1-1-1966

An assessment of the relationship between handedness and earedness.

Beatrix R. Horn
University of Windsor

AN ASSESSMENT OF THE RELATIONSHIP BETWEEN HANDEDNESS AND EAREDNESS

by

BEATRIX R. HORN
B.A. University of Toronto, 1959

A Thesis
Submitted to the Faculty of Graduate Studies through the
Department of Psychology in Partial Fulfillment
of the Requirements for the Degree of
Master of Arts at the
University of Windsor

Windsor, Ontario, Canada
1966

ABC 3189

APPROVED BY:

Stephen A. Kushnick

J. E. Callagan

J. V. Brown

136873

ABSTRACT

Forty-eight university students were selected on the basis of their ratings on the Harris Tests of Lateral Dominance, and were divided among five handedness groups (strong right, moderate right, mixed, moderate left and strong left). Their scores for each ear on a dichotic listening test were compared.

In view of Kimura's (1961) findings that the dominant ear is contralateral to the dominant hemisphere for speech and the once accepted theory that speech representation is in the left cerebral hemisphere for right-handers and in the right for left-handers, difference in earedness scores would be expected for all but the mixed group.

A significant difference between ears was found for only the two right-handed groups. A significant linear trend was found for the right ear across handedness groups. Suggestions for further research are made.

PREFACE

The first spark for this study came from A.L. Benton's invitational address to the Canadian Psychological Association which appeared in the Canadian Psychologist October, 1965. It brought to mind experiences in the clinical field of trying to assess the seriousness of mirror-writing and reading disabilities in children which seemed to be connected in some vague way with mixed lateral dominance.

The author wishes to express her gratitude to Dr. S.A. Kushnick for his time, interest and patience in directing this study. Sincere appreciation is also extended to the two Readers, Dr. J. E. Callagan and J.V. Brown for their moral and active support during the most critical stages. Finally a note of thanks goes to the seventy-five students who took time out during the busiest time of the academic year to act as subjects for this research.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

For many years the concept of lateral dominance appeared to be simple and straight forward. Handedness, the most familiar form of lateral dominance, was thought to be the result of the contralateral cerebral hemisphere being the dominant or major one. There is a great amount of empirical evidence that the voluntary motor functions of one side of the body are controlled by the cerebral hemisphere on the opposite, or contralateral side in normal human subjects. If one interprets dominant as meaning strongest or most influential, then it is logical to view the contralateral hemisphere as the dominant hemisphere in handedness. It would also be logical then to assume that other aspects of laterality would be similarily invested in the dominant hemisphere such that a right-handed person would also be right-footed, right-eyed, etc.

According to some authorities (Gardner 1958, Ranson & Clark 1959) the dominant hemisphere is considered the location of the speech and handedness are closely connected. It was from studies of aphasia (a general term which includes many language disorders due to brain lesions) that much of the evidence was obtained which supported the dominant hemisphere-handedness-speech theory. Until recently, information

as to which hemisphere was in fact the dominant one for speech was only available from the results of neurological lesions or neurosurgery.

It was also through the study of aphasia that the handedness-cerebral dominance theory was challenged. Penfield and Roberts (1959) state that the left hemisphere is dominant for speech regardless of handedness. Others (Goodglass & Quadfasel 1954, Brain 1964) take a less extreme view -- that there is no causal relationship between handedness and dominance for speech ("brainedness") but that each develops indendently. There are, however, strong tendencies for humans to be right-handed and to develop speech dominance in the left cerebral hemisphere. Still others (Gillies, MacSweeney & Zangwill 1960, Milner, Branch & Rasmussen 1964) although not denying that most dextrals (right-handers) and many sinistrals (left-handers) have left-hemisphere speech dominance, maintain that the right hemisphere is more likely to play a more important part in speech in people who are left-handed or ambidextrous. There are an increasing number of authors (Goodglass & Quadfasel 1954, Hecaen & Piercy 1956, Gillies et al 1960, Milner et al 1964, Benton 1965, Bryden 1965) who suggest that at least some persons who are left-handed or ambidextrous may not have developed the usual unilateral hemisphere specialization and may be "ambilateral" to some degree.

For many years information as to the dominant hemisphere for speech could be obtained only from the results of neurosurgery or focal brain lesions. Somewhat more conclusive information can now be obtained in such cases through the use of the

"Sodium Amytal Aphasia Test" (Wada & Rasmussen 1960). This test involves intracarotid injections of sodium amytal, one side at a time on successive days. This amytal injection results in immediate short term hemiplegia (paralysis of one side of the body) and, if the dominant hemisphere for speech is involved, some aphasia. This technique is gaining wide acceptance as a method of establishing the dominant hemisphere for speech (Penfield & Roberts 1959, Lansdell 1962, Milner et al 1964, Benton 1965). Unfortunately, there are risks involved in this technique so that its use on subjects without neuropathology cannot be justified (Milner et al 1964).

However, there now appears to be a technique which can be used with normals which indirectly indicates which hemisphere is dominant for speech. Kimura (1961) found that the ear contralateral to the dominant hemisphere for speech, as established by the amytal test, is the more efficient on a dichotic listening test. Using a technique developed by Broadbent (1954) she presented different digits simultaneously to each ear, through stereo earphones attached to a stereo tape recorder. Kimura found that the subject is usually able to report more of the digits arriving at the ear that is contralateral to that subject's dominant hemisphere for speech that he can from the ipsilateral ear. She explains this "earedness" in terms of the greater efficiency of the crossed auditory pathway. It appears that this effect is most likely to be found when there is competition between the two ears. Successive or unilateral presentation does not

usually produce a difference (Kimura 1963a, Palmer 1964a). It is also possible to show little or no difference with the dichnotic technique if the material presented is not of a sufficient level of difficulty (Kimura 1961).

Part of the confusion surrounding the concept of handedness may have arisen from the custom of regarding it as a dichotomy of right versus left, or in some cases, as right versus left and ambidextrous lumped together (Milner et al 1964). There are many who feel that it should be regarded as a continuum or graded dimension (Goodglass & Quadfasel 1954, Harris 1957, Gillies et al 1960, Palmer 1964b). This approach immediately raises the problem of classification or measurement. The traditional index, hand used for writing, although still being used (e.g. Bryden 1964b) would seem to serve only for a dichotomous concept. A slightly more complex approach involves the relative skill of the two hands in a stylus steadiness test (Simon 1964). Another method is the questionaire (Humphrey 1951, Crovitz & Zener 1962, Bryden 1965) on which the subject reports which hand he uses for various common activities. Harris (1957, 1958) combined the questionaire, skill, and other performance items into a short test battery on the basis of which a judgment can be made as to which of five handedness groups a subject belongs (viz. strongly right-handed, moderately right-handed, mixed, moderately left-handed, or strongly left-handed).

There are of course other aspects of laterality besides handedness. Ocular dominance was investigated by Crovitz

(1961), Crovitz & Zener (1962) and Hilborn & Coutlin (1964). Difference between right and left visual fields were studied by Bryden & Rainey (1963) and Bryden (1964). Tactile sensitivity was examined by Weinstein & Sersen (1961) and Fitzhurgh, Fitzhugh & Reitan (1962), while Froeschels (1961) investigated "tonguedness". There are even those who argue that there are personality differences between right- and left-handers (Palmer 1963). Traditionally, dominance of eye and foot were thought to be closely related to that of the hand, but there seems to be considerable difference of opinion on this. Goodglass & Quadfasel (1954) believe that all these functions establish themselves independently. Merrell (1957) claims that there is a close relationship between the preferred foot and the preferred hand but not between hand and eye. Bryden (1965) apparently assumes a close connection between hand and foot for he uses "foot used for kicking" as one of his indices of handedness. Humphrey (1951) found that 71 per cent of strongly left-handed subjects were also left-eyed. Froeschels (1961) found 40 per cent congruity between handedness and footedness, 40 per cent between handedness and eyedness and 20 per cent between all three.

Available information on the dominant ear is almost as confusing. Calearo & Antonelli (1963) presented "interrupted and distorted speech tests" to one ear at a time, to patients with unilateral temporal lobe lesions and to a small group of normals. The normals showed no difference between ears but the patients showed a marked inferiority of the ear contralateral to the lesion. Palmer (1964a) using a monaural

technique with wordlists of descending volume, sought to differentiate between the thresholds for the two ears but found only mild support for the superiority of the right ear. Corso (1963) using a large number of subjects found an average difference between the two ears of somewhat less than 5 db. in pure tone thresholds.

Kimura (1961) did find a difference between ears, as discussed above, with both patients and normal controls. In a later study using right-handed normal subjects, Kimura (1964) again found a right ear superiority for digits presented dichotically, but found a left ear superiority using melodies presented in the same manner with the same subjects. Kimura sees this apparent discrepency as being "related to the different roles of the right and left hemisphere of the brain in verbal and nonverbal perception" (Kimura 1964 p.355), thus reinforcing her original conclusion.

The relationship between this "earedness" for verbal material and handedness is still far from clear. Kimura (1961, 1963a) states that there is no relationship to handedness but carefully picks only right-handers for her normal groups. In another study (1963b) 25 left-handers were omitted "since there are strong reasons for believing that the incidence of right-sided speech representation is higher in natural left-handers" (Kimura 1963b p.899).

Bryden (1965) found the expected superiority of the right ear in a group of right-handed normal subjects using digits presented dichotically, but failed to find a significant difference between ears in a group of left-handers. It

should be noted that Bryden gave his subjects extra instructions to the effect that they were to report all the numbers arriving at one ear before any from the other. The ear to be reported first was alternated. These attention directing instructions may have interfered with the competition between ears which Kimura (1963a) feels is necessary to demonstrate the effect. Bryden also had some difficulty in explaining some of his results and admitted to "the possibility of a sampling artifact" (Bryden 1965 p.4).

Thus, there is as yet no report of a study replicating the method, with which Kimura obtained the relationship between the more efficient ear and the dominant hemisphere for speech, using normal subjects representing the full range of the dextral-sinistral continuum.

If the old theory of cerebral dominance-handedness-speech has any validity, the negative cases (right-brained right-handers and left-brained left-handers) which have been reported would have to be explained in terms of the effects of the neuropathology, or perhaps these atypical cases actually fall in the ambidextrous or mixed catagory as to handedness. The former seems unlikely in view of the various group comparisons that have been made (e.g. Goodglass & Quadfasel 1954) but the latter invites investigation.

This present study will attempt to asses the relationship between handedness and "earedness" using normal subjects. By implication, if Kimura's findings are valid, it should also provide some information on the relationship between handedness and cerebral dominance for speech. The null hypothesis

to be tested is therefore that there is no systematic relationship between handedness and earedness. If there is a systematic relationship one would expect it to be such that the strongly right-handed group would be strongly right-eared, the strongly left-handed group strongly left-eared with the intermediate handedness groups falling in between these extremes on earedness as well.

CHAPTER II

METHOD

Subjects

Selection of subjects for testing with the Harris Tests (see below) was based on students' own statements as to whether they were right- or left-handed. Seventy-five subjects were tested in an attempt to fill each of the five handedness groups with ten Ss each. The total group consisted of 75 students from the University of Windsor ranging in age from 17 to 34. No subject was used who was aware of having suffered any hearing loss or serious head injury. Thus two Ss were discarded on the basis of suspecting hearing loss. Another S was discarded because the vision of one eye was seriously impaired, and a fourth S excluded due to right-sided muscular weakness. More subjects than was necessary were obtained for three of the five groups. The 71 remaining Ss distributed themselves into the five Harris handedness groups as shown in Table 1.

Harris Tests

The Harris Tests of Lateral Dominance (Harris 1958) omitting the optional tests, were administered individually to all subjects. The nature of these test are as follows:

Hand Dominance

1. S pantomimed ten simple acts as throw a ball, cut

with a knife, etc. Hand used for each was noted.

Table I[a]

Composition of Groups

Handedness	No. Ss Tested	No. Ss Used
Strong Right	27	10
Moderate Right	8	8
Mixed	13	10
Moderate Left	13	10
Strong Left	10	10
Total	71	48

a For explanation of sampling procedure see p.12

2. S wrote the numbers 1 to 12 with both hands simultaneously with vision blocked. Number of reversals with each hand and better coordination were noted.

3. S wrote his name with each hand. Time and coordination were noted.

4. S made single dots in successive squares with each hand separately, as quickly as possible. The number made by each hand in twenty seconds was recorded as well as coordination.

5. S dealt one half of a deck of playing cards with each hand. Time taken and hand showing better coordination was recorded.

Eye Dominance

1. S was asked to look through a kaleidoscope, a telescope and sight a toy rifle. Eye used and shoulder for

rifle were noted.

2. S was asked to look through the cones of the ABC Vision Test which were held in both hands, and then to sight through a hole in a 7" by 10" piece of cardboard which was held in both hands at arms length. Sighting eye was recorded.

Foot Dominance

1. S was asked to kick a beanbag and then to repeat it with the other foot. Foot first used and that showing the better coordination were recorded.

2. S pantomimed stamping out a fire. Foot used was recorded.

All tests were given a rating of strong right, moderate right, mixed, moderate left or strong left in accordance with the directions provided by Harris (1958). A similar rating was then obtained from these for total hand dominance, eye dominance and foot dominance. All of these ratings were checked by a second rater. There was 99.44 per cent agreement between the two raters for the 900 ratings.

Dichotic Listening

Using a stereophonic tape recorder (Philips model 400) and stereo earphones, digits were presented simultaneously to each ear such that as one digit arrived at the right ear, a different digit arrived at the left. Two, 3-pair series were presented first for practice, followed by ten, 5-pair test series. The digits were presented at the rate of one pair per half-second, with twenty seconds between series to allow for reporting. The numbers one to nine were used,

which necessitated the repetition of at least one digit in each series. Any such repetition was always presented to the same ear as the original. Frequency of each number was balanced for the two ears as were initial and final numbers. Choice of series length and rate of presentation was made with regard for Kimura's (1961) warning that rather difficult material is necessary with normal subjects and Bryden's (1962) findings that undergraduates correctly reported 65 per cent under these conditions.

Unfortunately, it was found during the pilot study that the sound reaching the two ears was not exactly equivalent in volume or tone (the right appeared clearer) despite changes in the controls of the tape recorder. In an effort to balance the groups for this artifact, one-half of the Ss in each group used the earphones in the normal position and the other half used them reversed. This restricted the random choice of the experimental group from the larger group of that handedness rating. In the three groups where more subjects were obtained than were necessary, five Ss were randomly selected from those who had used the earphones in the normal position and five from those who used them reversed.

All subjects were instructed to attend to both ears and to report everything that they heard in any order they wished. Their total verbal reports were recorded by the experimenter. The number of digits from each ear that was correctly reported was scored for each series.

CHAPTER III

RESULTS

The primary data of this study consist of the number of correctly reported digits from each ear. The group means for each ear are presented graphically in Figure 1.

This data -- the number of correct responses from each ear for each of the five handedness groups -- were subjected to a two-way (5 X 2) analysis of variance according to the method presented by Winer (1962) for groups with unequal n. Table 2 presents the results of this analysis.

Table 2

Summary of Analysis of Variance

Source	SS	df	MS	F
Handedness	84.35	4	21.09	< 1
Earedness	758.08	1	758.08	11.72**
Interaction	547.50	4	136.87	2.12*
Error	5565.28	86	64.71	
Total	6955.21	95		

**p.005 = 3.49 *p.10 = 2.04

Table 2 shows that there was no significant difference between the handedness groups on overall efficiency on the dichotic listening test. There is, however, a significant difference in overall efficiency between the two ears.

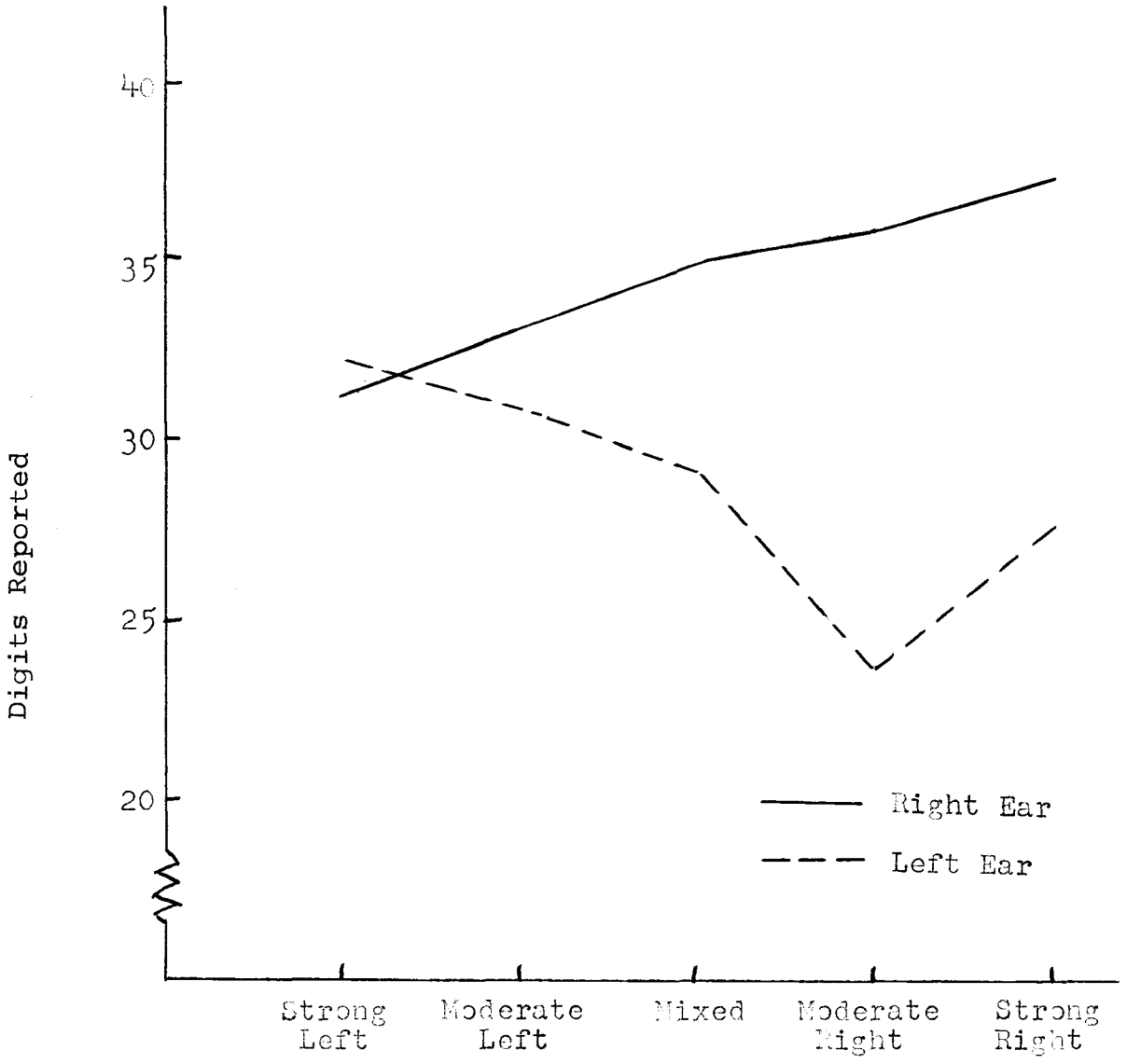


Fig. 1. Mean number of digits correctly reported from each ear for each of the handedness groups.

Referral to Figure 1 makes it apparent that the Ss showed overall superiority with the right ear in this study. The interaction, although not reaching the usual accepted level of significance, should not be completely ignored.

These results were then subjected to an analysis of simple effects (Winer 1962) of earedness for each of the handedness catagories. Table 3 presents a summary of this analysis.

Table 3

Analysis of Variance for Simple Effects

Source	SS	df	MS	F
Earedness for R group	438.68	1	438.68	6.78*
Earedness for r group	699.24	1	699.24	10.81**
Earedness for M group	138.80	1	138.80	2.14
Earedness for l group	23.04	1	23.04	<1
Earedness for L group	5.71	1	5.71	<1
Error	5565.28	86	64.71	

Note: R group - strong right
r group - moderate right
M group - mixed
l group - moderate left
L group - strong left

*p.05 - 3.96
**p.01 - 6.94

From Table 3 it can be seen that the difference between ears is not of the same magnitude for all of the handedness categories. Thus the moderate right and strong right groups show significant differences between ears, but the mixed and left-handed groups show no statistically significant differences.

As the interaction in the main analyses approached significance, it was considered legitimate to break the data into two, one-way analysis of variance (viz. one for each ear) in order to assess any possible trends within the handedness groups and thus obtain the most clear-cut picture of the results. The results of these independent analyses are presented in Table 4.

Table 4 shows that even when taken separately the effect of handedness on ear efficiency is not significant for either ear. Nevertheless, there is a significant ascending linear trend in the data from the right ear and a descending linear trend approaching significance for the left ear. Thus, if the strongly left-handed group is considered as the low point on a continuom of increasing right handedness, as people become more strongly right-handed the right ear increases in efficiency in a linear manner and the left ear trends toward a linear decrease in efficiency.

To test the possible correlation between handedness, eyedness and footedness the Contingency Coefficient was calculated as outlined by Siegel (1956). To meet the requirements for this test it was necessary to combine categories.

Table 4

Results of One-Way Analyses of Variance and Trend Analyses

Source	SS	df	MS	
Right Ear				
Handedness	213.7	4	53.43	1.08
Linear Trend	209.4	1	209.40	4.22**
Residual	4.3	3	1.43	<1
Error	2134.3	43	49.63	
Total	2348.0	47		
Left Ear				
Handedness	319.7	4	97.93	1.23
Linear Trend	271.3	1	271.3	3.30*
Residual	120.4	3	40.13	<1
Error	2431.98	43	79.81	
Total	3751.68	47		

**p.05 = 4.07 *p.10 = 2.84

For each comparison, the strong right and moderate right groups were combined into a single group, with the mixed, moderate left and strong left combined into the second group. Thus three, two-by-two contingency tables were drawn up and analyzed. Table 5 summarizes the results obtained. It should be kept in mind while referring to Table 5 that the maximum C (i.e. for a perfect correlation) on a two-by-two contingency table is .707.

Table 5

Contingency Coefficients

Between	Chi Sqare	C.	Significance
Hand & Eye	9.87	.413	.01
Hand & Foot	17.06	.512	.001
Eye & Foot	18.58	.528	.001

CHAPTER IV

DISCUSSION

On the basis of the five-by-two analysis of variance of the main effects, the null hypothesis (i.e. no systematic relationship between handedness and earedness) cannot be rejected, despite the fact that the interaction approaches significance. The only significant main effect was the difference between ears. However, on further examination through the analysis of simple effects, the obtained differences between ears appears to be mainly due to the marked differences for the two right-handed groups. The mixed and two left-handed groups do not show significant differences between ears. This would seem to imply some differences among the handedness groups in strength of earedness. Further support for this conclusion is given by the trend analysis which shows a significant linear relationship between the efficiency of the right ear and handedness. This shows that as the strength of right-handedness increases so too does right ear efficiency. An almost significant linear trend was found for the left ear which shows a tendency for left ear efficiency to decrease as strength of left handedness decreases. This is, in fact, the type of relationship predicted. These findings make it impossible to accept the null hypothesis without reservation. It would appear that the

underlying linear relationship, particularly between handedness and right-earedness, was overshadowed on the other analyses by wide within-group variation.

The Contingency Coefficients involving handedness, eyedness and footedness show significant correlations for all three combinations. Because of the different schema used for describing and comparing these aspects of lateral dominance, it is difficult to compare these results with those from other studies. Support can be given to Humphrey's (1951) findings in which 71 per cent of his strongly left-handed group were also left-eyed. Nevertheless the correlation between hand and eye was the smallest of the three computed. All three are highly significant, however, which would seem to indicate a certain degree of intra-individual consistency. A larger scale study, possibly including a measure of individual earedness, would probably yield more definitive information.

Bryden (1965) also found right-ear superiority for right-handers but no significant difference between ears for left-handers. However, his left-handed group showed greater variability than the right-handers which would not appear to be the case in this study (standard deviations are shown in Appendix A).

The lack of difference between ears in the two left-handed groups would be consistent with the theory advanced by Hecaen & Piercy (1956), Milner et al (1964) and Benton (1965) which maintains that many left-handers have not developed the same degree of hemisphere specialization as

the majority of right-handers have and are, to some extent at least, "ambilateral" for speech. In view of Kimura's (1961) findings one would therefore expect these left-handed groups to show little or no difference between ears, as they did in the present study.

On the other hand, according to some authorities such as Goodglass & Quadfasel (1954) and Penfield & Roberts (1959), many left-handers have left hemisphere speech representation. Estimates of the proportion of such cases vary but the majority fall in the 50 to 60 per cent range. If this is so then there may have been ten or twelve of the 20 Ss in the two left-handed groups in this study who were "left-brained" for speech and therefore, according to Kimura, right-eared. This would tend to minimize the difference between ears for these groups. By the same token, a much smaller proportion of the right-handers (estimates of six to ten per cent have been advanced) were probably left-eared. This would have a much smaller effect on group means. Thus this theory could also account for the obtained results.

To decide between these two possibilities, a refinement of the dichotic listening technique used in this study would be necessary so that the dominant ear for each individual could be ascertained instead of dealing only with group means. This would require more elaborate equipment so that the equality of reproduction of both tracks of the tape could be achieved, as well as a more precisely balanced stimulus tape. It would also be desirable to obtain some measure of

hearing for each ear for each subject and then to balance the volume for the two ears accordingly.

Another less costly improvement might be made in the dichotic listening test. Within-group variation might be decreased through the use of more practice at the beginning. In this study, only two, 3-pair series were used for practice. Observation of the subjects seemed to indicate that they were unprepared for the first 5-pair series. The Ss seemed to flounder and experiment with different methods of reporting etc. Only after the first three to five, 5-pair series did most Ss appear to "settle down" to a more consistent performance. It might prove useful to use three to five, 5-pair series as practice before beginning testing.

In this study, the moderate right group emerged as deviant, at least for the left ear. The difficulty in obtaining subjects for this group was unfortunate. A slight modification of Harris' scoring standards might serve to ease the situation for future projects. But it was not just the smaller number of subjects which contributed to the deviation of this group. Within this group was the most extreme pair of scores in the whole study. It was obtained from a subject who became very emotional during the dichotic listening test. If this subject was dropped the mean for the left ear for this group would be raised while that of the right ear would be lowered slightly. Such action would also destroy the balance of earphone position (as discussed on page 12) and further deplete the small group. A larger scale

study would make it feasible to drop subjects who manifest marked emotionality during testing. It would also lessen the effect of a few deviant scores.

Whatever else can be said for the rather indefinite results obtained in this study, they do appear to support the growing body of opinion which states that left-handedness is not simply the mirror image of right-handedness. There still appears to be a great deal to be learned about the nature of lateral dominance.

CHAPTER V

SUMMARY

This study undertook to assess the relationship between handedness, as measured by the Harris Tests, and earedness, as measured by a dichotic listening test. If Kimura's (1961) results are valid, then by implication, some light should also be shed on the relationship between handedness and cerebral dominance for speech.

Forty-eight university students were selected on the basis of their ratings on the Harris Tests in an effort to obtain ten Ss in each of the five handedness groups (the moderate right group had only eight). The number of digits correctly reported from each ear on the dichotic listening test were subjected to statistical analysis.

In the analysis of variance, the interaction between earedness and handedness did not quite reach significance. The difference between ears, which was statistically significant, on further examination appears to be mainly due to the marked difference for the two right-handed groups. The mixed group and the two left-handed groups did not show any significant difference in earedness.

A significant ascending linear trend was found in the scores for the right ear. For the left ear the trend, although linear and in the predicted direction, did not quite reach significance. Thus it can be concluded that there is probably

a linear relationship between handedness and earedness but it tends to be hidden by the within-group variation. Further research with a refined dichotic listening technique is needed. This study does tend to support, by implication at least, the theory that speech representation in left-handers is not simply the mirror image of that in right-handers.

The secondary consideration of the dominance of the eye and foot show a fairly strong correlation between handedness and eyedness, handedness and footedness, and eyedness and footedness. This would seem to indicate some degree of intrindividual consistency.

APPENDIX A

INDIVIDUAL SCORES

APPENDIX A

Table 1

Individual Scores
Strong Right-Handed Group

Sub. No.	Sex	Harris Tests Hand	Eye	Foot	Dichotic Listening Right Ear	Left Ear	Earphone Position
8	F	R	R	R	23	35	reversed
18	M	R	R	R	34	23	normal
21	M	R	R	R	48	18	reversed
22	F	R	R	R	42	47	normal
34	M	R	R	R	36	21	normal
37	F	R	R	R	33	21	reversed
43	F	R	R	R	28	24	normal
46	M	R	M	R	47	37	normal
59	F	R	R	R	44	23	reversed
73	F	R	R	R	36	32	reversed
Mean					37.1	27.5	
Standard Deviation					7.74	7.52	

Note: R = strong right
r = moderate right
M = mixed
l = moderate left
L = strong left

APPENDIX A (Cont'd)

Table 2

Individual Scores
Moderate Right-Handed Group

Sub. No.	Sex	Harris Tests Hand	Eye	Foot	Dichotic Listening Right Ear	Left Ear	Earphone Position
36	M	r	R	R	39	27	reversed
40	M	r	R	R	44	9	normal
53	F	r	r	R	35	28	normal
54	F	r	L	M	31	23	reversed
55	F	r	R	R	29	33	reversed
57	M	r	R	R	34	12	normal
70	F	r	L	R	37	12	normal
75	M	r	R	R	37	30	reversed
Mean					35.75	58.38	
Standard Deviation					4.38	8.05	

APPENDIX A (Cont'd)

Table 3

Individual Scores
Mixed-Handed Group

Sub. No.	Sex	Harris Tests			Dichotic Listening		
		Hand	Eye	Foot	Right Ear	Left Ear	Earphone Position
4	F	M	R	M	46	42	normal
5	M	M	R	R	18	41	reversed
15	F	M	r	r	40	16	normal
24	M	M	L	M	34	31	reversed
29	M	M	R	R	42	17	normal
39	M	M	M	R	28	27	normal
47	F	M	L	L	35	19	normal
58	M	M	l	L	40	36	reversed
62	F	M	R	M	29	32	reversed
63	F	M	R	L	35	32	reversed
Mean					34.7	29.3	
Standard Deviation					7.71	8.94	

APPENDIX A (Cont'd)

Table 4

Individual Scores
Moderate Left-Handed Group

Sub. No.	Sex	Harris Tests			Dichotic Listening		
		Hand	Eye	Foot	Right Ear	Left Ear	Earphone Position
6	F	1	L	M	36	43	reversed
7	F	1	L	L	31	17	normal
14	F	1	l	R	29	32	reversed
23	M	1	r	R	28	11	normal
26	F	1	L	R	28	33	normal
28	F	1	r	R	40	25	normal
33	M	1	L	L	34	40	normal
38	M	1	r	R	33	35	reversed
48	M	1	l	M	28	35	reversed
50	M	1	R	R	44	38	reversed
Mean					33.1	30.9	
Standard Deviation					5.24	9.71	

APPENDIX A (Cont'd)

Table 5

Individual Scores
Strong Left-Handed Group

Sub. No.	Sex	Harris Tests			Dichotic Listening		
		Hand	Eye	Foot	Right Ear	Left Ear	Earphone Position
1	M	L	L	L	23	44	reversed
10	F	L	L	M	19	40	reversed
16	M	L	L	M	33	30	normal
17	F	L	L	M	28	34	reversed
27	F	L	L	L	44	41	reversed
30	M	L	r	M	25	24	reversed
41	M	L	M	L	32	26	normal
45	M	L	L	M	37	21	normal
60	F	L	M	R	38	25	normal
74	F	L	L	L	32	37	normal
Mean					31.1	32.2	
Standard Deviation					7.16	7.69	

APPENDIX B

NUMBERS USED FOR DICHOTIC LISTENING

APPENDIX B

Table 1

Numbers used for Dichotic Listening

Series No.	Track 1	Track 2
a	618	294
b	852	636
1	39289	46741
2	26496	51357
3	16798	34252
4	53623	91614
5	65318	47929
6	92782	31536
7	51417	28698
8	45965	18732
9	87481	62965
10	34924	86157

With earphones in the normal position track 1 went to the right ear and track 2 to the left.

APPENDIX C

THE HARRIS TESTS OF LATERAL DOMINANCE

THE HARRIS TESTS OF LATERAL DOMINANCE

Record Blank

Name.....Age.....Date.....Examiner.....

1. Knowledge of Left and Right
R hand..... L ear..... R eye.....

HAND DOMINANCE

2. Hand Preferences R.....%
.1 Throw a ball .....
.2 Wind a watch .....
.3 Hammer a nail .....
.4 Brush teeth .....
.5 Comb hair .....
.6 Turn door knob .....
.7 Hold eraser .....
.8 Use scissors .....
.9 Cut with knife .....
.10 Write .....

3. Simultaneous Writing
No. of Reversals:
R..... L..... .....
Co-ordination better: .....

4. Handwriting
Time: R..... L.....
Co-ordination better: .....

5. Tapping
Number: R..... L.....
Co-ordination better: .....

6. Dealing Cards
Time: R..... L.....
Co-ordination better: .....

7. Strength of Grip (optional)
R..... L..... R..... L.....

EYE DOMINANCE

8. Monocular Tests
.1 Kaleidoscope .....
.2 Telescope .....
.3 Sight rifle
Eye .....
Shoulder .....

9. Binocular Tests
.1 Cone: ....
.2 Hole: ....

10. Stereoscopic Tests (optional)
.1 Teleb: R.....% L.....% Supp?.....

FOOT DOMINANCE

11.1 Kick
Pref..... Other..... Better.....

11.2 Stamp
Foot used.....

RATINGS

Test

KNOWLEDGE OF LEFT AND RIGHT

1 : :
Confused Hesitant Normal

HAND DOMINANCE

: : : :
L L M R R

2 : : : :
L L M R R

3 : : : :
L L M R R

4 : : : :
L L M R R

5 : : : :
L L M R R

6 : : : :
L L M R R

7 : : : :
L L M R R

EYE DOMINANCE

: : : :
L L M R R

8 : : : :
L L M R R

9 : : : :
L L M R R

10 : : : :
L L M R R

FOOT DOMINANCE

11 : : : :
L L M R R

11.1 : : : :
L L M R R

11.2 : : : :

Family Background:

Conversion:

Qualitative Comments:

SIMULTANEOUS WRITING

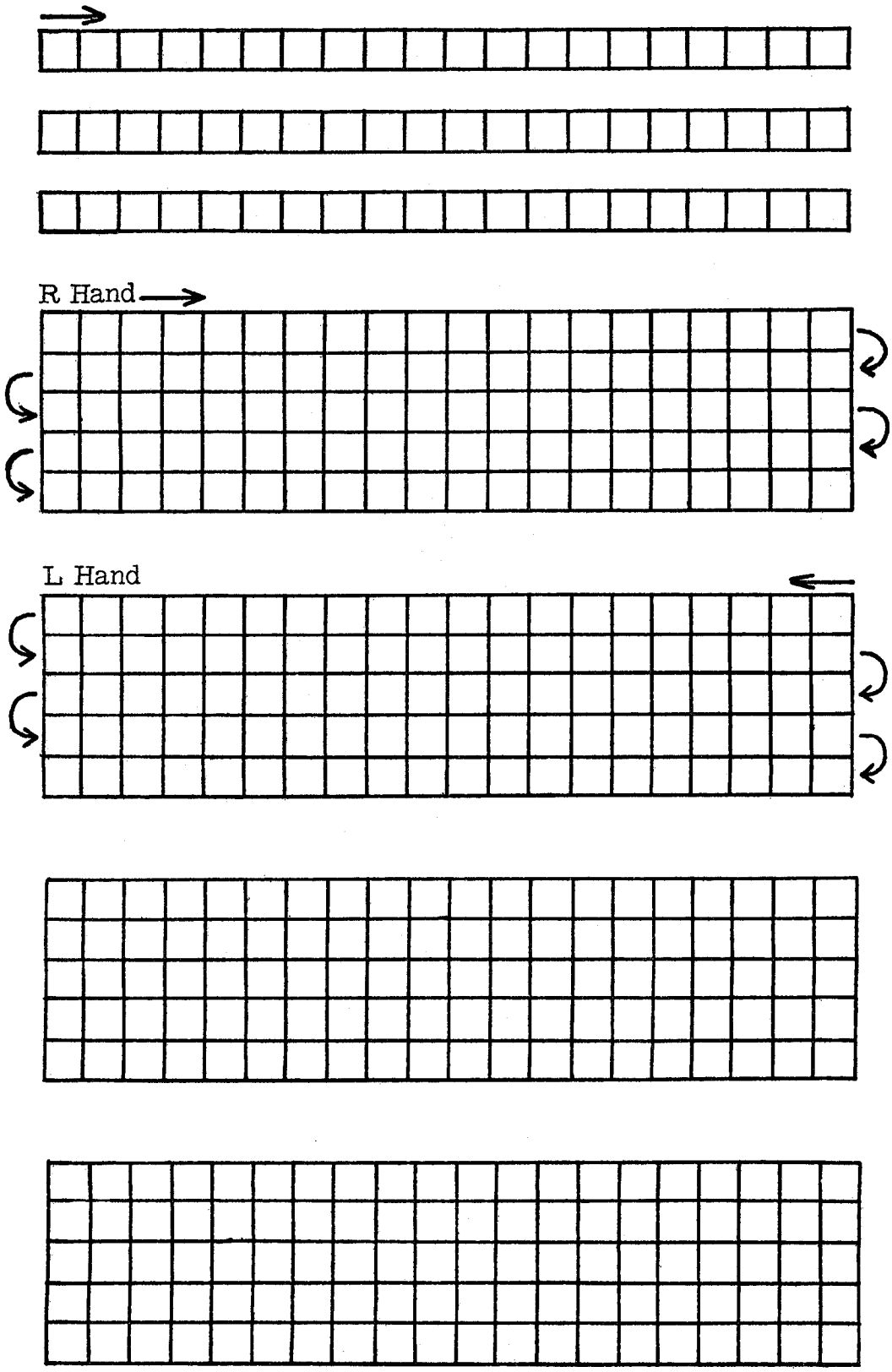
Left *Right*

Printed in U. S. A.

Name..... Hand..... Time..... sec.

Name..... Hand..... Time..... sec.

TAPPING



Distributed by

THE PSYCHOLOGICAL CORPORATION
522 Fifth Avenue
New York 18, N. Y.

BIBLIOGRAPHY

Benton, A.L. The problem of cerebral dominance. Canad. Psychologist, 1965, 6a, 332-348.

Brain, Lord. Statement of the problem. In A.V.S deRueck & M. O'Connor (eds.) Ciba Foundation Symposium on Disorders of Language, London; Churchill, 1964.

Broadbent, D.E. The role of auditory localization in attention and memory span. J.exp. Psychol.1954, 47, 191,196.

Bryden, M.P. Order of report in dichotic listening. Canad. J. Psychol. 1962, 16, 291-229.

Bryden, M.P. Ear preference in auditory perception. J.exp. Psychol. 1963, 65, 103-105.

Bryden, M.P. Tachistoscopic recognition and cerebral dominance. Percept.mot.Skills, 1964, 19, 686.

Bryden, M.P. Tachistoscopic recognition, handedness and cerebral dominance. Neuropsychologica, 1965, 3, 1-8.

Bryden, M.P. & Rainey, C.A. Left-right differences in tachistoscopic recognition, J.exp.Psychol. 1963, 66, 568-571.

Calearo, C. & Antonelli, A.R. "Cortical" hearing tests and cerebral dominance. Acta Oto-laryng. 1963, 56, 17-26.

Corso, J.F. Sex differences in pure tone thresholds. Arch. Oto-laryng. 1963, 77, 385-405.

Crovitz, H.F. Differential acuity of the two eyes and the problem of ocular dominance. Science, 1961, 134, 614.

Crovitz, H.F. & Zener, K. A group test for assessing hand and eye dominance. Amer.J.Psychol. 1962, 75, 271-276.

Fitzhugh, L.C., Fitzhugh, Kathleen & Reitan, R.M. Sensorimotor deficits of brain damaged subjects in relation to intellectual level. Percept.mot.Skills, 1962, 15, 603-608.

Froeschels, E. Is handedness organic or functional in nature? Amer.J.Psychother. 1961, 15, 101-105.

Gardner, E. Fundamentals of Neurology, Philadelphia, Saunders, 1958.

Gillies, S.M., MacSweeney, D.A. & Zangwill, O.L. A note on some unusual handedness patterns. Quart.J.Psychol. 1960, 12, 113-116.

Goodglass, H. & Quadfasel, F.A. Language laterality in left-handed aphasics, Brain, 1954, 77, 521-548.

Harris, A.J. Lateral dominance, directional confusion, and reading disability. J.Psychol. 1957, 44, 283-294.

Harris, A.J. Harris Tests of Lateral Dominance, Manual of Directions, New York, Psychological Corp. 1958.

Hecaen, H. & Piercy, M. Paroxysmal dysphasia and the problem of cerebral dominance. J.Neur.Neurosurg.Psychiat. 1956, 19, 194-201.

Hilborn, E.H. & Conklin, J.E. Lateral dominance as a factor in the perception of non-symbolic material. Percept. mot.Skills, 1964, 18, 83-86.

Humphrey, M.E. Consistency of hand usage. Br.J.educ.Psychol. 1951, 21, 214-225.

Kimura, Doreen. Cerebral dominance and the perception of verbal stimuli. Canad.J.Psychol. 1961, 15, 166-171.

Kimura, Doreen. A note on cerebral dominance in hearing. Acta Oto-laryng. 1963a, 56, 617-618.

Kimura, Doreen. Speech lateralization in young children as determined by an auditory test. J.comp.physiol.Psychol. 1963, 56, 899-902.

Kimura, Doreen. Left-right differences in the perception of melodies. Quart.J.exp.Psychol. 1964, 16, 355-358.

Lansdell, H. Laterality of verbal intelligence in the brain. Science, 1962, 135, 922-923.

Merrell, D.J. Dominance of eye and hand, Hum.Biol. 1957, 29, 314-328.

Milner, Brenda, Branch, H.C., & Rasmussen, T. Observations on cerebral dominance. In A.V.S. deRueck & M. O'Connor (Eds) Ciba Foundation Symposium on Disorders of Language. London, Churchill, 1964.

Palmer, R.D. Hand differentiation and psychological functioning. J.Pers. 1963, 31, 445-461.

Palmer, R.D. Cerebral dominance and auditory asymetry. J. Psychol. 1964a, 58, 157-167.

Palmer, R.D. Development of a differentiated handedness. Psychol. Bull. 1964b, 62, 257-272.

Penfield, W. & Roberts, L. Speech and Brain Mechanisms. Princeton University Press, 1959.

Ranson, S.W. & Clark, S.L. The Anatomy of the Nervous System. Philadelphia, Saunders, 1959.

Siegel, S. Nonparametric Statistics. New York, McGraw Hill 1956.

Simon, J.R. Steadiness, handedness and hand preference. Percept.mot.Skills, 1964, 18, 203-206.

Wada, J. & Rasmussen, T. Intracarotid injection of sodium amytal for the lateralization of cerebral speech dominance. J.Neurosurg. 1960, 17, 266-282.

Weinstein, S. & Sersen, E.A. Tactile sensitivity as a function of handedness and laterality. J.comp.physio.Psychol. 1961, 54, 665-669.

Winer, B.J. Statistical Principles in Experimental Design. New York, McGraw Hill, 1962.

VITA AUCTORIS

1931	Born in Carnduff, Saskatchewan, to Gilbert and Rosa Horn.
1937-49	Attended Public and High School in Carnduff, Saskatchewan.
1959	Graduated with the degree of B.A., University of Toronto, Toronto, Ontario.