1				3	7	2	1	13	3
p	12	12				5			1			
b	5	3	9	7	1	3	1				1	
t	3	3			10	13				1		
d					3		15	6		2	2	2
k	2				10	6			7	5		
g						1	1			15	13	

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	23		1		5						1	
b	13	1	8	1	5			1			1	
t	1		1		22	1	4			1		
d	2				4		21		1		2	
k	2				3		3	1	15		6	
g	1				4		9	1			14	
p	12	11			1	1	2		1	2		
b	15		13						1		1	
t	8	7			5		5	1	2		2	
d	1				2		21	1	3		2	
k	6	2	1		7	1	4	1	7		1	
g	2	1			1		8				18	
p	1	11	7	1	2	2	4	2				
b	4	4	10	3	1	1	3	3				1
t	1				9	8	7	5				
d						1	16	9			4	
k	1	2			3	2	2	6	5	3	4	2
g	1					1	9	8		1	8	2
p	10	12	2	1	1	3				1		
b	2	2	11	12				3				
t	8	9	1	2	1	1	3	5				
d					1	2	17	8			2	
k	5	10	1	1	6	2	1	3			1	
g							11	7		1	4	7

60 msec.

TABLES 313-324

BW - 425 - 3400 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	15	2	4						3		1	
	b	13		12		2				3			
Hin.	t	5				22		3					
List.	d	4		2		4		20					
to Hin.	k	10				4		3		9		3	
	g	2	1	3	1	2		13				8	
	p	11	5	3		3		1		6	1		
	b	7	3	9	1	3	2			4	1		
Hin.	t	8	4		1	3	1	6	2	4		1	
List.	d	3		2		5	2	17				2	
to Eng.	k	10	3	1	1	4	3	1		4	1	2	
	g	2	1			4	2	16				5	
Stimuli	p		8	6	11	1		2		1			1
	b	2	4	8	4	2	3	1	3		1	2	
Eng.	t	3	6	5	1	5	4	3	2		1		
List.	d		2	4	5			11	6		1	1	
to Hin.	k		4	7	3	2	1	1	2	4	3	2	1
	g		1	5	2		2	5	11	1		2	1
	p	4	6	2	1	2	4	3	1	3	1	2	1
	b	4		6	6	2	1	3	3	2	1		2
Eng.	t	2	2	5	3	2	4	3	4	2		1	2
List.	d		3	5	2		1	11	7	1			
to Eng.	k	2	2	6	3	6	4	3	1	3			
	g	1	1	6	5			9	5	1	1		1

Time 80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	7	1	3	1	1	2			10	1	3	1
b	10		2		3	2	3		7			3
t	4	1	3	1	6	2	3		8	1	1	
d	6		3	1		2	10		7	1		
k	12	1	4		2		6		3	2		
g	8		3		3	2	10	1	2	1		
p	4	4	4	1	6		1		7	1	1	1
b	2	1	4	1	2	5			11	1	1	2
t	2	1	3		8	2	3		7	2	1	1
d	3		2	1	5		9	1	7	1	1	
k	2	1	3	1	4		3		12	2	2	
g	2	4	1	2	4	1	5	1	6		2	2
p	3	3	5	1	3	5	4	2	2	2		
b	4	4	5		3	3	4	3	2		1	1
t	2	5	4	2	2	2	3	2	2	2	3	1
d	1	2	3	2	4	5	4	3	3		3	
k	1	2	6	5	2	3	4	2	1	4		
g	2	1	3	4	2	2	5	6	1	2	1	1
p	6	4	5	2	2	1	2	2	3	2		1
b	3	3	3	4	3	2	1	3	4		3	1
t	3	2	4	1	3	4	2	4	3	1	2	1
d	1	2	4	3	1	4	4	6	3	1	1	
k	3	2	4	1	3	2	4	5	3	2	1	
g	3	3	7	4	1	2	4	2	2	1		1

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	14		1		6	2	1		5			1
b	9	1	1		7	1			8	3		
t	7		1	1	7		1		8	3	1	1
d	10		2		5		1		7	2	2	1
k	9	1			5	1		2	8	3		1
g	8	1			6	2	1	1	9			2
p	4	1	3		11				7	2	1	1
b	4	1	3		7		1		7	5	1	1
t	4	3		1	10	1			7	3		1
d	4	1			8	2	5		7		2	1
k	5	3			7	1	5		7		1	1
g	5	2	1		10	1			6	1	2	2
p	2	3	1		6	3	4	2	2	5	1	1
b	2	5	2	2	4	4	2	1	1	5	2	
t	5	3	3	1	4	3	2	4	2	2	1	
d	2	3	1	1	4	6	5	2	3	2		1
k	3	5	4	1	2	5	5	1	2	1	1	
g		2	1	2	3	4	6	3	4	2	3	
p	3		5	1	2	4	3	5	2	2	3	
b	2	3	3	5	2	2	3	3	3	1	1	2
t	2	1	2		4	1	4	8	5		1	1
d	2	1	4	2	1	4	5	3	2	2	2	2
k	5		2	1	3	2	6	6	2	2	1	
g		2	5	2	5	3	4	3	1	3		2

120 msec.

TABLES 325-336

BW. - 425 - 6800 CPS.

Resp.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	28	2										
b	9	1	18	2								
t					28			1	1			
d					10		16			1	3	
k					1				23	4	1	1
g								1	1		28	

Hin.
List.
to Hin.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	18				1				6		1
b	3	6	18	3								
t					4	25			1			
d					4		20	2			2	2
k									8	22		
g									5		25	

Hin.
List.
to Eng.

stimuli

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	9	5	8	2	1	3			1	1		
b	6	3	13	5		2			1			
t	1				6	9	7	3	2	1	1	
d					3	1	13	6		1	6	
k					4		1	13	8	4		
g			1	1		1	4			2	15	6

Eng.
List.
to Hin.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	8	16				1	4			1		
b	2	7	11	9								1
t					11	15			1	1	2	
d		1			1	3	9	10			4	2
k	1				1	3			10	15		
g							1		1	2	10	16

Eng.
List.
to Eng.

Time

20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	24	1	2	1	1						1	
b	21	2	7									
t	1				26	1	1		1			
d			1		14		12	1	1		1	
k									24	4	2	
g	1				1		1		1	1	25	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	5	16				1	1	1	1	5		
b	10	4	14	2								
t	2	3			3	13	1		5	3		
d					3		17	2	1		6	1
k	1	1	1						11	16		
g	1				1				1		27	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	3	7	8	5		4	2	1				
b	4	4	13	5		2		2				
t					12	10	4	1			2	1
d						2	10	8			6	4
k	1				1	3			15	8	1	1
g						1		1	1	1	19	7

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	12	11				1	4			1		1
b	1	6	11	6		3	2				1	
t	2	3			9	9			1	1	5	
d						5	7	8	1		8	1
k	2	3			3	4			10	7	1	
g							1				16	13

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	23		3		3				1			
b	17	1	8		2						2	
t					1	26		2			1	
d	2				10		12				6	
k	1				2		3	2	19	3		
g							3	1			16	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	14	8				1	1			4	2	1
b	10		17	1					2			
t	4	2			12		2	2	4	1	3	
d			1		3		20	3			1	2
k	3	1		2	9		1		12	1	1	
g	1						5	2			22	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	4	10	6	2	1	1	2				
b	1	7	8	6	1	2	3			1		1
t		2			7	6	5	9			1	
d						1	12	9			6	2
k	1				2	1	2	1	6	6	6	5
g	1	1				1	10	5		1	6	5

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	7	14	1			1	5			1		1
b	3	5	8	13				1				
t	4	9	1		1	2	5	2	3		1	2
d						4	10	12			4	
k	5	5	1		5	6	4				2	2
g							9	6		1	7	6

60 msec.

TABLES 337-348

BW - 425 - 6800 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	15	3	7	1	1		2		1			
	b	10		11	1	2		2		3		1	
Hin.	t	6	1		1	10	1	5	1	3		2	
List.	d	3		2		3		19		1		2	
to Hin.	k	7	1	1		4	1	2	3	8		2	1
	g	1		2			1	12	1	1		12	

Hin.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	10	6		1	2	1			7	2	1	
	b	7	1	8	2	1	1	2		5		2	1
Hin.	t	1	4	3		5	1	2	1	8	1	3	1
List.	d	1				6	2	17	1			3	
to Eng.	k	6		2	1	4	1	3	1	7	3	2	
	g		1	2		5		10		4		8	

Eng.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	5	7	9	4			2	2			1	
to Hin.	b	2	7	8	5	1	2	4		1			
	t	1	7	5	2	3	2	4	3		1	2	
	d		4	8	2	1	3	7	5				
	k	1	3	6	2		1	4	2	1	4	4	2
	g	1	2	2	2	4	1	6	5			4	3

Eng.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	p	4	4	3	3	4	2	3	2	1	2	1	1
to Eng.	b	2	2	8	6	3	1	2	1	2	1	1	
	t	2	3	6	2	1	3	3	2	1	2	2	3
	d	1	2	6	2	3	2	8	6				
	k	5	4	2	3		2	7	1	3		3	
	g	1	3	7	1		2	8	7			1	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	3	3		4	1	2		10	2	1	
b	4	4	2	1			4		14			1
t	6	2	3		3	1	1	1	11	1	1	
d	7	2	2		4		5	2	5	1	1	1
k	6	1	3		4	2	4	1	7	1	1	
g	5	1	2	1	3	1	9		4		4	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	6	2	3	1	2	2	2	2	8	1	1	
b	5	1	3	1	3	2	4	2	5	1		3
t	2	1	1	2	5	2	3	3	8	1	1	1
d	4	2			3	1	7	4	6		2	1
k	3	2			1	3	5	2	11	2	1	
g	4	1	7		4	2	2	1	5	1	3	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	1	6	4	2	4	5	3	1	3			1
b	2	5	4	1	3	4	2		6	2	1	
t	2	6	3	1	5	4	1	3	2		3	
d	1	5	1	2	5	5	6	1	2		1	1
k	3	8	3	3	5	1	5	1	1			
g	2	4	3	3	2	2	7	2	2		2	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	3	4	5	1	2	4	1	1	2	3	4	
b	2	5	4	3		3		2	5	2	4	
t	3	5	5	2	1	1	1	3	4	1	2	2
d	3	2	5	2	5	1	4	3	3			2
k	3	2	2	5	6	2	2	1	3	1	3	
g	1	4	8	3	3	2	2	1	2		3	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	10	2	1	1	4	1	2		6	2		1
b	9	2	1		4		4		10	1		1
t	7	2	1		7		1		7	2		3
d	7	3			7				19	2	1	
k	7	1			6	4			10	2		
g	6		3		6	1	3	1	8	1	1	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	1			7	2	2	1	12	1		
b	6	2		1	5	1	1	1	10			3
t	3	3			9		1	1	10	3		
d	3	1			10			1	10	3	1	1
k	5	2			5	2	2		10	3	1	
g	6	1			5	2	2	1	11	1	1	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	6	1	1	2	1	5	2	4	1	1	2
b	3	6	1	2	3	2	5	2	2		2	2
t	1	5	4	3	2	2	4	3	4	2		
d	1	4			5	4	6	2	3	1	3	1
k	2	7	2		1	2	2	2	7	3	1	1
g	1	5	4	2	2	2	3	3	2	1	3	2

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	2	6	6	3	1	3	5	1	2	1		
b	2	5	5	1	1	2	6	1	1	3	2	1
t	4	5	2		2	3	3	2	2	2	4	1
d	3	4	2	1	1	2	5	3	5	1	2	1
k	2	6	4		1	2	5		5	2	1	2
g	2	3	3	2	1	3	6	2	3	1	2	2

Time 80 msec.

100 msec.

120msec.

TABLES 344-360

BV - 850 -1700 GPS.

Resp.		P	p	b	b	t	t	d	d	k	k	g	g
	P	14	6	4	2					1	1	2	
	b	9	11	5		1				1	1	1	1
Hin.	t	1				1	2	3		7	6	9	1
List.	d		1				2	5	2	5	7	2	6
to Hin.	k	1	1							10	17		1
	g	3	2			2				1	7	5	10

	P	p	b	b	t	t	d	d	k	k	g	g
P	17	7	1	2	2	1						
b	12	12	3							3		
t					2	2	1		11	7	5	2
d						2		5	5	8	6	4
k								1	15	10		4
g							1		6	13	4	6

	P	p	b	b	t	t	d	d	k	k	g	g
P	20	7	1		1				1			
b	12	6	8	1		1				1	1	
t		1			2	2	2	5	8	4	5	1
d					1	4	2	3	7	8	2	3
k	1				1	1		1	11	7	4	4
g						3	1	4	5	9	4	4

Hin.		P	p	b	b	t	t	d	d	k	k	g	g
List		5	12	1		1	2			1	6	1	
to Eng.	b	8	9	7	2						2	2	
	t		2			1	3		7	2	10	1	4
	d					1	1	5	1	3	3	10	6
	k		1			1	2		1	5	20		
	g		1			1		1	2	4	5	8	8

	P	p	b	b	t	t	d	d	k	k	g	g
P	8	11					2		2	6	1	
b	11	11	7		1							
t		3			3	5		1	11	3	2	2
d					1	7	1		5	13	3	
k		2			1	3		1	10	12	1	
g		1			1		2	3	6	3	7	7

	P	p	b	b	t	t	d	d	k	k	g	g
P	14	5			1		1	1	2	5		1
b	13	4	5	1	3				1	2	1	
t	4	2	1	1	5	1	2	2	5	3	2	2
d	1					1	7	6	3	6	5	1
k	2		1	2	10		1	1	10		1	2
g					3	2	5	2	4	2	6	6

Eng.	stimuli		P	p	b	b	t	t	d	d	k	k	g	g
List.			9	12	3	1		2				3		
to Hin.	b		10	10	5	2						3		
	t						2	4	2	2	5	12	3	
	d					1	4	4		5	3	2	1	
	k		1			1	1			11	15	1		
	g					1	1			10	16	1	1	

	P	p	b	b	t	t	d	d	k	k	g	g
P	12	9	1	1		1			1	4	1	
b	11	10	1	2		2			1	2	1	
t	2		1		5	7	1	1	7	5	1	
d					3	5	1	1	11	8	1	
k	2	3				4			15	6		
g					2	1			14	12	1	

	P	p	b	b	t	t	d	d	k	k	g	g
P	6	15	2		1	1	1	1		1	2	
b	7	8	2	6		3				1	3	
t	2				7	8	2	1	1	5	2	2
d			1		5	12	1	1	2	2	2	4
k	1	1			1	5	2	3	4	9	2	1
g	1	1	1		1	2			11	12	1	

Eng.		P	p	b	b	t	t	d	d	k	k	g	g
List.		9	14			2	1				4		
to Eng.	b	8	11	3	4			1	1		2		
	t					6	5			10	9		
	d	1		1		1	1	2	3	8	5	4	4
	k		1			1	5			12	10	1	
	g	2			1	1	4	1		4	5	7	5

	P	p	b	b	t	t	d	d	k	k	g	g
P	14	7	1			4	1		1	2		
b	9	6	5	1		2	2	1	1	1	2	
t	1	2			6	5			8	4	3	1
d			1		3	3	3	2	5	5	5	3
k	3	4			2	3			10	4	3	1
g		1	1		4	2	1	1	6	6	6	2

	P	p	b	b	t	t	d	d	k	k	g	g
P	14	6	2	1		3			1	1	1	1
b	3	7	8	4		1	2			1	4	
t	4	3			5	6	3	1	2	1	4	1
d		1	1		4	1	6	1	6	5	4	1
k	2	6	1	1	2	3	3	1	6	2	2	1
g	1	2	2		2	2	1	4	2	2	9	3

Time 20 msec.

40 msec.

60 msec.

TABLES 361-372 -

BW - 850 - 1700 CPS.

Resp.		P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	13	2	2	1	2	3	1		4	1	1	
	b	10	1	5		2	3	3		6			
	t	1		2	2	6		3	1	11	2	2	
	d			2	2	5	2	5		9	3	2	
Hin. List. to Hin.	k	4			3	2	2	1	3	7	5	2	
	g	2	1		1	4	5	5	3	7	1	1	

Hin. List. to Eng.		P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	6	6	2		3	1		1	5	3	2	1
	b	6	1	4		5	3	3	1	4	2	1	
	t	6	3			4	2	1	1	4	6	3	
	d				1	3	4	7		1	4	8	2
	k	5	4	2		5		1	1	9	2	1	
	g	1	2			4	4	8	1	4	1	3	2

Eng. List. to Hin.	stimuli	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	5	5	8	7	1	2	2					
	b	3	7	5	4	2	2	2	1	2	1		1
	t	1	2		1	5	12	3	1	3		2	
	d				1	7	8	4	2	4		2	2
	k	1	4	2	1	3	5	1	1	5	3	4	
	g		5			3	5	4	1	3	3	4	2

Eng. List. to Eng.		P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	3	7	2	4	3	4	2	1		2	1	1
	b	3	3	6	4	2	3	3		1	1	3	3
	t	3	10	2	1	2	1	3	1	2	3	1	1
	d			2		5	8	4	5	2		3	1
	k	1	5	5	2	2	1	7	2	1	1		3
	g		1	2		1	4	4	8	3	1	3	4

Time 80 msec.

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	3	3	1	1	8	1	3	1	8		1	
b	5		3		7	1	1	2	5	2	1	3
t	2	5		1	7		4		9	1	1	
d	3		2	1	7	1	6	1	6		2	1
k	4	1			8	1	3	1	8	3	1	
g	5		2	2	6	1	3	2	6	1	2	

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	6	5	2	1	6	2	1		6		1	
b	1	4	2	1	6	3	1		9	1		2
t	2	3		1	10	3		1	7	2	1	
d	3	5			7	3	5		5	1		1
k	4	3	2		8		2		7	2	1	1
g	5	1	2		8	2	4		6	1	1	

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	1	3	4	1	3	4	3	4	5	1	1	
b		2	3	2	4	4	4	3	3	2	1	2
t	1	3	7	2	3	4	4	4	1			1
d	1	1	4	1	3	4	3	4	2	2	4	1
k	1	5	5	1	2	5	5	1		3	2	
g	1	1	5		4	4	3	3	4	1	3	1

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	2	5	3	2	3	2	3	3	1	1	4	1
b	2	2	5	2	1	3	6	5	2		1	1
t	3	2	1	1	1	5	7	4	2	2	1	1
d	2	4	5		3	3	6	1	3	1		2
k	2	2	5	1	4	6	2	5	2			1
g	1		2		2	10	7	3	1		3	1

100 msec.

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	3	3			5	5			11	1	2	
b	5		1		6	1	2	2	5	6		2
t	5	1			10	1	2		10	1		
d	2			2	6	2	1	1	10	3	1	2
k	7		2	1	5	1			3	6	5	
g	1	3		3	5		1	1	12	3	1	

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	3	3	1	1	2	3	2	1	11	3		
b	4	1		2	5	1	2		10	4		1
t	2	1		1	5	3	2		8	4	1	3
d	5	2	1	1	8		1	1	6	3	1	1
k	5	2	3	1	5	1	1		9	2		1
g	5	1	2	2	2	3		1	8	5		1

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	1	3	4		4	4	5	3	5	1		
b	2	4	5	2	3	2	1	4	4		3	
t	1	4	6	2	5	4	2	1	3	1	1	
d	1	2	5		3	4	3	1	5	3	1	2
k	4	2	4		3	4	4	3	4	1		1
g		2	3		7	5	3	3	3		3	1

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	3	4	3		1	3	4	3	2	2	4	1
b	1	4	3	3	2	2	4	3	3	1	4	
t	3	3	6	1	5	1	3	2	2	1	3	
d	5	1	4	1	3	4	4	1	3	2	2	
k	2	3	3	1	3	2	6	3	3	3		1
g	1	6	4		3	4	3		3	3	1	2

120 msec.

TABLES 373-384

BW - 850 - 3400 CPS.

Resp.	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	21	6	2		1						
	b	11	8	8		2	1					
Hin.	t				10	11	3	4			1	1
List.	d				5	6	5	10	3		1	
to Hin.	k	2		1	1	1			13	8	1	3
	g		1		1	3	1	3	5	5	7	4

Hin.	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	P	6	13	1		1	1			6	1	
to Eng.	b	11	9	6	1	1	1			1		
	t	1			5	21		1	1		1	
	d				4	4	10	7		1	2	2
	k	1	1			3			8	17		
	g	2			3	1	1	1	1	2	11	8

Eng.	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	P	10	14	2	3		1					
to Hin.	b	8	8	6	6				2			
	t					13	14	3				
	d					10	13	4	3			
	k								11	15	4	
	g	1				2	5	1		8	10	2

Eng.	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
List.	P	10	13	1		1	2			1	1	1
to Eng.	b	9	12	5	4							
	t					12	18					
	d					3	11	6	5	2	1	2
	k					1	2			14	13	
	g		1						1	8	11	4

Time 20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	20	4	3		2	1						
b	13	8	5		3				1			
t					9	13	2	4		1	1	
d					7	9	2	9	1		1	1
k					1	1			14	8	3	3
g			1		1	3		3	3	5	6	8

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	6	15	1	1		2				1	3	1
b	14	9	6		1							
t	4		1	7	9		1	6			2	
d				7	3	10	7		1	1	1	
k	1	2		1	3		1	9	13			
g	1		1		1	1	1	3	1	15	6	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	10	7	3	6	1	3						
b	9	10	4	5		1	1					
t					10	18	1		1			
d					12	13	2	3				
k					1	3			10	15	1	
g	1				2	3			12	10	1	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	11	16				1		1		1		
b	8	10	5	5		1						1
t					12	13		1	1		2	1
d					10	10	3	3	3		1	
k					5	5			11	6	1	
g					2	1	1	13	3	2	8	

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	19	6	2		1	1				1		
b	14	5	6	1	1		1		1	1		
t		1			11	12	3	1	1			1
d		1		1	4	7	2	8	2	2	3	
k	1	1	2		1				12	5	5	3
g		1			5	10	2	3	1	2	3	3

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	14	7	2	1	1	2			1	1		1
b	13	5	8	1	1	1						1
t	5	4		2	4	1	8	3	2			1
d		1			4	5	7	9	2	1	1	
k	4	2	2	1	5	4		1	5	2	3	1
g		1			1		2	5	5	1	9	6

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	8	12	3	2	1	4						
b	5	10	4	1	2	3	1			3	1	
t		1			14	12	1	2				
d					13	11	1	4		1		
k	1	5	1		1	2	1		7	7	3	2
g					8	10		1	5	3	1	2

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	7	14	3		1	2		2		1		
b	6	8	5	6				1		2	1	1
t	1	4	1	2	4	8	4	3			2	1
d	1	1			7	10	6	4	1			
k	3	5		1	4	6	2	4	1	1	1	2
g	1				2	8	4	1	3	5	3	3

60 msec.

TABLES 385-396

BW - 850 - 3400 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	10	4	7	1	3	1		1	1	1		
	b	11		11	1	2	1	1	2	1			
Hin.	t	2	1	2	1	10	2	6	1	3		2	
List.	d	1		1	1	2	2	11	2	5		3	2
to Hin.	k	4		1	1	2	1	2	2	7	5	4	1
	g	1		2	1	1	4	3	4	1	2	7	4
	P	3	8	3	2	5	2		1	3	2	1	
	b	6	5	5	1	3	1	2		5	1	1	
Hin.	t	3	2	3		5	1	2	2	5	2	3	2
List.	d	2				3	1	12	4	3		4	1
to Eng.	k	4	5	1	2	3	1	1	10	1	1		
	g		1	1		2	3	7	3	4	2	4	3
Stimuli	P	8	7	4	1		2		4	1	1	1	1
	b	1	4	9	6	3	1	1	3	1		1	
	t				1	7	7	10	3	1			1
Eng.	d					6	19	5	1	1			3
List.	k		4	4	2		3	1	1	5	7	2	1
to Hin.	g					7	12	4	2	1	3	1	
	P	4	6	2	4	2	2	1	2	2	1	1	3
	b	2	5	4	6			1	3	1		4	4
Eng.	t	3	3	2	3	2	6	3	2	1	1	1	3
List.	d			2		3	9	6	6	2	1		1
to Eng.	k	2	2	1	3	1	3	2	7	2	3	2	2
	g	2	1			2	4	4	7	2	2	2	4

Time 80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	4	1	6		6	1	2	2	6	2		
b	6	2	2		6	1	3	1	5	1	2	1
t	4	1	1	2	6	2	6		4	4		
d	3	1	1		8	1	6		3	3	3	1
k	4	1	2		3	4	4		4	4	4	
g	2	1	1	1	2	6	6	1	3	3	3	1
P	7		4	2	5	2	1		6	2	1	
b	2		4	2	10	2	3		6	1		
t	3		3	1	7	4	3	1	6	2		
d	1	2		1	9	2	5	3	5	2		
k			1	1	12	1	3	3	7	1		1
g		2	3		7	2	5	2	6	3		
P		1	4	3	4	4	2		6	3	1	2
b	3	6	1	1	3	2	2		5	4	1	2
t	3	3	1	1	3	5	7	2	1	1	2	1
d	1	1	1		2	4	7	6	2	1	5	
k	3	3	3	1	1	3	2	1	6	2	3	2
g	1	2		1	2	4	4	5	5	1	3	2
P	5	4	2	3		5	1	1	1	2	1	5
b	2	2	4	4	1		5	2		2	4	4
t	2	1	4	2	2	4	2	3		4	4	2
d	2	1	1	2	5	4	4	5		3	2	1
k		1		3	3	1	6	1	4	6	3	2
g	1	1		1		6	7	4	4	2	2	2

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	3	1	1	1	10	2	2	1	8		1	
b	3	2	1		8	1	1		10	1	2	1
t	5	1	1	1	7	2	1	1	8	2	1	
d	3	2			9		6		9		1	
k	2	1	1		10	2	3		8	2	1	
g	4	1	2		8	2	3	2	7	1		
P	4	1	2		9		3	2	6	1	2	
b	5		2	1	6	2	1	1	9	3		
t	2	1	4	1	8	1		1	7	3	1	1
d	3	1	2	1	8	1	2	1	9	2		
k	1	1			9	4	2	1	10	1	1	
g	5		2		7	2	3	2	6	2	1	
P		3		2	11	5	2	2	3		1	1
b	3	3	4	3	2		6	3	2	1	3	
t	3	3	1	1	2	9	2	1	5		2	1
d		2	3	2	3	5	9	3	1		2	
k	2		2	3	4	2	3	7	3	2	1	1
g		1	1	2	3	4	7	3	3	1	5	
P	2	4	2	2	1	2	5	3	1	2	6	
b	3	2	2	2	5	3	5	2	1	4		1
t	2	4	2		2	3	3	3	3	4	3	1
d	5	2		1	1	3	3	3	5	2	3	2
k	3	2	1	2	5	2	5	2	2	3	2	1
g	2	2	2		5	3	3	2	3	6	1	1

120 msec.

TABLES 397-408

BW - 850 - 6800 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	19	7	3							1		
	b	13	7	10									
Hin.	t				1	15	10	1	3				
List.	d		2			7	9	3	7			2	
to Hin.	k					2	3	1		10	8	1	5
	g	1	1			3	3		3	3	4	6	6
	p	2	20	3						1	4		
	b	8	7	10	1	1				1	2		
Hin.	t	1				4	21		2	2			
List.	d					5	10	4	6			3	2
to Eng.	k	1	2			1	3			7	16		
	g	1		1		1	2		2	5	1	13	4
stimuli	p	6	11	3	4	1	2	1		1		1	
	b	5	6	8	10		1						
Eng.	t					13	14	1	1				
List.	d			1		12	15			2			
to Hin.	k	1				4	4	1		8	11		1
	g					3	8			9	7	2	1
	p	4	14	2	1	1	2			2	4		
	b	8	8	4	7	1	2						
Eng.	t					11	18			1			
List.	d					6	12	4	5	2			1
to Eng.	k					1	7		1	11	10		
	g						5	2	1	6	5	4	7
Time													

20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	26	4										
b	14	11	3	1					1			
t					14	11	1	4				
d					7	13	3	6			1	
k					4	3		1	15	2	3	2
g	2				1	2	1	1	4	9	5	5
p	4	18		1		1			2	3		1
b	11	11	3	1	2	1			1			
t	5				4	10	1	1	5	1	3	
d	1				6	8	7	6	1		1	
k					3	1			18	8		
g	1					3	1	6	3	10	6	
p	11	12	2	2	1	2						
b	9	8	5	4		3	1					
t					12	13	2	3				
d	1				12	13		1	3			
k	1	1			4	5			11	7	1	
g					4	4			8	10	4	
p	10	14	1			3			1		1	
b	6	10	6	5		2				1		
t	1	1			11	14			1	2		
d	1				4	10	6	1	6	2		
k	1				6	6			8	8		1
g					1	3	2	1	8	4	4	7

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	21	4	2		1	1			1			
b	12	6	7	1	1			1	2			
t	1				14	10	4	1				
d	1				10	1	9	2		3	1	
k	2				1		1	13	4	4	4	
g	3	3			10	3		3			4	4
p	11	8	1	2		2			2	2		2
b	13	3	10	1		1			2			
t	5	3	2	2	7	1	5			2		3
d				2	5	5	6	8		2	2	
k	2	5		1	6	2	4	1	8		1	
g					1	4	1	1	5	2	11	5
p	12	7	5	3		3						
b	6	8	7	6		2			1			
t	1				18	10		1				
d					17	11		1	1			
k	5				3	5		1	7	5	2	2
g	1				8	11			5	3	2	
p	7	14	1	2	2	2			1		1	
b	8	5	4	6		1	1	1		2	1	1
t	6	3	2	5	3	6	1	2	1		1	1
d	1				14	8	1	3	1	2		
k	5	6	1	1	1	4	2	2	2	1	2	3
g					1	5	7		1	4	3	4

60 msec.

TABLES 409-420

BW - 850 - 6800 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	4	1	7		1	3	1	1	1		1	
	b	7	1	9	4	5	1	1		1		1	
Hin.	t	1			2	1	1	4		5	3	3	
List.	d	2		1		4	6	4		2	1	5	5
to Hin.	k	2			1	1	4			8	4	8	2
	g	1	1			5	4	1	4	3	2	5	4
	p	10	3	2	2	4	3	1		2	1	1	1
	b	10	1	5	2	4	1		1	1	1	2	2
Hin.	t	6	1	7		4	3		2	3	2	1	1
List.	d				1	5	4	5	3	3	1	7	1
to Eng.	k	5	2		1	4	2	2	2	6	1	2	3
	g	2			1	2	2	6	1	5	3	5	3
Stimuli	p	6	1	7	8	1	1	2	2	1	1		
	b	6	5	9	5	1	1	1	1				1
Eng.	t			1	1	6	6	5	4	4		2	1
List.	d					1	8	3	2	4	2		
to Hin.	k	1	3	2	1	3	3	1		10	3	1	2
	g				1	7	1	5	1	2		2	1
	p	3	7	5	3	3	4	2	1	1		1	
	b	4	5	6	6	2		1	2	1	1	2	
Eng.	t	3	7	2	4	5	2	1	1	2	1	1	1
List.	d				1	5	8	6	4	2		2	2
to Eng.	k	1	3	1	1	4	1	7	2	5	3	1	1
	g					2	3	9	4	2	3	4	3
Time													

80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4		3	2	6	3			7	2	2	1
b	3		7		8	2	1	1	5	2	1	
t	5	1	2	1	6	3	5		4	1	2	
d	2	2	1		4	2	5	1	4	1	1	2
k	4		3		8	1	1	1	6	3	2	1
g	2	1	2	3	7	4	1		5	1	3	1
	p	7	4	4	1	4	1	2		4	2	1
	b	6	4	3		6	3	1		5	1	1
	t	4	2	2	1	9		4	1	5	1	1
	d	3	2	1	1	8	3	4	1	3		3
	k	4	2	2		9	2			7	1	3
	g	5	3	2	1	5	4	3		3	2	1
	p	1	3	5	2	2	3	3	5		4	1
	b	3	5	2	3	2	3	3	2	2	2	1
	t	3	2	1	1	2	5	5	8	1	2	
	d	1	3	3		3	4	5	4	4	1	2
	k	1	4	1	1		8	3	4	4		3
	g		3	3	1	1	8	4	5	3		2
	p	2	9			3	1	5	2			4
	b		3	2	1	5	1	4	2	2	2	3
	t	3	6	2	2		6	3	2	3		1
	d	1	3	1		2	5	6	5	1	2	3
	k	1	4		1	2	4	4	3	5	2	2
	g		2			2	2	8	4	2	2	4

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	5	1	2	3	7	1	1		5	1	4	
b	4	3			5	1	3		1	1		2
t	4	4			6	2	1		1	1		1
d	4	2	1		7		2	3	7	2	2	
k	4	2		2	8	1	2		7	1	3	
g	6	1	3		6	2		1	7	2	2	
	p	4	5		1	8	4	1		6		1
	b	2	3	1	1	9	3		2	8	1	
	t	5	4			8	1		2	8	2	
	d	3	3	2		8		6		5	1	1
	k	3	5	1		6	5	4	1	4	1	1
	g	4	4	2		7	1	3	1	5		1
	p	3	5	1		2	5	2	4	6		2
	b	2	5	3	2	1	5	2	4	5		1
	t	3	3	2		4	4	3	5	2	1	3
	d		3	2	1	3	6	4	4	2	2	1
	k	1	6	3		4	5	2	2	3	1	3
	g	2	6	3		3	4	3	6	1		5
	p		3	3	5	1	4	7	2	2	2	1
	b	2	2	3	4	1	3	4	3	2	5	1
	t	1	5	1	4	6	2	4	2	1	3	1
	d	1	2	3	3	4	5	2	2	4	3	1
	k	1	3	3	2	3	6	2	1	2	5	2
	g		1	4	4	4	6	3	2	2	3	1

120 msec.

TABLES 421-432

BW - 1700 - 3400 CPS.

Resp.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	6	3	1		7	3		1	5	1	3	
b	6	3			9	3	7		2			
t	1				17	2	2		5	2	1	
d					6	2	13	3	3	1	2	
k	2		1		3	3			14	4	3	
g	1	1	1		10	1	4	1	5		6	

Hin.
List.
to Hin.

p	3	1			4	4	2	1	2	10	1	2
b	1	5	3		2				9	4	6	
t					10	15	1	1		3		
d			4		4	2	12		5		3	
k	1	1			4	9			3	10		2
g	2		4		2	1	3		10	2	6	

Hin.
List.
to Eng.

Stimuli

p	2		2	1	3	3	4	3	2	3	5	2
b	3	1	2	1	2	5	8	3	2		2	1
t	1				10	4	7	8				
d			1		8	1	6	5		1	4	4
k	2	3	2	1	5		1	1	5	2	3	5
g	2		1		2	1	9	5	1		3	6

Eng.
List.
to Hin.

p	5	4	2		6	5	1	1	4	2		
b	2	2	4	1	2	4	3		3	4	3	2
t	2				15	12			1			
d			2	1	4	2	13	2			2	4
k	4	4			9	4			5	3		1
g	2	2	2	2	4	1	3	2	2		4	6

Eng.
List.
to Eng.

Time

20 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	7		1		8			2	10		2	
b	7				7	1	6	2	5		2	
t					15	2	4	1	6		2	
d					7		12		3	1	7	
k	3	1			2	2	1	1	14	1	5	
g	1		1		3		2		6	2	14	1

p	3	2			1	3	1		7	11	2	
b	2	1	6		2	2	2		5	1	11	
t	3				6	2	2	3	6	5	2	1
d	2		3		3	2	6		3	3	8	
k	6	1		1	1	1	1		13	3	3	
g	2		5						6	3	13	1

p	3	1	1	5	3	9			3		2	3
b	1			2	3	3	7	6	2	1	3	2
t	2	1			11	3	8	3		1	1	
d			1		5	1	11	8	1		1	2
k	4	2	1	1	3	1	1		5	3	5	4
g	3		2	1	2		7	2	1	1	3	8

p	4	2	1		5	7	4		3	3	1	
b	4	1	8	4	3	1			1		2	2
t	3	2	1	1	10	8	2		2		1	
d	1		1	1	7		11	5	1		2	1
k	10	1		1	3			5	4	3	3	
g	2		4	3	1		9	2	2		4	3

40 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	6		4		4	1	4		4		2	
b	1		6		11		11	1				
t					14		9	2	1		4	
d			1		7		14	1			7	
k	4		5	2	2		2	1	6		8	
g	1		2	1	2		9	2	2		11	

p	2	3	3		4	1	3	1	5	3	3	2
b	2		13	1	2	1	2	1	1		7	
t	3		9		6		4		4		3	1
d	1		5		4		13	2			5	
k	4	1	7		3	2	3	2	5		3	
g	3		11		1	1	5				1	6

p	1	1	7	1	2	4	10	3	1			
b			10	2	1	2	9	4			2	
t	1		7		3	2	9	7			1	
d			3		6		13	5			1	2
k	4		4	2	2	2	2	3	6		4	1
g	2	1	7		1		7	6	2		3	1

p	2	3	3	2	4	2	4	1	3	2	3	1
b	1	1	11	8		1	2	2			4	
t	3	2	5	3	1	1	3	3	1	1	5	2
d	1		3	1	5		13	7				
k	4	2	13	4	1	2	1	2			1	
g	2		6	5	1		5	5	1		4	1

60 msec.

TABLES 433-444

BW 1700 - 3400 CPS.

Resp.

Hin.
List.
to Hin.Hin.
List.
to Eng.Eng.
List.
to Hin.Eng.
List.
to Eng.

Time

80 msec.

100 msec.

120 msec.

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	4	1	6	1	7	4	3	2	1		1	
b	5		6		9	1	7	1		1		
t	2	2	4		12		7		3			
d	3		5		9	1	6	2		2	2	
k	4		6	1	9	1	3		3		3	
g	1		5		7	2	5		4		6	

P	7		3	1	6	1	2	3	3	1	2	1
b	5	1	8	1	4	1	4	3	1	1	1	
t	1		7	1	7	1	5	3	3	1	1	
d	2		4	3	13	2	3		2		1	
k	5		5	1	9		2	2	2	1	3	
g	2		9	2	7	3		1	4	1		1

stimuli

P	1	2	9	3	4	1	4	3	2			1
b		1	11	6	3	2	4	1	2			
t	2	3	9	6	2	1	3	1	1	1	1	
d	4	1	8	5			3	3	1	1	3	1
k	2	1	9	4	1		7		2	2	1	1
g	4	1	4	3	1	2	7	3	3		1	1

P		5	3	2	3	3	6	2	2	4		
b	1	2	6	6	1	1	4	3	3	2	1	
t	6	1	7	7		2	3	1	1	2		
d	1	1	7	5	2	1	9	3	1			
k	2	4	8	3	2	1	2	3	1	2		2
g	3	2	7	7	1			3	2	1	4	

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	8		2		10	1	6		2			1
b	6				12	1	4		3		3	1
t	6	1		1	8	4	5	2	3			
d	6		4		9	1	4	2	3	1		
k	8	2	2		9	2	4	1	1			1
g	5		5	1	10	2	2	1	2		2	

P	4	1	2	1	7	1	7	2	3	1	1	
b	4		2		10	2	1	3	3	2	3	
t	5	2	1	1	8	1	4	1	5		2	
d	5	1	3		8	2	4		2		4	1
k	7		1		8	2	7		3		1	1
g	6	1	5		6		5	1	3	2		1

P	1	2	6	3	3	2	4	3		3	3	
b	3	1	9	3		1	5	4	3	1		
t	2	3	2	3	6	3	4	5	1		1	
d	1	1	5	1	3	4	5	2	2	3	3	
k	2	2	7	2	4	5		1	2	4	1	
g	2	2	3	2	3	5	2	1	3	5	1	1

P	3	1	7	1	2	5	3	5	1	1	1	
b	3	1	7	5	6	1	6	1				
t	3		7	2	1	5	2	2	2	3	2	1
d	1	1	6	2	7	1	6	2	1	1	1	1
k	1		5	2	6	1	2	1	2	3	3	4
g	3	1	5	4	4	4	3	2	1	1		2

	P	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	8		2	1	10	2	2		4			1
b	5		1		9	2	2	3	7			1
t	3		1		10	2	1	3	6	1	2	1
d	5				11	2	3	1	6			2
k	6		2		11	2	2		5		1	1
g	8			1	8		3	6	4			

P	4			1	13	1	2	1	4	3	1	
b	5		1		9	3		2	8	1		1
t	4	1			11	1	2	1	4	4	2	
d	3		1		11		2	2	6	3	1	1
k	4		1		8	6	3	1	6	1		
g	6	1	2	1	10		3		2	2	2	1

P	5	2	4	3	4	4	3	1	2	1		1
b	3	2	5	2	4	4	5	1		3	1	
t	2	1	7	2	7	3	1	3	2	2		
d	1		5	3	7	2	4	2	5	1		
k	1	2	3	3	11	2	2	2	3	1		
g	3	2	3		3	5	4	3	4	1	1	1

P	4	1	5	2	2	3	4	2	2	4		1
b	5	2	5	4	2	2	5	1	1	2	1	
t	4	1	4	1	6	1	2	1	5	3	1	1
d	2	6	6	1	3		3	1	4	2		2
k	5	1	5	3	10	2	1		2	1		
g	2	6	3	1	4	2	8	2	2	5	1	

TABLES 445-456

BV - 1700 - 6800. OPS.

Resp.

Hin.
List.
to Hin.Hin.
List.
to Eng.Eng.
List.
to Hin.Eng.
List.
to Eng.

Time

20 msec.

40 msec.

60 msec.

	P	p	b	b	t	t	d	d	k	k	g	g
P	10		1		8	1		1	5	1	3	
b	8	2	2		8	2	3		2		2	1
t					22	5	1		2			
d	2				12	2	9		2		3	
k					5	5			13	5	2	
g	2	2			8				8	1	9	

	P	p	b	b	t	t	d	d	k	k	g	g
P	4	8	1	1	5	1	1		4	5		
b		3	4	1	3	6			3	3	7	
t					10	17			1	2		
d	3		2		7	2	14	1	1			
k	1	1	1		6	5			5	11		
g	2		6		6	1	1		9		4	1

	P	p	b	b	t	t	d	d	k	k	g	g
P	2	1	5	4	4	2	4	3	1	1	2	1
b	2		4	2	4	1	9	4	1	2		1
t	1			1	12	6	5	5				
d	1				5	4	8	7	1		1	3
k	1		1		4	3	1	2	7	5	3	3
g	2		2		4	2	2	1	1		8	8

	P	p	b	b	t	t	d	d	k	k	g	g
P	6	6			3	4	2		5	3		1
b	1	2	7	1	4	2	2	2	1	2	4	2
t					18	10		2				
d			2		3	2	10	5	3		2	3
k	2				10	6		1	6	4		1
g	3	1		1	3	3	4		2	1	8	4

	P	p	b	b	t	t	d	d	k	k	g	g
P	8	1			6	2	2		6		5	
b	4	1	2		10	1	6		4	1	1	
t					25	2	1		2			
d					8	1	14	1	4		1	1
k					4	2	1		14	5	4	
g	3		1		4		2		5		15	

	P	p	b	b	t	t	d	d	k	k	g	g
P	3	1			8	1			6	8	1	2
b	5		7		1		1	1	7	1	5	2
t	1		1		7	8	3	1	1	7	1	
d	1		3		3	2	13		1		7	
k	4				1			1	16	4	4	
g	1	2	3		1		1		4		17	1

	P	p	b	b	t	t	d	d	k	k	g	g
P	1	1	2	1	3	4	10	1	1		2	4
b		1	3	1	3	4	6	5	3		1	3
t		1			11	6	4	5				3
d	1				2	3	12	4	1		2	5
k					4	4	2	1	4	3	4	8
g	1		3		1	3	1	2		1	9	9

	P	p	b	b	t	t	d	d	k	k	g	g
P	4	5	1		5	6	1	1	2	4	1	
b		2	5	2	1	3	2	1	3	3	8	
t	3		1		9	11		1	3	1	1	
d			1		3	2	10	8	1		3	2
k	3	2			4	5		1	7	6	1	1
g			4	1	3	2	2	2	1		10	5

	P	p	b	b	t	t	d	d	k	k	g	g
P	4		7		10	1	4	1	2		1	
b	3		6		9	1	9		1	1		
t					14	4	5	1			1	
d	2	1	1		6	3	9	1	4		3	
k	4		3		2	1	3	1	10	1	5	
g		1	3		3		10	1	4		8	

	P	p	b	b	t	t	d	d	k	k	g	g
P	2	3	4	2	1	2	4		5	2	5	
b	5	1	18		1				1	1	3	
t	2	1	9		5		6	1	6		1	
d	1		6		5		16		2			
k	7		8		3		2		5		5	
g	2	2	14		1	2	2			1	6	

	P	p	b	b	t	t	d	d	k	k	g	g
P	2	2	6	5	2	3	6	3				1
b	3		5	1	1	2	7	10			1	
t			2		8	4	8	7			1	
d	1		4		2		12	9			2	
k	3	1	5	3			2	6	4	4	1	1
g	3		5		1		5	6		2	5	3

	P	p	b	b	t	t	d	d	k	k	g	g
P	4	7	2		2	5	3	1	3	3		
b	1	1	8	5	1	2	2	5		1	3	
t	5	2	5	2	6	1	2	2	2	1		2
d			4	1	4		13	7	1			
k	4	3	5	4	1	3	4	1	1	1	2	1
g	1		6	5	1		5	6	1	1	2	2

TABLES 457-468

BW - 1700 6800 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	p	5		9	1	2	1	3	1	6		2	
	b	4		8	1	2	3	4		5		3	
Hin.	t	7	1	8	1	3	1	5		4			
List.	d	4		8	1	1		9		3	1	3	
to Hin.	k	5	2	7		2		3		6		4	1
	g	3		7		2	1	6		3		8	
	p	5	1	3	1		4	2	2	10	1		1
	b	2	2	10				4		8		1	3
Hin.	t	3	1	5	1	2	1	5	3	5	1	2	1
List.	d	1		6	1	2		10	1	5		2	2
to Eng.	k	4		7			2	5	3	5		3	1
	g	2	1	10	3			4		7	1	1	1
stimuli	p			7	9	4	4	2	1		1	1	1
	b	2	1	6	9		2	4	1	1		3	1
Eng,	t	2	3	9	7	2		4	1	1			
List.	d		1	6	6	2	2	4	4	2	1	1	1
to Hin.	k	4	2	5	4		2		2	4	3	1	2
	g	1	1	4	4	1		5	4	3	2	3	2
	p	1	3	5	3	4	5	3	2	3	1		
	b	3	2	7	6	2	1	3	2	1	2		1
Eng.	t	3	2	9	4	1		2	2	2	4	1	
List.	d	1		6	3	3		4	9	1	1		
to Eng.	k	2	4	3	4	4	3	2	2	3		2	1
	g	2		8	7	2	2	2	3	2	1	1	

Time

60 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	3	3	4	1	4	3	1		9		1	1
b	3	2	4		3		7	2	6		2	1
t	4	1	4		7	1	3	1	6		2	1
d	3		5	1	4		4	2	7		2	2
k	3		4	3	5	1	5	1	6		2	
g	3	1	10		1	1	3	1	5		3	2
p	3		6		5	1	5	1	5	1	3	
b	2	4	3	1	5	4	4	1	4	2		
t	3	2	5	1	4	2	3		6	3	1	
d	3	1	6	1	3		8		5		1	2
k	2	1	5		4	1	4		7	2	2	2
g	3	2	4	1	5	1	2	2	6		4	
p	3	1	6	5	3		3	2	1		4	2
b	2	2	9	5	2	1	2	3	3			1
t	1	5	7	1	6	1	3	2	2	1	1	
d	2	3	9	2	3	1	3	3	1		3	
k		2	6	6	1	2	5	1	4		2	1
g	2	1	9	6	3	1	1	2	1		2	2
p	2	5	6	2	1	2	3	5		2	1	1
b	5		3	5	4	1	5	3		2	1	1
t	3	2	7	2	2		4	7		1	1	1
d	3	3	8	4		2	4	4	2			
k	1	1	4	3	4	5	4	6		1		1
g	2	1	6	7	1		2	4	2	2	1	2

100 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	1		2	9	1	2	2	7	1	1	
b	5		1		9	1	1	1	8			4
t	7	1			11	2	1		5		2	1
d	5	1		1	9	2	4	1	6			1
k	3		1	1	10		5	1	8			1
g	4	1			10	1	2	1	6		4	1
p	3	3	1		7	2	4	1	6	1		2
b	1	1	1		8	1	2		10	2	2	2
t		2	1	1	14	1	2		7	1		1
d	1	2	1	1	6		4	2	11		1	1
k	2				7		6	9	3	1	1	
g	2	3	2		5	1	3	2	10			2
p			5	2	3	3	6	1	2	4	2	2
b	2		6	1	3	3	6	2	2	2	2	1
t	3	5	6	1	1	2	6	2	2		1	1
d	1	1	4	4	3	3	6	2	3		2	1
k	3	4	4	2	2	2	6	1	5			1
g		2	7	2	4	1	5	2	3	1	1	2
p	3		4	3	2	3	6	5	2		1	1
b	2		6	6	4	1	2	4	3		2	
t	1	1	5	3	2	1	3	3	5	3	2	1
d		1	11	4	3	2	7	1				1
k	5	2	4	2	2	1	4	6	2	1		1
g	2		7	4	1	4	4	3	2	2		1

120 msec.

TABLES 457-468

BW - 3400 - 6800 CPS.

Resp.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	19	5							6			
b	9	8	7						6			
t					18	3	2	1	5			1
d					9	1	12		5		2	1
k			1		1	2		1	2	2	2	
g					1	2	4	1	10	1	11	

Hin.
List.
to Hin.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	4	13	2		3				1	4	2	1
b	11	4	7		1	1			6			
t		2			11	12			1	3		1
d					9	2	13	1	4	1		
k	2	1	1		6	9		2	8		1	
g		1	2		5	2	8	2	3		7	

Hin.
List.
to Eng.

Stimuli

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	9	7	4	7	1		1				1	
b	5	4	8	11						2		
t					6	9	9	6				
d					1	1	12	12			3	1
k						3	1	1	7	7	7	4
g					1	1	5	4	3	2	8	6

Eng.
List.
to Hin.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	10	17	1						1	1		
b	1	7	14	4			1	1	1		1	
t			1	1	11	17						
d			1				13	12			2	2
k	1				7	6	2		6	6	1	1
g					1	1	2	6	5	1	7	7

Eng.
List.
to Eng.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	17		5	1					7			
b	12	2	6	2					8			
t					19		3	1	6		1	
d					2	1	17	2	7		1	
k					4	2		1	18	1	3	1
g						1	6	1	10	2	10	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	6	12	1	2					6	3		
b	12	2	9	1			1		5			
t	1	4	1		7	4	1	2	8		2	
d	1	1			3	1	13	3	6		2	
k	2		1		5	8	4		8	1		1
g					1		14	1	7		5	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	5	11	4	7			1	1	1			
b	8	7	8	5					1		1	
t					1	6	8	12	3			
d						1	5	13	9		1	1
k					1	3	2	2		9	6	5
g					2		5	8	1	3	5	6

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	9	13	1	3			2	2				
b	3	5	11	10					1			
t	1	2			1	9	14	1			1	1
d						1	15	13	1			
k	3	1			4	11		1	2	5	1	2
g							11	9	1		6	3

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	14	1	10						4		1	
b	6		14	1				1	6		2	
t					13	1	10		5		1	
d					4		18	2	6			
k					3		5	1	10	2	8	1
g	2					2	13	1	6		6	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	13	5	2		2				6	3	1	
b	8		17						7		1	
t	5	3			4	1	7	2	5		3	
d	1				3	1	17	3	6			
k	3	2			12		6		4		3	
g						2	16	1	6		5	

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	6	5	8	8			2		1			
b	2	7	9	8					1	1	1	1
t			1		3	2	14	8	1			1
d	1				2	1	13	11		1	1	
k			2	1	1	5	3	3	4	3	5	3
g					1	1	1	11	5	1	1	4

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
p	6	9	3	1	1	1	3	1	1	1	1	2
b	3	2	9	11					1	1	1	2
t	4	3	2	3	5		5	2	2		2	2
d							1	18	8	2		1
k	1	2	5	2	6	3	2	4			3	2
g			2		2		8	10	1		3	4

Time 20 msec. 40 msec. 60 msec.

TABLES 469-480

BW - 3400 - 6800 CPS.

Resp.		p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
	P	3		18	2	1				5		1	
	b	5		15		2	1			6		1	
Hin.	t					8		17	1	4			
List.	d					2	2	18	2	6			
to Hin.	k	3				2		6	4	9	1	5	
	g			1		1	1	14	2	7		4	

	p	8	4	3	2	1		3	1	5		1	2
	b	6		14		1		3		4		2	
Hin.	t	3	1	5	1	6	2	5	1	4		2	
List.	d	1		1		2		19	1	5			1
to Eng.	k	4	1	2		9	1	2	1	7	1	1	1
	g			5		1	1	11	4	5		3	

Eng. List.. to Hin.	stimuli	g			5		1	1	4	5		3		
		p	3	5	6	7			3	2	3	1		
		b	2	3	6	6	3	1	4	2	1		2	
		t			2		5	1	10	8	2		1	1
		d	1		2			1	13	12	1			
		k	1	2	2	4	2	2	6	3	1	2	1	4
		g			1	1	3	1	6	10	2		2	4

	p	4	4	5	2	1	1	2	6	1	1	2	1
	b	3	1	7	6	2		3	5	1			2
Eng.	t	1	2	3	2	3	2	3	4	4	1	1	4
List.	d			2	2	1	1	15	6			2	1
to Eng.	k	1	1	2	1	3	4	6	4	3	1	2	2
	g	1		2	1		1	11	8		2	2	2

Time

80 msec.

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	13	2	3	1	1	1			6		1	2
b	9		5			1	1	1	8	1	2	2
t	8		4		3	2	3	1	7		1	1
d	3		1		4	1	8	1	9		3	
k	3	1	3		1	2	6		10		3	1
g	3		3		1	1	10	2	6		4	

P	6	1	7		2	2	3		7	1	1	
b	5	2	6		4	2	3		5	2	1	
t	4	1	5		2	3	2	1	8	1	3	
d	3	1	2		4	1	8	1	5	2	1	2
k	4	1	4		3	4	2		8	2	1	1
g	4	1	7	1	2	2	2		7		3	1

p		2	1	5	1	3	4	5	1	3	4	1
b			5	6		3	3	7	4	2		
t	2	2	1		5	4	6	7	1	2		
d	2		1		3	5	7	9	1		1	1
k	2	4	1	1	3	1	5	7	2		2	2
g			1	1	1	4	10	7	1	1	4	

p	1	4	3		4	4	4	3	3	2	1	1
b	1		3	6	4	3	3	2	1	3	2	2
t	1	2	5	1	1	5	6	4	2	1	2	
d	1	1	3	1	3	4	9	4	1		3	
k	4		3	1	3	2	8	5	3		1	
g		3	1	2	2	3	11	3	2		2	1

	p	p ^h	b	b ^h	t	t ^h	d	d ^h	k	k ^h	g	g ^h
P	3		3	1	4	1			11	1	3	3
b	3		1	1			3	1	12	1	5	3
t	2		1	1	6	2	2	2	13			1
d	3		1		2		4	1	15		2	2
k	4		1		2		4	2	13	2	1	1
g	3			1	3	1	2	1	14	1	3	1

p	4	2	1	1	6		1	1	11	1	1	1
b	1		1		8	1	2	2	12	2		1
t	2	2	2		6		4	1	11		1	1
d	3				6	1	3	1	11	1	3	1
k	2	1		1	10	1	1	1	10	1	1	1
g	3	2			5	1	3	1	11	1	1	2

p	3	3	1	2	2	2	6	2	4	1	3	1	
b	3	1	2	5	2	2	4	1	3	1	3	3	
t	4	1	2	1	2	5	5	2	3		4	1	
d	2	2	3	1	4	5	5	4		1	3		
k	6	2	4	2	3	2	6	1	1		2	1	
g	1	3	2	3	2	2	9	1	2	1	3	1	

p	1	1	3	2	3	1	5	2	2	2	6	2
b	4	2	3	2	2	3	2	3	2	2	4	1
t	3	2	1	3	3		5		6	4	1	2
d	1	4	3	1	2	3	7	5	1		1	2
k		3	2		5	3	8	2	4		2	1
g		3	2	3	2	2	7	2	1		6	2

120 msec.

160 msec.

BIBLIOGRAPHY

- Balakrishnan, A. V. "Signal Selection Theory for Space Communication Channels," Advances in Communication Systems. New York: Academic Press (1965), Vol. 1, pp. 1-31.
- Black, J. W. "Equally Contributing Frequency Bands in Intelligibility Testing," Journal of Speech and Hearing Research, Vol. 2, No. 1 (1959), pp. 81-83.
- Castle, W. E. "Effects of Selective Narrow-band Filtering on the Perception by Normal Listeners of Harvard PB Word Lists," National Institute of Neurological Diseases and Blindness, BPD-15 (1963), in conjunction with NIH Grant #62-4616-20 (1964).
- Chomsky, Noam. "Current Issues in Linguistic Theories," The Structure of Language (ed.) Jerry A. Fodor and Jerrold J. Katz. New Jersey: Prentice-Hall, Inc. (1964), Chap. 3, pp. 50-118.
- Cohen, A., and t'Hart, J. Proceedings of the Speech Communication Seminar, Vol. II, Speech Transmission Lab., R.I.T., Stockholm/Sweden, Session F (1962).
- Cooper, F. S., Delattre, P. C., Liberman, A. M., Borst, J. M., and Gerstman, L. "Some Experiments on the Perception of Synthetic Speech Sounds," Journal of the Acoustical Society of America, 24 (1952), pp. 629-639.
- Cooper, F. S., Liberman, A. M., Harris, K. S., and Grubb, P. M. Proceedings of the Second International Congress of Cybernetics, Namur, Belgium (1958).
- Delattre, P. C., Liberman, A. M., and Cooper, F. S. "Acoustic Loci and Transitional Cues for Consonants," Journal of the Acoustical Society of America, Vol. 27, No. 4 (1955), pp. 769-773.
- Denes, P. B. "On the Motor Theory of Speech Perception," Symposium on Models for the Perception of Speech and Visual Forms, Boston (1964).
- Fant, C. G. M. Acoustical Theory of Speech Production. The Hague (1960), pp. 224-225.
- Flanagan, J. L. Speech Analysis, Synthesis, and Perception. New York: Academic Press, Inc. (1965), p. 236.
- Fletcher, H., and Galt, R. H. "The Perception of Speech and Its Relation to Telephony," Journal of the Acoustical Society of America, 22 (1950), pp. 89-151.

- French, N. R., and Steinberg, J. C. "Factors Governing the Intelligibility of Speech Sounds," Journal of the Acoustical Society of America, 19 (1947), pp. 90-119.
- Garner, W. R. Uncertainty and Structure as Psychological Concepts. New York: John Wiley and Sons, Inc. (1962).
- Garner, W. R., and Carson, D. H. "A Multivariate Solution of the Redundancy of Printed English," Psychological Reports, 9 (1960), pp. 123-141.
- Grimm, W. A. "The Perception of Segments of English-spoken Consonant-vowel Syllables," Ph.D. Dissertation, The Ohio State University, 1965.
- Hadding-Koch, K. and Abramson, S. "Duration versus Spectrum in Swedish Vowels: Some Perceptual Experiments" (to appear in Studia Linguistica), Status Report on Speech Research, S-R-2 (1965), Haskins Laboratories, New York.
- Halle, M. "On the Basis of Phonology," The Structure of Language (ed.) Jerry A. Fodor and Jerrold J. Katz. New Jersey: Prentice-Hall, Inc. (1964), pp. 324-333.
- Halle, M., Hughes, G. W., and Radley, P. Jr. "Acoustic Properties of Stop Consonants," Journal of the Acoustical Society of America, 29 (1957), pp. 107-116.
- Halle, M., Hughes, G. W., and Radley, J. P. A. "Acoustic Properties of Stop Consonants," Journal of the Acoustical Society of America, Vol. 29 (1957), pp. 107-116.
- Harris, K. S., Hoffman, H. S., Liberman, A. M., Delattre, P. C., and Cooper, F. S. "Effect of Third-formant Transition on the Perception of the Voiced Stop Consonants," Journal of the Acoustical Society of America, Vol. 30, No. 2 (1958), pp. 122-126.
- Hockett, C. F. "The Problem of Universals in Language," Universals of Language (Massachusetts: M.I.T. Press, 1963), pp. 1-22.
- Jakobson, Roman, Fant, C. G. M., and Halle, M. Preliminaries to Speech Analysis (Massachusetts: M.I.T. Press, 39, 1952).
- Jakobson, R., and Halle, M. "Phonology and Phonetics," Roman Jakobson Selected Writings (Gravenhage: I. Morton and Co., 1962), pp. 464-504.

- Jakobson, R., and Halle, M. "Tenseness and Laxness," Roman Jakobson: Selected Writings, I, Phonological Studies. The Hague (1962), pp. 554-555.
- Jones, D. An English Pronouncing Dictionary, 7th ed. New York (1946).
- Kryter, K. D. "On Predicting the Intelligibility of Speech from Acoustical Measures," Journal of Speech and Hearing Disorders, 21 (1956), pp. 208-217.
- Liberman, A. M., Cooper, F. S., Harris, K. S., and MacNeillage, P. F. Proceedings of the Speech Communication Seminar, Speech Transmission Laboratory, R.I.T., Stockholm/Sweden, Session D (1963).
- Liberman, A. M., Delattre, P. C., and Cooper, F. S. "The Role of Selected Stimulus Variables in the Perception of Unvoiced Stop Consonants," The American Journal of Psychology, 65 (1952), pp. 497-517.
- Liberman, A. M., Harris, K. S., Hoffman, H. S., and Griffith, B. C. Journal of Experimental Psychology, 54 (1957), pp. 358-368.
- Lisker, L., and Abramson, A. S. "A Cross-language Study of Voicing in Initial Stops, Acoustical Measurements," Word, 20 (1964), pp. 384-422.
- Miller, G. A., and Nicely, P. E. "An Analysis of Perceptual Confusions among Some English Consonants," Journal of the Acoustical Society of America, 27 (1955), pp. 338-352.
- Mol, H., and Ulenbeck, E. M. "The Analysis of the Phoneme in Distinctive Features and the Process of Hearing," Lingua, Vol. IV (1954-1955), pp. 167-193.
- Ohman, Sven. On the Perception of the Swedish Consonants in Intervocalic Position, R.I.T., Stockholm/Sweden, Report No. 25 (1962).
- Pollack, I. "Effects of High Pass and Low Pass Filtering of the Intelligibility of Speech in Noise," Journal of The Acoustical Society of America, 20 (1948), pp. 259-266.
- Saussure, F. de. Courses in General Linguistics (ed.) Charles Bally and Albert Secheaye. New York Philosophical Library (1959).

Shannon, C. E., and Wever, W. The Mathematical Theory of Communication. Urbana: University of Illinois Press (1949).

Singh, S., and Black, J. W. "Study of Twenty-six Intervocalic Consonants as Spoken and Recognized by Four Language Groups," in Press (1966).

Twaddell. "On Defining the Phonemes," Supplement to Language, XVI (1935).