COMPUTER ASSISTED DIAGNOSIS OF PERCEPTUAL ERRORS

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ABSTRACT

A computer program has been developed for the scoring and analysis of perceptual errors in classifying German vowels. The program, written in "BASIC" for MS-DOS system computers, plots out specific errors and provides an accuracy index and length agreement correlate. A second part of the program provides the learner with a ranking list of specific vowel difficulty and an explanation of the likely nature of the perceptual error. The results may either be printed or viewed on the screen.

INTRODUCTION

The author has for some time been concerned with studies of perception, in particular its application to corrective procedures with the ultimate goal of correcting and improving pronunciation of learners of German. It has long been the author's belief that errors of pronunciation and errors of perception go hand in hand and that correction of both perception and production must be addressed. This has been the subject of several earlier papers ([1, 2]) and is the underlying premise of a book co-athored by H.-H. Wängler which has recently been published by Western Washington University Press [3] and is now used as a text by a number of German departments in the USA.

The contrastive phonetic approach used in the book is ideally suited for computer application. Each sound is treated individually with a number of pedagogically oriented steps provided to facilitate mastery of the sound in context based on potential perception and articulation difficulties. A perceptual or listening frame with accompanying listening tests in each case precedes actual production exercises. The listening exercises set a framework for contrastive problems both between potentially conflicting native (L_1 = English) as well as target (L_2 = German) sounds and contexts. The predetermining factors as the potential of likely problems for each sound are based upon contrastive phonetic principles and upon data gathered in the past administration of a perception test developed for native German speakers and then modified for non-native learners [4]. The test which has been modified numerous times has

served in the past as an accurate indicator of degree of nativeness in perception. It is comprised of minimal pairs containing variations of German vowels which are then classified as one of fifteen phonemic categories in German. The test has in the past yielded valuable data about ranking order of vowel difficulty for students at various levels of study and has provided numerical indexes corresponding to performance standards for levels from first year college to advanced graduate student status [5].

However in its specific application here, the test is seen as an invaluable aid as part of a basic program aimed at improving individual language skills. This is done by administration of the test at varied intervals noting specific progress at elimination or improvement of certain perceptual errors. The computer program is designed to indicate specific perceptual errors, provide a priority listing of most frequently made errors and the likely nature of both errors affecting the general classification (or misperception) of vowel categories as well as specific vowel errors. As such the program has proved to be a valuable learning tool facilitating more automatic and accurate assessment of difficulties and has applications which greatly facilitate computer-dependent learner acquisition of sound perception/production.

EXPERIMENTAL PROCEDURES

The test was administered individually via a Tandberg Model 812 cassette recorder and headphones linked to an IBM-PC by a serial connection. The test material is displayed for the subject on a Teknika MJ-22 RGB Monitor or may be printed on an Epson LQ-1500 or FX-80 printer. The equipment is housed in the Foreign Language Learning Center at Western Washington University.

The student must classify each of 100 items on tape as one of fifteen phonemic choices. These choices appear as orthographic representations. The choices are indicated as letters A through O. At the conclusion of the test the student is provided with a display of all errors made along with a general assessment of major perceptual errors (6). The student may review the errors on the screen or receive a printed hard copy via printer as shown in Figures 1 and 2.

Se 89.1.1

Figure 1

NAME: 1286e1m31
Level: 314
DATE: 12/86

INCORRECT RESPONSES				LAF	
ITEM	TOTAL NO.	SUBSTITUTIONS MADE		YES	NO
[i:]	6	1	(y:)- 100	1	0
[I]	3	1	(e:)- 100	0	1
[e:]	7	4	(I:)- 50 (e:)- 25 (ɛ)- 25	3	1
[ɛ:]	1	1	(e:)- 100	0	0
[ɛ]	11	9	(e:)- 22 (a:)- 22 (a)- 33 (æ)- 11 (E)- 11	5	4
[a:]	15	3	(ɔ:)- 66 (a)- 33	0	3
[a]	2	1	(ɔ:)- 100	1	0
[u:]	6	1	(ʊ)- 100	1	0
[ʊ]	4	2	(a)- 50 (ɔ:)- 50	2	0
[o:]	12	0		0	0
[ɔ:]	3	0		0	0
[y:]	10	7	(ø:)- 28 (Y)- 28 (a)- 14 (e:)- 14 (E)- 14	4	3
[Y]	0	0		0	0
[ø:]	14	5	(e:)- 40 (y:)- 40 (u:)- 20	3	2
[œ]	5	4	(U)- 100	4	0
TOT.	100	38	TOTAL PERCENTAGE OF CORRECT RESPONSE: 62	24	14
			TOTAL PERCENTAGE OF LAF: 63		

Figure 2

NAME: 1286e1m31
VOWELS IN ORDER OF DIFFICULTY:

VOWEL	ERRORS
[ɛ]	9 OF 11 OR 81%
[æ]	4 OF 5 OR 80%
[y:]	7 OF 10 OR 70%
[e:]	4 OF 7 OR 57%
[U]	2 OF 4 OR 50%
[I]	1 OF 3 OR 33%
[a]	5 OF 16 OR 31%
[ɑ:]	3 OF 15 OR 20%
[I:]	1 OF 6 OR 16%
[u:]	1 OF 6 OR 16%

GENERAL OBSERVATIONS:

LAF = 63% - TOO MUCH DEPENDENCE ON LENGTH FACTOR NOT ATTENTIVE ENOUGH TO QUALITY DISTINCTIONS AMONG VOWELS

6 ERRORS OR 15% OF THE ERRORS ARE DUE TO AN INABILITY TO CLEARLY DISTINGUISH BETWEEN UMLAUTED AND NON-UMLAUTED VOWELS. BE ATTENTIVE OF ORTHOGRAPHIC DIFFERENCES BETWEEN A/Ä, U/Ü, ETC.

2 ERRORS OR 5% ARE DUE TO THE INABILITY TO CLEARLY DISTINGUISH BETWEEN LIP-ROUNDED AND NON LIP-ROUNDED FRONT VOWELS. BE ATTENTIVE OF THE DIFFERENCE BETWEEN [i:]/[y:], [e:]/[ɛ:], ETC.

9 ERRORS OR 22% OF THE ERRORS HERE DUE TO THE SUBSTITUTION OF ONE UMLAUTED VOWEL FOR ANOTHER. THIS INDICATES THAT THERE IS SOME CONFUSION IN DISTINGUISHING ONE UMLAUTED VOWEL FROM ANOTHER. BE ATTENTIVE TO THE DIFFERENCE BETWEEN Ö/Ü VOWELS.

COMPUTER PROGRAM

The computer program written for this application is in two parts. The first part generates on-screen directions for taking the test and generates data files through a sub-routine of test responses. The responses themselves are converted from letters A through O accessed on the keyboard to numerical values 1 through 15.

The second part of the program is the analysis routine [7]. It is written in BASIC for MS-DOS with sub-routines compiled in machine language to increase response time. It comprises two major sections. The results of the first section are illustrated as Figure 1. The program first performs a matching function comparing the data file generated by the student with the data file of the key of correct responses. Sub-routines perform the statistical functions of calculating the errors made. The initial analysis compiles an error index for each vowel based upon the agreement factor for the test with the individual vowel. A total percentage for the test is calculated. A second sub-routine in the program classifies each vowel as a subset of either a short vowel group or long vowel group and calculates errors on the basis of whether they are in agreement with the length or in disagreement. The extent of this agreement is calculated as the LAF (length agreement factor). Further sub-routines classify the errors and create a hierarchical arrangement of the errors for individual vowels along with the percentage of the frequency of that error for the specific vowel.

The display of errors as indicated in Figure 1 are in phonetic symbols and may be displayed either on the screen or printed. The screen program is accomplished through a screen sprite routine using an IBM character generator. The printer routine utilizes graphics characters generated through Printworks [8] graphics program and downloaded to the internal buffer of the printer.

The basic display of errors and statistical analysis is followed by a second section which provides more directed diagnostic help to the learner based on further analysis of the errors. The results of the second phase of analysis are indicated as Figure 2. The types of errors are reclassified to provide more specific diagnostic help aimed at assisting the student to improve his/her perception. First a listing of vowels is provided, arranged in terms of perceptual difficulty for the student. The number of errors compared to the total number of that specific vowel contained on the test is indicated along with a percentage of misclassification of that vowel.

This is followed by a section called "General Observations" and is again comprised of a number of sub-routines comparing errors to specific arrays of character strings. The first statement provides an analysis of the LAF mentioned previously. Since the test items were intended to exhibit deliberate manipulation of both the quality and length axis, the errors should have been roughly divided evenly between length and quality, an LAF of 50% ± 10% would thus be considered within the norm. If the LAF is less than 40%, the LAF percent factor is indicated along with the statement "Wrong length substituted—Not attentive enough to length differentiation among vowels." If on the other hand the LAF is greater than 60%, a statement such as that in Figure 2 appears indicating that too much dependence was placed upon length in classifying vowels and not enough upon qualitative distinctions. Further routines in this part of the program compare errors as character strings to distinguish between umlauted vs. non-umlauted sounds (indicating possible orthographic interference), lip-rounded vs. non lip-rounded and umlauted vs. other umlauted vowels. These categories usually account for approximately 50% of all student perception errors.

The following would serve as an example of the nature of a small segment of the analysis routine. A statement intending to express the substitution factor of lip-rounded for non lip-rounded vowels and vice versa would use as a basis the mutual substitutions of y:/Y/ø:/oe for i:/I/e:/ε and vice versa. The letter codes would analyze substitutions of ABCD for LMNO and vice versa, whereas the routine would identify them as numbers 1,2,3,4 for 12, 13, 14, 15 and vice versa. The complete statement for this routine is given below as lines 6540 through 6570 as it actually occurs in the program.

List: 6540-6570

```
6540 IF ER>0 then if O$="p" OR O$="P" THEN LPRINT
AI$:LPRINT A2$:LPRINT A3$:LPRINT ELSE PRINT
AI$:PRINT A2$:PRINT A3$:PRINT

6550 ER=CRI(1,12) + CRI(1,13) + CRI(1,14) + CRI(1,15)
+ CRI(2,12) + CRI(2,13) + CRI(2,14) + CRI(2,15) + CRI(3,12)
+ CRI(3,13) + CRI(3,14) + CRI(3,15) + CRI(4,12) + CRI(4,13)
+ CRI(4,14) + CRI(4,15)

6555 ER=ER+CRI(12,1) + CRI(12,2) + CRI(12,3) + CRI(12,4)
+ CRI(13,1) + CRI(13,2) + CRI(13,3) + CRI(13,4) + CRI(14,1)
+ CRI(14,2) + CRI(14,3) + CRI(14,4) + CRI(15,1) + CRI(15,2)
+ CRI(15,3) + CRI(15,4)

6560 AI$=STR$(ER)+" ERRORS OR" + STR$(INT
(ER/NW*100)) +"% ARE DUE TO THE INABILITY
TO CLEARLY DISTINGUISH": A2$="BETWEEN LIP-
ROUNDED AND NON LIP-ROUNDED FRONT VOWEL
S. BE ATTENTIVE"

6570 A3$="OF THE DIFFERENCE BETWEEN [i:]/[y:],
[e:]/[" + CHR$ (SCR(14)) + "]:], ETC."
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The program has been further developed to provide a more detailed diagnostic analysis of individual vowels. A student can choose to review the errors for individual vowels. The most common errors indicated as substitutions in Figure 1 are then diagnosed in detail along with the severity of that error. For example if [i:] were perceived as [I] a statement indicating that the long vowel (bieten) was perceived as short (bitten) would appear; if [i:] were perceived as [e:] a statement would ensue indicating that the perception was one of the wrong quality (beten instead of bieten); or if [i:] were perceived as [ε] a statement would follow indicating that a long high vowel was perceived as a short vowel of lower quality (betten instead of bieten). In this fashion errors reflecting all commonly substituted vowels are given brief explanations as to the nature of the error.

RESULTS

This analysis program has provided a useful tool in attempts to correct perception errors. It affords the possibility of self-administration of the test and repeated attempts at frequent intervals to monitor progress towards the elimination of errors. It furthermore allows the opportunity to concentrate efforts in goal-directed fashion on specific perceptual problem areas. Since the nature of the errors are by and large predictable based upon contrastive phonetic distinctions between English and German, this program could be further enhanced by providing moving graphic illustrations on the screen correlative to specific physiological activity produced in yielding the error. The program also has the potential coupled to a digitizing/synthesizing package to serve as a precursor to provide virtually automated recognition and correction of pronunciation errors. Together with an interactive video display the result ultimately could be a "computerized phonetician," at least within a limited context where errors are relatively predictable.

REFERENCES

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[2] Weiss, R. and H.-H. Wängler, "Über das Unterrichten deutscher Vokalwerte auf der Grundlage perzeptorischer Normen," Forum Phoneticum, Vol. 5, Hamburg: Helmut Buske Verlag, 1978, pp. 63-78.

[3] Weiss, R. and H.-H. Wängler. German Pronunciation: A Phonetics Manual, Bellingham: Western Washington University Press, 1985, 386 pp.

[4] Weiss, R. "Perception as an Aid in Teaching Pronunciation," Proceedings of the IXth International Congress of Phonetic Sciences, Vol. I, Copenhagen: Institute of Phonetics, University of Copenhagen, 1979, p. 426.

[5] Weiss, R. "A Perception Test as a Diagnostic Tool in Teaching German Pronunciation," Current Issues in the Phonetic Sciences II, (ed. by H. and P. Hollien), Amsterdam: John Benjamin, B.V., 1979, pp. 905-916.

[6] A second version of the test is now almost complete which allows specific vowels to be isolated and provides immediate feedback of errors. It is expected that this version will be particularly useful for an experiment to determine whether goal-directed practice of perception has a significant effect upon changing perceptual parameters.

[7] The analysis routines and sub-routines were developed according to the author's specifications by Scott Honaker, a computer programming student at Western Washington University.

[8] Printworks is a registered trademark of SoftStyle, Inc., 7192 Kalanianaole Hwy., Suite 205, Honolulu, Hawaii 96825. For this application Version 1.0 (Copyright 1984) was used.