A SPEECH DISCRIMINATION TEST USING BILINGUAL COMPETING MESSAGES

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Abstract

Pairs of overlapping arithmetic statements have been recorded by native and non-native bilingual talkers using the English and French languages. In each language numerals are chosen that are easily confusable. Message pairs are counterbalanced by language, sex of talker, ear on playback, etc. such that listeners can be asked to listen to their native (non-native) language, to the (fe)male talker, left (right) ear, true (false) statement, or to the talker with(out) the foreign accent. Control tests,both messages in the same language measure the listeners' basic ability to listen selectively to one of two messages. Results on six bilingual Institut personnel confirm earlier results of a Czech/English version of the test. Only the most bilingually proficient obtain results showing both languages to be equally interferring in a selective attention task. For the others their native language prevails.

Basic Assumptions

This study starts with two basic assumptions, first, that people learn to think in a second language long before they learn to calculate in it, and that the most difficult of communicating situations is when messages compete for your attention, that is when you are trying to listen when two or more people are talking at the same time. Combining these two assumptions into a quantitative, selective attention, speech discrimination test should therefore measure a persons bilingual capability.

Test Paradigm

The basic paradigm is; use pairs of mathematical statements, either true or untrue, that overlap each other, to wit: English/English (E/E)

Fifteen and five = twenty
Fifty minus nine = six

French/French (F/F)

Cent moins dix = quatre-vingt-dix
Cinq et six = cent six

and the bilingual versions of the same sets, E/F and its equivalent F/E:

Fifteen and five = twenty or
Cinq et six = cent six

Cent moins dix = quatre-vingt-dix
Fifty minus nine = six

Note that in all overlapping pairs, one statement is true while the other is untrue. Other parameteLcybxiM balanced in the recording and playback of the test are: one of each pair is spoken by a male voice, the other by a female voice; one is played back to the left ear, the other to the right; and half of the time the English (and the French) message is the first message. When the messages are both in the same language one is spoken by a native speaker, the other by a non- native speaker, that is with a foreign accent.

To make the statements equally difficult in the two languages numeral pairs are specifically chosen to be maximally confusable. In the above examples; in English fifteen and fifty differ by a single phoneme, they are logically and actually very confusable, as are five and nine. In French, both cinq and cent & six and dix are also maximally confusable. The first step in writing the test script is to confer with native phoneticians and map out logical and known confusions. In this manner tests have been layed out in English/Russian, English/Czech, English/Serbo-Croatian and English/German. The matrices are so chosen that any pair of languages in the sets can be matched against each other. For example, Czech/Russian, or Russian/German, or Czech/Serbo-Croatian. Although both the English/Russian and the English/Czech matrices were recorded, only the English/Czech tests were tried out on bilingual listeners, [1].

The test can be used as a simple speech discrimination test by playing back only one of the two channels and requiring a response for the "answer" to the arithmetic statement only. It was in fact tried out in this manner at schools for the deaf in Moscow and Belgrade [1].

Test Construction

The present version of the test compares English with French. Co-authors, Prof. Mario Rossi and Dr Christian Cave furnished me the list of confusable French numerals listed in Table 1.

TABLE 1

CONFUSABLE PAIRS	NUMBER OF TYPES	NUMBER OF TOKENS
1-4*,9*	2	12
1-20	1	1
2-10^,12^	2	4
3-4*	1	6
3-13^	1	2
3-30	1	1
5-7*	1	6
5-100	1	1
6-10^	1	2
11-12^	1	2
13-15^,16^	2	4
30-40^^	1	8
70-90^^	1	8
Total	16	54

KINDS OF TOKENS

*(20,30....60.80)+(1-4,9)
^(60,80)+(2-10,12)
^^(2,3....9)+(30-40)

To interpret the table note in the left column (CONFUSABLE PAIRS) that "un" is confusable with "quatre", and "neuf". In column two this is noted as two TYPES of confusions. However "un", "quatre" and "neuf" are also confusable when combined with "vingt, trente, quarante, cinquante, soixante or quatre vingt", in English twenty, thirty, forty, fifty, sixty and eighty, as shown at the bottom of the table under, KINDS OF TOKENS . Therefore these two TYPES of confusions are represented by twelve TOKENS, as noted in column 3. In line two, note that "un" is also confusable with vingt, one additional TYPE and TOKEN.

Response Format

The answer sheets for these tests are in a multiple-choice format where a choice among four alternatives is required for the actual word discrimination part of the test. Table 2 shows the portion of the answer sheet that the listener would see when answering statements about the confusable pairs "un" and "quatre" and "cinq" and "cent". Choices must also be made between the operator words; plus, and, minus & less in English and between plus, et & moins in French. For the "answer" to the arithmetic statement a one-in-eight choice must be made. Scores between zero and ten points (bits) can be accumulated for correctly perceiving the arithmetic statement. Six additional points can be accumulated for the correct identity of which of the two messages was the first (second) of the overlapping pair, which was in the right (left) ear, which was spoken by the male (female), or with (without) the foreign accent and double credit for specifying whether the statment was arithmetically true or false.

Table 2

PROB TYPE	5 &100 / 1 & 4	35 & 45 / 1 & 4
x 5 ET 1 =	1 96 x	31 41
x 35 PLUS 4 =	4 99 x	34 44
x 45 MOINS 9 =	6 101 x	36 46
x 100 MOINS 20 =	9 104 x	39 49

To the left in Table 2 under "Problem Type" note the column of numerals five, thirty five, forty five and one hundred; the operator words, "et", "plus" and "moins"; and the numerals one, four, nine and twenty. Then note in the column after the equal signs the sets five and one hundred and one and four. The eight numerals in the cell below these represent all eight of the possible combinations of the larger numerals (5 & 100), the operator words and the smaller numerals (1 & 4) from the first column.

Listening Tasks

Three native French and three English speaking listeners, all with considerable knowledge and experience of both French and English served as listeners for a series of F/E, E/F, E/E and F/F tests. After extensive instructions on how to respond on the rather complex answer sheets, they were given the following series of tasks:

Task 1. On the F/E test, "respond to the message in your native language".
Task 2. On replay, "respond to the message in your non-native language".
Task 3. On the third replay, "respond to the left (right) ear message".
Task 4. On the E/E version of the test, "respond to the left (right) message".
Task 5. On the F/F version, "respond to the left (right) ear message".
Tasks 6, 7 & 8. Repeat 3, 4 and 5 answering the first (second) message.
Tasks 9, 10 & 11. Repeat 3, 4 and 5

answering the male (female) voice. Tasks 12 & 13. Repeat 4 and 5 answering only the native (non-native) talker. Tasks 14, 15 & 16. Repeat 3, 4 and 5 answering only that statement that is true. (No attempt was made to have them answer only the untrue statement, this would be much too difficult).

General Results

The listener's test scores can be analized in many ways. Some questions to be answered are: How well are the numerals and operator words in the mathematical statements perceived, that is, how does the test function as a word discrimination test? What type of discrimination errors are made? Do the errors tend to be random or are they concentrated on the specially chosen confusable number pairs? How accurately can the extra-acoustic and phonetic aspects of the messages be identified? Can the message content, the truth or falsity of the arithmetic statement, be be correctly ascertained? How well can the messages be selected on the basis of the acoustic, phonetic and cognitive information contained in them? Tables 3 and 4 will help to answer some of these questions.

Table 3 shows what percentage of the ten bits of information in the arithmetic statement are correctly perceived. Averaged over all listeners and listening conditions that figure is 76.18% Other aspects of the messasge that are perceived this well are the sex of the talker and the ear in which the message is heard. Whether the talker had a foreign accent or not was perceived more than half the time. Not unexpectedly the most difficult thing for the listeners, in the time allowed, (10 seconds), to record the answer was to judge whether the arithmetic statement was true or false. The most surprising shortfall was ascertaining which of the two messages was first, or second. Listeners, including the experimenters, noted that memory for the time of arrival was flighting, if the response was not recorded immediately it could not be recalled. This was not true for talker sex or accent or message localization, left vs right ear. These aspects could be answered any time before the next message arrived. The 69% overall score is ideal for tests of this type, not too difficult and no real problem of truncation.

Table 3
Test Scores in Percent
for various message parameters of the
Bilingual Listening Competing Messsage
Numerical Statement Test

	Listeners		
	French	English	All
Problem(10)	70.63	81.74	76.18
Acoustic(2)			
Ear	69.28	81.13	75.21
Time	38.28	63.02	50.65
Talker(2)			
Sex	69.01	83.64	76.32
Accent	51.43	69.20	60.32
Cognitive(2)	41.28	45.86	43.57
Average	63.55	75.40	69.48

Table 4 shows the average listener scores (in %) according to the task required of them. Column 1 gives the task number, the details of which are listed above. Column 2 is a short hand reference to the tasks listed above. Columns 3 and 4 list scores (in %) for the three native English-language listeners, and columns 5 and 6 list native-French-listeners scores (in %). Columns 2 and 4 are scores for statements spoken in English and columns 3 and 5 for those spoken in French.

Table 4
Test Scores in Percent
for the various listening tasks
Bilingual Listening Competing Messsage
Numerical Statement Test

		Listeners			
		English		French	
		Tests			
Tsk	Selectn Critria*	E/E F/E	F/F *F/E	E/E *F/E	F/F *F/E
1,2	N/nN*	75.00	76.69	59.38	69.79
3	Lft/Rt*	76.95	74.61	63.02	77.34
4,5	Lft/Rt	70.90	72.46	58.08	77.61
6	1/2*	75.39	78.13	53.65	66.15
7,8	1/2	73.05	69.85	62.11	77.87
10,11	Mn/Wmn	88.09	86.62	69.79	84.11
12.13	No/Act	79.45	88.28	60.94	71.62
14	Tr/Fls*	69.14	69.79	39.84	34.63
15,16	Tr/Fls	67.58	40.62	34.90	44.79
Average*		74.12	74.81	53.97	61.98
Average		75.68	72.42	57.16	71.20
ColumnAv		74.99	73.48	55.74	67.10
Grand Average			67.83		

*for the (N)ative/no(nN)ative Language task and all other tasks marked with the asterisk, the F/E test was used.

In both Tables 3 and 4 it will be noted that the "English" listeners obtain higher scores than the French listeners. This reflects the fact that as a group they were considerably more experienced in French ,than the French listeners were experienced in English. Two of the three had been married for ten years to French spouses and had residied in France the whole period The French listeners had at most spent two years in America, and one was a student who had yet to spend any time in an English speaking country. As a group the English listeners show negligible differences between scores on the English statements and scores on the French statements. By contrast the less experienced French listeners make higher scores on French statements regardless of whfether they are overlapped by other French messages or by English messages.

Concerning the types of word/numeral confusions: the majority of errors were ommission errors, but there were many cases of obvious errors among confusable pairs. These were often made to make a logically untrue statement true. The use of numerals does seem to sort out those who have really mastered the second language. Where the experieced English listeners did differ was on asnswereing true statementa as well in French as in English. Only one person could do this and he admitted he had finally learned to "calculate" only withibn the last two years, which happened to coincide with helping his young elementary school boy memorize his "arithmetic tables".

[1] J.C.Webster,"Applied Research on Competing Messages" in J. Tobias and E.D.Schubert, Eds, Hearing Research and Theory, Academic Press, 1983, New York