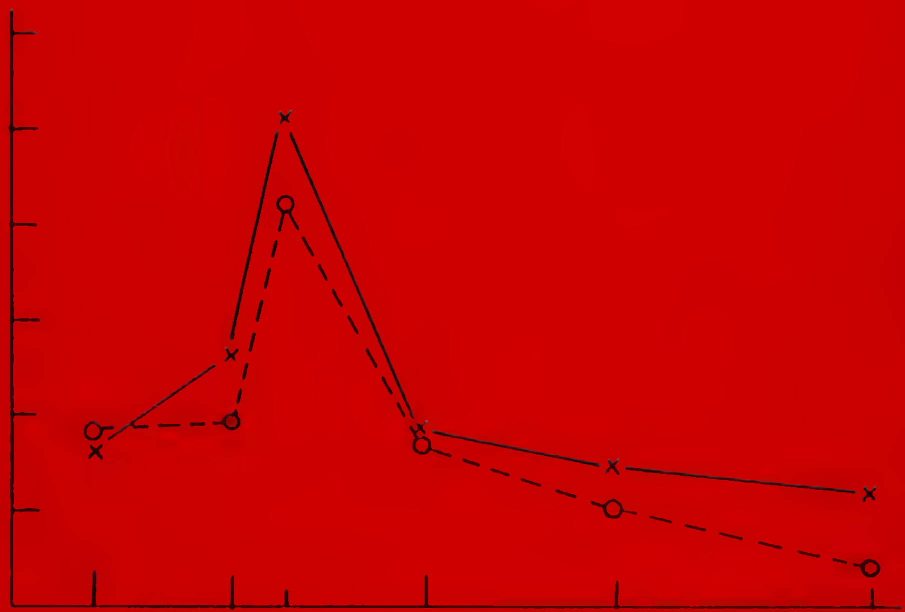
RESEARCH BULLETIN



Number 2 December 1962

AMERICAN FOUNDATION FOR THE BLIND
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RESEARCH BULLETIN

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AMERICAN FOUNDATION FOR THE BLIND

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PREFATORY NOTE

The American Foundation for the Blind, as a matter of course, peruses and evaluates a considerable number of articles, reports and manuscripts. Students occasionally submit their thesis or dissertation for possible publication. A Foundation staff member often encounters a research report or statistics which, in his opinion, merits wider dissemination. In some cases, the Foundation initiates or contracts for a research project and is naturally interested in publishing the findings.

Of these various papers, a few may be fortunate enough to find their way into journals not widely circulated. Others, because of their subject matter or length, may never be published.

For this reason, the Division of Research and Statistics of the American Foundation for the Blind publishes a Research Bulletin, composed both of original manuscripts and of previously published articles. The Research Bulletin appears from time to time and contains sociological, psychological and technological papers of interest primarily to research personnel, and secondarily, to those interested in the general improvement of services to the visually handicapped.

Personnel of the Division of Research and Statistics, together with other specialists on the Foundation staff, constitute an informal editorial board. Papers must be either directly or indirectly relevant to some aspect or problem of visual impairment, and must meet generally accepted research criteria. Since these are the only standards for selection, the articles published herein do not necessarily reflect the opinion of the Trustees and Staff of the American Foundation for the Blind.

We earnestly solicit contributions from all scientific fields and welcome all reaction to published articles.

M. Robert Barnett
Executive Director

TABLE OF CONTENTS

I

SELECTED IMPAIRMENTS BY ETIOLOGY AND ACTIVITY LIMITATION UNITED STATES, JULY 1959 - JUNE 1961

EDITOR'S NOTE:

This paper represents pages 4-14 of Health Statistics Series 5-35, published by the U.S. Department of Health, Education and Welfare, July, 1962. Gracious permission is given the American Foundation for the Blind to publish these excerpts in this issue of the RESEARCH BULLETIN.

VISUAL IMPAIRMENTS

Definitions.- According to the estimates and classification methods of the Health Interview Survey about 3½ million persons among the civilian, noninstitutional residents of the United States have some chronic or permanent difficulty in seeing. This number excludes persons with refractive errors which have been corrected to an extent that they do not cause trouble in seeing. It includes reported visual defects which are defined by the survey according to severity as follows:

1. Severe visual impairments include: that degree of visual impairment in a person 6 years old or older which, according to the respondent's reply, renders him unable to read ordinary newspaper print with glasses; or, for persons under 6 years of age or who have never learned to read, a report of "blind in both eyes," or in terms indicating no useful vision in either eye. This class of impairment is coded to category X00 of the X-Code.

2. Other visual impairments include: visual difficulty in a person 6 years old or older which, however, is not severe enough to prevent him from reading ordinary newspaper print with glasses; or for persons under 6 years of age, or who have never learned to read, a report of trouble in seeing (or something equivalent) but not indicating loss of vision in both eyes. Impairments of this degree are coded to X01-X05 of the X-Code.

In this report the term "severe visual impairments" will be used to denote cases of visual impairment included in class 1 above, whereas in the earlier report (Series B, No.9) the term "blindness" was applied to these cases. The use of the term "blindness" presented the possibility of confusion with the more specific definition of blind persons, which includes those who are considered legally blind, i.e., their central visual acuity is 20/200 or worse with the best correcting lens, or even if they see better than 20/200 their field of vision has been reduced to 20 degrees or less.

Of the 3½ million people reporting visual defects, 988,000 were classified by the survey as having severe visual impairments. The prevalence rate for this degree of severity is 5.6 persons per 1,000 population, and has been consistent during each of the first four years of the Health Interview Survey.

According to the Public Health Service Publication No. 706 - "Facts on Blindness in the United States" [1] - the estimated number of blind persons in this country as of 1957 was 339,000 - a rate of 2.0 per 1,000 population. The considerable difference in rates of 5.6 and 2.0 per 1,000 indicates that the survey question "Can you see well enough to read ordinary newspaper print with glasses?" must be producing negative responses from a number of people who may not be blind to the degree of legal blindness, or perhaps, whose visual acuity might be improved if they possessed and used glasses with the necessary correction. It is also true, however, that a certain proportion of these people are blind and have no useful vision in either eye.

Tabulations of visual impairments in this report show totals for severe and other types combined, and for the severe and other types separately. By this means estimates of the extent of visual problems in the United States may be obtained, at least in so far as they are known to the household members reporting them.

The total number of visual impairments shown herein is also a count of persons, since a person is coded only once by degree of visual loss.

Age and sex.- In all tables which present visual impairments in relation to the age of the person, age groups are shown as under 65, and 65 years of age and over, with the exception of table A which shows finer age breaks. It can be seen that totals for the younger ages, particularly for the severe impairments, are small and are therefore subject to high sampling error.

Two thirds of all cases of severe visual impairments occur among persons 65 years of age or older, with 44.4 per cent among persons 75 years old or older. All types of visual impairments - even the less serious - increase greatly with ages over 45.

Table B shows the prevalence of visual impairments by age and sex in terms of rate per 1,000 population. At ages 65 and over, 108.4 persons per 1,000 have visual impairments; among males of this age the rate is 101.2; among females, 114.3. The rates are higher for females than for males of these ages, regardless of the severity of the impairment. Among younger persons, 11.4 per 1,000 are impaired visually. However, the difference in the rates for males and females noted among those 65 and over is not present among younger persons.

Etiology.- The reported causes of visual impairments by age and sex are shown in tables 1 and 2, arranged in 7 etiologic groups. Each of the 7 groups is composed of 1 or more of the 12 etiologic codes applicable to visual impairments as provided for in the Classification of Impairments (X-Code).

In cases of multiple causes - a not uncommon finding - arbitrary rules were followed in coding. Only one visual impairment per person was assigned and only one etiologic code, per impairment, was applied. For example, when a case was due to injury and also reported to be due to any other cause, preference was given to injury; or if injury was not implicated, and both cataract and glaucoma had caused the impairment, the etiologic code for cataract was selected; or if injury was not implicated, and cataract and also diabetes were the causes, preference was given to diabetes.

The etiologic groups shown in this report for impairments of vision are defined as follows:

The etiologic group "cataract (with any other local eye disease)" contains any case due to cataract alone or with any other local eye disease; it includes cataract of congenital origin, but excludes cataract due to injury or to general diseases.

"Glaucoma, only" includes cases due to glaucoma, congenital or not, but not due to any other cause, and not coupled with any other local eye disease.

"Other local eye diseases" includes cases due to any eye disease, congenital or not - other than cataract or glaucoma - of the types included in categories 370-379, 380-384, 386 and 388 of the International Classification of Diseases (ICD). Here

[1] Source: National Society for the Prevention of Blindness

Table A. Average prevalence and percent distribution of visual impairments by age: United States, July 1959-June 1961

Age	All visual impairments	Severe visual impairments	Other visual impairments	All visual impairments	Severe visual impairments	Other visual impairments
	Average number in thousands			Percent distribution		
All ages						
Total	3,494	988	2,507	100.0	100.0	100.0
Under 65						
Total	1,832	326	1,506	52.4	33.0	60.1
Under 14	211	21	189	6.0	2.1	7.5
15-24	198	21	177	5.7	2.1	7.1
25-34	205	28	177	5.9	2.8	7.1
35-44	259	37	222	7.4	3.7	8.9
45-54	416	88	328	11.9	8.9	13.1
55-64	544	131	413	15.6	13.3	16.5
65+						
Total	1,662	662	1,001	47.6	67.0	39.9
65-74	726	223	504	20.8	22.6	20.1
75+	936	439	497	26.8	44.4	19.8

are classified càses due to retrolental fibroplasia, detached retina, refractive errors, strabismus, corneal conditions, etc., including many cases due to ill-defined eye diseases.

"General diseases (diabetes, stroke, etc.)" includes cases, not involving injury, due to diseases included in ICD categories 140-369, 400-468, and 590-594, such as neoplasms, vascular diseases, diabetes, hypertension, renal diseases.

The group "Injury (with any other cause)" includes cases due to injury alone, or to injury with mention of any other cause.

"Other and ill-defined conditions" includes cases due to trachoma, tuberculosis, poliomyelitis, venereal, or other infective or parasitic diseases, as well as causes not classifiable elsewhere. It is known to include many cases in which the only cause reported was "old age."

The final group "Unknown to respondent" includes cases in which the respondent did not or could not supply any cause of any kind. In 15.4 per cent of all reported visual defects the cause was unknown to the respondent.

Since the prevalence of severe visual impairments is highest along older persons, often because such impairments are caused by diseases characteristic of this segment of the population, the rates among persons of all ages are heavily weighted by the rates for persons 65 years and over. For this reason, the order of frequency of the reported causes of severe visual impairments was the same for all ages as it was for persons 65 years and older (table C). Cataract was the leading cause of severe visual impairments.

The number of cases of severe impairment said to be due to glaucoma ranks last which is contrary to the general opinion. The survey classification methods may be responsible for the relatively small number of cases of any degree of visual impairment reported to be due to glaucoma. Another possibility is that the specific name of this eye disease may not be well known to household respondents. If the latter is true,

Table B. Average prevalence and rate per 1,000 population of visual impairments by sex and age: United States, July 1959-June 1961

Sex and age	All visual impairments	Severe visual impairments	Other visual impairments	All visual impairments	Severe visual impairments	Other visual impairments
	Average number in thousands			Rate per 1,000 population		
Both sexes						
All ages	3,494	988	2,507	19.8	5.6	14.2
Under 65	1,832	326	1,506	11.4	2.0	9.4
65+	1,662	662	1,001	108.4	43.2	65.3
Male						
All ages	1,642	426	1,216	19.1	5.0	14.2
Under 65	943	164	780	12.0	2.1	9.9
65+	698	262	437	101.2	38.0	63.4
Female						
All ages	1,852	562	1,290	20.5	6.2	14.3
Under 65	889	162	726	10.8	2.0	8.8
65+	964	400	564	114.3	47.4	66.9

some cases due to glaucoma may be attributed to some ill-defined eye condition.

Cataract, glaucoma, and other local eye diseases, combined, accounted for 49.5 per cent of all cases of severe visual impairment, for persons of all ages, and 55.0 per cent for persons 65 years of age and over.

The general diseases (diabetes, vascular disease, neoplasms, and hypertension) caused 10.5 per cent of the severe cases at all ages, and 10.1 per cent of such cases at ages 65 and over. Injury (with any other cause), as shown in table C, ranks next to last, as the cause of severe visual impairments at all ages, and also among older persons.

The reported causes of visual impairments are shown in table D, by age, in terms of rates per 1,000 population. Injury is the leading cause among persons under age 65. Of these ages, 2.7 persons per 1,000 have visual impairments due to injury. Table 1 shows that injury accounted for 23.4 per cent of the visual impairments included among persons under 65 years of age. Cataract is the outstanding cause in persons over age 65. The rate for all causes, all types is 108.4 per 1,000 among older persons, but only 11.4 for persons under 65 years of age.

The causes of visual impairments without respect to severity are shown in figure 1 by sex, in terms of rates per 1,000 population. Cataract is the leading cause among females, while injury is the leading cause among males. The rate per 1,000 population in each category of causes is higher for females than for males, except for cases due to injury. The rate for all causes, all types, is 19.1 among males and 20.5 among females, as indicated in table 2.

Activity limitation.- Figure 2 shows, for all visual impairments combined, the extent of activity limitation caused by the person's state of vision. Among all visually impaired persons, under age 65, 78.7 per cent were not affected in their ability to work, keep house, or go to school; 5.4 per cent were unable to engage in the major activity of their group because of their vision; and 15.9 per cent attributed lesser activity restriction to their vision.

Table C. Average prevalence, percent distribution, and rate per 1,000 population of severe visual impairments by etiology, for all ages, and ages 65+, in relative order: United States, July 1959-June 1961

Etiology	All ages			65+		
	Average number in thousands	Percent distribution	Rate per 1,000 population	Average number in thousands	Percent distribution	Rate per 1,000 population
All causes----------	988	100.0	5.6	662	100.0	43.2
Cataract (with any other local eye disease)------	305	30.9	1.7	255	38.5	16.6
Unknown to respondent-----	175	17.7	1.0	103	15.6	6.7
Other and ill-defined conditions--------------	137	13.9	0.8	91	13.7	5.9
Local eye diseases except cataract and glaucoma----------------	135	13.7	0.8	76	11.5	5.0
General diseases (diabetes, stroke, etc.)----	104	10.5	0.6	67	10.1	4.4
Injury (with any other cause)------------------	85	8.6	0.5	37	5.6	2.4
Glaucoma, only------------	48	4.9	0.3	33	5.0	2.2

Table D. Average prevalence and rate per 1,000 population of visual impairments by etiology and age: United States, July 1959-June 1961

Etiology	All ages	Under 65	65+	All ages	Under 65	65+
	Average number in thousands			Rate per 1,000 population		
All causes----------------------	3,494	1,832	1,662	19.8	11.4	108.4
Cataract (with any other local eye disease)----------------------------	936	249	687	5.3	1.5	44.8
Glaucoma, only------------------------	200	100	99	1.1	0.6	6.5
Other local eye diseases--------------	546	376	170	3.1	2.3	11.1
General diseases (diabetes, stroke, etc.)-------------------------------	232	112	120	1.3	0.7	7.8
Injury (with any other cause)---------	570	429	142	3.2	2.7	9.3
Other and ill-defined conditions------	471	267	203	2.7	1.7	13.2
Unknown to respondent-----------------	539	299	240	3.1	1.9	15.7

However, it was found that among the 798,000 males, 17 through 64 years of age, who had visual impairments, 20.9 per cent were reported to be either unable to work or limited in the amount or kind of work they could do.

About 20.6 per cent of the persons aged 65 years and over were reported as having major limitation, 18.7 per cent partially restricted, and 60.6 per cent with no restriction in their usual activities because of their vision. It may be that older persons with visual impairments are attributing activity limitation to causes other than their visual status, or they may consider that they have no regular activity with which their vision interferes.

Among the estimated 4 million persons in the population who are unable to engage in the major activity of their group because of chronic conditions, 442,000 or 11.1 per cent, are limited to this degree because of visual impairments. The corresponding figure for persons with partial limitation is 603,000 or 3.9 per cent.

Table 1. Average prevalence, percent distribution, and rate per 1,000 population of visual impairments by etiology according to age: United States, July 1959-June 1961

[Data are based on household interviews and refer to the living, civilian, noninstitutional population. The survey design and information on the reliability of the estimates are given in Appendix I. Definitions of terms are given in Appendix II]

Etiology[1]	All visual impairments			Severe visual impairments			Other visual impairments		
	All ages	Under 65	65+	All ages	Under 65	65+	All ages	Under 65	65+
	Average number in thousands								
All causes	3,494	1,832	1,662	988	326	662	2,507	1,506	1,001
Cataract (with any other local eye disease)	936	249	687	305	49	255	631	200	432
Glaucoma, only	200	100	99	48	(*)	33	152	86	66
Other local eye diseases	546	376	170	135	59	76	411	317	95
General diseases (diabetes, stroke, etc.)	232	112	120	104	37	67	129	75	54
Injury (with any other cause)	570	429	142	85	48	37	486	381	105
Other and ill-defined conditions	471	267	203	137	46	91	333	221	112
Unknown to respondent	539	299	240	175	72	103	364	227	138
	Percent distribution								
All causes	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cataract (with any other local eye disease)	26.8	13.6	41.3	30.9	15.0	38.5	25.2	13.3	43.2
Glaucoma, only	5.7	5.5	6.0	4.9	(*)	5.0	6.1	5.7	6.6
Other local eye diseases	15.6	20.5	10.2	13.7	18.1	11.5	16.4	21.0	9.5
General diseases (diabetes, stroke, etc.)	6.6	6.1	7.2	10.5	11.3	10.1	5.1	5.0	5.4
Injury (with any other cause)	16.3	23.4	8.5	8.6	14.7	5.6	19.4	25.3	10.5
Other and ill-defined conditions	13.5	14.6	12.2	13.9	14.1	13.7	13.3	14.7	11.2
Unknown to respondent	15.4	16.3	14.4	17.7	22.1	15.6	14.5	15.1	13.8
	Rate per 1,000 population								
All causes	19.8	11.4	108.4	5.6	2.0	43.2	14.2	9.4	65.3
Cataract (with any other local eye disease)	5.3	1.5	44.8	1.7	0.3	16.6	3.6	1.2	28.2
Glaucoma, only	1.1	0.6	6.5	0.3	(*)	2.2	0.9	0.5	4.3
Other local eye diseases	3.1	2.3	11.1	0.8	0.4	5.0	2.3	2.0	6.2
General diseases (diabetes, stroke, etc.)	1.3	0.7	7.8	0.6	0.2	4.4	0.7	0.5	3.5
Injury (with any other cause)	3.2	2.7	9.3	0.5	0.3	2.4	2.8	2.4	6.8
Other and ill-defined conditions	2.7	1.7	13.2	0.8	0.3	5.9	1.9	1.4	7.3
Unknown to respondent	3.1	1.9	15.7	1.0	0.4	6.7	2.1	1.4	9.0

[1]For inclusione in each etiology group, see text, under Hearing Impairments, Etiology.

Table 2. Average prevalence, percent distribution, and rate per 1,000 population of visual impairments by etiology according to sex: United States, July 1959-June 1961

[Data are based on household interviews and refer to the living, civilian, noninstitutional population. The survey design and information on the reliability of the estimates are given in Appendix I. Definitions of terms are given in Appendix II]

Etiology[1]	All visual impairments			Severe visual impairments			Other visual impairments		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
	Average number in thousands								
All causes	3,494	1,642	1,852	988	426	562	2,507	1,216	1,290
Cataract (with any other local eye disease)	936	345	591	305	104	201	631	241	390
Glaucoma, only	200	79	120	48	18	30	152	61	91
Other local eye diseases	546	239	307	135	58	77	411	181	230
General diseases (diabetes, stroke, etc.)	232	78	155	104	33	71	129	45	84
Injury (with any other cause)	570	440	131	85	62	23	486	378	108
Other and ill-defined conditions	471	220	251	137	71	67	333	149	184
Unknown to respondent	539	242	298	175	81	94	364	161	203
	Percent distribution								
All causes	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cataract (with any other local eye disease	26.8	21.0	31.9	30.9	24.4	35.8	25.2	19.8	30.2
Glaucoma, only	5.7	4.8	6.5	4.9	4.2	5.3	6.1	5.0	7.1
Other local eye diseases	15.6	14.6	16.6	13.7	13.6	13.7	16.4	14.9	17.8
General diseases (diabetes, stroke, etc.)	6.6	4.8	8.4	10.5	7.7	12.6	5.1	3.7	6.5
Injury (with any other cause)	16.3	26.8	7.1	8.6	14.6	4.1	19.4	31.1	8.4
Other and ill-defined conditions	13.5	13.4	13.6	13.9	16.7	11.9	13.3	12.3	14.3
Unknown to respondent	15.4	14.7	16.1	17.7	19.0	16.7	14.5	13.2	15.7
	Rate per 1,000 population								
All causes	19.8	19.1	20.5	5.6	5.0	6.2	14.2	14.2	14.3
Cataract (with any other local eye disease)	5.3	4.0	6.5	1.7	1.2	2.2	3.6	2.8	4.3
Glaucoma, only	1.1	0.9	1.3	0.3	0.2	0.3	0.9	0.7	1.0
Other local eye diseases	3.1	2.8	3.4	0.8	0.7	0.9	2.3	2.1	2.5
General diseases (diabetes, stroke, etc.)	1.3	0.9	1.7	0.6	0.4	0.8	0.7	0.5	0.9
Injury (with any other cause)	3.2	5.1	1.4	0.5	0.7	0.3	2.8	4.4	1.2
Other and ill-defined conditions	2.7	2.6	2.8	0.8	0.8	0.7	1.9	1.7	2.0
Unknown to respondent	3.1	2.8	3.3	1.0	0.9	1.0	2.1	1.9	2.2

[1]For inclusions in each etiology group, see text, under Hearing Impairments, Etiology.

Table 3. Average prevalence, percent distribution, and rate per 1,000 population of visual impairments according to age by degree of activity limitation caused by visual impairment: United States, July 1959-June 1961

[Data are based on household interviews and refer to the living, civilian, noninstitutional population. The survey design and information on the reliability of the estimates are given in Appendix I. Definitions of terms are given in Appendix II]

Age and degree of activity limitation	All visual impairments	Severe visual impairments	Other visual impairments	All visual impairments	Severe visual impairments	Other visual impairments	All visual impairments	Severe visual impairments	Other visual impairments
	Average number in thousands			Percent distribution			Rate per 1,000 population		
All ages									
Total	3,494	988	2,507	100.0	100.0	100.0	19.8	5.6	14.2
With major limitation	442	312	130	12.7	31.6	5.2	2.5	1.8	0.7
With partial limitation	603	266	336	17.3	26.9	13.4	3.4	1.5	1.9
With no limitation	2,449	409	2,041	70.1	41.4	81.4	13.9	2.3	11.6
Under 65									
Total	1,832	326	1,506	100.0	100.0	100.0	11.4	2.0	9.4
With major limitation	99	63	37	5.4	19.3	2.5	0.6	0.4	0.2
With partial limitation	291	103	188	15.9	31.6	12.5	1.8	0.6	1.2
With no limitation	1,441	160	1,281	78.7	49.1	85.1	9.0	1.0	8.0
65+									
Total	1,662	662	1,001	100.0	100.0	100.0	108.4	43.2	65.3
With major limitation	343	250	93	20.6	37.8	9.3	22.4	16.3	6.1
With partial limitation	311	163	148	18.7	24.6	14.8	20.3	10.6	9.7
With no limitation	1,008	248	760	60.6	37.5	75.9	65.7	16.2	49.6

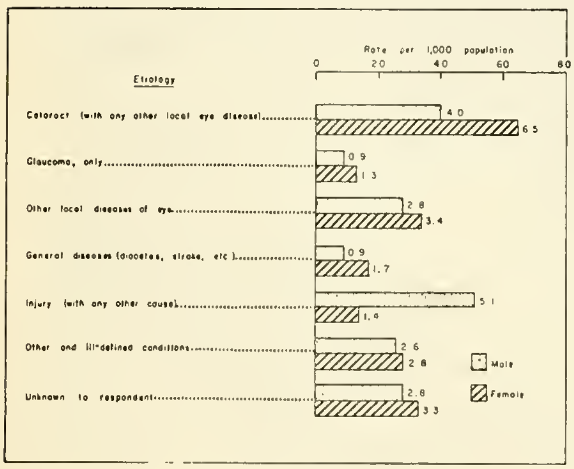


Figure 1. Average prevalence of visual impairments per 1,000 population by sex and etiology.

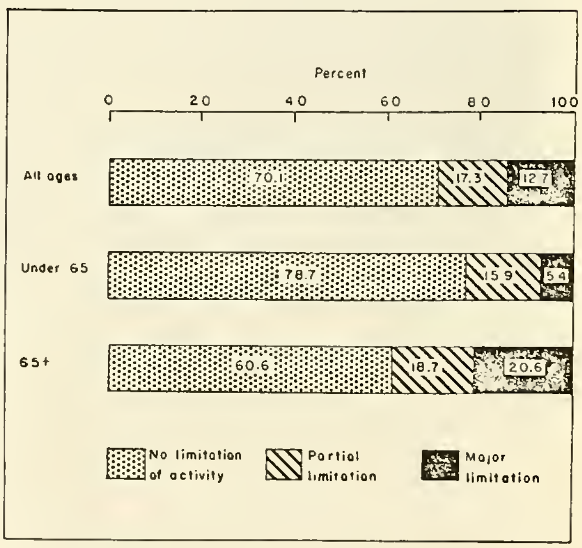


Figure 2. Percent of total visual impairments by activity limitation caused by the impairment according to age.

The average prevalence of hearing impairments, of all degrees of severity, among the civilian, noninstitutional population of the United States for the years July 1959-June 1961, is estimated to be about $6\frac{1}{4}$ million - a rate of 35.3 per 1,000 population. This is somewhat higher than the 5,822,000 cases (34.6 per 1,000 population) shown in the earlier report for the fiscal year 1958.

The survey definition and general questioning technique in relation to the number of hearing impairments did not change during these years. The interviewer asked for the cause, and whether one or both ears were affected, but there was no special question, as in the case of visual impairments, to obtain the degree of hearing loss. Hearing impairment can be coded in several degrees of severity as shown in the Classification of Impairments (X-Code) in Appendix II, but all degrees, specified or not specified by the respondent, have been combined in this report.

The number of hearing impairments is also the number of persons who have loss or decrease of hearing since only one hearing impairment per person is coded.

Age and sex.- Rates for hearing impairments increase greatly with age, and are appreciably more prevalent among males than among females, as summarized in tables E and F.

The rates of persons with hearing impairments, particularly among children, are less than rates derived from audiometric examinations. The rates shown here more nearly approximate other estimates of the volume of persons who will voluntarily seek professional care when informed of clinical evidence that they have hearing loss. The Health Interview Survey item on Card B concerning "deafness or serious trouble with hearing" elicits reports of hearing loss measurable at a level which the respondent considers serious. It provides an estimate of the number of persons with functional defects relative to the person's age and other characteristics. The survey does not provide an estimate of the number of clinically detectable cases, nor of the number of persons who would benefit from professional help.

Etiology.- The causes of hearing impairments, as reported by household respondents, are coded in the survey by adding the appropriate etiologic code to the type of

Table E. Average prevalence, percent distribution, and rate per 1,000 population of hearing impairments by age: United States, July 1959-June 1961

Age	Average number in thousands	Percent distribution	Rate per 1,000 population
All ages	6,231	100.0	35.3
Under 25	607	9.7	7.6
25-44	1,008	16.2	22.2
45-64	1,843	29.6	51.2
65-74	1,300	20.9	129.6
75+	1,472	23.6	277.4

Table F. Average prevalence, percent distribution, and rate per 1,000 population of hearing impairments by sex: United States, July 1959-June 1961

Sex	Average number in thousands	Percent distribution	Rate per 1,000 population
Both sexes	6,231	100.0	35.3
Male	3,584	57.5	41.8
Female	2,647	42.5	29.2

hearing impairment. The 12 etiologic codes applicable to all impairments, except of vision, are listed in Appendix II, following category X99 of the X-Code. These factors have been combined into 4 etiology groups as shown in tables 4 and 5.

"Infection" includes all cases due to infective and parasitic diseases - as in categories 001-138 of the International Classification of Diseases - or to infection, abscess, or any inflammation of the ear or any part of the body.

"Injury" includes cases due to sudden accidental injury.

"Other and ill-defined conditions" include all cases due to named causes other than infection or injury. It is known to include many cases said to be due to "old age," or described as "hereditary," with no specific disease given. It also includes cases of hearing impairment due to continued exposure to loud noise.

In 35.0 per cent of all cases no cause of any kind was reported, and this was true of both sexes. Older people who developed hearing loss in early childhood often do not know the cause of the impairment. Also, persons whose hearing loss has developed gradually are frequently unable to ascribe it to a particular cause.

Infection was reported to be responsible for 20.7 per cent of all cases of hearing impairment in larger proportions among persons under 45 years of age. Infection caused a slightly higher number of cases among females than among males.

The considerable difference in the per cent due to injury as shown in this report compared with that shown in the earlier report warrants comment (table G).

Effective July 1, 1959, instructions to interviewers and coders emphasized the ruling that conditions due to continued exposure, except to poisonous fumes or substances, should not be counted as accidents, nor as due to accidental injury. It is likely, therefore, that during the early years of the survey some cases of impaired hearing due to working in noisy places or to the effects of war service were charged to injury. Beginning July 1, 1959 such cases were not classified as due to injury. The difference in numbers and per cent is seen to be entirely among males whose occupations often involve continued exposure to loud noise of one kind or another. Survey classification methods, to date, do not provide for the precise identification of hearing impairments or any other condition due to occupational hazards of a prolonged nature.

The other and ill-defined conditions, not involving injuries or infection, caused 37.0 per cent of all hearing impairments.

Activity limitation.- About 93 per cent of the persons with hearing impairments were reported to have no limitation of any kind in their usual activities because of this type of impairment. Because of the low percentage of cases causing activity limitation, detailed figures on this aspect of hearing impairments are not included in this report.

Table G. Average number and percent of hearing impairments due to injury, by sex, during July 1957-June 1958 and July 1959-June 1961

Time interval	Number in thousands			Percent		
	Both sexes	Male	Female	Both sexes	Male	Female
July 1957-June 1958	750	644	106	12.9	19.7	4.2
July 1959-June 1961 (average)	452	345	107	7.3	9.6	4.0

Table 4. Average prevalence, percent distribution, and rate per 1,000 population of hearing impairments by etiology according to age: United States, July 1959-June 1961

[Data are based on household interviews and refer to the living, civilian, noninstitutional population. The survey design and information on the reliability of the estimates are given in Appendix I. Definitions of terms are given in Appendix II]

Etiology[1]	Age					
	All ages	Under 25	25-44	45-64	65-74	75+
	Average number in thousands					
All causes	6,231	607	1,008	1,843	1,300	1,472
Infection	1,291	239	301	422	187	142
Injury	452	55	133	154	62	48
Other and ill-defined conditions	2,308	175	303	614	490	726
Unknown to respondent	2,180	138	271	654	562	555
	Percent distribution					
All causes	100.0	100.0	100.0	100.0	100.0	100.0
Infection	20.7	39.4	29.9	22.9	14.4	9.6
Injury	7.3	9.1	13.2	8.4	4.8	3.3
Other and ill-defined conditions	37.0	28.8	30.1	33.3	37.7	49.3
Unknown to respondent	35.0	22.7	26.9	35.5	43.2	37.7
	Rate per 1,000 population					
All causes	35.3	7.6	22.2	51.2	129.6	277.4
Infection	7.3	3.0	6.6	11.7	18.6	26.8
Injury	2.6	0.7	2.9	4.3	6.2	9.0
Other and ill-defined conditions	13.1	2.2	6.7	17.1	48.9	136.8
Unknown to respondent	12.4	1.7	6.0	18.2	56.0	104.6

Table 5. Average prevalence, percent distribution, and rate per 1,000 population of hearing impairments by etiology according to sex: United States, July 1959-June 1961

(See headnote on table 4)

Etiology[1]	Sex								
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
	Average number in thousands			Percent distribution			Rate per 1,000 population		
All causes	6,231	3,584	2,647	100.0	100.0	100.0	35.3	41.8	29.2
Infection	1,291	619	672	20.7	17.3	25.4	7.3	7.2	7.4
Injury	452	345	107	7.3	9.6	4.0	2.6	4.0	1.2
Other and ill-defined conditions	2,308	1,353	955	37.0	37.8	36.1	13.1	15.8	10.5
Unknown to respondent	2,180	1,267	913	35.0	35.4	34.5	12.4	14.8	10.1

[1]For inclusions in each etiology group, see text, under Hearing Impairments, Etiology.

II

AN EXPERIMENT USING REVISED STIMULUS PRESENTATION

by

S. Karp

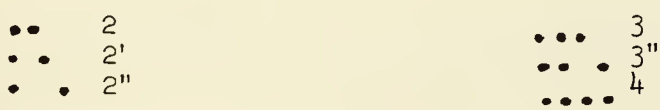
EDITOR'S NOTE:

This paper has been received from The Engineering Projects Laboratory Department of Mechanical Engineering, Massachusetts Institute of Technology, April 3, 1962 (M-8768-5). The research was supported in part by the Department of Health, Education, and Welfare (OVR) under contract SAV-1004-61 and sponsored by the Division of Sponsored Research of M.I.T.

The purpose of this additional experiment was to determine whether the physical techniques used in the previous experiments would hold up when the stimuli were varied in such a way as to facilitate learning.

In previous experiments, with the exception of the distance judgement experiment, the performance was poor enough so that it was felt that the learning of the stimuli themselves was a problem - this in addition to the tactual recognition.

The new stimuli were chosen specially so that they would not present the above problem as before 6 were used. They consisted of rounded escutcheon pins mounted on a cardboard base and raised about one diameter. They are pictured below in full scale:



In the training session, the following instructions were read to the subjects (12 M.I.T. male students).

"You are going to be presented with six different stimuli. They will consist of 2, 3 or 6 pin heads pushed through small pieces of cardboard. Here are the six stimuli." (Arranged on the desk so subjects may look at them). "As you can see they are identified by the number of pins in the pattern. The appearance of a prime means that there is a space in the line and a double prime means that there are 2 spaces. Your task will be to learn to identify these stimuli with your index finger and without looking at them."

It was predicted that the three methods of presentation (place, movement, and free movement) would order themselves as before and that if anything the effects of these methods would be even stronger than in previous studies. It was felt that in the previous methods by introducing the additional learning, the main effects (methods of presentation) were diluted.

The analysis of variance done on the data follows:

Analysis of Variance for Supplementary Experiment

Source	df	subjects	ms	f
between S,s	(")	(75.57)		
B	2	5.73	2.86	1
error (b)	9	68.84	7.65	
within S,s	24	(1175.32)		
A	2	943.73	471.86	49.05*
AB	4	58.43	14.61	1.52
error (w)	18	173.16	9.62	
Total	35	1249.86		

*significant at $\angle$ 0.001 level

It may be seen that the main effect A was very highly significant. The number of errors in the experiment was found to be 285 as compared to 644, 700, 702 in previous experiments with the same number of trials. Thus as predicted, the errors fell tremendously and the effect was far stronger than before.

Lateral or Tangential

The experiment also tested for an additional effect. The instructions given to the subjects during training follow:

"There will be 2 methods of presenting the patterns, one half of the stimuli being presented each way. In the first case the stimulus will be given so that the line of pins is parallel to the line of your finger." (termed "tangential" below). "In the other half of the trials, the presentation will be perpendicular." (termed "lateral" below).

This was done to see whether any sizeable differences between the two methods would occur. The following table summarizes some of the results.

Method (Number of Errors)

Movement		Free Movement		Place	
65		57		162	
Tan.	Lat.	Tan.	Lat.	Tan.	Lat.
37	28	25	32	80	82

Thus it may be seen that the difference between the number of errors was decidedly insignificant.

A further breakdown disclosed more of the same sort of results. This time the errors were broken down by stimuli rather than by method. The following results were found:

Errors

Stimulus	Lateral	Tangential
2	3	10
2'	23	34
2"	23	13
3	31	38
3"	28	22
4	30	30

It can be concluded that while there were definite differences between the difficulty of the stimuli, the differences were minor between the methods of presentation. Possible exceptions to them are 2 and 2".

Another breakdown by error follows:

	2	2'	2"	3	3'	4
2	x	5	1	5	0	
2'	13	x	10	5	26	1
2"	2	18	x	3	13	0
3	11	17	4	x	30	6
3'	1	17	28	4	x	1
4	0	5	3	33	20	x

This shows also that although there are obvious differences in where errors are made, there is no systematic trend.

Thus, in regard to the lateral versus tangential presentation, neither form of presentation is significantly better.

In regard to motor participation, however, free motion by the subject over the raised dot pattern yields much better recognition than if the pattern is presented by the experimenter in one place or moved over the skin at a constant rate.

III

EXPERIMENTS IN TACTUAL PERCEPTION

by

S. Karp

EDITOR'S NOTE:

This paper has been received from The Engineering Projects Laboratory, Massachusetts Institute of Technology, February 27, 1962 (DSR-8768-4). The research was supported in part by the Department of Health, Education, and Welfare (OVR) under contract SAV-1004-61 and sponsored by the Division of Sponsored Research of M.I.T.

Background. The purpose of this report is to discuss the results of a series of 4 experiments in tactile discrimination. The experiments concerned various physical techniques in learning to identify tactile stimuli with the finger. Of special interest was the role of motor activity in tactile sensing.

The physical techniques involved are as follows:

1. The "place" method. In this procedure S's were given the stimulus directly on their fingers.
2. The "movement" technique. Under these conditions the stimulus was moved across S's finger at a speed controlled by the experimenter.
3. "Free movement." The individuals in the experiment were allowed to move their fingers freely over the stimuli.

It was predicted that S's would do best under condition 3, second best under condition 2 and least well with the place method. The basis of this prediction comes from various studies which have been done on tactual perception. (Austin and Sleight, 1952, a[1] and b[2], 1952; Bauer, 1952[3]; Groth and Lyman,[4] 1958) in which it has been shown that movement facilitates tactual perception. It was suggested by these studies that free movement would be better than controlled movement in being a perceptual aid.

In all four of the experiments, S's received 36 test trials under each of the above described conditions. The conditions were counterbalanced in order to control for a possible "ordering" effect. The above control appears as main effect "A" in the later reported analyses of variance.

Training in all experiments consisted of 3 presentations of each of the six stimuli under the condition given first. Under the following 2 conditions the stimuli were presented once each. It may be repeated here that the conditions were ordered in 3 different ways and that as a result the longer training was under different conditions.

The four experiments and their results are as follows:

1. The Distance Judgement Experiment.

In this study 15 male M.I.T. students were trained to judge the distance between two blunted pins attached to the end of a pair of dividers. In this experiment, as in the following, there were six stimuli involved. The distances between pins - 1/6", 2/6", 3/6", 4/6", 5/6", 6/6". They were called 1, 2, 3, 4, 5, 6 in the order of their magnitude. The data were analyzed using a two way analysis of variance. This is reported in Table 1. The number of errors made under the different conditions was considered the critical variable.

Table 1

Analysis of Variance for Distance Judgement Experiment Using Number of Errors

Source	df	SS	MS	F
Between S's	(14)	(1118.6)		
Ordering (B)	2	112.1	56.5	<1
Error (b)	12	1006.5	83.27	
Within S's	(30)	(359.4)		
Methods (A)	2	25.2	12.60	<1
Interaction (AB)	4	15.5	3.88	<1
Errors (w)	24	318.7	13.28	
Total	44			

It can be seen from Table 1 that the methods did not differ significantly from

[1] Listed in Bibliography

each other under these conditions. The actual raw data for the whole group showed 113 errors under free movement conditions, 122 under place, and 140 under movement. It is unwise to speculate from insignificant results. Nonetheless it may be that the especially poor results under movement conditions may be a result of conflicting cues set up by the motion - which are irrelevant to the distance judgements.

It may be noted here also that the ordering effect and the interactions were also insignificant.

2. <u>The Braille Card Experiment</u>.

In this study <u>S's</u> were trained to discriminate the following six stimuli printed with a braille machine on 3x5 cards.

1	2	3	4	5	6
. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .

The braille cell is a 3x2 block $\left(\begin{smallmatrix}\cdot&\cdot\\\cdot&\cdot\\\cdot&\cdot\end{smallmatrix}\right)$. Thus the above configurations represent 6 out of the 7 possible configurations of 2 bumps which can be discriminated apart from any surrounding context.

<u>S's</u> in this experiment were 12 male M.I.T. students. The procedure, apart from the stimuli themselves, was identical with the one used in Experiment 1.

The data collected were analyzed again using an analysis of variance technique. The results appear in Table II.

Table II

Analysis of Variance in Braille Card Experiment

Source	df	SS	MS	F
Between <u>S's</u>	(11)	(678.9)		
Ordering (B)	2	70.1	35.0	∠1
Error (b)	9	608.8	67.6	
Within <u>S's</u>	(24)	(1732.7)		
Techniques A	2	779.1	389.5	6.45*
Interaction AB	4	235.4	58.8	1.47
Error (w)	18	718.2	39.9	
Total	35	2411.6		

* sign∠1.0

It is quite clear that the three techniques cause different numbers of errors to be made. The differences are significant at the one per cent level. In addition, the order of the three condition is as predicted. That is 272 errors were made under place, 232 under movement, and 139 under free movement.

Interactions and order were again insignificant.

3. Braille Card-Pin Experiment.

It was found in the braille card experiment that S's were making large numbers of errors. (A total of 644 errors in 1296 presentations occurred). In an effort to improve conditions, the heads of brass pins were stuck through the cards. These pins were chosen because they were about the same size as the original cardboard raised dots. It was felt that the metal would be easier to perceive than the cardboard. It was found that on the contrary the pins caused more errors to be made (700 as compared with 644). The data was further examined to see whether this experiment produced any different results than the one before. The analysis of variance performed is shown in Table III.

Table III

Analysis of Variance in Braille Card-Pin Experiment

Source	df	SS	MS	F
Between S's	(11)	(1196.22)		
Ordering (B)	2	96.22	48.11	<1
Error (b)	9	1000.00	111.11	
Within S's	(24)	(966.67)		
Methods (A)	2	502.39	251.20	10.79*
Interaction AB	4	45.28	11.32	<1
Error (w)	18	419.00	23.28	
Total	35	2162.89		

* $<.005$

Thus the methods are again shown to be the only significant effect in the experiment ($F = 10.79$ sign $<.005$ for 2 and 18 df). Thus the experiment may be regarded as a replication of number 2.

The loss of accuracy is hard to explain. Perhaps the harder metal caused inhibition of nearly neurons and thereby a loss of ability to discriminate. But this is only speculation.

4. Braille Cards with Revised Training Procedure.

This procedure was another attempt at improving learning. It involved giving full feed-back to the first 12 of 36 stimuli on the first presented method and to the first six on the second and third methods. It was also found here that learning was less good than under the original conditions of Experiment 2. (702 errors as compared to 644). The analysis of variance follows:

Table IV

Analysis of Variance for Experiment Using Braille Cards with Revised Training Procedure

Source	df	SS	MS	F
Between S's	(14)	(2394.33)		
Ordering (B)	2	1485.22	742.61	9.80*
Error (b)	12	909.11	75.76	
Within S's	(30)	(862.67)		
Methods (A)	2	366.50	183.25	9.12*
Interaction AB	4	13.78	3.44	<1
Error (w)	24	482.39	20.10	
Total	44			

* sign $<.005$

This showed quite a different pattern than previous experiments. Both the methods and the ordering were found to be highly significant. No explanation is offered.

Conclusions.

From this series of experiments the following conclusions may be drawn:

1. Performance under each of the three conditions was essentially the same when distance judgements were made.
2. The free movement condition was best, movement second best, and place least good for all experiments involving pattern learning (i.e., Experiments 2, 3 and 4).
3. Using rigid metal pin heads as compared with embossed paper and increasing the feed-back while using embossed cards did not seem to improve learning.

Source of Variance	degrees of freedom	Sum of Squares	mean square	F	
between subjects	$n-1$	$SS_S = \sum_j \sum_k (\sum_i x_{ijk})^2/a - \frac{T^2}{N}$	*		
ordering B	$b-1$	$SS_B = \sum_j (\sum_i \sum_k X_{ijk})^2/ac - \frac{T^2}{N}$		$\frac{SS_B}{SS_{error(b)}}$	→ main effect B
error (b)	$n-b$	$SS_{error(b)} = SS_S - SS_B$			
within S's	$n(a-1)$	$SS_w S = SS_T - SS_S$			
methods A	$a-1$	$SS_A = \sum_i (\sum_j \sum_k X_{ijk})^2/n - \frac{T^2}{N}$		$\frac{SS_A}{SS_{error(w)}}$	→ main effect A
interaction AB	$(a-1)(b-1)$	$SS_{AB} = SS_{\overline{AB}}$ ** $- SS_A - SS_B$		$\frac{SS_{AB}}{SS_{error(w)}}$	→ interaction AB
error (w)	$(a-1)(n-b)$	$SS_{error_w} = SS_w S - SS_A - SS_{AB}$			
Total	$an-1$	$SS_T = \sum_i \sum_j \sum_k (x_{ijk}) - \frac{T^2}{N}$			

* In all cases mean square is equal to sum of squares divided by degrees of freedom.

** $SS_{\overline{AB}} = \sum_i \sum_j (\sum_k X_{ijk})^2/c - \frac{T^2}{N}$

Appendix

Experimental Design Employed

a

Order (b)	$i = 1$	$i = 2$	$i = 3$
$j = 1$	k=1 k=2 k=3 k=4	k=1 k=2 k=3 k=4	k=1 k=2 k=3 k=4
$j = 2$	k=1 k=2 k=3 k=4	k=1 k=2 k=3 k=4	k=1 k=2 k=3 k=4
$j = 3$	k=1 k=2 k=3 k=4	k=1 k=2 k=3 k=4	k=1 k=2 k=3 k=4

a = total number of methods i (3 in all cases)
b = total number of orders j (3 in all cases)
c = total number of subjects in each cell k
n = total number of subjects
T = total sum of scores across subjects, orders and methods = sum of all entries in table
N = total number of entries

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A STUDY OF BRAILLE CODE REVISIONS

by

Gerald Francis Staack

EDITOR'S NOTE:

This paper is excerpted from a Master's Thesis submitted to the Massachusetts Institute of Technology in 1962. A great deal of useful historical background and discussion about the use of specific contractions has been omitted. For the same reason illustrative Appendix E which illustrates the 7090 program is available only in the complete thesis. The material presented herein should be sufficient for learning the results of the braille space saving research and comprehension testing. The research was supported in part by the Department of Health, Education, and Welfare (OVR) under contract SAV-1004-61 and sponsored by the Division of Sponsored Research of M.I.T.

ABSTRACT

This thesis is an analytical study of Grade II braille for the purpose of determining what revisions are necessary to make it possible to translate from regular printed material to braille. At the present time, this problem is complicated by both the 189 contractions which are used in braille and the requirements that many of these contractions not be allowed to overlap syllables.

Three criteria are developed for the evaluation of braille contractions. These are:

1. Their ability to reduce the bulk of material saved as determined by their frequency of occurrence and the number of characters saved each time they are used.
2. Their effect on the readability of braille as evaluated by previous studies.
3. Their ability to be translated mechanically without consideration of pronunciation or syllabication.

The contractions are divided into groups on the basis of their braille form and the rules governing their use. The contractions within each category are then evaluated with respect to the above three points. Specific recommendations are made concerning the omission of infrequent current contractions, the adoption of new contractions, and changing the rules restricting the use of some contractions. The over-all efficiency of the braille contraction system as a means of saving characters is evaluated in terms of the mathematical theory of communication.

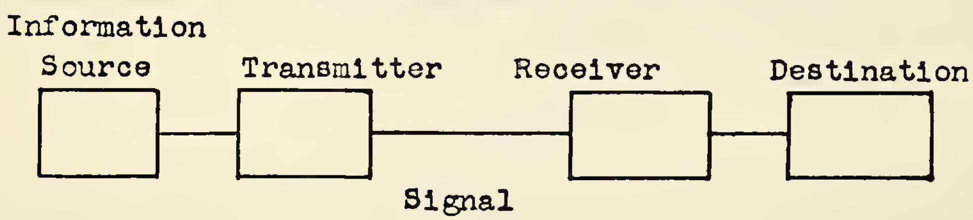
Some of the recommended changes were tested on a sample of blind people. Both the results of the reading test and the comments of the subjects strongly indicate that the recommended changes can be adopted with little problem for the average blind person and with desirable long range effects. A computer program has been written to count the frequency of contractions in various texts and to record the words in which they occur. This program should serve as a useful tool in future evaluation of present

contractions, and also proposed changes of contractions and existing braille rules.

SOME COMMENTS ON THE EFFICIENCY OF BRAILLE

So far in this thesis, the number of characters saved per 100,000 words has been used as a measure of space saving. This is a convenient figure since it is easy to calculate once the occurrences of words or contractions have been counted. Also, it is quite satisfactory for the comparison of the contractions to see which are most effective in reducing the space required by braille and which are superfluous and save little space. The number of characters saved per 100,000 words is not, however, a good measure for the evaluation of the entire system. Certainly a much larger number of characters could be saved by the addition of more contractions, further reduction of short form words, and assigning multiple meanings to more characters, but if this were done the value of braille as a means of communication might be destroyed. Therefore, some better means of over-all evaluation is needed to judge the efficiency of braille.

The mathematical theory of communication offers a means of converting the raw data into a figure of merit which can be applied in judging the present braille system and suggested revisions of it. Any communication system consists of several elements which have general names as shown in the diagram below:



These elements are given specific names when a particular communication system is considered. In the case of braille, the information source is a book to be translated, or an idea in the mind of some individual; the transmitter consists of the process of translation into braille and the actual embossing on paper. The receiver is the fingers and mind of the reader who changes the braille signal back into the message for his mind, which is the destination. The part of this system of primary interest here is the signal and the channel carrying this signal, the embossed braille. The system which braille will be compared to is printed English, wherein typewriters or printing presses take the place of braillewriters or slates, eyes the place of fingers, and the channel which carries the signal corresponds to a printed page.

The basic unit of information is the bit, a name shortened from binary digit. One bit of information is that amount of information which is determined when a choice is made between two possible messages, such as 0 and 1, yes and no, or the presence or absence of a raised dot in one position of a braille cell. Two independent sets of two choices each would contain two bits of information. This combination could give four possible messages. For example, suppose one choice is 0 or 1, and the other A or B, then the possible messages are 0A, 0B, 1A, and 1B. Extension of this reasoning shows that N bits of information allow 2^N possible messages. Inversely, M possible messages are uniquely determined by the logarithm of M to the base two bits of information is:

$$I \text{ (number of bits)} = \log_2 M \text{ (number of different possible messages)}$$

The English alphabet contains twenty-six letters, so:

$$\log_2 26 = 4.7$$

Therefore, each letter could transmit a maximum of 4.7 bits of information.[11] This figure represents the amount of information which could be transmitted if our language were structured such that any letter was equally likely to occur at any time. However, the structure of English reduces the amount of information. For example, the "u" after "q" transmits no information, because everyone knows that "q" in any word is followed by "u." Just the different frequencies of letter usage reduce the maximum information content to 4.14 bits per letter.[11] There are also other reductions based on the probabilities that one letter will follow another, for instance, "e" often follows "th" forming the word "the." Furthermore, there are long range effects which reach over hundreds of words. This effect was mentioned earlier when the I.B.M. 704 braille translation program was described. The program is revised slightly after testing a sample of each book or author, and this generally adjusts the program to each writer's vocabulary.

Shannon [33] conducted experiments in which people guessed the next letter of a particular passage. If they guessed wrong, the correct letter was supplied; right or wrong they then proceded to the next letter. The number of corrected letters supplied by the examiner was used to measure the information actually transmitted. It was assumed that letters which were correctly guessed contained no information. Using this data, Shannon calculated the maximum information content of English to be about 1.6 bits per letter.

It should be noted that apparently none of these calculations considered the effect of punctuation. These marks are obviously necessary to transmit information in some cases, such as in these sentences:

> The professor said, "The dean is ignorant."
> "The professor," said the dean, "is ignorant."

These marks also increase the maximum information per character, so no conclusions can be drawn of their effect on the over-all average information content per character.

Since English contains only 1.6 out of a possible 4.7 bits of information per letter, it has a relative information content, or a relative entropy, of:

$$\frac{1.6}{4.7} = 34 \text{ per cent}$$

Redundancy is defined as one minus the relative entropy, i.e., English is 66 per cent redundant according to Shannon's experiment. It should be possible to transmit the same amount of information using the same alphabet but 66 per cent fewer characters.

Since each dot of a braille cell can transmit one bit of information, each cell contains a maximum of six bits of information. If braille obtained the maximum reduction of English text, it would reduce it by:

$$1 - \frac{1.6}{6} = 73 \text{ per cent}$$

On the space saving of the individual braille contractions, Grade II braille would save a total of 116,320 characters per 100,000 words. The average length of a word in English is 4.5 letters. Therefore, braille reduces English text by approximately 26 per cent since:

$$\frac{\text{characters saved}}{\text{total characters}} = \frac{116{,}320}{4.5 \times 100{,}000} \approx 26 \text{ per cent}$$

This means that the text is reduced by a little over one-third of the maximum possible reduction. While the structure of English prevents realization of the maximum reduction, a study of this structure would aid in approaching this maximum. For instance, Dewey [4] states that the 9 most common words comprise about 25 per cent of the words in writing English. Frequently occurring words are most easily recognized when only some of their letters are retained; therefore, these words contribute more to the redundancy of English, and they offer the greatest area for lessening this redundancy in braille. By shortening all of these words to one character, a great deal of space is saved. However, insignificant amounts of space are saved in words which occur very rarely. If the primary space saving effects of braille are achieved by decreasing the redundancy, then there should be little added difficulty in the reading of braille. For example, of the 50 most common words in English, 29 are already among the 189 braille contractions, and 17 more require only two braille characters. Of the remaining 4, the following contractions should be formed: "al" for "all," which requires that the current short form of "also" be changed to "als," thus making it easier to recognize this word; "hz" or "hs" could be used for "has," and "wht" for "what." It would be difficult to reduce the last word, "been," without confusing it with "ben" or violating the rule concerning lower contractions. The addition of these three contractions would save more space than the 26 least efficient contractions now used. It is apparent that by studying the redundancy of English further, more useful, easily recognized contractions could be formed to replace the inefficient ones now in use. Studies, such as those by Paul Ebert,[29] should be conducted to find which frequent part word letter sequences are not contracted now.

Table VIII, which lists the current contractions in order of decreasing space saving and Figure I, which shows this data graphically, indicate the wide variation among the current contractions. The solid line shows the cumulative total of space saved by the contraction to the left of any point on the line. The slope of the line indicates the decreasing value of the contractions. For example, half of the total space saved by 15 of the 189 contractions, and 80 contractions, less than half, save 90 per cent of all the space economized. The use of more frequent contractions can reduce the redundancy inherent in English without making reading more difficult. Tests such as Shannon's have shown that many letters are unnecessary to understanding, even when no consistent rule is applied to their use or omission.

It should also be pointed out that dropping many of the present contractions and replacing them with fewer, but more frequent contractions, will probably make it easier for blind people to read and most certainly reduce the problems of teaching braille reading. In addition, such changes would make the design of a mechanical translator easier and less expensive because not as many contractions would have to be sought and checked for correctness by the machine.

Table VIII

Braille Contractions in Decreasing Order of Space Saved

the	7650	for	2468	ow	1219
and	7570	th	2469	it	1216
to	5848	ar	2458	by	1200
in	4284	ea	1939	not	1178
er	4008	with	1860	sh	1146
of	3998	have	1851	this	1144
ed	3943	was	1678	ch	1098
en	3344	ou	1633	wh	1084
ing	2826	will	1335	his	1034
st	2769	ation	1323	but	1008
that	2690	from	1299	tion	1000

Table VIII Continued

can	964	ence	235	name	90
which	908	after	224	enough	88
be	846	those	224	ount	87
had	844	right	222	immediate	84
people	815	ff	219	o'clock	84
com	790	between	216	here	82
as	782	your	214	ourselves	80
you	775	its	208	already	75
little	728	many	208	together	75
gh	705	out	203	go	73
some	688	do	203	child	72
one	633	again	192	either	72
more	630	ally	190	gg	71
were	610	day	190	whose	70
would	598	through	186	children	70
him	540	part	182	according	68
ance	534	still	174	behind	68
dis	528	word	174	altogether	65
into	498	ought	174	neither	64
ness	498	less	172	tomorrow	55
said	484	today	170	lord	54
about	470	necessary	165	friend	51
because	432	must	163	above	50
before	417	young	160	tonight	48
ble	405	where	159	mother	48
time	404	perhaps	156	yourself	48
themselves	396	afternoon	155	bb	47
can	394	work	154	across	42
there	384	against	146	although	36
every	374	itself	144	herself	33
himself	364	ful	142	afterward	32
shall	360	cc	141	paid	32
like	339	also	140	deceive	32
ity	325	these	139	declare	30
know	323	great	134	beside	30
ever	318	such	132	perceive	30
upon	306	us	123	quick	30
under	304	knowledge	120	rejoice	24
so	300	character	116	blind	20
sion	296	dd	112	yourselves	20
could	292	quite	108	beneath	18
very	290	letter	108	conceive	15
ong	276	much	104	thyself	15
their	273	world	102	receiving	12
ound	266	almost	102	below	9
ment	266	spirit	100	rejoicing	3
always	264	receive	100	perceiving	2
first	262	myself	99	braille	0
just	254	beyond	99	conceiving	0
cannot	248	rather	96	deceiving	0
good	244	father	96	declaring	0
should	236	question	92	oneself	0

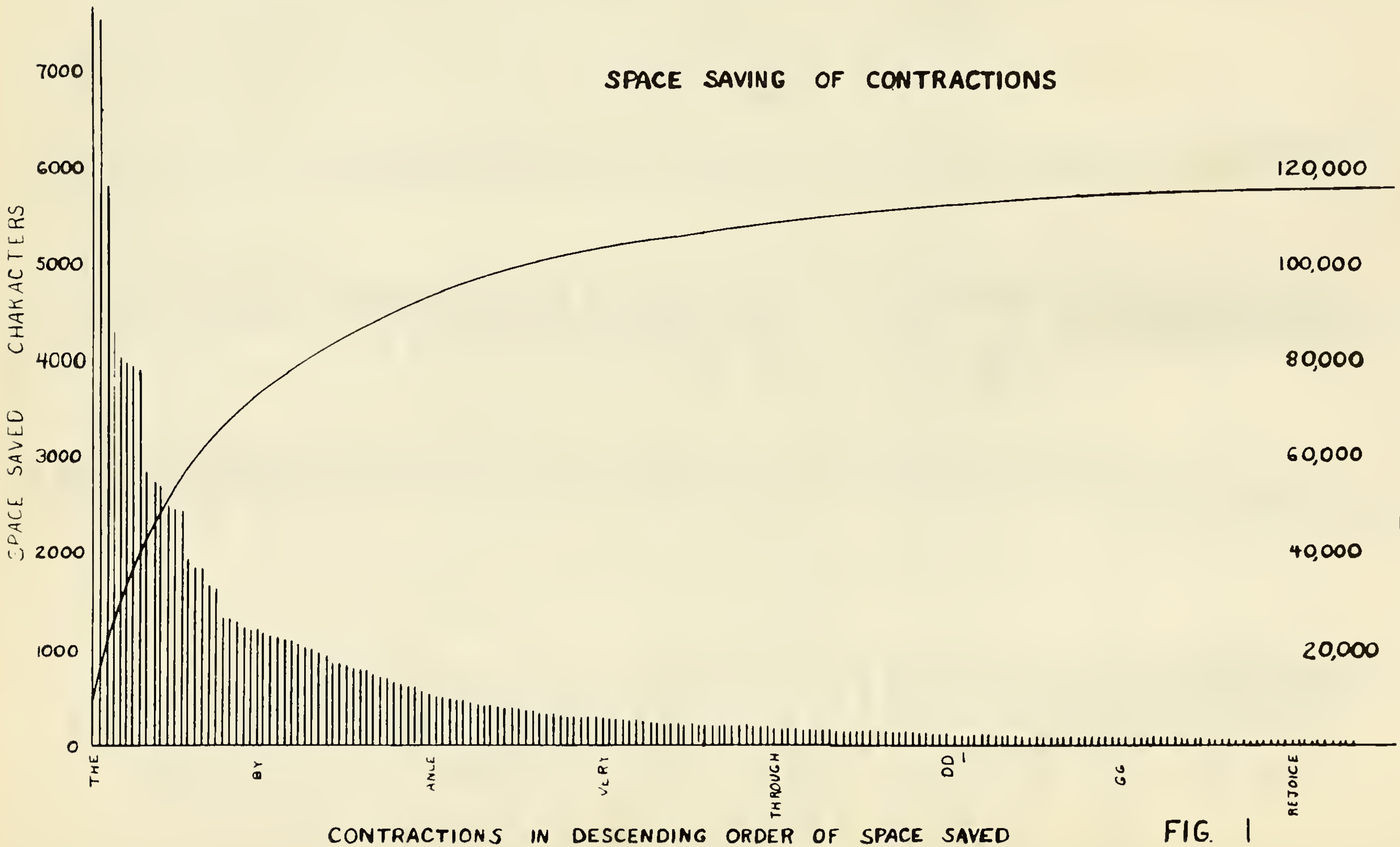

SPACE SAVING OF CONTRACTIONS
SPACE SAVED CHARACTERS
0
1000
2000
3000
4000
5000
6000
7000
CUMULATIVE SPACE SAVED
20,000
40,000
60,000
80,000
100,000
120,000
THE
BY
ANCE
VERY
THROUGH
DD
GG
REJOICE
CONTRACTIONS IN DESCENDING ORDER OF SPACE SAVED

FIG. 1

SUMMARY OF RECOMMENDATIONS

It was suggested that consideration be given to the following changes of contrations:

1. "g" to represent "great" instead of "go."
2. "r" to represent "right" instead of "rather."
3. Discontinue the use of a single cell contraction for "enough."
4. Stop using the double letter contractions "bb," "cc," "dd," "ff," and "gg."
5. Eliminate use of the initial letter contractions "mother," "father," "lord," "spirit," "name," "world," "character," and "whose."
6. Discontinue use of the short form words "onself," "declaring," "deceiving," "conceiving," "receiving," "perceiving," "rejoicing," "below," "yourselves," "thyself," "conceive," "beneath," "blind," "rejoice," "deceive," "perceive," "declare," "afterwards."
7. Add contractions "al" for "all," "hz" or "hs" for "has," and "wht" for "what.
8. Change the contraction for "also" from "al" to "als."

Furthermore, each contraction, particularly short form words, initial and final letter contractions, and lower contractions, should be thoroughly studied with reference to ease of reading and space saving. New contractions should be devised for those words among the one or two hundred most common words which are currently spelled out in full, and which have obvious contractions which would not impair reading.

It is also suggested that the following rules concerning the use of contractions be changed so that the rules are consistent with themselves and with the capabilities of mechanical translators.

Rule 34. Amend so that contractions are used when the sequence of letters they represent appears in a word, regardless of pronunciation or syllables.

Rule 36 b. Revise so that the alphabetic and similar whole word contractions are permitted before the apostrophe in all words, even colloquial ones.

Rule 37. Revise so that space is omitted between "a," "and," "for," "of," "the," and "with" at all times, except when they are separated by punctuation.

Rule 41. Revise so that the contractions are always used for, and the space omitted after, "to," "into," and "by" except when they are followed by punctuation.

Rule 42 b. Omit this section, thereby allowing double letter contractions and "ea" to be used whenever they occur in the middle of a word.

Rule 43. Revise so that "be," "con," and "dis" can be used whenever they appear at the beginning of a word and not just as the first syllable.

Rule 45. Revise so that punctuation is not considered in using the initial letter contractions as part words.

Rule 45 a. c. d. Eliminate these three sections so that "one," "some," and "part" may be used as part words at all times without regard to syllabication.

Rule 46 b. c. Omit these sections so that "ness," "ity," and "ally" can be used at all times.

Rule 47. Amend so that short form words are used as part words wherever they appear, or so that some are used as part words all the time and others are not used at all.

READING TESTS OF SOME OF THE RECOMMENDED REVISIONS

Many of the recommendations in the preceding chapter may be summarized by saying that the use of contractions may be limited by position in a word, but otherwise a contraction should be used whenever the appropriate sequence of letters occurs without regard to syllabication or punctuation. As was pointed out in the section on history, British usage based on this point is different than American, for the British hold much more to a rule of sequence with some exceptions, while the Americans apply a rule of syllabication with a few exceptions. Therefore, a large group of braille readers are already subject to some of the proposed changes, apparently with no determent to their reading ability.

A preliminary investigation was made of the effect of the revised rules on the ability of American blind people to read braille. The changes tested were:

1. Use of the contraction "be" when it appears at the beginning of a word, but is not the first syllable.
2. Changing the form of a base word when a prefix or suffix is added.
3. Use of initial letter contractions as part words when their pronunciation is changed.
4. Allowing contractions to overlap a primary division between a base word and its prefix.
5. Allowing contractions to overlap the primary syllable division between parts of a compound word.

In deciding on test words, the words "really" and "equally" were used as examples where the "ally" contraction should not be employed because the braille form of the base words "real" and "equal" would be altered. Such use is prohibited by Rule 34 b. (1) and the word "equally" is cited as an example. However, Rule 46 c. specifically prohibits the use of the contraction only when "y" has been added to a base word, and "really" is cited as an example of correct use of the contraction. The revisions suggested in the preceding section would correct the misleading effect of Rule 34 b. (1), or the inconsistency of interpretation, whichever the case is, by consistently allowing the use of "ally" in all words.

Two paragraphs were written which contained the following words:

1. Examples of "be" contracted when not a syllable in "best," "beets," "beckons," "better," "beefy," and "bellowing."
2. Words where the base word was changed after the addition of a prefix or suffix, "uneasy," "really," "equally," and "unfulfilled."
3. Words using initial letter contractions when the pronunciation was changed, "severe," "sphere," and "feverishly." The initial letter contraction "part" was used in "partaken" where it specifically is prohibited by the rules.
4. Contractions which overlapped primary syllable divisions between prefixes and suffixes in the words "erection," "changeable," and "prediction."
5. Contractions which overlapped the division in the compound words "pineapple," and "painstaking."

Each of two paragraphs which were prepared to test these changes contained 10 of the above words. Text material for the paragraphs was condensed and paraphrased from current issues of <u>Time</u> and the <u>Reader's Digest</u>. A list of 10 words, five from each paragraph, was prepared to be read by each subject before the paragraphs were read. The list and paragraph combinations were embossed twice, once in correct braille, and once using the revised rules in the words where they were applicable.

The test subjects were requested to read one paragraph in standard braille and the other in revised braille. Errors and hesitations as well as the time required to read each paragraph were recorded on separate forms for every subject. Appendix D contains a copy of the form used in these tests.

Since this was intended as merely a preliminary check, and subjects were difficult to contact during the summer vacation season, only 12 subjects were tested. Most of these were instructors of the blind, as well as being blind themselves. Their ability to read braille ranged widely, depending on how long they had relied upon it. Some had been blind since childhood and knew no other means of reading except braille, while others had become blind as adults and only learned to read braille in the last year or two. When further tests are made, it is recommended that school children be included so that the complete range of braille readers can be checked.

The paragraphs using revised spelling required an average of 12 per cent more time to read than their standard counterparts. However, much of this difference must be attributed to the time taken by subjects to comment on revisions even though they were asked to save comments until after they had finished reading. The few cases where subjects did not comment resulted in time differences of less than 6 per cent, with 2 subjects favoring the revised paragraphs and 2 subjects favoring the standard paragraphs. The individual times and the number of hesitations and errors for each paragraph are recorded in Table IX.

Only two words were read incorrectly in the revised paragraphs. "Unfulfilled" was twice read as "unbelieved," probably because the contraction for "ful," dots 5-6, 1, was mistaken for dots 2-3, 1, which is the contraction for "be" followed by "l," even though the "be" contraction was never used in the middle of a word. The error was not realized, because either word would fit adequately into the context of the sentence. The word "predication" meaning assertion, was substituted by one person for "prediction," probably because the person was trying to keep the "ed" contraction in one syllable. It should further be pointed out that either word fits perfectly into the context of the entire paragraph, and that confusion often results between the final letter contractions for "sion," "tion," and "ation."

The revised words caused by 25 hesitations out of 120 encounters in lists for an error index of .21, while the standard words caused 7 hesitations for an error index of .06. In the paragraphs, standard words caused 8 hesitations out of 120 encounters for an error index of .07, while the revised words caused 21 hesitations which combined with 3 errors gives a total error index of .20. It should be remembered that these errors were primarily hesitations, some of which were very minor, so that all the error indices indicate a great deal more difficulty than is really the case.

After reading, the subjects were asked for any comments which they might have on the proposed changes. Seven of the 12 said that they felt the changes would not slow them down or cause them any trouble if they became the standard, since they would quickly become accustomed to them even though they looked a little strange now. Three people further commented that there are many mistakes found in braille printing and that, therefore, some of the changes should cause no problems and might not even be noticed.

Two things are offered in support of these last comments by the subjects. First, two or three unintentional mistakes were made in embossing the pages used for the reading tests. About one-third of the people hesitated on the mistakes, and only half of those were aware that mistakes had been made. Second, many people reported that they had seen some of the words in books, embossed in the incorrect or revised, form used in the tests. Among these words were "pineapple," "uneasy," "equally," "changeable," and "unfulfilled." Also, a few people said that in writing their own notes, they used some of the contractions in the revised manner. Some commented that since the slate was still in wide-spread usage for taking notes, any revisions which saved space were highly desirable.

A summary of the test results would indicate that, while more study is necessary, the changes proposed in this thesis generally would not add a burden to reading after they became accepted as standard. The question of how to teach braille and correct spelling to blind children is one which has already been raised frequently and will continue to exist whether these changes are adopted or not.

Table IX

Summary of Reading Test

	Standard			Revised			
S.	W.L.H.	P.H.	P.T.	W.L.H.	P.E.	P.H.	P.T.
1	0	0	1:15	5	1	1	1:40
2	0	0	1:10	0	1	2	1:25
3	0	0	5:20	0	0	2	11:50
4	1	0	1:50	2	1	2	1:20
5	2	1	1:40	2	0	1	1:55
6	3	0	2:10	3	0	3	2:45
7	1	0	1:50	3	0	0	1:55
8	0	0	3:50	3	0	2	3:35
9	0	2	1:30	2	0	0	1:25
10	0	0	2:45	0	0	2	3:00
11	0	1	2:30	5	0	3	2:50
12	0	4	2:55	0	0	2	3:05

S. = Subject
W.L.H. = Word list hesitations
P.H. = Paragraph hesitations
P.T. = Paragraph time
P.E. = Paragraph errors

7090 COMPUTER PROGRAM FOR FINDING BRAILLE CONTRACTIONS

At the present time adequate data is lacking on the frequency of braille contractions. The Irwin and Wilcox [19] study does not cover some of the newly added contractions, and also leaves much to be desired in the range of material sampled. Word counts, such as Dewey [4] and others are not adequate except for those contractions which are used only as whole words. For these reasons, it would be desirable to conduct a frequency count of the current contractions in a wide range of material.

Furthermore, it would be advisable to count the number of times which the revisions suggested in this thesis would affect braille. In this way, their space saving could be calculated and some idea obtained of how often a reader may be bothered by them. Also, it would be advantageous to have some means of measuring the frequency of any proposed new contractions.

While it is possible to do this counting by manual methods, it is a time consuming task, which also presents the opportunity for inaccuracies, since the human eye and mind have a tendency to miss some such letter sequences when scanning a page. Therefore, it seemed desirable to write a computer program to search text for braille contractions. Once written, the program would save a great deal of time in any such counting and, if each contraction is searched for separately, new contractions could be counted easily with very little additional work.

Computers are capable of performing simple mathematical or logical operations quite rapidly. By combining sequences of these operations, they are able to do large amounts of repetitive calculations in short periods of time. Often in mathematical problems, these repetitive operations can obtain numerical solutions to problems which could not be solved otherwise. In order to perform these tasks, a computer must be instructed precisely what to do, and each operation must be ordered in the proper sequence. A program is a set of instructions which tell a computer what to do. In order to make the programming of particular problems easier, general programs have been developed which take one instruction written in the special program language and change it into a series of elementary steps in the language of the electronic computer. Without these general programs, only highly trained people could write instructions for computers.

The machine translation group at M.I.T. has developed a programming language named COMIT [15,16] which is especially well suited to linguistic work of any kind. The COMIT system was selected as the means of writing the braille contraction search program. In addition, the machine translation group has available large quantities of English text selected from newspapers, literature, and patents. This material provides a source of text samples which are already prepared for computer use on punched cards or magnetic tape.

The major part of the search program consists of a number of independent sections. Each section searches the sample text for a particular sequence of letters. In the computer each letter is a separate element; words are distinguished by the spaces between them. When using COMIT, these spaces are represented in the computer by hyphens, and the hyphens have special symbols to distinguish them from spaces. In order to specify the position of a contraction in a word, the hyphens are also used in the sequence. For example, the contraction "be" is used only as a whole word or at the beginning of a word. Therefore, the computer is instructed to search for the sequence "-be." Wherever such a sequence is found, the computer increases a counter by one and also prints the sequence plus everything following it up to the next space. At the end of the text, the computer prints out the total count and then is ready for instructions to search for a new sequence.

The print out of each word containing a contraction is used to correct the total count, since a word such as "wither" would appear under four contractions, "with," "the," "th," and "er." Only the "with" and "er" contractions are used, however, and the counts for the "the" and "th" would have to be corrected. It is easier to correct the counter manually than to write a computer program which would allow for all such contraction overlaps. Also, the information gained by checking for overlaps gives a better estimate of the effect of adding or omitting contractions. For instance, the sequence "ear" occurs in many words. The "ar" contraction is used in preference to the "ea." If the "ar" contraction were to be no longer used (an example, not a suggestion), it would make no difference in the length of words with "ear" and therefore, these should not be counted in evaluating the effect of such a change on space saving.

Printing out each word also allows easy counting of the times when a contraction is currently not used because of syllabication. This number can then be used to evaluate the space saving of such changes, the number of times a reader is likely to encounter them, and the relative frequency of different words affected by the removal of syllabication rules. This last information is useful because, regardless of rules concerning syllabication, some words will probably be easily recognized while others may be more serious reading problems. A study of particular words in relation to their frequencies is a much fairer way to evaluate changes than merely to cite examples of words that are easy or hard to recognize from memory.

Any number of contractions can be counted in one computer run by the addition or deletion of the independent sections for each contraction. The other portions of the program control computer input operations and adjust the format of the input to the braille search program.

Most of the search, print out, and counting operations are performed by one rule for each contraction. A second rule prints the total number and returns all elements to their original state in preparation for the next independent contraction search. Originally it was planned to have the computer search for sequences, such as the following example for "and;" an indefinite number of unknown elements is indicated by "$" in this search:

- + $ + A + N + D + $ + -

In this manner, the sequence "and" and everything surrounding it, from the space preceding it to the space following it, was to be picked out. The computer, however, picked out the first available space rather than the space immediately preceding the sequence "and." This led to mechanical problems which made running the program impractical and often impossible.

There was no apparent way to distinguish the space immediately preceding a contraction without slowing the search process considerably. Therefore, it was decided to record a specific number of characters preceding the contraction. Thus, when a contraction is found, the 25 characters preceding it are printed, regardless of what they are, as well as all the characters following the contraction up to the next space. After a contraction is found, the material to be printed is duplicated in the workspace. The copy is then used for print out on the usual computer output monitor tape and the original is maintained in the workspace for further search. Material preceding the 25th character before the last sequence which has been found is queued on a shelf. A running count of occurrences is recorded as the subscript on a special marker.

After all the text in the computer workspace has been searched and queued, the number of occurrences is printed out, the marker subscript is returned to zero, and the shelved material is returned. The computer then starts a search for the next contraction.

The amount of material in the computer workspace is limited by the size of the core memory; in the case of the I.B.M. 7090, it is approximately 120 cards or about 1,350 English words. Since it is usually desirable to search more material, the amount which the computer will read at one time is controlled to prevent overflowing the workspace. After the material read in one workspace limit has been searched for all contractions, it is replaced by the next section of text.

Several difficulties other than normal programming problems were encountered in obtaining results from the program. Among other things, the computer failed to read the magnetic tapes containing sample texts on three successive runs. This was apparently due to the decay of the tapes, which are several years old.

Table X

Results of Computer Search

Contraction	Occurrences in Sample	Occurrences per 100,000 Words	Irwin and Wilcox
and	366	4,575	3,785
for	43	537	1,243
of	254	3,175	3,521
the	830	10,380	7,650
with	44	500	930
in	426	5,320	4,284
ar	193	2,290	2,458

Table X Continued

Results of Computer Search

Contraction	Occurrences in Sample	Occurrences per 100,000 Words	Irwin and Wilcox
ch	108	1,350	1,098
ed	272	3,400	3,943
en	305	3,810	3,344
er	362	4,508	4,008
gh	33	425	705
ou	120	1,500	1,633
ow	99	1,240	1,219
sh	124	1,550	1,146
st	208	2,600	2,769
th	219	2,740	2,469
wh	137	1,095	1,084
ally	9	113	190
ance	20	250	267
ation	37	462	441
ence	22	275	235
ful	12	150	142
ity	21	262	325
less	4	50	86
ment	24	300	266
ness	6	75	49
ound	15	188	266
ount	6	75	87
sion	11	136	148
tion	48	600	500
ong	19	238	276
ble	28	350	405
ing	247	3,085	2,826
bb	3	38	47
cc	12	150	141
dd	11	135	112
ea	167	2,087	1,939
ff	11	137	219
gg	6	75	71
be	63	786	801
com	30	375	395
con	128	1,600	482
dis	13	163	264

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this thesis has been to analyze Grade II braille and recommend those changes which would be necessary to allow machine translation from inkprint to braille. The recommendations are based on a translator which would be of economical size and a feasible cost. Thus, it is not possible for this translator to have a special record of every word, or even the words where contractions are currently restricted by rules other than those which are easily defined in terms of letter and other symbol sequences. Also indicated in the analysis are such factors as the space saving effect of various contractions and their influence upon the readability of braille.

The history of braille and other forms of raised printing for the blind in this country indicates that the objective approach which the Uniform Type Committee took up in the 1930's needs to be revived again. This approach enabled the early committees to sponsor major studies of the readability and other features of various systems. The desire for world uniformity and the resistance of the British to change has, in recent years, led to a more emotional and less scientific basis for the standards of braille. Unfortunately, this change of approach has still not achieved the desired uniformity.

This study has repeated the findings of other studies, in that some of the current braille contractions are not achieving the primary purpose of contractions, that of saving space, both to reduce the bulk of books and to make reading more rapid. It has further applied some of the ideas of the mathematical theory of communication and the abilities of the high speed electronic computer to the task of accurately selecting the least worthwhile contractions and of finding more practical ones with which they may be replaced.

The entire set of braille contractions has been divided into logical categories and the contractions in each of these categories have been evaluated on three points: space saving, readability, and translatability. From this analysis, recommendations have been made to eliminate several current contractions and change the rules concerning the use of other contractions. These recommendations may be summarized by saying eliminate all infrequently used contractions and omit rules concerning syllabication and pronunciation. It is felt that these changes will increase the value of braille for several reasons. First, by simplifying the rules and dropping the infrequent and difficult contractions, many people will learn braille, and others who already know it will find more use for braille because they will not be discouraged by its current complexity. Second, allowing for mechanical translation improves the possibility of making available newspapers and a much wider range of books and magazines to the blind without long delays for translation. In addition, these materials will be produced at a lower cost. Third, by eliminating many of the current contractions which save very little space, it will become easier to adopt a few new contractions which would save much more space and actually be an aid to reading.

This thesis should present some form of basis for further study in various directions. First, from the ideas of information should come some research to find those parts of our language, primarily frequent words and part word letter combinations, which are the major contributors to the high redundancy of English. An analysis of these words and parts of words should then be made, considering their effect on space saving changes as determined from the results of the braille search computer program, their effect on readability as determined by reading tests based on words selected as typical from the search program and weighted by frequency, and their ability to be easily assimilated into a translating machine.

Another area for study is that of an actual translating machine based on the revised braille rules suggested in this thesis. This should not only include design, but actual construction and testing of the device. The operation of such a device should serve as a strong impetus to the over-all revision and improvement of braille.

Finally, it is hoped that consideration of this and other changes in braille will not be stifled by the prejudices of those sighted people who have devoted a great deal of time to the blind. The blind people who must use braille every day as their primary means of written communication should be the judges of what is best for them. The requests and suggestions of these people concerning the availability of reading material originated the interest in this study and the comments of other blind people, particularly those who assisted in the reading tests, have encouraged this author to believe that many of the blind desire to have braille improved and are especially willing to accept any changes necessary to make a larger quantity of more varied braille material available.

Appendix D

Braille Reading Test

Name ____

Paragraph "Space"	Standard	Revised

best
uneasy
severe
beets
erection

sphere
pineapple
painstaking
bellowing
really

Time ______________________

Recording errors

Place a "c" above a word if the reader automatically corrects himself.
Draw a wavy line under a word if the reader hesitates on it.
Write out phonetic spelling of a word if it is misread.
Encircle a word, syllable or letter omitted.
Use a caret to write in additional words read.
Draw a line under a word for each time it is repeated.

SPACE

"Space is the future of man" is the PREDICTION of D. Brainerd Holmes. Mr. Holmes' concern is not with the SPHERE on which we live, but the moon. He is confronted with the UNEASY task of heading the U.S. effort to reach the moon. This UNFULFILLED ambition of mankind BECKONS as one of the most challenging projects imaginable. At BEST, the prospect is not very reassuring, for a manned voyage to the moon is far more difficult than most people think. However, Mr. Holmes has PARTAKEN in EQUALLY difficult projects. He supervised both the ERECTION of B.M.E.W.S., our northern radar defense, and the Talos missile program. It seems unlikely that there could be a BETTER or more enthusiastic engineer to supervise our space planning.

Time ______________________

Paragraph "Elephant"	Standard	Revised

changeable
beckons
equally
prediction
unfulfilled

better
uneasy
feverishly
partaken
beefy

Time ______________________

ELEPHANT

Portland, Oregon first heard the news last January 10th. A 10 year old Siamese elephant, Belle, at the local zoo, was 18 months pregnant and 1,000 pounds overweight, which is a bit BEEFY even for an elephant. Previous to this discovery, the zoo men had been UNEASY about Belle's recent CHANGEABLE moods. PAINSTAKING preparations were undertaken so that Belle would not trample her young offspring. Expectant elephants must eat something constantly, whether it be oats, PINEAPPLE, or BEETS! Belle was no exception and the keepers worked FEVERISHLY to keep her satisfied. Finally, after more than three months, the precautions REALLY paid off. In the early morning of April 13th, Belle began thrashing and BELLOWING. Five hours later, the SEVERE labor was over and Belle was the mother of a 225 pound baby elephant!

Time ____________________

Comments:

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THE ELECTROENCEPHALOGRAM IN PARTIALLY SIGHTED CHILDREN RELATED TO CLINICAL AND PSYCHOLOGICAL DATA

by

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EDITOR'S NOTE:

This paper was presented at the International Congress on Technology and Blindness, June, 1962, and will be included in Vol. 2 of the Proceedings.

In the past, two kinds of results have been reported in the electroencephalogram (EEG) records of blind subjects.

1. Background activity is badly organized: the alpha rhythm is missing or greatly reduced [1,5] or the alpha rhythm appears more abundantly in parietal than in occipital leads [4]. This finding seems to be directly related to the defect in visual function because of the predominance of an occipital alpha rhythm in the sighted and its blocking when the eyes are opened.

2. Spikes are often seen in EEG records of the blind, especially from the occipital leads. Several interpretations have been proposed for this occipital spiking. It has been suggested to prove the existence of a central basis for the visual disorder; to reflect a vascular or toxic injury to the occipital cortex, concomitant with the ocular lesion (this hypothesis has more specifically been brought up in the case of retrolental fibroplasia); to be the consequence of a retino-cortical degeneration; or to result from the deafferentation from sensory impulses of the cortical visual area.

We have investigated a group of partially sighted children and adolescents who use residual sight as their primary channel of learning. The EEGs from this group show the same two series of disturbances for the blind, namely, background activity badly organized, and occipital spiking. They present important differences, however, which will be described. We also have sought psychological similarities between the partially sighted and the normally sighted subjects who present similar EEG patterns.

Relationships among the EEG, medical and psychological findings are presented which bear on the functional adaptation to a sensory defect rather than the consequences of a defect in an anatomical structure.

Method

Fifty-four partially sighted subjects have been examined at least once, and 30 have had one or more repeat examinations. In all, 105 EEGs have been recorded. The age range is 6 to 18 years, with a mean age of 10½ years. All of the subjects have sufficient sight to be educable using partial vision in a special class, although 11 children are legally blind. Visual acuities range from 3/100 to 4/100. Neuropsychiatric, psychological, and EEG examinations have been performed at the same time on all subjects. Some testing was done with an additional group of 4 totally blind subjects, aged 10, 15, 17, and 18 years.

The psychological investigation included a long clinical interview; a detailed report of the child's behavior at school; and a battery of psychometric tests, including tests of intelligence and psychomotor functioning. Since the visually impaired subjects were trained to use residual sight as much as possible, normal tests were employed. The Binet-Simon or the Wechsler-Bellevue tests were usually used to measure intelligence, except for a few subjects with insufficient vision with whom the Hayes-Binet test was used.

Six different tests were applied to give a psychomotor profile[12]. They were:

1. A test of rhythm (R) elaborated and calibrated by Mira Stamback, which measures the ability to reproduce sound structures.
2. A test of motor speed (speed of distribution of 40 playing cards using each hand).
3. The Piaget-Head test, which measures the appreciation of the body image and of space.
4. The Kwint test, which quantifies the capability of reproducing the facial movements.
5. The crossing-out (CO) test of Zazzo ("pointillage"), which consists of striking out repeated elements of a series of small squares as fast as possible.
6. The Bender test (B), which measures the quality of reproduction of geometric figures.

The last two tests are visual motor tests, or more precisely visuo-practognostic ones.

Results

The neurological examinations failed to show symptoms of gross neurological damage. But in over half of the cases, a picture of either psychomotor retardation or of psychomotor dysharmonia was revealed. These findings could be the result of the operation of several factors, among them, restriction of afferent impulses, restriction of early motor experiences, anxiety, and others [10].

The first interesting results inferred from the EEG are the poorly organized background activity and changes in alpha rhythm. A greater prevalence of alpha activity in the parietal than in the occipital lobes has been reported in many blind children [4]. This result was confirmed for 3 of our 4 totally blind subjects, but it is not so common in the partially sighted [3].

We have measured the alpha index (percentage of the waking resting record in which alpha predominates) and the average amplitude in the occipital and parietal leads. Sixteen subjects exhibited a higher alpha index in the parietal than in the occipital leads. Six subjects showed a higher alpha amplitude in the parietal leads, but only 4 showed both a higher alpha index and amplitude in the parietal than in the occipital leads.

Table I shows the comparison of the mean alpha indexes of the subjects distributed among 3 categories of visual ability. The ratio of the mean occipital alpha amplitude to the mean parietal alpha amplitude is presented in column 4.

It is apparent from the calculations of the mean that the reduction of the alpha index and amplitude in the occipital leads is related to visual factors; in the partially sighted group, however, it is not proportional to the degree of visual impairment. The corresponding enhancement of alpha in the parietal leads is not so commonly observed for our group as it was for the totally blind. The poor organization of the background activity of the waking EEG remains to be considered.

Table I

	N	Mean Alpha Index		Mean Alpha Amplitude
		Occipital	Parietal	Occipital : Parietal
	1	2	3	4
Sighted*	54	92%	72%	2
Partially sighted	54	76%	73%	1.5
Blind	4	65%	85%	0.8

* These 54 sighted subjects were matched for age and intelligence quotient with the 54 partially sighted.

Figure 1 illustrates what is meant by well organized and poorly organized EEG records. Three different samples of EEGs taken with bipolar transverse derivations are shown. The sample on the left demonstrates a well organized record, showing high voltage alpha activity in the occipital leads and a good differentiation of rhythms and amplitudes in space, for the alpha is poorer in the parietal, and much poorer in the rolandic leads. The second sample shows a poorly organized record with an alpha activity of the same or higher voltage in the parietal than in the occipital leads. The sample on the right shows a very badly organized EEG, in which it is impossible to differentiate posterior and anterior rhythms.

The spatial postero-anterior differentiation S is quantified by the equation -

$$\underline{S} = \frac{O}{P} \times \frac{O}{R}$$

with O, P, and R representing the mean amplitude of the dominant rhythm in the bi-occipital, biparietal, and birolandic channels. The index S has previously been studied for large normally sighted populations [8,9]. It can be seen that the value of the index varies for the three samples of Figure 1. Figure 2 shows the distribution of the values of S in 100 sighted children, it varies from 0.1 to 50, the median value being 5.

Among the partially sighted group, almost all the values of S are in the lowest part of the scale. None is higher than 13 and the median value is 2.5 rather than 5. A positive relationship exists between the value of S and the quantity of residual vision. Very low values can be found in each of the three subgroups of acuity (10/100, 10/100 to 20/100, and 20/100), but the higher values of S increase with the amount of vision, as shown in Table 2.

Table 2

Degree of Vision		10/100 or less	Between 10/100 and 20/100	20/100 or greater
S index	Range	1 - 4	0.6 - 8.2	0.5 - 13.5
	Median	2.2	2.3	3.1

A direct statistical relationship between S and intelligence quotient (mean I.Q.) can be traced for groups of normally sighted subjects. Among the partially sighted groups, on the contrary, we find an inverse relationship between S values and mean I.Q., as shown in Table 3.

Table 3

Index S	S 3 or less	S between 3 and 6	S 6 or greater
Mean I.Q.	97.3	86.4	80.8

The EEG records of normally sighted children and adolescents may show similar pictures of poor organization of background activity and a low value of the index S. Among sighted children and adolescents who are seen in neuropsychiatric practice, the poorly organized records are obtained from among those who show psychomotor disturbances or psychomotor functioning which is obviously lower than the level of mental functioning [8,9].

The mean psychomotor profile of our partially sighted group shows that the decrease in psychomotor efficiency, compared with the intelligence level, characterizes these subjects (as seen in Figure 3). The perceptual-motor tasks, such as the crossing-out test and the Bender test, are those which are performed at the poorest level.

The few exceptional subjects in the test group who present a well organized EEG are the mentally retarded. This confirms the interpretation above mentioned. Figure 4, which presents the psychological profiles of three subgroups of intelligence level (the very intelligent, the dull, and the mentally retarded) shows that the difference between the mean mental level (MA) and the mean motor and perceptual-motor level is much less for the mentally retarded group than the difference between these measures for the two other groups. The difference between the psychomotor and the MA measures is greatest for the subgroup of very intelligent partially sighted subjects.

Clinically, these subjects who are mentally defective appear to be rather indifferent to the visual defect, which is not as great a handicap for them as their mental defect. The visual defect does not, in itself, disturb their psychomotor functioning which is minimal in any case due to their low intelligence quotient.

The poorly organized EEG may therefore represent a "normal" adaptation to the visual defect. Conversely, the so-called "normal" record in the partially sighted population has usually a rather pessimistic significance and may connote mental retardation. This finding may seem somewhat surprising, but it deserves attention by the clinicians who have to interpret such records.

The second EEG feature which needs interpretation is the occipital spiking.

For blind subjects, spikes have been observed on either occipital lobe, described in various proportions, by several authors [4, 6, 7, 11].

Among our partially sighted group, spikes and sharp waves have also been observed in the occipital or temporal occipital area, but exceptionally on the right side. Left occipital spike foci are seen, however, in nearly one-fourth of our cases. Bi-occipital slow waves or sharp waves occur in almost one-half of the cases. In the remaining one-fourth of the cases, no peculiar EEG pattern is noticeable in the occipital channels.

The ocular conditions which accompany the left occipital spike foci are very low residual vision and ocular nystagmus, either occurring separately or jointly. The role of the spontaneous nystagmus must be discussed. In physiological experiments,* optokinetic nystagmus can induce occipital spikes which are related to eye movements and are identified as lambda waves. These experimental conditions are not identical, however, to the clinical conditions of our study. Among the partially sighted subjects, the spikes do not seem to be related to the nystagmus movements. They appear at different times; the occipital spikes appear when the eyes are closed, and are blocked by opening the eyes; the nystagmus movements occur or are enhanced when the eyes are open and when the subject watches something (Figures 5 and 6). Thus, the left occipital spikes of our partially sighted subjects cannot be identified as lambda waves.

Psychological profiles of the subjects with various kinds of occipital activity show marked differences, as shown in Figure 7. The mean I.Q. (MA) is high for the group of subjects with left occipital spike foci (EEG Type 1). These subjects achieve the highest scores on the rhythm (R) test and the lowest scores on the perceptual-motor tests (CO and B). They are obviously individuals who have the greatest difficulty in performing the visual-motor tasks.

The subjects not exhibiting occipital spikes, sharp, or slow waves (EEG Type 3), the so-called "normal" occipital activity group, has a low mean I.Q. and low scores on the R test but relatively good scores on the Bender test. The middle group with bi-occipital slow or sharp waves (EEG Type 2) have scores between these two groups on mental and psychomotor tests.

Such differences in the psychological profiles of the three groups lead us once again to raise the question of "compensations" for the visual defect. When better performances in other communication modalities is demonstrated in the blind or partially sighted, is the performance due to intensive training, or is there a biological basis for the compensation in other sensory modalities? We feel that statistical studies, such as Axelrod's,[2] do not give a satisfactory answer to this question, since the individual compensatory mechanism in each subject may be unique, and become lost in the process of averaging. The individual clinical histories of the Type 1 EEG cases (left occipital foci) show that these children appear to have turned their interest toward music or the learning of languages, while Type 3 subjects ("normal" occipital activity) exhibit a tendency to turn toward drawing, painting, and manual activities. These two types seem to reflect different, or perhaps even opposite, modes of adaptation to the same sensory defect.

Thus, left occipital spiking in a partially sighted population does not represent necessarily an EEG "abnormality," but only an EEG signal for a certain modality of adaptation to the visual defect. This modality may be the most favorable for a given individual.

Finally, what might explain the left occipital spiking in our population? This is quite specific for the partially sighted, since the occipital spikes described in the blind, or the partially sighted educated as blind, are as frequently located on the right as on the left side. The low perceptual-motor performance in the group with the left occipital spike focus suggests that spiking might be a functional expression of the over-solicitation of a cortical area. This cortical area might be the association area for the visual-motor function, rather than the specific visual projection area. If such is the case, the visual defect and/or the nystagmus might not be directly responsible for the left occipital spike focus; they may, however, play an indirect part in increasing the difficulties in achieving perceptual-motor efficiency among those children who are usually motivated to use their sight because of the sound level of their intellectual functioning.

* Shanzer, personal communication

Repeated follow-up of our cases presents evidence strengthening such an interpretation. The disappearance of left occipital spike foci with age and increased learning has been observed accompanying the improvement of perceptual-motor performances (Figures 8 and 9). In other cases, a left occipital focus has appeared in a re-examination when the previous record has shown bi-occipital slow or sharp waves. In such cases, the intellectual level has raised with age, more than the perceptual level of performance so that the difference between the mental and perceptual-motor level is greater on re-examination than at the time of the first examination (Figure 10).

This hypothesis of the over-solicitation of a cortical area might also explain the focalization in the left posterior cortex of epileptic discharges in patients who are both epileptic and partially sighted (Figure 11).

The data which have been reported here raise more problems than they solve. They illustrate the main difficulty of the EEG, which is that the morphology of the EEG has no absolute significance in itself and that the same patterns may get quite different meanings according to the clinical and the psychological context of the interpreter.

Figures

Figure 1: Three samples of differently organized EEGs with different values of index S (in 3 sighted intelligent children).[9]
right: well organized record: S = 44
middle: poorly organized record: S = 2.97
left: very badly organized record: S = 0.66

Figure 2. Distribution of the values of the index S in 100 sighted subjects (children and adolescents), plotted on a logarithmic scale, and related to the visual appreciation as well organized (left column "W").
poorly organized (middle column "P").
badly organized (right column "B")[9]

Figure 3. Mean psychological profile of the whole group of 54 partially sighted sujects.
ordinate: mean values, 100 corresponding to the mean real age ($10\frac{1}{2}$ years.
abcissa: RA = Real (chronological) age
MA = Mental age
R = Rhythm
C = Cards (motor speed)
PH = Piaget-Head
K = Kwint
CO = Crossing-out ("pointillage")
B = Bender

Figure 4. Mean psychological profiles according to the intelligence level
full line = very intelligent subjects (I.Q. 100 or greater)
dashes = dull subjects (I.Q. between 100 and 75)
dotted line = mentally retarded subjects (I.Q. 75 or less)
ordinate and abcissa: same significance as above

Figure 5. Left occipital spike focus and nystagmus movements
nystagmogram on the 3 upper channels; the nystagmus movements appear when opening the eyes (O)
the spike focus appears only when the eyes are shut
(Girl aged $5\frac{1}{2}$ years; congenital glaucoma; acuity 3/100)

Figure 6. Left and median occipital spike focus and nystagmus movements
the nystagmogram appears on the 4th channel when opening the eyes (O)
the spike focus is blocked by opening the eyes
(Girl aged 18 years; albinism; acuity 10/100)

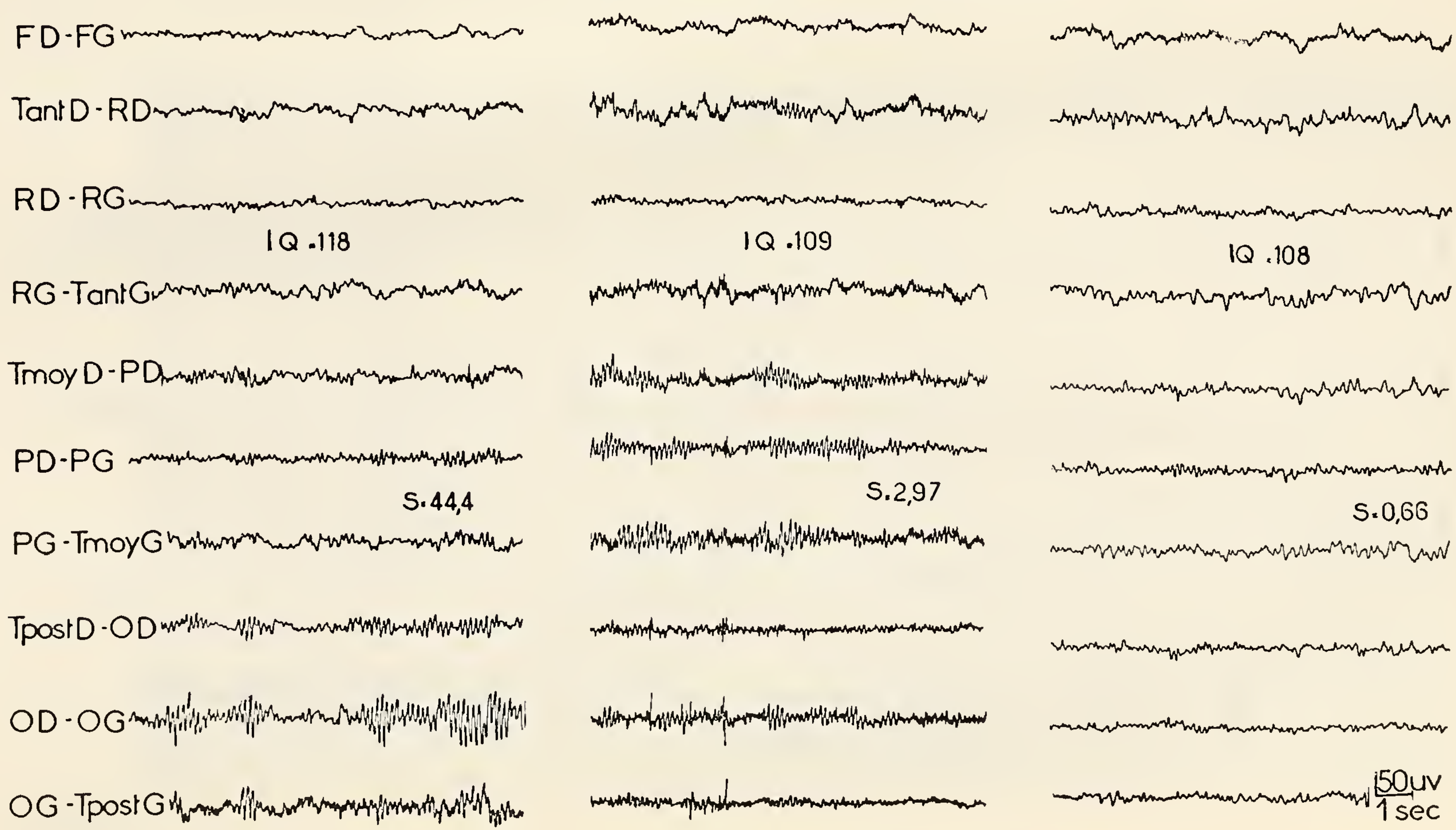
Figure 7. Mean psychological profiles according to the EEG occipital pattern
1 left occipital focus
2 bi-occipital slow or sharp waves
3 occipital activity free of spikes, sharp or slow waves
ordinate and abcissa: same significance as Figures 3 and 4

Figure 8. Disappearance of the left occipital focus with age and learning
Congenital glaucoma (same case as Figure 5); acuity: 3/100 I.Q. 120
Between 6 and $6\frac{1}{2}$ years of age, the child learns to read and write.

Figure 9. Disappearance of the left occipital focus with age and learning
Retrolental fibroplasia; acuity: 10/200; I.Q. 127
Learns to read and write in a very short time at 6 years of age

Figure 10. Evolution of the EEG in a case of normal evolution except for the perceptual-motor tasks (writing and Bender)
Congenital cataract; acuity: 10/100 with nystagmus; I.Q. 95
At 9 years of age: bi-occipital sharp waves
At 11 years of age: predominance of the sharp waves on the left

Figure 11. Epilepsy and visual defect
evolutive glaucoma and evolutive encephalopathy
boy aged 12 years at the time of recording of the EEG; acuity: 10/100 (complete blindness one year later)
progressive dementia
left part of the record: continuous spike and waves complexes predominant in the posterior part of the left hemisphere
right part of the record: beginning of a seizure: left occipital critic discharge of slow spikes. The seizures were clinically of the generalized type (grand-mal).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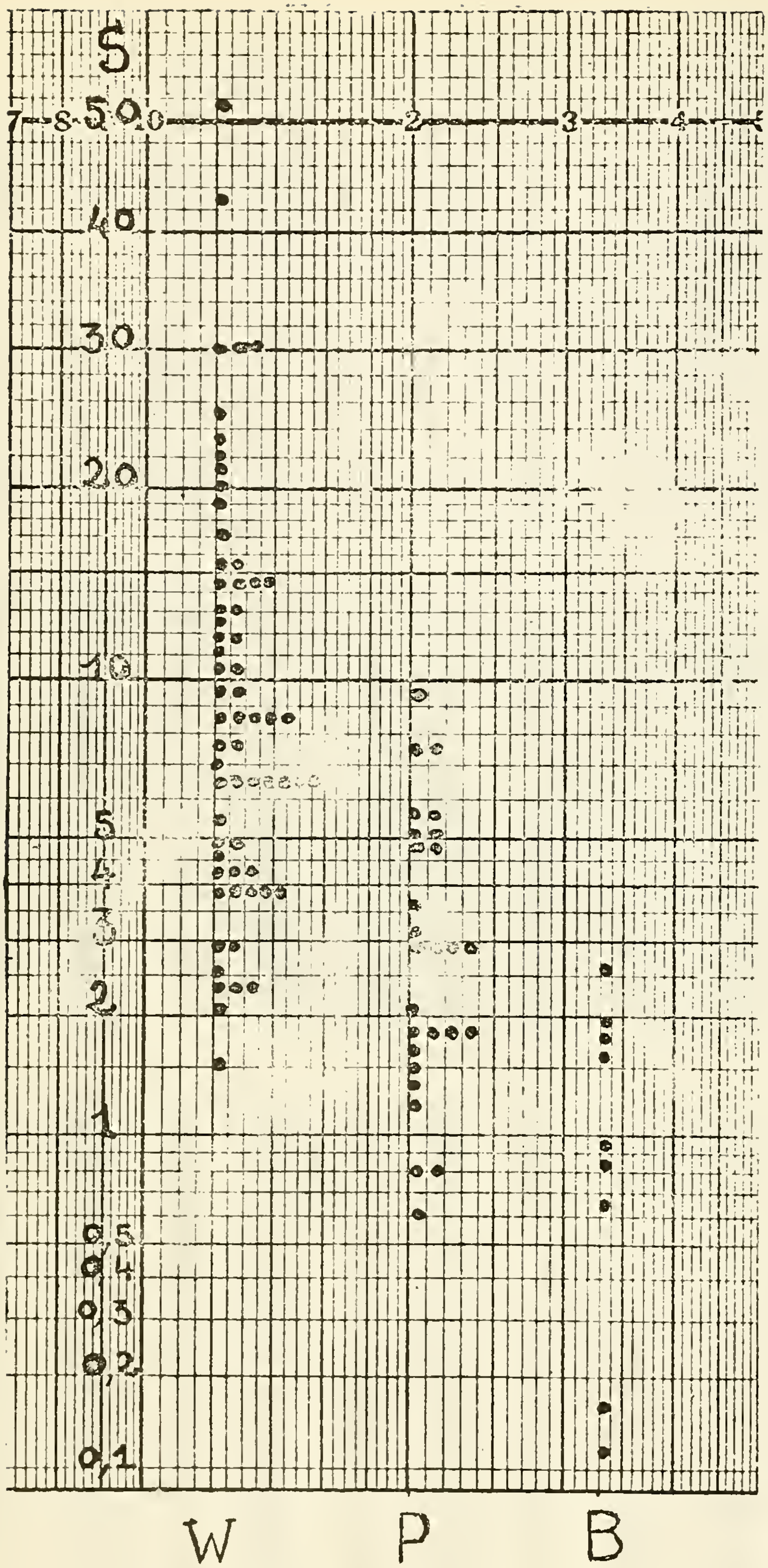

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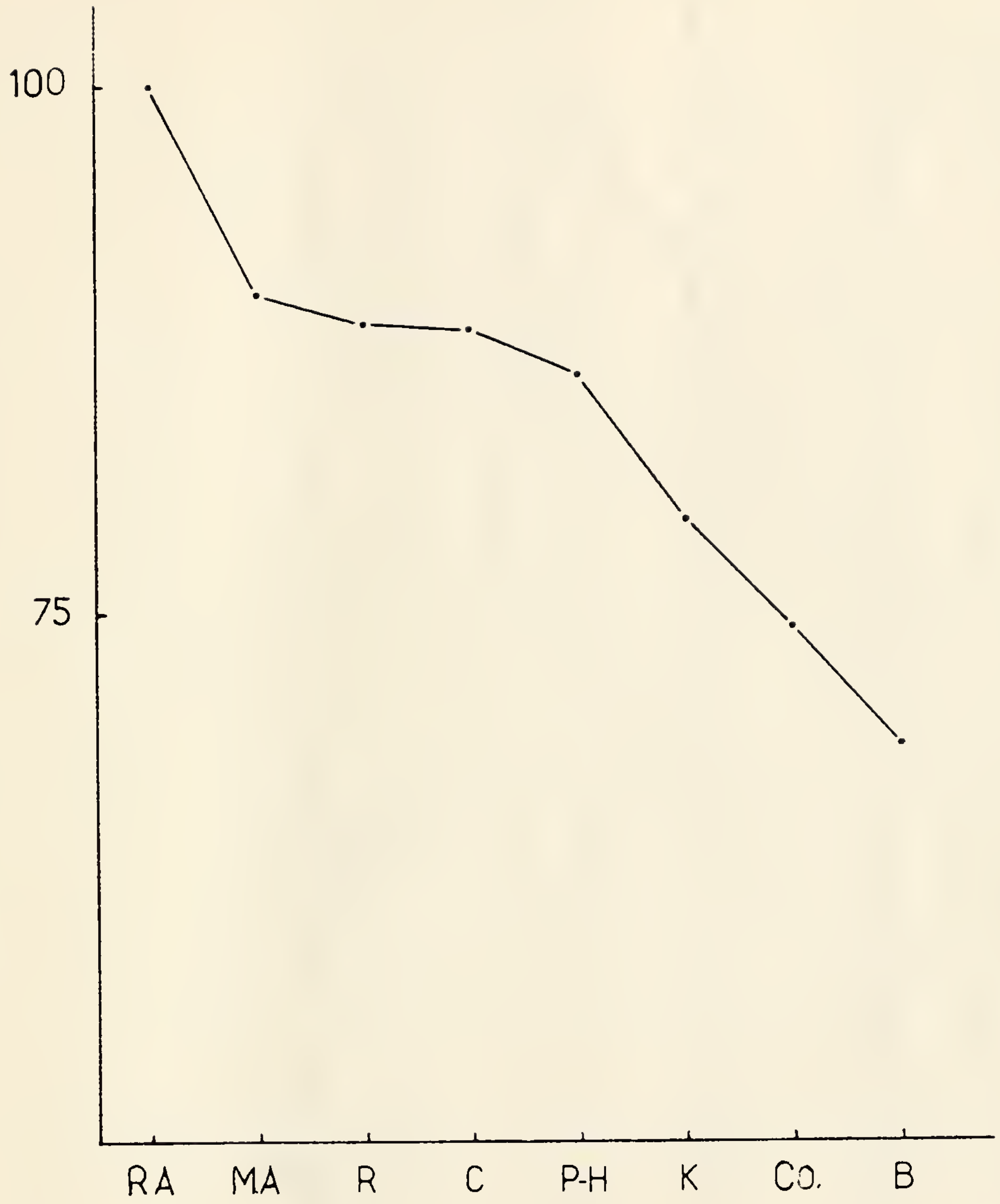

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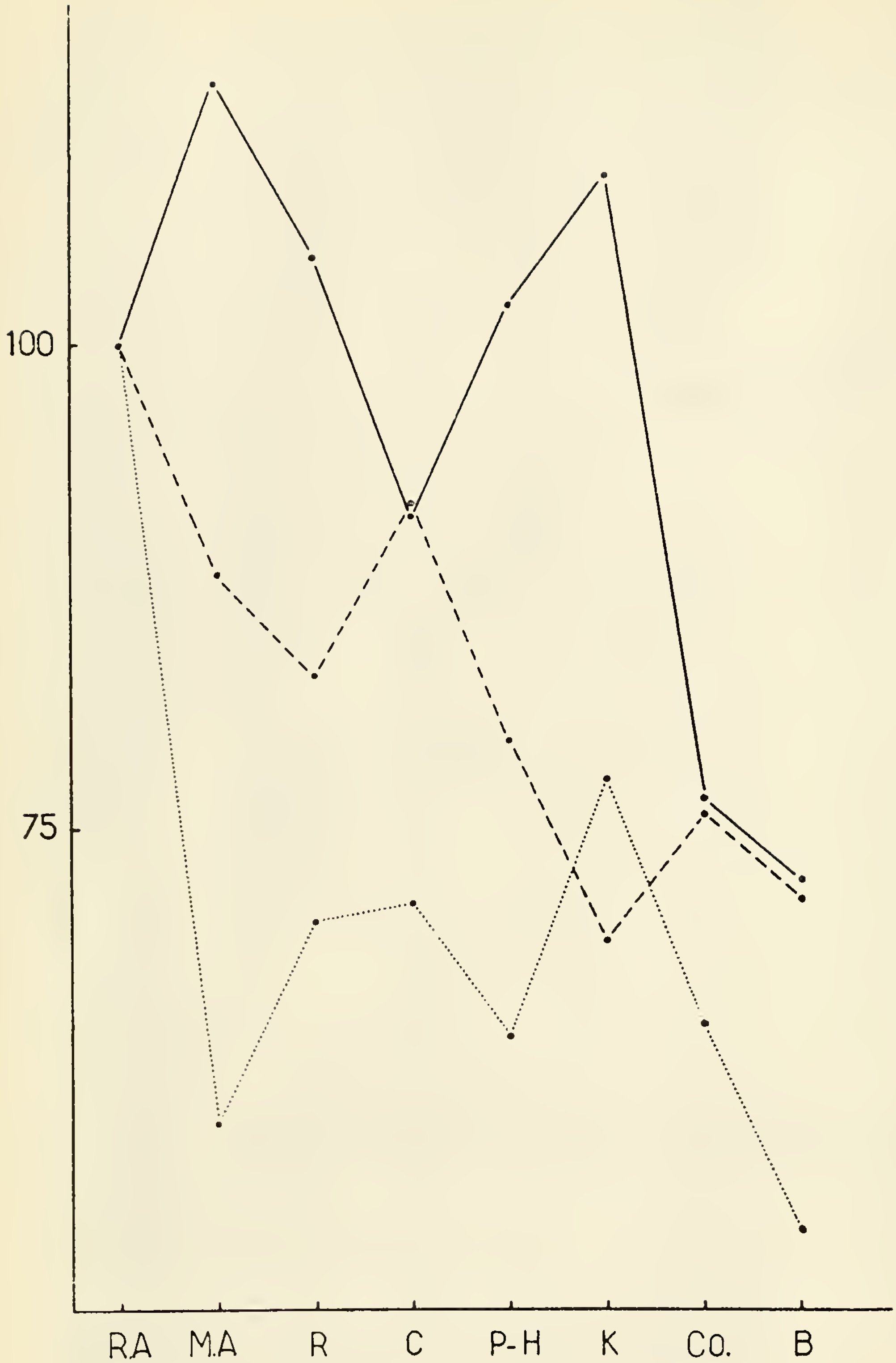

Figure 4

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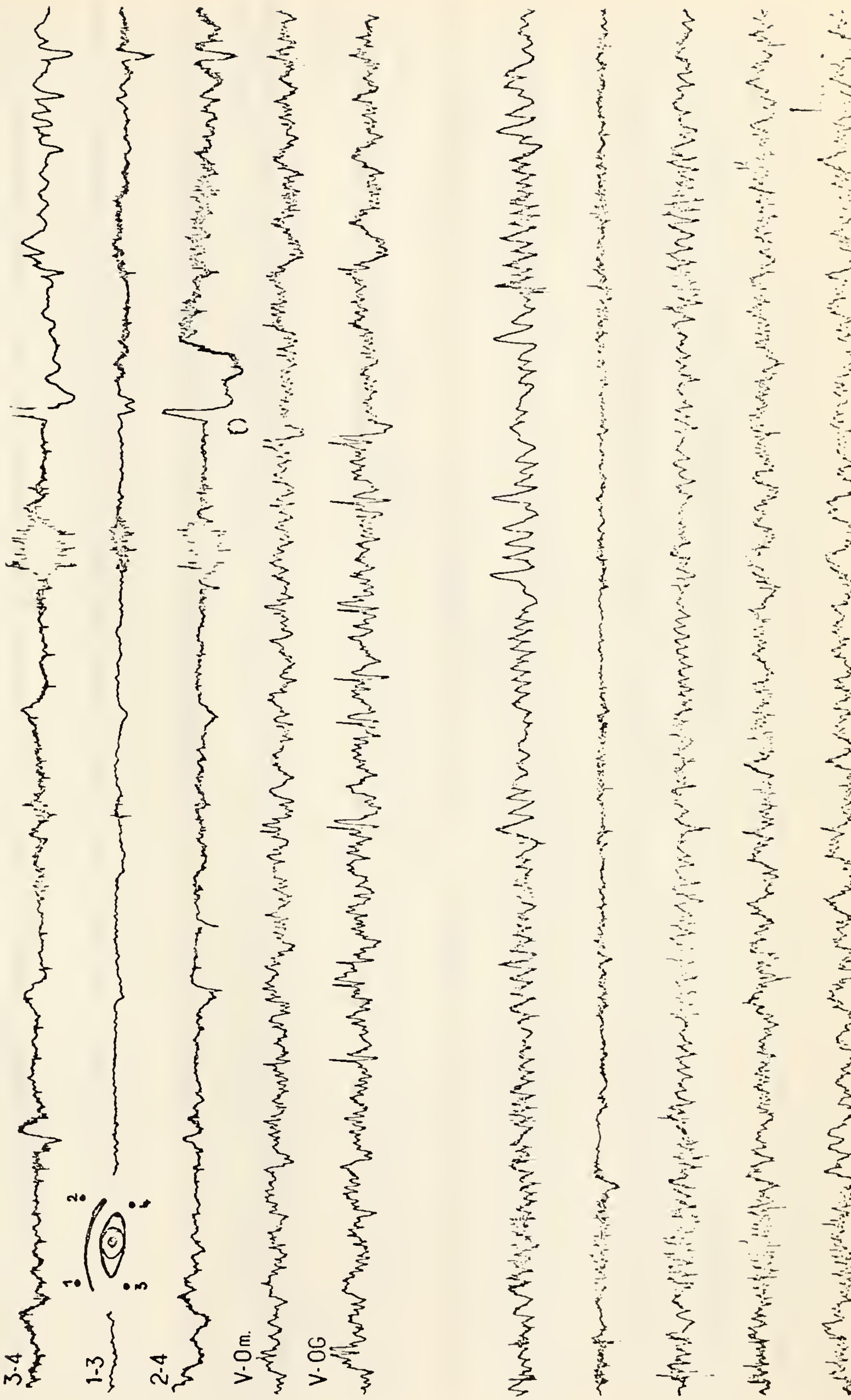

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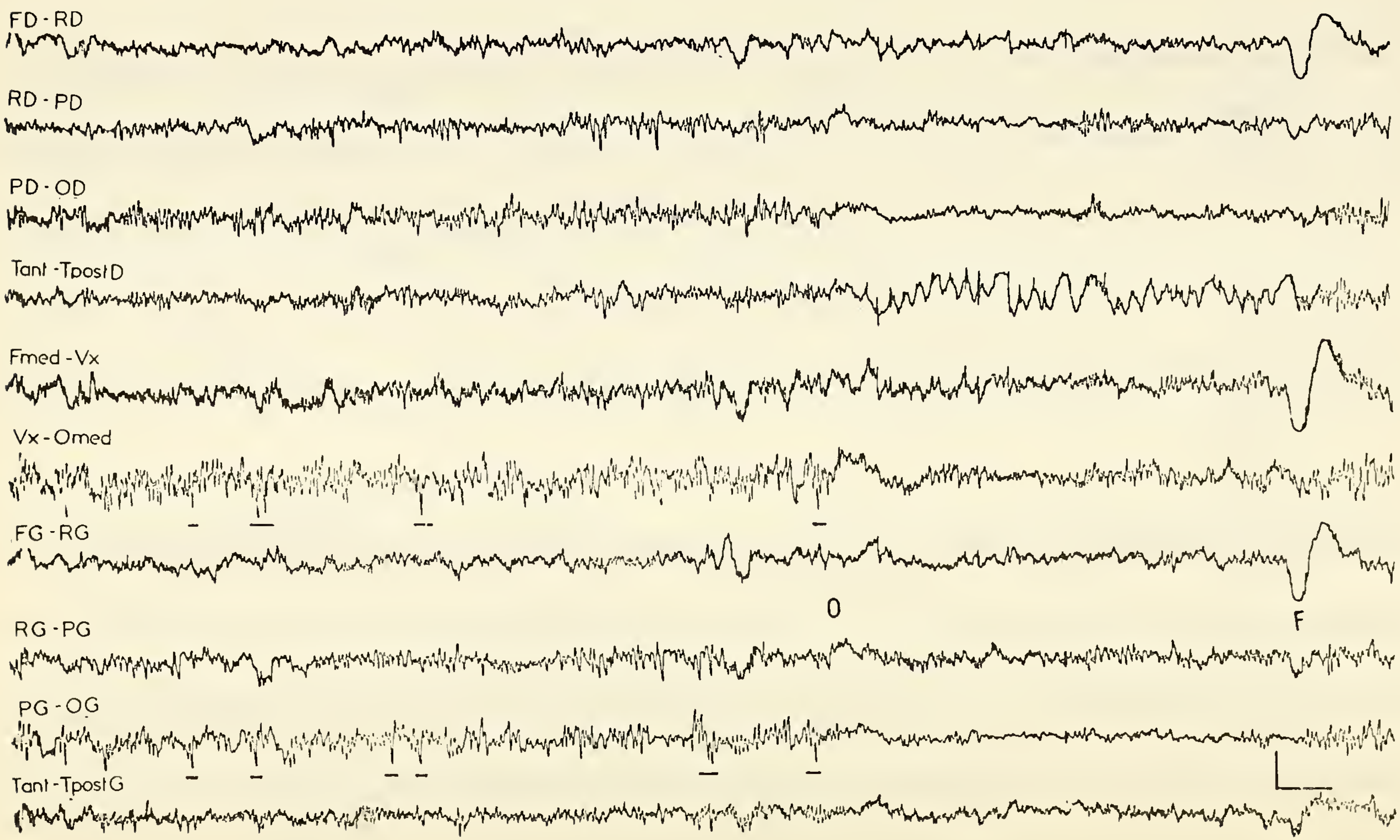

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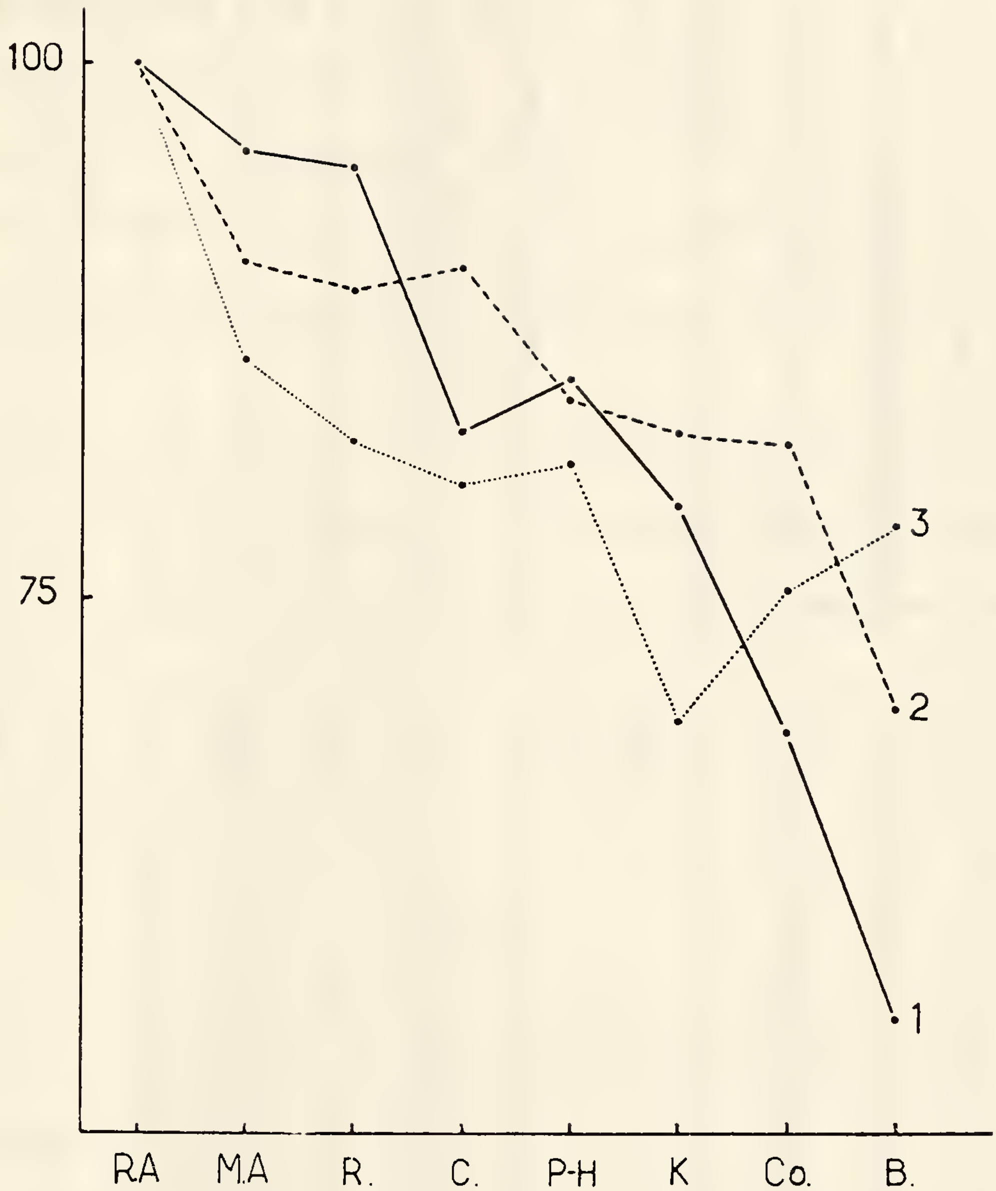
Figure 7



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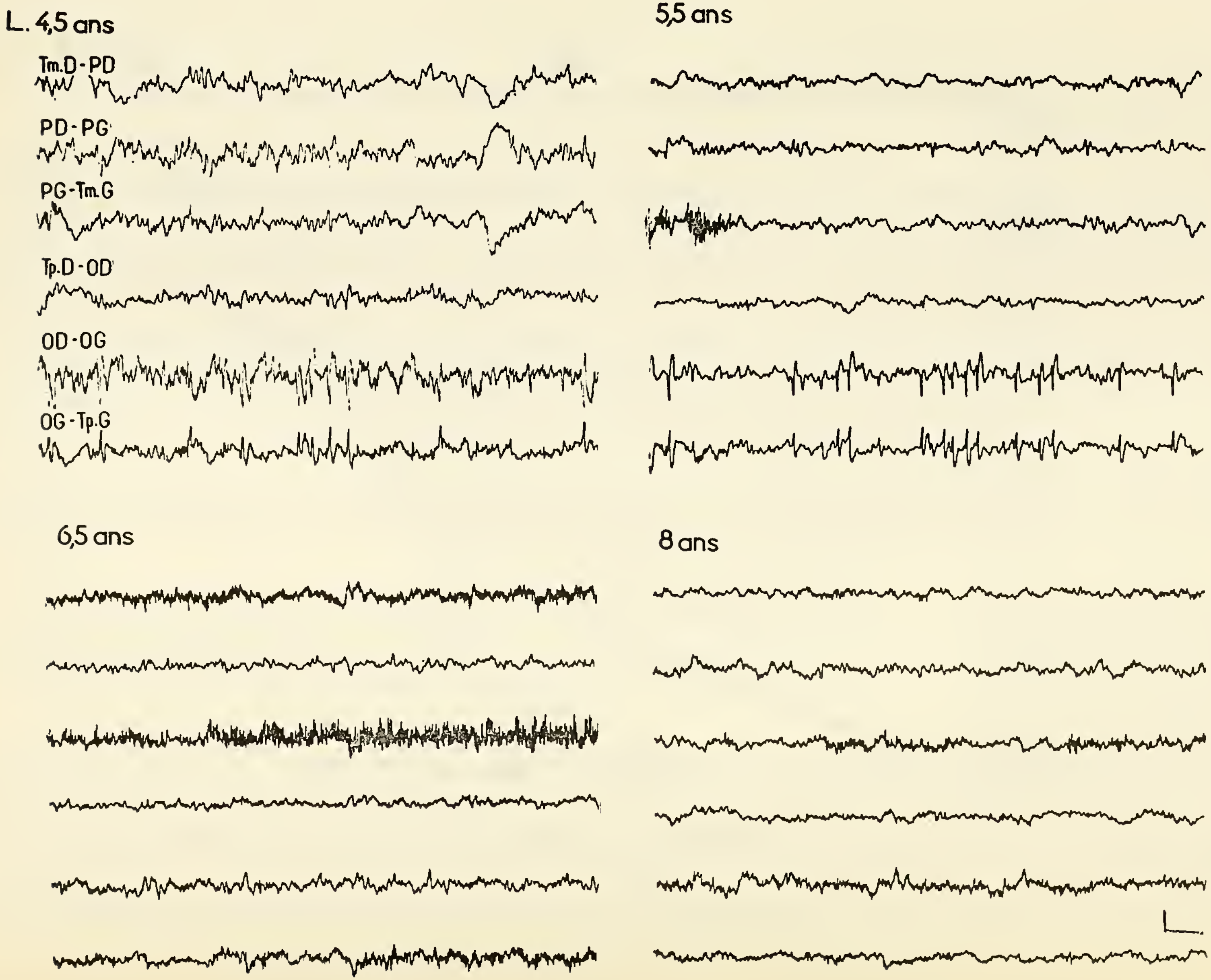

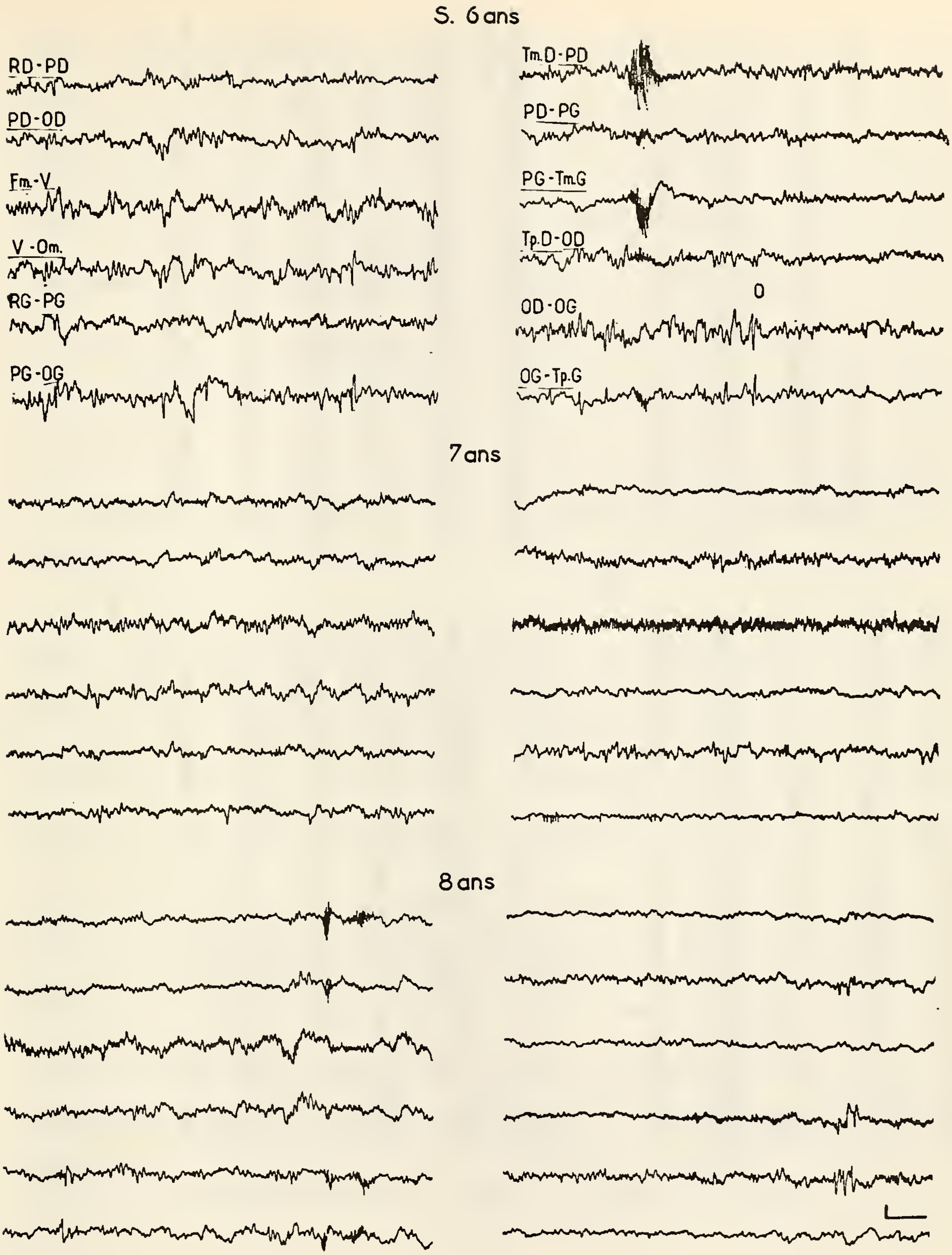
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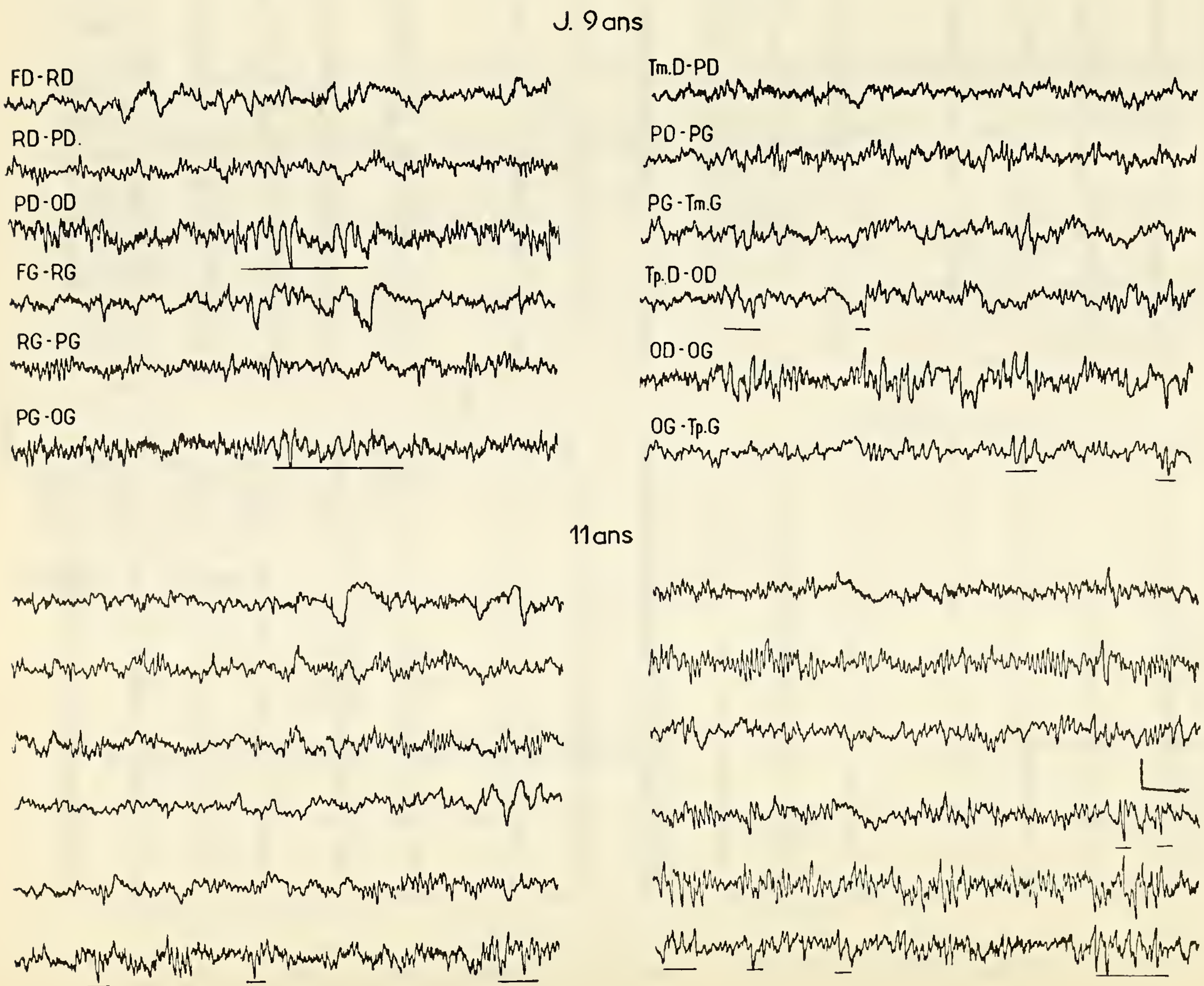
Figure 9

Figure 10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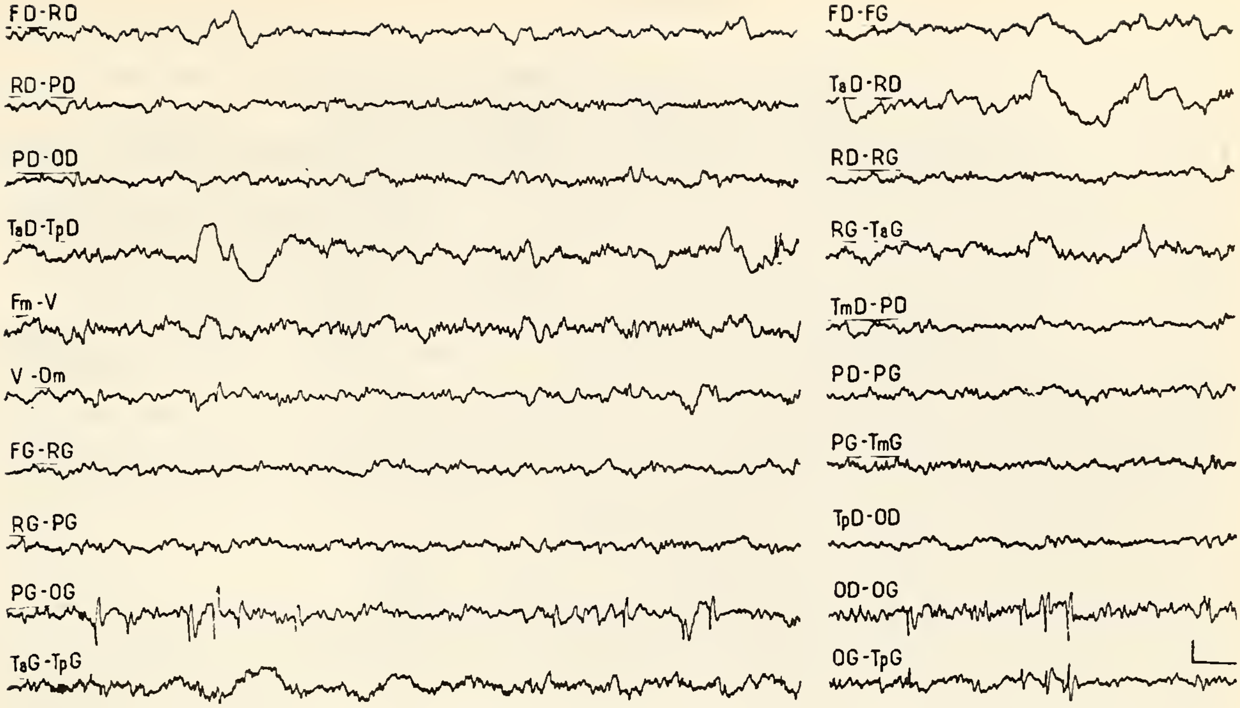
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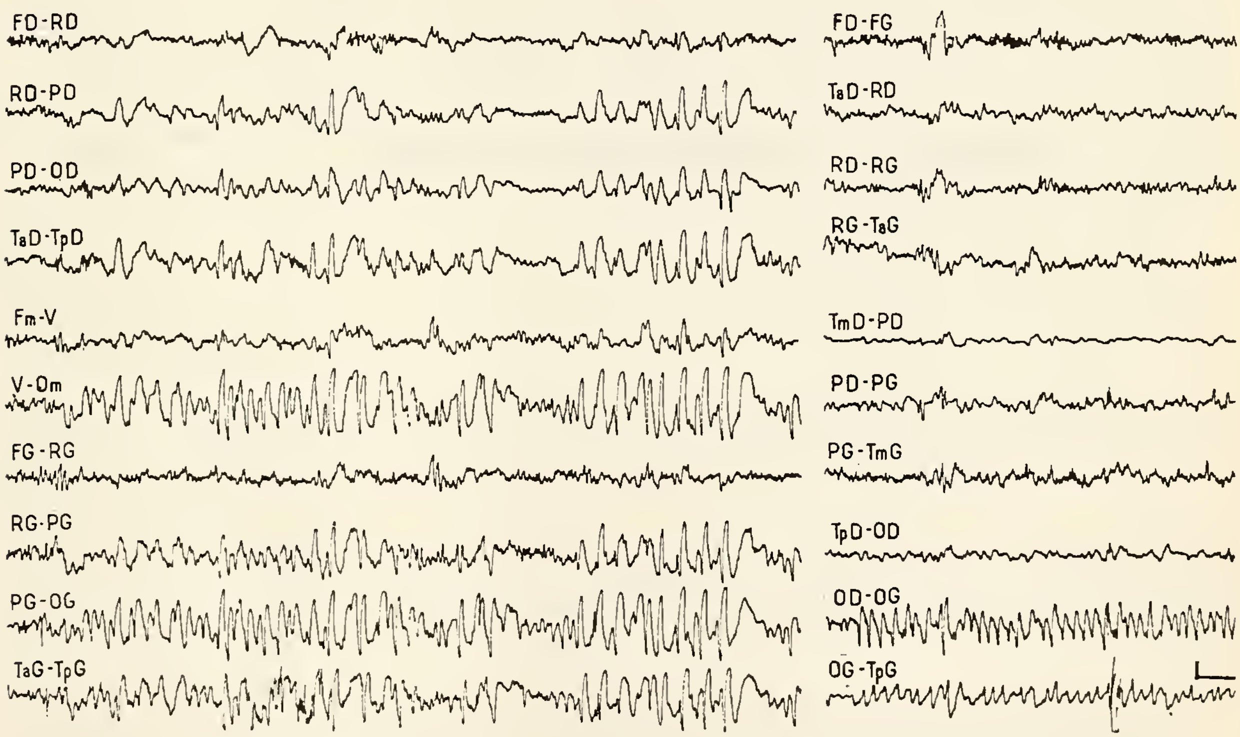
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PERSONALITY AND ATTITUDES OF BLIND TEEN-AGERS LEARNING CANE TRAVEL

by

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REVIEW OF THE LITERATURE

To move about freely, to go where one desires when one desires, without having to depend upon anyone else, is a privilege so common to all that it is hardly ever regarded as a privilege.

> The need to travel or move about freely is one of the obstacles presented by the handicap of blindness, and the inability to do so often becomes its most formidable limitation. [1]

Lowenfeld claims that the handicap of blindness restricts the individual in three basic ways: (1) in the range and variety of experiences; (2) in the ability to get about; and (3) in the control of the environment and the self in relation to it.[2]

The cost of freedom of movement for a blind person varies from one individual to another. Travel without vision requires the constant, minute by minute taking of calculated risks, some of which are out of the person's control. One has to face such hazards as heavy traffic, toys left by children on the sidealk, trash cans sprawled on the pavement, a hole dug by workmen and left with only a warning lantern, and icy spots on an otherwise dry street during the winter.[3]

However, in spite of ever present obstacles, the values of travel ability are insurmountable. Teaching the blind to travel in safety helps the individual to meet needs in physical health, mental health, social activities and independence, and economic and vocational opportunities.[4]

The ability to travel counteracts poor posture, the sunken chest, and dropped head which result from an excessive sitting position. The bumps, bruises, and skinned shins, characteristic of the visually handicapped are caused, for the most part, by incorrect

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1 Martha Miller, "Foot Travel Without Sight," Outlook for the Blind, November,

2 Berthold Lowenfeld, "Psychological Foundation of Special Methods in Teaching Blind Children," Blindness, ed. Paul Zahl, New Jersey, Princeton University Press, 1950, p. 95.

3 Pennsylvania State Council for the Blind, Adjustment to Blindness, 1954, p. 99.

4 Francis Hetherington, "Travel at the Michigan School for the Blind," International Journal for the Blind, June, 1952, p. 93.

travel. The blind have an inherent fear of bumping into objects, and as a result, they are almost always under a nervous and mental strain. Their muscles become tense from the expectation of the jar that comes when they collide with an object. The opportunity to learn to travel helps to remove many unhealthy attitudes and blocks.

An individual who travels well, safely, and with confidence, is one who can enjoy a wider range of social activities. The ability to go somewhere without being dependent upon someone to take him makes for a more well-rounded person.[5]

One of the first questions asked of a blind person by a prospective employer is "Can he get around and take care of himself?" According to the placement officer in the Division of the Services for the Blind in Michigan, "it is practically impossible to place the visually handicapped in a position unless he is able to travel to and from work."[6] He must not only be able to produce on a level equal to that of the sighted person, but he must also be independent and not a safety hazard. Observations have indicated there is a high correlation between the blind person's skill in travel and his success in his chosen occupation and in his ability to lead a normal life.[7] Philip Trupin, once a placement agent for the New York State Vocational Rehabilitation Service, recalled that many good employment opportunities did not result in actual placement because of the inability of the client to travel and move about freely, and that lack of ambulatory ability caused the dismissal of blind people he had placed. He advocated that the ability to travel effectively be included in a blind person's vocational rehabilitation plan.[8]

In nearly all of the writings which are concerned with the problems of blindness, there are many references to different methods and systems to aid in independent movement. Of all the devices, aids, and methods used, one of the most important but also most neglected is that of the cane, staff, or stick.

The historical references to different uses of the cane, staff, or stick show the varied ideas as to its use and value. It was used to ward off dogs and other intrusive animals; it was used just to make a loud noise and to warn sighted people that a blind man was coming, so everyone could move aside; it was used to swish back and forth in the gutters to determine whether or not water was present; and it was used as a support in the case of falling.[9]

The first recorded case of blindness is in the Bible, with reference to Isaac's having become dim of vision.[10] Also in Holy Writ, is found the self-reliance of the blind in walking abroad without a guide, protected by the special command of Jehovah himself, "Thou shalt not curse the deaf, nor put a stumbling block before the blind, but shalt fear thy God. I am the Lord."[11] Another example in the Bible which shows the care of God, and is a repudiation of the people's thoughts to thwart the blind man's freedom, is "Cursed be he that maketh the blind to wander out of the way."[12]

In ancient literature mention is made of the blind traveling alone with the aid of only a cane or stick. It was considered to be a miraculous gift of the gods, as

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5 Ibid., p. 94.
6 Ibid.
7 Alexander Bishop, "Independence for the Blind," International Journal for the Blind, February, 1953, p. 147.
8 Philip Trupin, "Foot Travel: Via Hoover Cane Technique to Placement," Outlook for the Blind, April, 1949, p. 112.
9 Richard Hoover, "Cane as a Travel Aid," Blindness, p. 354.
10 Ibid., p. 353.
11 Leviticus 19:14.
12 Deuteronomy 27:18

exemplified by the instance of Teresias, an ancient prophet who was deprived of sight for an offense against the gods. He was pitied by the goddess Chariclo, who gave him a staff, by which he could travel as safely as he could before he had lost his sight.[13]

In the 17th century, Sir Kenelm Digby, an English author, wrote, "The blind man who governs by feeling in defective eyes receives advertisement of things through a staff."[14]

In the 1800's there were attempts to describe systematized methods of using canes or rods to make travel more efficient and much safer. However, the systems were only suited to a particular individual's needs. No effort was made to find techniques which would be beneficial for an entire population.

It was not until Word War II, when the United States had approximately 1,400 blinded veterans to rehabilitate, that any attempt was made to teach a standardized system of travel with the cane.[15] Dr. Richard E. Hoover of Johns Hopkins Hospital started investigating foot travel, and was largely responsible for the progress made in this area. He developed a technique by actually blindfolding himself and by self-experimentation.

Since World War II, there has been a decided effort on the part of may organizations, institutions, and homes to furnish cane instruction to people for whose education and training they are responsible.

The Department of Medicine and Surgery, Medical Rehabilitation Service of the Veterans Administration, is one such example. They have realized the vocational, educational, and therapeutic value to be gained by keeping this motor activity alive among the veterans blinded in the war.

As stated previously, the attempt to standardize cane travel techniques has been rather recent. However, as far back as 1870, W. Hanks Levy, in his book, Blindness and the Blind, described a technique for using the cane, which, after very extensive trial and error, has been adopted almost two generations later as the standard technique in many adjustment and training centers for the blind throughout the country.[16]

The cane has two main functions ; it is primarily used as a bumper, secondarily as a probe. As a bumper, it protects the traveler from many blows and shocks to which his body would otherwise be liable. As a probe, the feeling and sound gained from its rhythmic swing indicates the nature of the area onto which the next step is to be made and the obstacles, if any, that are present, i.e., telephone poles. fire hydrants, mailboxes, etc.

The bumper function derives its first place status from the "normal position" in which the cane is held and which serves as a reference point to which the cane is frequently returned in the gamut of manipulations through which it passes while in use. This position is described thus:

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13 W. Hanks Levy, "On the Blind Walking Alone, and of Guides," Outlook for the Blind, April, 1949, p. 106.

14 Hoover, p. 353.

15 Ibid., p. 355.

16 Harold Richterman, "Some of the Important but Less Obvious Values of Physical Orientation and Foot Travel for the Blind," American Association of Workers for the Blind, 1951, p. 89.

. . . . grasp the shaft of the cane firmly at the point where the crook curves into the shaft with the arm extended forward to about a 45 degree angle to the body, the inside of the wrist rotated downward, the forefinger extended along the side of the cane with the crook of the cane turned outward and the shaft of the cane extended downward across the body, placing the tip of the cane about an inch or two above the floor in front of the foot opposite to the hand holding the cane.[17]

This position is employed in all indoor travel. This term, indoor travel, refers to the usual habitat of a blind person. Other indoor areas such as public building, by virtue of their unfamiliarity to a blind person, fall into the category of techniques for outdoor travel. Whether the abode of a blind person be a private home or an institution, he is expected to know the immediate environment well enough to negotiate without the aid of a cane. In the event a cane need be employed "at home", it should be confined primarily to the bumper function. Barring institutionalized living, the area of one's living quarters is normally too restricted to permit the effective use of a cane in a role other than that of a bumper.

The world beyond the boundary of a blind person's immediate living quarters imposes considerably more problems on him as a cane traveler. A student is faced with the necessity to learn the rhythmic technique of the cane, to maintain a sense of direction, to recognize landmarks which will serve as guidance clues, to maintain equanimity in the face of dangerous threats, to develop awareness of the hazard his cane can constitute to other pedestrians, to ascend stairs, to descend stairs, to cross streets, to use public transportation, to overcome distracting noises of the outdoors, to travel in unusual weather conditions, and to maintain a good workable relation with the public.

The rhythmic technique fulfills the probing function of the cane by assuring the traveler that the area onto which his next step will be placed is free from obstacles. The student is taught that the position of the cane for this aspect of travel varies slightly from that of the normal position, and it is between these two positions that he alternates in his use of the cane either as a bumper or as a probe. The hand gripping the cane in the indoor technique is now dropped in a natural position at the side; the back of the elbow is then rotated inward slightly so that it rests firmly on the hip bone. The student must learn to guide his cane largely by the thumb and forefinger. If his cane has a crook, the crook is turned down and the hand holding the cane is brought into a position in front of the center of the body and close to it. With his forearm remaining stationary, his hand moves back and forth, pivoting the cane so that the tip describes an arc in front of him, touching the ground lightly on each side.[18] His swing should be about four to six inches to the right and left of the width of his shoulders, and should be made by the motion of only his wrist, not his arm, which should remain stationary with relation to the rest of his body. If the arm is used to create the swing, the movement of the cane will not be symmetrical.

The student is taught to swing to the left at the same time as his right foot is brought forward. The cane should touch the ground at the same time that his opposite foot does. The cane, in a sense, becomes his substitute eye, since it is placed in approximately the same spot as his foot will fall at the next step.[19]

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17 Kentucky School for the Blind, Foot Travel, Pamphlet file at Perkins Schhol for the Blind, p. 7.

18 Hoover, p. 362.

19 B.A. Loutfy and O.J. Baker, "The Use of the Cane," Outlook for the Blind, September, 1949, p. 198.

Levy's technique differed in one important respect from the one that is at the present so widely used. It involved the rhythmic movement of the cane so that the tip of the cane touched the ground in front of the forward foot rather than in the reverse position, which experience has proved affords greater safety. Levy's error might have been soon corrected if his technique had been practiced instead of having been allowed to remain for so many decades as untested conjecture. When one considers the soundness of W.H. Levy's writing, it is disheartening to realize how little contemporaries have contributed to the technique of traveling with a cane.[20]

The cane travel student should never swing the cane suddenly or strongly in any direction. Courtesy and good taste are always in order. It is important for him to keep his head straight as though he were looking ahead. Looking down causes his gait to be choppy, and turning his head to the side causes his body to follow in the same direction. This will result in veering off to the side in which his head is pointing.

If his cane suddenly touches an object in front of him, the traveler can tell whether it is a tree, step, pole, or whatever it is by feeling and tapping with the cane. However, it is better to depend on the cane. The more one relies on it, the more useful it will become.[21]

In ascending or descending stairs, the instructor must teach the student to follow three basic steps. First, he should prepare for movement either up or down; secondly, he must make the ascent or descent; thirdly, he has to resume walking at the end of either the ascent or descent in as smooth a manner as possible. When the cane comes in contact with the bottom step of an ascending flight of stairs, the student should hold it firmly against the step and walk forward until his toes touch the riser on either side of the cane. Standing in this position, he should, with his left hand holding the cane, run the tip of it to the left along the tread of the first step until it contacts the end of the step on the left side. He should then return the tip of the cane to him and run it along the tread to the right of the step. With the tip of the cane firmly on the right side of the step, he should move to the right so as to place himself in a position to ascend the steps on the right side. The learner should be shown how to determine the height and depth of the steps before making the ascent.[22] This is achieved by running the tip of his cane from the front to the back of the tread of the first step and from the bottom to the top of the riser of the second step. The student should hold the cane in a perpendicular position in front of the center of his body at a height which will place the tip of the cane against the nosing of the second step. The cane will then tap each step as the ascent is made. When it fails to contact the step, the learner will know that he has reached the top step. However, before resuming walking, he should extend the cane forward, moving the tip along the floor in front of the foot opposite the hand holding the cane to determine whether any tripping hazards or obstructions lie in the area immediately in front of him.[23]

When the learner detects that he has come to a descending flight of steps, he should hold the tip of the cane firmly on the edge of the step and walk forward until the toe of his left foot protrudes slightly over the edge of the step. He should then

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20 Richterman, p. 89.

21 Loutfy and Baker, p. 199.

22 Industrial Home for the Blind, Instruction in Physical Orientation and Foot Travel, New York, Industrial Home for the Blind, 1950, p. 33.

23 Ibid., p. 35.

place the tip of the cane on the tread of the step below him and move it to the right until it contacts the right side of the step. With the cane held firmly on the right side of the step, he should move to the right so as to place himself in a position to descend the steps. The student should hold the cane in the manner employed in the indoor technique and drop his arm to his side. The tip of the cane will then extend a few inches beyond and below the edge of the step below. As the learner descends the steps with his arm in this position, the tip of his cane will move freely over the edge of each successive step until he reaches the bottom landing, at which point it will tap the floor, thus indicating that the descent has been completed. Upon reaching the bottom, before resuming walking, he should extend his cane forward, moving it along the floor, to determine whether any obstacles lie in the area immediately in front of him.[24]

When the learner reaches a street intersection, the tip of his cane will detect a down curb by dipping from four to six inches. At this point, he should hold the tip of the cane firmly on the curb and move forward in such a manner as to place both of his feet on the curb with his toes protruding slightly over the edge. From this position, without turning his body, he should transfer his cane to his other hand and run the tip of it along the curb as far as he can comfortably reach, return it to him along the curb, transfer the cane back to his cane hand, and repeat the process with that hand. If the cane moves on a lateral line with his shoulders on both sides, it will indicate that he is facing directly across the street. In this position, he should extend his cane forward in an arc moving the tip along the street, to determine whether he may step down from the curb without encountering a parked vehicle, water puddle or other obstruction. The instructor should impress upon the student the importance of listening for the movement of parallel traffic, for the crossing of pedestrian traffic, and for the stopping of cross traffic before he steps down from the curb. In crossing the street, he should hold the cane at a 45 degree angle straight out in front of him about two inches above the street. As the cane tip comes in contact with the opposite curb, just above its juncture with the street, he should measure the height of the curb before stepping up onto the sidewalk. As he steps up on the curb, he should extend his cane forward and outward in an arc in changing it to the position used in the rhythm technique in order that he may detect any rubbish receptacle, pole or other obstruction along the sidewalk.[25]

Types of canes vary with each individual, according to the length of stride, posture, length of arm, method of holding the cane, etc. The ideal cane should be six ounces or under in weight and should be durable. It should be a good conductor of sound and vibration, as this is often very important in determining terrain, position, etc. The handle should be comfortable and easy to hold without causing fatigue, without becoming extremely cold in winter, as metal might, or extremely slippery and hard to manage in other circumstances.[26]

Research is constantly taking place to improve canes. There has always been a demand for a good collapsible cane, and two types are offered by the Technical Research Department. The first is the so-called Avon cane, which employs the principle of the collapsible aluminum cup. The second is a modified leg from a camera tripod. It is offered with a crook handle and with or without the "glide ferrule." The glide ferrule is a rubber-mounted metal cap such as is used on chair legs. Its properties include a tendency to skip over cracks, and the ability to make a high frequency pulse of short duration. This pulse is useful for generating meaningful echoes from surrounding objects.

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[24] Ibid., pp. 37-39

[25] Ibid., pp. 23-27.

[26] Hoover, p. 364.

The ferrule is used on the Shank cane also, which is made from a golf club shaft. It has a plastic handle and is the lightest of the currently available canes. The Dural cane, made of aluminum alloy tubing and equipped with a solid steel ferrule or the glide ferrule, is most popular. It has been extremely valuable in supplying data to deaf-blind trainees.[27]

Other recent developments include illuminated canes, fluoroscent canes, canes with spring-loaded tips to absorb shock, canes of rattan, and come-apart canes.[28]

According to Hetherington, since so many of the basic needs, stated earlier, are met by travel ability, courses in travel training should not only be recommended, but should be compulsory in residential schools for the blind.[29] Ave-Lallemant claims that the residential schools are responsible for such training, since education means the development of the whole pupil, and that freedom of movement is one such part of the development.[30]

Georgie Lee Abel recently stated that the blind adolescent should have early instruction in the basic orientation and mobility skills. Early instruction will help him and his advisors to know when he has reached the point of readiness to consider whether he will travel with a good cane technique or a guide dog.[31]

The Maryland School for the Blind and the Kentucky School for the Blind were among the first educational institutions to introduce cane technique as an aid to travel and to recognize its necessity for the complete education of their students. The New York Association for the Blind, Federal Security Agency (Office of Vocational Rehabilitation), Industrial Home for the Blind, are examples of the first to recognize the need to train instructors in cane travel technique.[32] Since then, many others have realized this need, including Boston College, which now offers a Masters program in cane travel techniques for instructors.

Auch states that a blind person may have everything in his favor necessary for mobility except the readiness. As in all learning, motivation is essential. Until the desire for travel arises within the individual, the visually handicapped person will be satisfied with his inactive status. Parents and friends of a blind person can be of inestimable help by encouraging him to be independent. Until confidence is instilled within the individual, he will be perfectly willing to accept others as cructhes to lean on, and the chances are that he will never develop a positive mental attitude toward travel.[33]

Lashley brought out the point that the design of aids is somewhat restricted by the social sensitiveness of the handicapped. Many are unwilling to carry or wear anything that will attract attention or mark them as different from other people. Some say the cane symbolizes the misfortune and should be dispensed with. This notion,

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27 Charles Ritter, "Devices to Aid the Blind," Blindness, p. 413.
28 Ibid.
29 Hetherington, p. 95.
30 Frederick Ave-Lallement, "Travel Techniques Should Be Taught in the Residential Schools," American Association of Workers for the Blind, 1947, p. 79.
31 Georgie Lee Abel, "Adolescence: Foothold on the Future," New Outlook for the Blind, March, 1961, p. 105.
32 Hoover, p. 360.
33 Arnold Auch, "Blindness and Travel," Outlook for the Blind, November, 1949, p. 214.

of course, implies a mistaken notion of psychotherapeutic values. Nothing can be gained by denying and supressing the handicap. On the contrary, a more healthy attitude will be assured by facing the handicap realistically, and utilizing all available means of compensation.[34]

The following is an excerpt from reactions of a group of high school girls' introduction to the cane and the change in their attitude after several lessons:

> As soon as "traveling with a cane" was mentioned to us, our spirits were crushed and our hopes fell. The first thing that popped into our mind was the picture of a big, thick, wooden, white cane which would resound noisily as it tapped along the pavement. However, our feelings were somewhat altered when we were introduced to a new, light and easier to handle aluminum cane. It may be adjusted in length according to the user's height. Our first travel lesson was a pretty tough piece of work. It wasn't easy to walk out on the street trying desperately to use the cane the way in which we had been instructed. It seemed as if a million eyes were centered upon us; it was impossible to keep the right rhythm; the cane was in the way, hard to manage, and the roads appeared to be twice as long and bumpy as usual. We felt so conspicuous to passers-by, and it was all we could do to keep going. We even decided to take our lessons at night as we couldn't be noticed. After about three or four such trips were behind us, however, these feelings began to diminish, and we became more and more accustomed to the use of a cane. Cane lessons have aided in building up our self-confidence, with or without the cane. We have a more confident feeling, inasmuch as it doesn't seem as impossible to get around by ourselves. These lessons have also helped to do away with a great part of that antagonizing fear which tends to hold us back and keep us from trying things on our own. The cane, when used scientifically and correctly, enables us to walk with free and even steps, and it teaches us to be keenly alert and more observing as to what is taking place around us.[35]

Hoover found when working with the rehabilitation of the blind that the factor most significant in the resistance to the cane, is the strong desire, both on the part of the blind person and those engaged in their rehabilitation, to avoid the appearance of blindness.[36]

As long as the blind are a minority group and continue to live in a visual world, the best prevention plan devised will remain but a partial answer to the problem of free movement. One is as one thinks, and the blind person who intends to travel alone or independently must begin his journey within the boundary of his own mind.[37]

A problem which is the concern of all who teach travel is the optimum age to begin cane travel. According to Hoover, children usually have no prejudices one way or another and will accept a training program as planned for them. If they were to grow up with a cane in their hands, so to speak, there would be no selling

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34 Karl Lashley, "Psychological Problems in the Development of Instrumental Aids for the Blind, Blindness, p. 508.

35 Frances Wright, "Foot Travel Without Sight," Outlook for the Blind, February, 1947, p. 37.

36 Warren Bledsoe, "Resistance," New Outlook for the Blind, November, 1952, p. 248.

37 Miller, p. 246.

problem involved as to the need and benefit of such an aid.[38]

Girls of high school age who have always been led around and who are satisfied with this method of travel, are difficult to convince of the importance of becoming independent and of the advisability of training. Many react negatively to the cane because they conjecture in their minds the picture of a large, clumsy, heavy stick in the hands of a beggar as he taps his way down a busy street. Another factor for rejecting the cane at this age is that the desire for social approval, especially to the opposite sex of the same age, is assuming a new importance, and it is difficult to envision a cane helping toward an admirable or pleasurable acceptance. Also, girls of this age usually carry a pocketbook and don't want the additional burden of a cane. Very often, their activities and recreations are usually of such a nature that it is not hard to obtain and use a guide, which, of course, misrepresents the situation which will be encountered after the termination of school years.

As people grow older, fears, misapprehensions, lack of agility, coordination and adventuresomeness all make it rather easy to say, "I got along before; why change now?"[39]

A newly blinded person, in learning to use the cane, tends to revert to a framework of mannerisms exemplifying the sighted person's use of it, either as a walking stick or weight-supporting aid. These mannerisms he has seen as a sighted person, and they appeared to dominate his unconscious ideas of how a cane should be used to such an extent that they had a continuous tendency to work against the methods which served the patient's immediate practical needs.[40]

Many persons have stated that the cane, while useful when traveling from point to point, is cumbersome and awkward to handle when one's destination has been reached. This may be true in many cases. However, to the skilled traveler his cane becomes so much a part of him that he does not feel self-conscious in carrying it with him at all times.[41]

The following statement, made by Hoover, is a most valuable one in promoting a positive attitude toward the cane:

> A blinded person using the cane to the fullest advantage is recognized as a blinded person, but if actions are engineered effectively, the attention drawn to the person will be favorable attention.[42]

Some problems caused by blindness have received much attention and investigation while others have fared less well. The comparatively small number of blind children with the resulting wide scatter in age, intelligence, socio-economic background and geographic location has retarded research. It is difficult and often very impractical to perform studies on large groups. It is, therefore, reasonable to understand why the literature on the psychological effects of blindness in children is limited, and that in many areas, experience, observations and theoretical presentations are the

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38 Hoover, p. 358.
39 Ibid., p. 359.
40 Bledsoe, p. 248.
41 Frederick Ave-Lallemant, "A Review of Travel Methods, Their Advantages and Disadvantages," American Association of Workers for the Blind, 1951, p. 88.
42 Richard Hoover, "Foot Travel at Valley Forge," Outlook for the Blind, November, 1946, p. 250.

entations are the only contributions available.[43]

No comprehensive research on the psychological factors involved in mobility is available. Work on the perception of obstacles, which occupied European scientists around the turn of the century, received particular attention in studies pursued at Cornell University and published from 1944 on.[44] Although it is recognized that obstacle perception is only one factor influencing a person's mobility, the other factors have received little attention and almost no scientific investigation. There is, for instance, no study available which shows the effects of the restriction in mobility on the personality formation of the blind, or on his relations to others on whom he must depend in order to get about.[45]

Some blind children hardly dare to sep out into unfamiliar grounds and hesitate even in familiar surroundings, while others show a surprising facility in getting about. If a blind child has not been encouraged to develop his ability to move about and has not achieved a reasonable degree of independence in it, he may not only take help for granted, but may develop a generalized expectancy of help characteristic of regression. He may also develop a resentment toward the seeing society as a whole.[46]

In 1933 Thomas Cutsforth's The Blind in School and Society was published as the the first major work dealing with personality problems of the blind. In it he stresses the unavoidable injury to the ego of the blind person as a result of his position of dependency in locomotion. Since the blind live in a world of the seeing, they must procure visual aid and information. This represents a curtailment of self-expression and is registered emotionally as such. The act of asking a stranger the name of an approaching street car is an admission of inferiority for which there must be some compensation.[47]

The child who is congenitally blind experiences the world in his own way, which is different from that of most children, and must also cope with special difficulties in getting about. His personality is affected by these differences and it can be assumed that, by reason of his handicap, he is more likely to be under nervous strain and to harbor feelings of insecurity and frustration.[48] Very often a blind child develops a fear of being observed, which in itself is liable to produce tension and self-consciousness. He cannot determine whether he is being observed or when the observation begins or ends unless the observer makes himself known by some non-visual means.[49]

Particularly hazardous functioning, such as walking on a crowded street, even with a guide dog, certainly demands unusual tension and the concentration of all the faculties. Fear of seeming clumsy and inept certainly adds to the tension. How much it actually contributes must, of course, vary with the personality, but that it is a major factor in many cases is indicated by the refusal of some to function

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43 Berthold Lowenfeld, "Psychological Problems of Children with Impaired Vision," Psychology of Exceptional Children and Youth, ed. William N. Cruickshank, New Jersey, Prentice-Hall, Inc., 1955, p. 215.
44 Ibid., p. 248.
45 Ibid., p. 248.
46 Ibid., p. 249.
47 Thomas Cutsforth, The Blind in School and Society, New York, American Foundation for the Blind, 1951, p. 73.
48 Lowenfeld, p. 253.
49 Ibid., p. 270

in public at all.[50]

Lowenfeld has stated, however, that the blind individuals who are more successfully meeting their objective world are those with the psychosomatic nervous disturbances. He indicated that these people might be regarded as emotionally more mature, educable, and adaptable than the less nervous who have hardly made any attempt to meet the demands of the world.[51]

The most significant factor in the blind child's adjustment, however, is the quality of the parent-child relationship. This factor far outweighs training and education in enabling the blind child to develop a normal personality. Because blindness realistically creates a need for great dependency, parents and others frequently "do for" the child to a degree that keeps him from developing strength of personality and from learning how to relate to others in a mature manner. Once parents can see possibilities for the child and are relieved of anxiety about his mental capacity and their ability to teach him, they show great resourcefulness in carrying out a constructive program.[52] Much of the "lack of motivation or drive" attributed to children with physical deficiencies is due to its slow infiltration. If these young people are to live adequate lives with attendant satisfactions, they must be able to develop the capacity to master their environment. Without this, they feel themselves victims and ultimately either give up the battle for satisfaction or seek to punish the world with antisocial behavior.[53]

Over-protection of children with limitations is likely to engender in them feelings that their limitations excuse them from all responsibility. This leads to the development of individuals who look upon their disability as an alibi for not even attempting to participate in life.

The key to healthy development of personality is a sense of security. All children need the assurance that they are genuinely loved and wanted; children with physical limitations such as blindness need it in an especially high degree.[54]

Parents do not always respond rationally to the painful fact that they have a markedly limited child. Some can hardly disguise their resentment and act it out in punishing attitudes. Often they reveal their feelings through the rigidity with which they hold their children; others, in their attempt to cope with these tendencies, lean over backward, sacrificing their lives completely, to the detriment of the blind child and to others in the family. These unfortunate attitudes on the part of the parents are in part reflections of the attitudes of the community in general. To the extent that this is true, revision of parents' attitudes requires community changes.[55]

Thus, services directed toward establishing healthy parental and community attitudes must accompany those directed toward the social and emotional adjustment of the blind child if he is to accept his limitations, make full use of his assets, and develop

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50 Hector Chevigny and Sydell Braverman, The Adjustment of the Blind, New Haven, Yale University Press, 1950, p. 201.

51 Thomas Cutsforth, "Personality and Social Adjustment Among the Blind, Blindness, pp. 179-180.

52 Helen Witmer and Ruth Kotinshky, (eds.), Personality in the Making, New York, Harper & Brothers, 1952, p. 74.

53 Ibid., p. 65.

54 Ibid., p. 66.

55 Ibid., p. 67.

into a wholesome personality that will relate to society in a mature and realistic way.

The question of the value of paper-pencil tests for the sighted and the blind, with particular reference to the California Test of Personality, is of significance to this study.

According to Jackson, if one wishes to minimize or eliminate the effect of such extraneous factors as school achievement or intelligence upon personality evaluation, one should resort to the use of the paper-pencil test or the interview. He found the paper-pencil test reliable in divulging the secondary school student's mental and behavior make-up.[56]

An instrument is valid if it accomplishes the purpose or purposes for which it is designed. The purpose of the California Test of Personality is (1) to provide a frame of reference regarding the nature of personality determinants and their relationships to each other and to the total functioning personality; (2) to provide information about individuals which is useful in understanding their problems and improving their adjustment; (3) to serve as an instrument of research for obtaining other types of information.[57]

The California Test of Personality has been designated to identify and reveal the status of certain highly important factors in personality and social adjustment usually designated as intangibles. Personality refers to the manner and effectiveness with which the whole individual meets his personal and social problems and indirectly, the manner in which he impresses his fellows.[58]

The Educational Research Bulletin of the New York City schools has stated, "The procedure (inventories organized so students can answer questions by themselves) which is followed in the California Test of Personality is perhaps the most diagnostic of any test of this type. It is, however, best used for clinical procedure and is particularly useful with problem boys and girls."[59]

The problems of slanting answers or beating the test has little significance on the levels where personality tests are of greatest assistance to teachers. Baker says,"There is often a theoretical but entirely invalid objection upon the part of those who have never used such tests (personality inventories) that children will not be truthful. It is generally known that children's problems are so close to their lives that they can scarcely refrain from answering what applies to them."[60] This situation is similar to the tendency of most people to unburden themselves about their problems even to strangers if they are encouraged to talk about themselves.

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56 J. Jackson, "Relative Effectiveness of Paper-Pencil Test, Interview and Ratings as Techniques for Personality Evaluation," Journal of Social Psychology, February, 1946, 23: p. 35.

57 Louis P. Thorpe, Willis W. Clark, and Ernest W. Tiege, California Test of Personality Manual, Secondary Grades 9 to College, Form AA, Los Angeles, The California Test Bureau, p. 2.

58 Ibid.

59 Appraisal of Growth in Reading, Educational Research Bulletin of the Bureau of Reference, Research, and Statistics, Board of Education of the City of New York, November, 1941, 2: p. 28.

60 Harry Baker, Introduction to Exceptional Children, New York, The Macmillan Company, 1945, pp. 379-380.

As a student matures, he may recognize and be able to distort responses on certain items but he is generally trapped by others. In order to lessen the effects of this tendency to distortion, the authors of this test have attempted to disguise as many items as possible which might conflict with the examinee's tendency to protect himself. Instead of "Are you too sensitive?," they ask "Have you found that many people do not mind hurting your feelings?"[61]

Barker made a statement that must be weighed when using this test on the blind, "Personality inventories are replete with items that probably measure visual function, i.e., visual function largely determines the answer."[67] This indicates that personality inventories standardized on persons with normal sight are inadequate for the blind.

Sommers did a study of "some of the factors conditioning the behavior and the personality of the adolescent blind, and to find out whether there exists a relationship between parental attitudes and actions and the blind child's behavior patterns and attitude toward his handicap." She used the California Test of Personality as a method to obtain her results and the scores indicated that the personal and social adjustment of blind adolescents as a group was below that of the seeing and that blind girls were slightly better adjusted than blind boys. Sommers concluded, however, that this test like other personality tests designed for the seeing, does not adequately measure the personal and social adjustment of this group.[63]

Baker did studies in which various personality inventories were used and agreed with Sommers in questioning the general validity of personality inventories in research with the blind. The life situations of the blind differ greatly from those of the groups used in standardizing the inventories, and also many items in such inventories are of "different interpretive significance" for persons with normal sight and for those who are blind.[64]

Barker stated that a technical, experimental problem in work with the blind concerns the equivalence of different methods of administering tests to the blind and seeing subjects. A reader to the blind can influence the responses simply by emphasizing or not emphasizing particular words.[65]

In spite of the shortcomings of this type of test for use with the blind, the author of this study was forced to use it, since no standardized test for the blind has been designed yet. This clearly brings out the necessity of developing a test for use with the blind which would evaluate the effects of blindness in relation to the total growth pattern and total social environment of the blind individual.

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61 California Test of Personality Manual, p. 10.

62 Roger Barker, Adjustment to Physical Handicap and Illness: A Survey of the Social Psychology of Physique and Disability, Bulletin 55 of the Social Science Research Council, New York, Social Science Research Council, 1953, p. 286.

63 Cruickshank, p. 254.

64 Ibid., p. 263.

65 Barker, p. 287.

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VII

THE USE OF THE REMAINING SENSORY CHANNELS (SAFE ANALYZERS) IN COMPENSATION OF VISUAL FUNCTION IN BLINDNESS

by

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EDITOR'S NOTE:

This paper was submitted in English for the International Congress on Technology and Blindness held in New York June 18-23, 1962, and will be included in the published proceedings. The editors have made several minor stylistic changes in the paper to render its English more idiomatic. Where words are substituted, the original is put in parentheses, so that both sense and original form are retained.

Modern society with its technical progress demands from man a high and harmonious development of his mental and physical abilities.

Humanistic treatment of blind people by the Soviet state and Soviet people makes it necessary to establish a scientific system of education and thorough development of blind people, on the basis of which they can be prepared for life and work in society. This problem is solved in connection with the organization of the universal secondary and nine-year education for the blind, the organization of polytechnical education in schools for the blind, the development of the system of professional training on the basis of which the vocational problems for the blind can be solved.

At the present time all blind children of school age are in a system of universal education. State schools for the blind provide the pupils with a general educational program equal to the program of normal school, polytechnical, aesthetical, physical and moral education, and prepare them for different types of professional activities. Blind people in the Soviet Union work in different fields of industry, using different types of technical equipment and modern progressive methods of work; many of them have been very successful in intellectual work.

Investigation of the abilities of blind people became very important in connection with new perspectives of further development of general, polytechnical and professional education of the blind. People of different professions - teachers, psychologists, physiologists, clinicists, engineers and hygienists are involved in such kinds of investigation.

The present investigation represents a part of general work in the field of compensation of blindness and the development of blind people's personality. We shall discuss here principles and mechanisms of the use of the remaining sensory channels and correlative sensory aids ("safe analyzers") in compensation of the visual function in blindness. The understanding of mechanisms of compensation in blindness helps us to control them, to create rational methods of education, to organize corrective educational work preventing some secondary negative results of blindness, and to develop new methods of the perception of the world by the blind.

The investigation of the use of the remaining senses ("safe analyzers") by the blind is also of great importance for designing and constructing different technical devices for the blind (reading machines, measuring instruments, different types of models for education, devices, helping the blind in labor and space orientation, etc.)

For a long time the problems of physiological mechanisms and principles of substituting visual functions in the blind has drawn the attention of many investigators. But it is necessary to mention that these investigations were not based on a sufficient theoretical and experimental analysis which sometimes brought the authors to contradictory conclusions. The attention of many investigators was concentrated on the problem of what mechanisms and functions became deranged after the loss of vision, while the most important task is to investigate what remains unimpaired and how the compensation of lost functions goes on.

Our investigation was based on the teaching of I.P. Pavlov and I.M. Setchenov and on the new theories of compensation developed by Soviet scientists, P.K. Anokhin[1], E.A. Asratyan[2], L.S. Vygotski[3], A.M. Lomkina[4], A.N. Leontiev[6], A.R. Luria[7], and others. In our investigation, we tried to make clear how the rearrangement of functions of the analyzers develops after the loss of vision, which plays such an important role in the life of man.

The investigation was carried out on the basis of synthesis of many years of observation of blind people in the course of the process of education and work, psychological, physiological and educational experiments, organization of experimental educational programs in the schools for the blind, observations of the labor activity of the blind in different spheres of manual and intellectual work. In exploring physiological mechanisms of compensation, electrophysiological methods were widely applied. Theoretical analyses of the modern theories of compensation and the results of our own investigations permitted us to formulate some principles of compensating functions after the loss of vision.

In the light of modern theories of interaction and interchange of different cortical sensory centers ("analyzers"), the processes of compensation are realized on the basis of normal physiological mechanisms, i.e., the mechanism of analyzers and the mechanism of cortical associative function working on the principle of the conditioned reflex. With the help of these mechanisms, the perception of information from the outer world, its processing, selection and usage in the course of human activity, is going on.

An important role in the processes of compensation belongs to the feed-back mechanism, which serves for evaluation and correction of the results of performed action with the help of auditory, somathetic and other analyzers used in the process of human activity.

The loss of vision leads to change in all the afferent systems and in the cortical neurodynamics. As a result of limitation of afferentation after the vision loss, a broad irradiation of nervous processes and the involvement of different trace connections, which are of secondary importance in the presence of vision, are observed. A normal human organism possesses great reserves which are not used or used only to a limited extent in normal conditions with the presence of visual system. In the course of activity of people with a vision loss, a wide use of the remaining sensory channels ("safe analyzers") becomes necessary. These analyzers provide them with different types of information which in the presence of vision is excessive. Different organs and systems can be used as reserve sources for signal reception. Multiple signal reception from different sensory channels ("analyzers") provides conditions for the formation of complex dynamic systems of connections which play an important role in compensation for blindness. In the early period of blindness, a wide irradiation of neural ("nervous") processes takes place. This creates favorable conditions for the formation of conditioned interconnections.

The change in the sensory systems ("system of analyzers") after onset of blindness ("vision loss") is not limited to the change of some isolated functions but involves the whole central nervous system. The development of processes of compensation evokes a change of the type of intra-analyzer connections and mechanisms of cortical regulation. In the absence of vision, the mechanisms of cortical regulation are based on the extension of the use of hearing, tactile, motor and other systems of sensory analysis ("safe analyzers") which have a compensatory function in blindness.

Afferentation of the cortex in blindness is supplied not only through the use of signals from receptor organs but also through previously formed and stored dynamic systems of interconnections. In persons who used vision before they became blind, the traces of their visual experience are included in the patterned interconnection ("systems of connections"). This enriches their impression of the outer world and becomes an important factor in their spatial orientation.

Loss of vision leads to important changes in the dynamics of spatial orientation ("orienting reactions"). The orienting reactions in the blind are characterized by different relations between cortex and subcortical structures. The reticular formation becomes a source of strong excitatory impulses, stimulating cortex and maintaining the level of its excitability[4]. Such type of change in nervous processes can be observed at the first stage of blindness or in the conditions of orientation which are exceptionally difficult for the blind. The structure of spatial orientation ("orienting reactions") is not fixed and can change in connection with the requirements of the external conditions[8].

Many authors have shown that higher mental functions of speech and thinking are most important for developing compensation in the blind. Different processes of rearrangement and substitution of functions in blindness do not appear spontaneously as a result of biological predetermination but are formed in active voluntary activity of man and depend upon the contents and conditions of this activity. The mastery in the course of education of social experience which is realized in active labor, activity, in language as a means of intercourse and learning, in the products of labor, in the social forms of life, plays an important role in the appearance and rearrangement of nervous processes. The mastery of social experience with the help of language in the course of education is an important factor in the development of higher functions in the blind: perception, voluntary attention, creative and reproductive imagination, logical memory and abstract thinking.

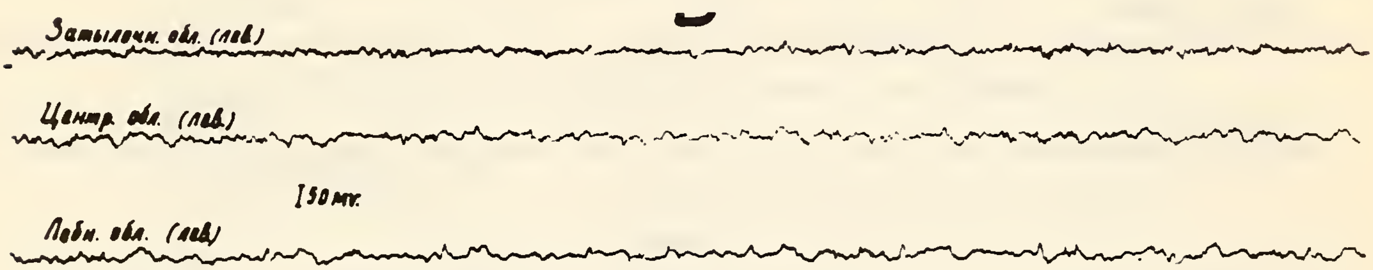
For understanding mechanisms and ways of compensation, we shall analyze certain experimental data.

The physiological basis of psychological processes is provided by the mechanisms of cortical activity. To show in what way these mechanisms change after the vision loss, we investigated electrical activity of the brain in 150 blind people.

It was shown that the electroencephalogram (EEG) of the blind differs greatly from 99 per cent of the sighted people and was characterized by the absence or poor expression of the alpha rhythm, which dominated in the EEGs of sighted people.

Together with the absence of the alpha rhythm, a pronounced depression of electrical activity in the blind can be shown (Figure 1).

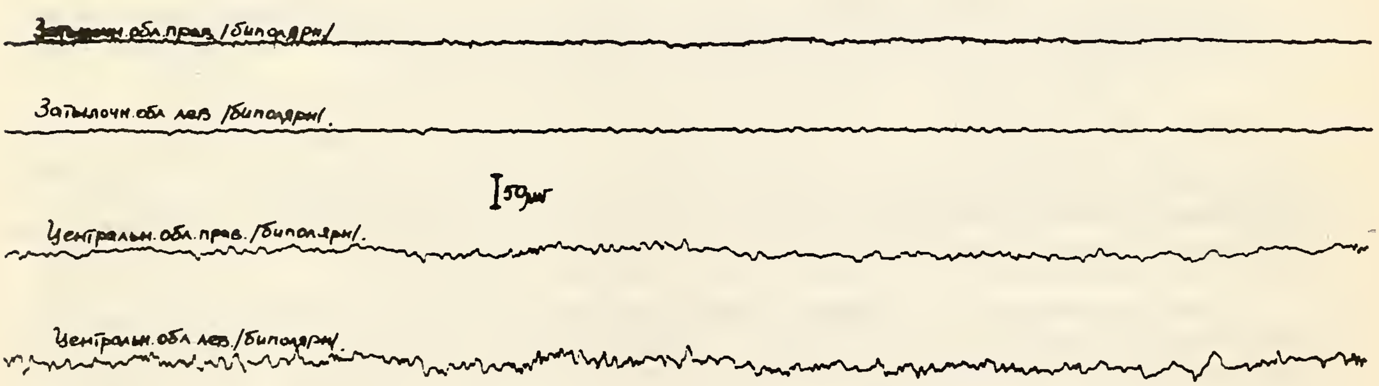
Figure 1



On the basis of investigation of blind people as well as experiments on animals, it is possible to conclude that the specific EEG of the blind is a manifestation of the lowered level of cortical excitation, resulting from the absence of visual afferentation input. Thus, the complex reflective activity in the blind is carried out against a background of certain lowering of the level of cortical excitation.

In connection with the problem of sensory compensation, it is interesting to note that the depression of electrical activity in the blind is most expressed in the occipital region of the cortex (Figure 2). In the sensory motor region of the cortex

Figure 2



in the blind, as well as in the people with useful vision, M rhythm (Rolandic rhythm) can often be registered (Figure 3). It is important that Rolandic rhythm, augmented under the influence of proproceptive, tactile and sound stimulation, should spread to the occipital region of the cortex (Figure 4). This fact testifies to the preservation of the intercentral connections of the occipital cortex with the other regions and can be used for explanation of mechanisms and processes of compensation in the blind, providing additional afferent input on the basis of the use of other analyzers.

Figure 3

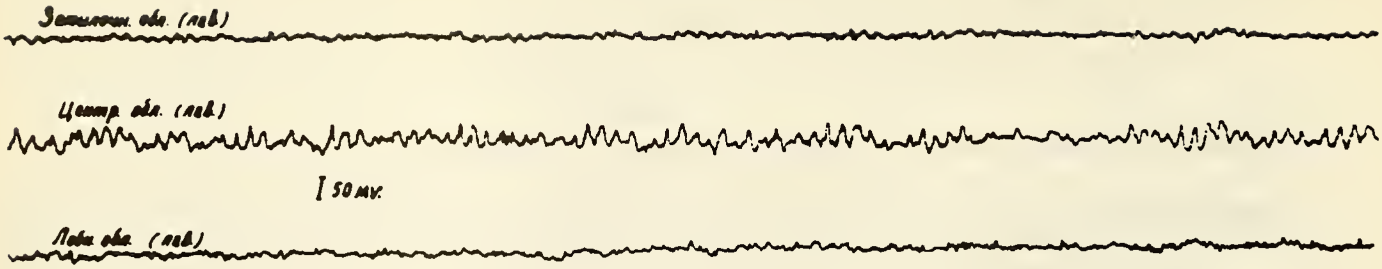
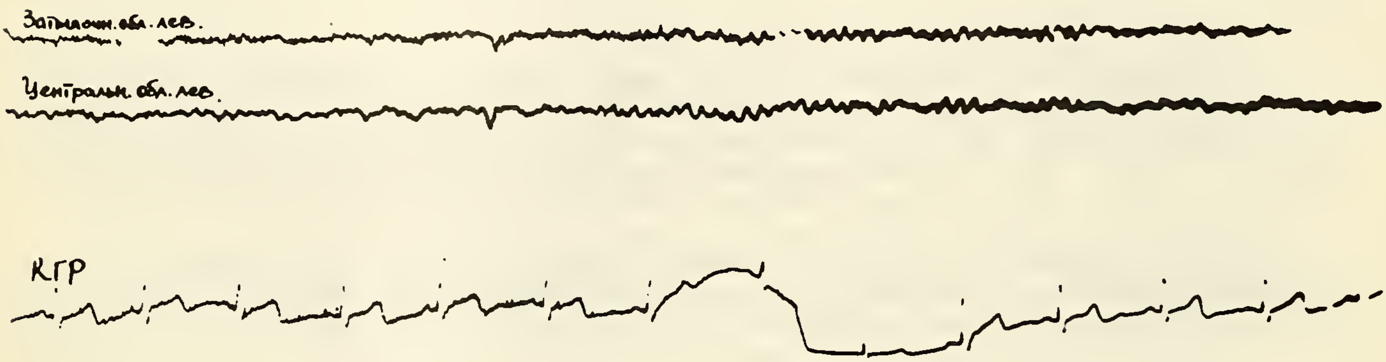


Figure 4



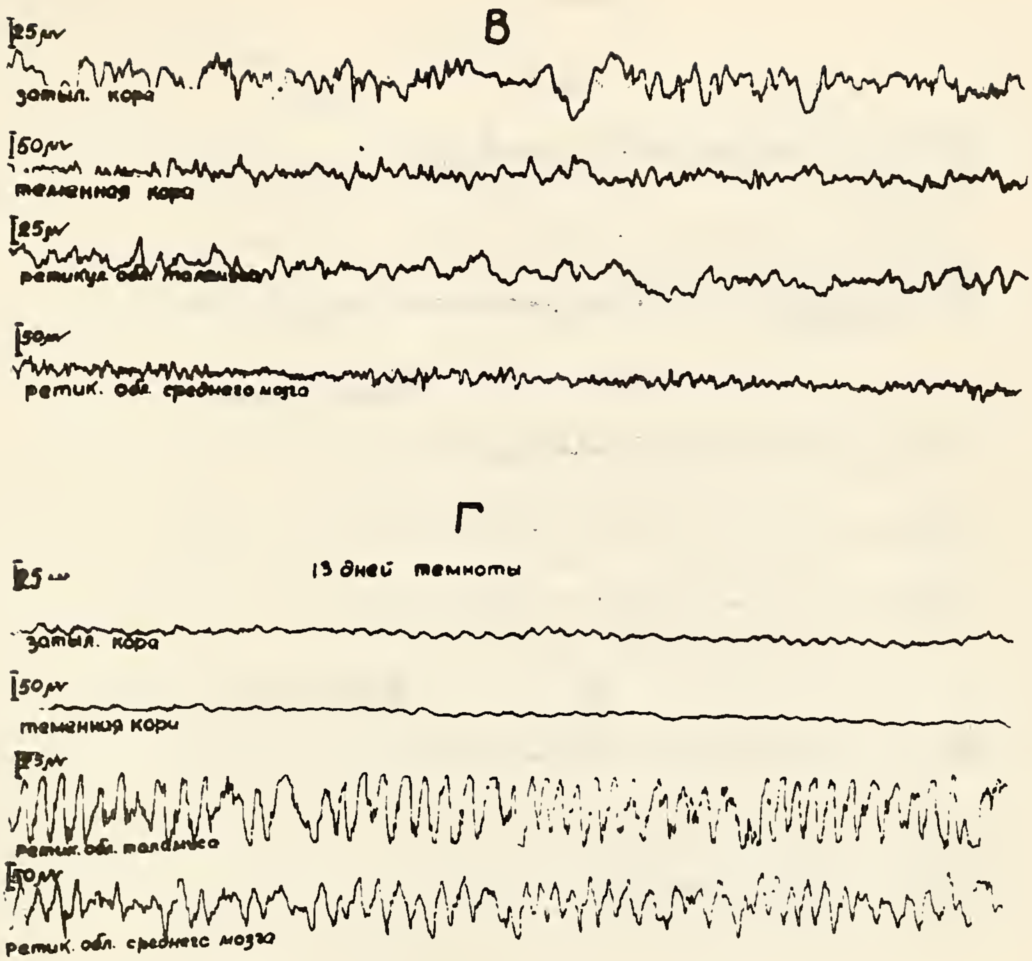
Experiments on rabbits showed that the lowering of the cortical excitation level resulting from absence of visual afferent input, evokes disinhibition of subcortical structures, particularly of the reticular formation (Figure 5).

Thus, the peculiarity of the neurodynamics among the blind manifests itself not only in the lowering of the cortical excitation but also in the increase of the level of excitation in subcortical structures. This increase of the excitation level in subcortical structures serves as one of the sources of compensatory excitation of the cortex and explains several specific features of vegetative reactions in the blind.

In the experiments on blinded animals, complex relations between the cortex and the reticular formation were observed. Several months after the blinding of a rabbit, when the level of the electrical activity in the cortex became equal to 30-40 per cent of the initial level, a strong excitation of the reticular formation was observed. In the period of maximum exaltation in the reticular formation, a certain augmentation of the cortical excitation level was noticed. Later, after the blinding of the animal, the normalization of inter-relations between the cortex and subcortical structures takes place.

In a series of experiments, the electrical activity of the brain after enucleation of the eyes and keeping the animal in absolute darkness for several months were compared. It appeared that prolonged keeping in darkness resulted in the same lowering of the amplitude of the cortical electrical potentials as after the enucleation. After bringing the sighted animal into conditions of normal illumination, the level

Figure 5



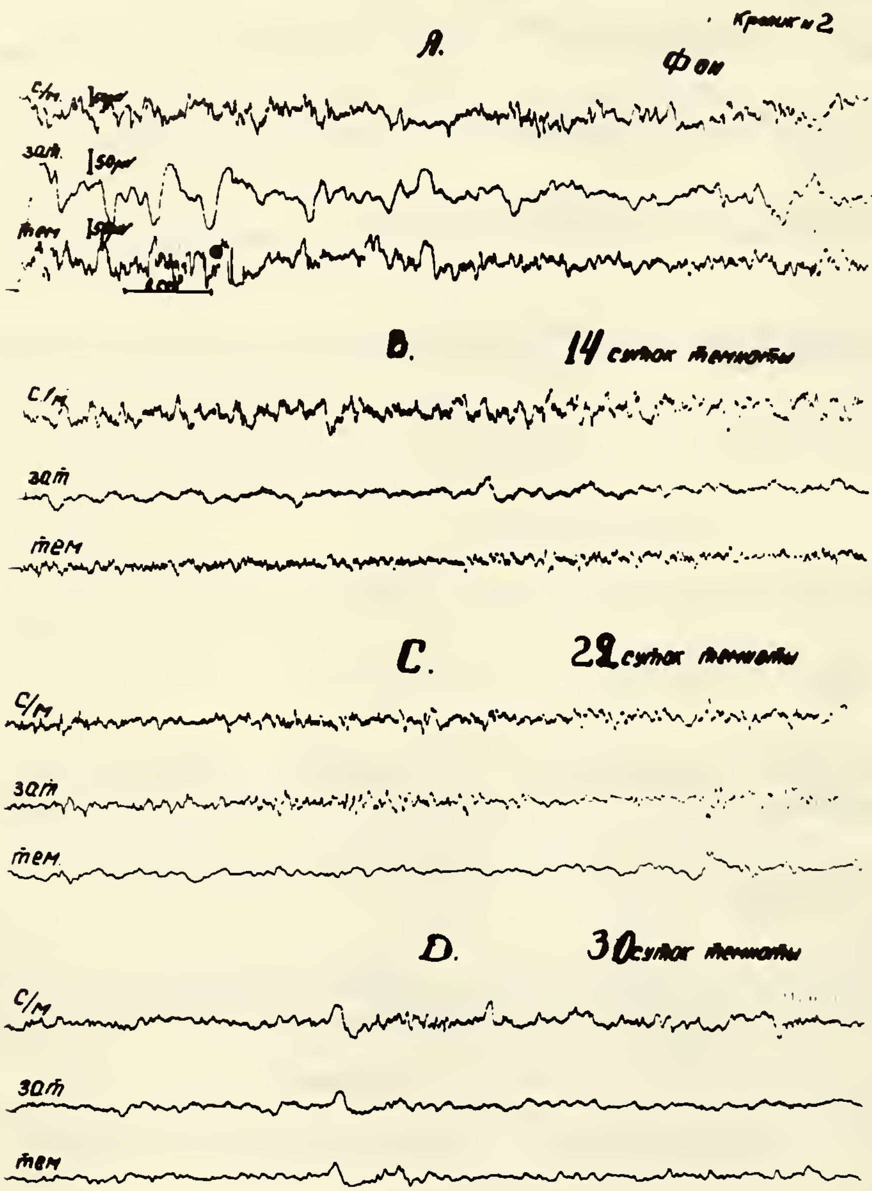
of exitation in the cortex grew continuously, eventually returning to the initial state (Figures 6 and 7). On the basis of these observations, a hypothesis can be proposed that the changes of the electrical rhythms in the cortex of the blind are based not on the morphological (structural) but on functional changes.

These observations are of interest for the problems of rehabilitation of the visual function.

From the experiments described above, it is obvious that loss of vision evokes important neurodynamic changes, which represent compensatory rearrangements in the brain.

The rearrangement of the central sensory ("analyzers") functions in man develops in the course of practical activity and depends upon its contents and conditions. The improvement of analyzers and synthesizers is selective. Thus, when learning Morse code or in using reading machines with auditory output, the auditory (hearing) analyzers and synthesizers develop. When learning is based on the braille system, stenography, graphical alphabet, the tactual perception becomes improved. The development of the analyzers and sythesizers results not from the elementary sensory functions but from systemic activity of central nervous functions ("safe analyzers"). The development of the remaining sensory channels ("analyzers and synthesizers") is based on the formation of both intra-analyzer and intra-analyzer connections.

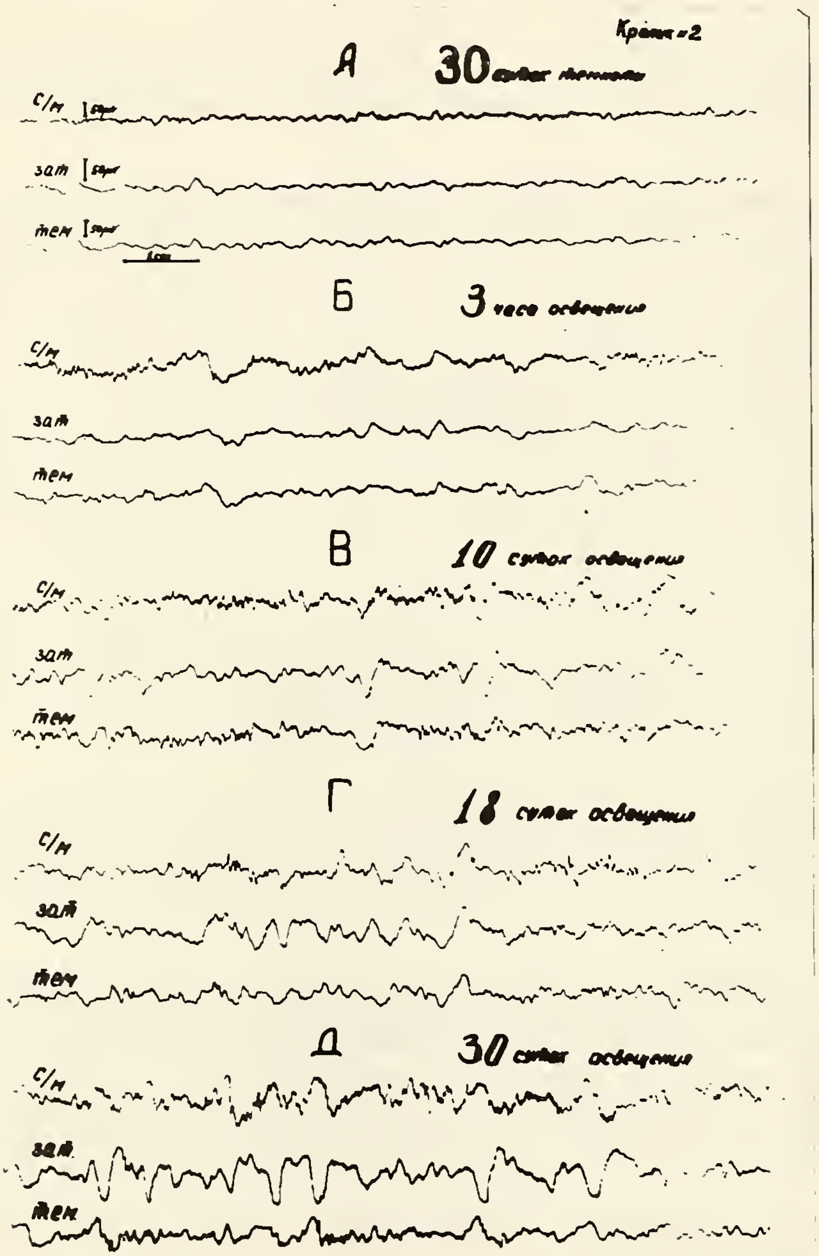
Figure 6



Comparative study of changes with age of sensory functions in blind children and children with normal vision showed that there are trends in the development of sensory channels ("analyzers"), depending upon the age: with age, both in blind and sighted children, sensitivity rises to a certain level[5].

In this process, the blind are able to obtain a higher level of development of tactile and hearing perception than that in people with normal sight. It results from the fact that in the course of education, blind people more often use tactile and hearing perception and this provides conditions for the development and improvement of tactile and hearing analyzers and synthesizers. In appropriate conditions, people with normal sight are also able to obtain a high level of development of different sensory functions.

Figure 7



Different sensory channels ("analyzers") play unequal roles in the processes of compensation. For the perception of the objects of the outer world, tactile and proproceptive analyzers are most important. With the help of these channels ("analyzers") the blind immediately perceive the objects of their environment. Kinesthetic and tactual perception also play important roles in the feed-back mechanism, providing signalization from the peripheral organs, on the basis of which estimation and correction of movements in labor activity, walking, sport, etc., can be carried out by blind people.

The significance of tactile perception for compensation in blindness has been noted by I.M. Setchenov: "The hand feeling objects gives to the blind everything that we receive through the eye, except the colors of ojects and the perception at a distance."[10] I.M. Setchenov supposed that the "image" of tactile perception and the image in visual perception have a basic likeness in their contents, insofar as they represent in the human brain the objects and phenomena of the outer world.

The theory of I.M. Setchenov on the interrelationship among sensory channels ("intersubstituting functions of analyzers") and their interaction is very important in understanding the process of transfer among sense modalities ("of use of the safe analyzers") in blindness.

Soviet and foreign authors have repeatedly discussed the question - how and to what extent tactile perception can substitute for vision in the perception of objects and phenomena of the outer world? It is known that with the help of tactile perception as well as with the help of vision, it is possible to distinguish different features characterizing objects: their structure, form, size, etc. All these features are synthesized and as a result of it, a detailed "image" of the object is created. It was shown that on the basis of interaction and intersubstitution of sense modalities ("analyzers"), the formation of the image can be carried out on the basis of very limitsed sensory information, even with the absence of vision, hearing and speech. In these cases, sensory input ("afferentation") is provided by tactile and kinesthetic cues and by the transfer of sensory traces in the neuropile wherein substitute sensory processes are developed on the principle of the conditioned reflex[11,14].

Tactual perception in the blind develops according to the same laws as vision and other forms of perception. Experiments with the perception of figures, evoking visual illusions provide good examples. The cases of perceptual illusions are the expression of connective activity which, in every day life, provide correct, adequate perception of the outer world and only in artificial conditions, created by specially chosen figures, materials create the effect of illusion.

In our experiments, the figures in relief evoking visual illusions were presented to 40 pupils of the 4th and senior grades of the school for the blind. Among the pupils, 19 were totally blind and 21 possessed the remnants of vision (up to 0.05). Tactile perception of the figure was carried out by the moving hand. Each figure was presented only once.

During the tactile perception of the figure evoking the Müller-Lyer illusion (Figure 8), illusion was obtained in 30 pupils of the school for the blind. Ten pupils perceived the segments as equal by measuring them with the help of their fingers. To this group, the figures were presented again, this time the measurements being prohibited. In these conditions, the Müller-Lyer illusion was observed in all the pupils. This fact provides a good illustration for Setchenov's concept of the role of the movement of a feeling hand being similar to that of a seeing eye.

The results of experiments with Müller-Lyer's illusion coincide with the data described by G. Revesz[16].

We shall also describe the experiments with a figure evoking the illusion of perspective, which seems to be a specific value for vision and presumably because of that, was not investigated by G. Revesz.

Seven pupils with total blindness and 8 pupils with remnants of vision evaluated the vertical segments in Figure 9 for nonequality. Such results were obtained because in our schools the relief figures and diagrams are widely used. In these figures, there are some elements which are arranged in accordance with the laws of visual perspective. Practice of perception of such figures by blind children resulted in the formation of appropriate nervous mechanisms, systems of conditioned connections, corresponding to the laws of perspective drawing for the sighted.

Figure 8

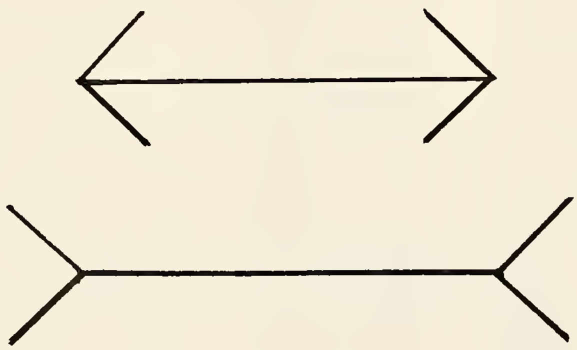
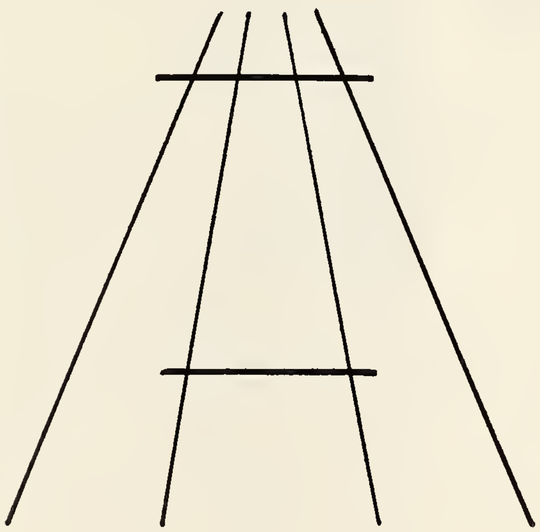


Figure 9



Contrary to the conclusion made by G. Revesz in the above-mentioned paper about the "inborn nature" of perceptual illusions, our experiments show the dependence of the presence of illusion upon the practice of perception. Among the blind children participating in the experiments, there could be distinguished a group which showed the presence of different illusions. These pupils also possessed the most developed tactile perception.

The role of practice for the development of perception can also be shown by the following experiment. It is well known that the Charpantier illusion can be observed in the blind (K. Bürklen[15]). In our experiments the pupils of the 4th year of education and older groups showed the presence of this illusion in the conditions of tactile perception of comparable weights, i.e., on the basis of determination of their volumes. If the tactile perception is excluded (lifting the weights by the attached strings), the illusion vanishes, as with sighted people with closed eyes. At the same time, experiments with the pupils of the 2nd and 3rd year of education in the school for the blind (16 pupils) showed the absence of the illusion of the weight. Thus, as a result of restricted practice of perception, the neural mechanism underlying the Charpantier illusion in the blind children forms only at the age of 11-12, while in the children with useful vision, it already exists at 5-6 years.

The same 16 blind pupils of the 2nd and 3rd year of education were presented with a relief figure evoking the Müller-Lyer illusion. In 3 of them, the illusion was absent. These pupils also showed the absence of the illusion of weight. The tactile image gives adequate representation of reality but it is much poorer than the visual image. That is why in creating the "image" of the object, the blind use logical constructs developed from language so extensively. The question arises whether the perception of the blind is based on the abstract schemata or whether it is based on the concrete images. In this respect, the investigations of the topographic images in the blind are very interesting. They showed that the blind, as well as people with normal sight, are capable of making a correct mental reproduction of the topographical map, showing the position of different objects in space in their mutual relations and in their relation to the perceiving subject. They can easily determine the directions of the geographical points, surrounding them nearly with the same degree of accuracy as people with normal sight can do. The images, arising in these conditions in the blind are not schematic but are characterized by the specific "motor explicitness."

Types of the images in people with or without sight are different but their content is common to both because they both represent the objectively existing reality[12,13]. The important role in the evaluation of position and direction of geographical objects belongs to the searching apparatus provided by the eye movement in the normally seeing person when looking around. In the blind, the eye movement is substituted by the movement of the feeling hand. In persons who previously used vision, in the process of estimating the position and direction of objects, the whole visual-kinesthetic dynamic complexes underlying a visual image and formed in the course of individual experience are reproduced. In these cases, body position ("a pose"), position of the head and "adjustment of the eyes" typical of people with sight are observed. The person who lost vision behaves as if he visually observes the objects placed in different directions without any stimulation of the eye's retina.

Investigations of the perception of sculptural portraits by the blind are of great interest. People who were blind, who never used vision, as a result of tactile perception of the sculpture and subsequent verbal description of the image, can correctly evaluate the shape of the face, eyes, nose, mouth, head and body position ("the pose"), express movement, significance of gestures, features of the portrait resemblance and expression of emotions[9]. Many blind people have created remarkable sculptures. Especially high level of perfection in the art of sculpture can be achieved by people who became blind later in life. The sculptress, Lona Po, who lost her vision as an adult, created remarkable sculptures in which she skillfully represents human emotions, movement, shapes, proportions, grace (Figure 10). She created many sculptures possessing high sacral significance ("The heroic deed," "The guerillas," "The woman with the label," etc.). Some of her sculptures are exhibited in the Tretyakov picture gallery.

Figure 10

A 

B 

Very interesting are the sculptures of the blind Malkovsky (German Democratic Republic). His sculpture, "Seeing hands," is especially impressive. In our schools for the blind, acquaintance with sculpture, together with the broad musical education, is an important means of aesthetic education. An important role is played in the compensation of blindness by special graphical methods, relief designing and relief drawing widely used in schools for the blind.

Common features of visual and tactual perception enable us to use in special representation in relief ("graphics"), many different types of representation used in inkprint two-dimensional reproductions ("flat diagrams and drawings"). But in making relief drawings, the specific features of tactual perception must also be taken into account.

Orthogonal projections can be used with the addition of some special notation for relief drawing. Pupils can not only learn to read and reproduce relief designs correctly but can also draw the design of the object themselves or vice versa, reproduce the object in three dimensions with the use of air-setting plastic material (Figure 11).

Figure 11

Relief drawings, unlike the designs, represent some qualities of the object, obvious for tactual perception, especially its shape. In schools for the blind, different types of relief drawings, applying different methods of representation of objects (contour, application low relief) are very popular in the preparation of relief drawings because the elements of visual perspective are widely used (Figure 12).

Good results were obtained in the course of experimental training of blind children in understanding relief drawings with the help of the method of nonuniform dot covering and perspective change of the size. In such a drawing, all the surface of the object represented is covered with relief dots, the density of which is higher the nearer the given segments of the surface are to the person tactilely perceiving the object. By the nonuniform density of the dots, the shape of the surface of any complexity can be reproduced. The relief drawing is made in correspondence with the laws of visual perspective. In explanation of this method of representation to the pupils, the laws of vision need not be referred to; everything can be understood just on the basis of tactual perception.

Figure 12

Experimental training was performed using the flat geometrical figures which can be placed at different angles of rotation for tactile perception. Relief drawings of these figures were prepared for six different angles of rotation.

The training sessions of blind pupils were repeated many times. By the fourth lesson the blind children made a correct choice of the drawing, corresponding to a specified angle of the figure rotation. A sharp decline in errors can be achieved by letting the pupils themselves set the angle of rotation of the figure on the basis of the drawing. If, at the 1st lesson, the mistake is equal approximately to 15 degrees, by the 6th or 7th lesson it is reduced to 3-4 degrees.

After training with the flat figures, the pupils were given the drawings of three-dimensional objects. They correctly modelled these objects in air-setting plastic material, correctly determining the size of the objects which were represented in the drawing at different distances.

The use of relief drawings and diagrams shows great possibilities of the development of the complex forms of tactual channels ("synthesizers and analyzers") in blind children.

Hearing perception, closely connected with the development of speech and thinking, is of great importance for the formation of images in the blind. With the help of speech, the blind can communicate with people around them, learn to read, write, draw, receive new information from books, hear stories told by seeing people and from other sources (music, lectures, radio, theatre, etc.). All this helps their intellectual development.

Discussing the role of the remaining sensory channels ("safe analyzers") in the substitution of the visual function in the blind, it is necessary to mention investigations of obstacle perception by the blind. Comparative experiments have shown that discrimination of distantly placed objects which produce no sounds is not characteristic for the blind. Under certain conditions, sighted people are also able to perceive objects at a distance without the use of vision. But because of the necessity of using this kind of perception permanently, the blind use it with a high degree of perfection. With specially organized training this process of perfection is attained more rapidly.

In obstacle perception at a distance, complex afferent systems (hearing, kinesthetic, tactile temperature analyzers and others) are involved. Complex synthetic stimuli and signals from different channels ("analyzers") help the blind to represent their environment correctly and thus, to orient themselves in space. The preponderant role in this process belongs to the auditory channel ("hearing analyzers"). In the course of orientation, the blind perceive the slightest changes of pitch, loudness, timbre ("quality of the sound"), and the direction of its source. The predominant signalling role in this process belongs to reverberated sounds. Making use of them, the blind are able to perceive objects at a distance. These sounds, as components in the complex system of different connections, provide an important means of orientation for the blind during movement.

In summary, we have shown that after vision loss, different, unused capacities of the remaining sensory channels ("reserve functions of the safe analyzers") are mobilized. This permits the blind to achieve a high level of perfection in formation of spatial perception and cognitive processes ("logic thinking").

Continuous and frequent use of the remaining sensory channels ("safe analyzers") in the process of learning and labor provides favorable conditions for a thorugh development of the personality and for the adjustment of the blind to life and work in modern society.

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THE RELATIONSHIPS AMONG INTELLIGENCE, EMOTIONAL STABILITY AND USE OF AUDITORY CUES BY THE BLIND

by

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EDITOR'S NOTE:

This study was supported by the U.S. Office of Vocational Rehabilitation (Contract No. RD-510, "The Use of Auditory Cues by the Blind for Travel") and The Seeing Eye, Inc., Morristown, New Jersey.

The purpose of this study was to investigate the relationship between intelligence and emotional stability, factors often considered in the rehabilitation of the blind, and to relate each to the use of auditory cues.

Subjects were ranked on their relative use of exterosensory (especially auditory) cues, on the assumption of an increasing use of auditory cues as the traveler relies more and more on his own senses and less and less upon any of a variety of mobility aids. Note that some mobility aids, while very efficient in assisting the traveler to get from Point A to Point B, make it unnecessary for the traveler to exercise to the fullest his own resources.

Probably the most reliable and easiest method for traveling is to go with a reasonably intelligent sighted companion. The companion-guided traveler has no need for attending to the sounds about him, he neither has to time nor to measure traffic flow in order to cross a street, he need pay no attention to the contours and surfaces on which he is walking, etc. In short, he need not attend to any particular exterosensory cue; the companion does this for him.

The dog-guided traveler likewise need not be concerned with all the hazardous details of his immediate environment; he has almost as much freedom from such considerations as if he were with a sighted human companion. He must, of course, use some auditory and/or other cues to navigate and orient himself in his immediate environment and to comprehend the dog's behavior.

With a cane, the traveler cannot rely on information filtered to him by another intelligence, human or infrahuman; he is forced to concentrate on and act upon the information supplied him by the mechanical extension of his arm and most especially on the exteroceptive cues which may be present relative to hazards, other details of his immediate environment and his goal. It seems clear that, though locomoting less efficiently, probably slower and through a more variable route than the guided traveler, nevertheless the cane traveler is using all auditory cues available, to an extent approaching in some cases the optimum.

Lastly, the individual who travels with no aid whatsoever is manifestly relying on exterosensory information.

One may next distinguish between familiar and unfamiliar environments. Many travelers will use no assistance in their own homes or in trips within the immediate neighborhood, but require an aid of one sort or another when going to a new locale.

Assuming with Wright (1962), that a traveler will never use less mobility aid assistance in an unfamiliar environment than in a familiar environment and on the assumption given above that the more dependence upon mobility aids the less use of auditory cues, each subject can be ranked in respect to his relative use of auditory cues. The individual who utilizes less mobility aid assistance and especially in unfamiliar environments will rank higher than the individual who uses more aid, or travels only in familiar envirnoments.

The hypothesis tested in this study is that there is a positive correlation between each pair of the three variables, intelligence, emotional stability, and use of auditory cues.

Method

Subjects

Twenty-two subjects participated in this investigation[1]. Although the range in age of subjects was 50 years, all met three requirements considered most important for this study. First, all subjects were totally blind, i.e., no visual input. It was necessary to restrict our sample in this way because Hayes (1941) demonstrated that within the blind population (20/200 - total blindness), I.Q. is inversely related to amount of vision. Each of the subjects had been totally blind for at least a year and partially blind for at least six years. As a result, duration of blindness was not expected to play any significant part in the results of experimentation. Second, all subjects were required to have normal hearing in both ears. It was necessary to eliminate all hard-of-hearing subjects because of the possibility that this defect might influence the type of mobility aid used. Third, no subjects participated who had any physical disability (other than blindness) that might restrict them in travel because this condition might also affect the type of mobility aid employed.

The ranking of the 22 subjects in respect to relative use of auditory cues is shown in Table I where it can be seen that the travel ability of the subjects covers a wide range, from expert all the way to homebound.

Tests Administered

A. Wechsler Adult Intelligence Scale (WAIS 1955)
The Verbal Scale portion of the WAIS was administered. The Performance Scale, requiring sight, was not applicable to this investigation.

The complete Verbal Scale is composed of the following tests: (1) Information, (2) Comprehension, (3) Arithmetic, (4) Similarities, (5) Digit Span, (6) Vocabulary.

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1 The subjects in this study were obtained from the American Foundation for the Blind, the New York Association for the Blind, St. Paul's Rehabilitation Center in Newton, Massachusetts, the State of Connecticut Board of Education for the Blind, and the Veterans Administration.

Although the majority of literature in the area of intelligence testing of blind adults has reported use of the Wechsler-Bellevue Form I or Form II, Cole and Weleba (1956) gave 46 blind subjects both the W-B I and WAIS alternately and successively. The correlation between the W-B I Verbal Scale and the WAIS Verbal Scale was $+.87$. Thus, the tests are about equally valid. However, for our purpose, the WAIS standardization sample was superior in that it was national and included large ethnic groups proportionate to the 1950 census, while the W-B I was standardized largely on white persons in New York State. The WAIS also has the advantage of less ambiguity and more adequate restriction of item difficulty than the W-B I (Wechsler, 1958).

B. Emotional Factors Inventory (EFI)

The EFI is a personality inventory, (Bauman, n.d.), including material indicative of both personality characteristics and problems arising from blindness.

This questionnaire-type personality inventory consists of 170 statements divided into the following eight categories: (1) Sensitivity, (2) Somatic Symptoms, (3) Social Competency and Interest in Social Contacts, (4) Attitudes Toward Blindness, (5) Feelings of Inadequacy, (6) Depression, (7) Paranoid Tendencies and (8) Validity.

The inventory was originally standardized on 200 persons of both sexes. The degree of visual loss in this standardization group extends from legal blindness (20/200) to total blindness. New norms are now available for this inventory based on the responses of 2200 blind individuals.

Each of the statements was read directly to the subject who was required to indicate whether he agreed or disagreed with each.

Table I

Ranks of Subjects in Respect to Relative Use of Auditory Cues

Rank	Description	Number of Subjects
1	Travels in familiar environments with no assistance	1
	" " unfamiliar " " a cane	
2	" " familiar " " " "	8
	" " unfamiliar " " " "	
3	" " familiar " " " "	3
	" " unfamiliar " " " companion	
4	" " familiar " " " "	4
	" " unfamiliar " " " "	
5	" " familiar " " " "	
	Does not travel in unfamiliar environments	6

Results and Discussion

The analysis used the Spearman rather than product-moment technique because the use of auditory cues obviously cannot be given interval scaling treatment. There is no way of estimating or assuming that the difference in the degree of dependence on auditory cues is the same between any two consecutive ranks.

Intelligence and the Use of Auditory Cues

Three of the subjects did not take the I.Q. test because of language problems (they were of foreign extraction). A Rho on the remaining 19 of +.52 was found, significant with a one-tailed test between the .05 and .01 level[2].

It might be concluded that the person with high intelligence (as measured by the WAIS) somewhat more fully utilizes auditory cues.

The above result could have some implications for the rehabilitation and travel training of the newly blinded and the homebound blind. Those with depressed I.Q. might be advised against depending too fully on their own senses and interpretation.

Emotional Stability and the Use of Auditory Cues

Column A in Table II shows the eight correlations between the use of auditory cues and the eight categories of the EFI.

Table II

Correlations (Spearman Rho) of Emotional Factors Inventory Categories with Use of Auditory Cues and Verbal I.Q.

EFI Categories		Use of Auditory Cues	Verbal I.Q.	
		A	B	C
	N:	22	19	14 △
Sensitivity		.58**	.65**	.65**
Somatic Symptoms		.40*	.48*	.60*
Social Competency		.57**	.47*	.67**
Attitudes re Blindness		.45*	.58**	.72**
Inadequacy		.44*	.57**	.61*
Depression		.52**	.54**	.60**
Paranoid Tendencies		.63**	.73**	.83**
Validity		-.07	-.41	-.02

*p < .05, one tailed
**p < .01, one tailed
△ See page 92, paragraph 7

Seven of the correlations were significant; four at the .01 level and three at the .05 level. The only category that did not correlate significantly was the Validity category[3].

These high correlations confirm the hypothesis that the more stable an individual, the less he may depend on outside assistance. It should also be noted that if an individual is nervous or emotionally unstable he might be so concerned with himself that he would not be able to attend to all the available auditory cues.

The results in Column A could serve as a guide in determining the most appropriate

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2 It must be remembered that no dog-guided individuals were included in the sample tested and although the results and conclusions may apply to this segment of the blind population, one cannot be positive until a representative sample of this portion of the population is tested.

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3 See Footnote 2.

mobility aid for a newly blinded or homebound blind person. If, after testing, a person appears to be emotionally unstable, and it is agreed that this instability is not a result of length of blindness (he will not overcome the instability after adjusting to his now-darkened world) it can be assumed that the individual will require outside assistance and hence can be trained with a mobility aid that will alleviate some of the burden on himself.

The information obtained from a guide-type aid is usually more easily and quickly analyzed for travel purposes than auditory information, hence the guided traveler has more information available in a given interval of time and his task is simplified. As a result, traveling will be easier and traveling performance will be superior for this individual. If, then, an individual uses a guide-type aid simply for practical reasons, i.e., will arrive at his destination more safely, easily and quickly, there should be no significant correlations in Column A. However, it is seen in this column that this is not the case. Column A clearly shows a relation between certain personality traits and ranking of subjects in respect to their relative use of auditory cues. It seems more likely that some individuals depend on outside assistance because of emotional instability (not practicality). Of course, the reasons why a particular individual chooses one or another type of assistance are immensely complicated.

Intelligence and Emotional Stability

Column B of Table II shows the correlations between the WAIS and the eight categories of the EFI.

Seven of the eight correlations were significant, two at the .05 level and five at the .01 level.

The only correlation not significant was that between the Validity category and the Verbal I.Q. The correlation was negative (-.41) and merits further discussion.

Bauman (1950) describes the Validity category as follows: "Validity items were included to attempt to measure the individual's understanding of the inventory content and his frankness in responding to it."

The above statement does not refer to validity in the usual technical sense, that is, empirical validity, but more to the consistency of a subject's response as an index of his understanding of the test. If a subject does not understand the inventory content, he may very well respond differently to questions designed to yield similar answers. Thus, as a result of not understanding, the responses will be inconsistent. This inconsistency will imply poor validity. However, if a subject is frank or, conversely, deceptive in all his responses he will respond in the same way to questions designed to yield similar answers. This consistency, however, may or may not indicate satisfactory validity.

In line with the above discussion, the negative validity correlation makes the remainder of the EFI data suspect. To overcome this, the five subjects who yielded especially low validity estimates were omitted and correlations between Verbal I.Q. and EFI were then performed with an N of 14.

Column C of Table II shows these results. It can be seen from Column C that seven of the categories still correlated significantly with the Verbal I.Q., either at the .05 or .01 level, and the Validity category correlation now stands at -.02.

It appears from the Validity category correlation of -.41 in Column B that those people with higher verbal I.Q.'s are more likely to be less consistent in their responses. Second, in Column C it was noted that after reducing the N, seven of the eight categories still show significant results. This makes the data in these seven categories less suspicious and it is safe to say that the hypothesis of positive relationship between EFI and I.Q. is supported. However, the same cannot be stated for the data in the Validity category. The correlation of -.02 seems to imply that the consistency of a subject's responses is not related at all to verbal intelligence as measured by the WAIS, and that the lack of consistency of responses in the Validity category does not carry over to the other seven categories.

The results in Columns B and C appear to have one important implication for the rehabilitation of the newly blinded and homebound blind. In general, it should be safe to assume that the more intelligent clients will also be better emotionally adjusted[4]. However, it must be remembered that all the subjects used in this investigation had been partially blind for at least six years and totally blind for at least one year. The above relationship may not hold true for those clients attending rehabilitation institutions who have been blind for a shorter period of time.

Summary

The relationships among intelligence, emotional stability, and use of auditory cues was investigated using a sample of 22 totally blind adults. Positive relationships were predicted.

Each subject was given the Verbal Scale of the Wechsler Adult Intelligence Scale, the Emotional Factors Inventory and ranked in respective use of auditory cues. A correlational analysis was performed on the data. Significant correlations were found between the Verbal I.Q. and use of auditory cues, the Emotional Factors Inventory and use of auditory cues, and Verbal I.Q. and Emotional Factors Inventory. These findings were in agreement with the hypotheses.

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[4] See Footnote 2, page 91

PSYCHOSOCIAL RESEARCH AND BRAILLE: THE NEED FOR A PROGRAM OF RESEARCH AND DEVELOPMENT

by

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EDITOR'S NOTE:

The author of this paper is director of the Division of Research and Statistics of the American Foundation for the Blind.

Introduction

It was once said of a famous man that talking to him was like peeling an onion: each layer revealed some fascinating new facet that gave promise of more interesting things in the next layer. To the laymen or researcher who considers for a minute or a month the subject of braille, the effect is the same. "Braille" and "blind" are words closely equated in the mind of the uninformed. Braille as a word means finger-reading, or maybe raised dots, or maybe even Grade 1, $1\frac{1}{2}$ or 2 to the somewhat better informed. The next layer may reveal confusing questions concerning orthography and codes and perception and comprehension rates and the like. At about this layer the braille onion becomes only promises to all but a very few braille specialists.

Still even a superficial consideration by a group of research (non-braille) specialists and braille specialists reveals what every researcher has come to expect about any subject: there are differences of opinion and practice, there are issues that are unresolved, at times explicit knowledge has faded into mystery. These are topics that in themselves could be expected to engage the attention of research specialists concerned with services for the blind and visually impaired. Combine this fascination with the unknown and two other major developments and something like a moral imperative to undertake research on braille emerges. The first development is the steadily increasing number of blind and severely visually impaired people in the United States (discussed in some detail later below). The second is the emergence of new systems of technology that promise new, more efficient systems of braille reproduction (also referred to below). The charge clearly is to match need with method, a familiar charge to researchers. To do this, a great deal of preliminary preparation is necessary: a good many more layers of the onion remain to be peeled off before it is described accurately.

Realizing this, an exploratory conference of braille specialists and research specialists with varying degrees of knowledge about braille were called together in a two day meeting in September, 1961[1], to discuss possible psychosocial and educational research needs in braille since technological and instrumentation needs had been the subject of another meeting[2]. Papers and discussion in the September meeting succeeded in identifying both specific problems and large problem areas that might lend themselves to research treatment. Still lacking was any program concept or the sum of the interrelated parts set forth so as to encourage research personnel to undertake systematic investigation of all parts of the puzzle and their relationships. This paper, by discussing the need for a program approach through research and development, can do little more than draw attention to that fact and to suggest one of the many approaches toward ultimate program development.

Limitations

Two important limitations of this paper have already been suggested: it is exploratory in nature, not definitive, and it is not primarily concerned with technological research and development, although many of its parts must be highly relevant to the building and testing of instrumentation devised through technological research and development.

Another important limitation of this paper (and of any similar attempt to formulate a research and development program for braille) is what must be called the conscious attempt to deal with attitudes aroused by discussion of scientific studies of braille. Braille, like many subjects connected with blindness, rouses many emotions. Any research and development on braille can be hampered by the weltering confusion of conflicting "expert" testimony, but taken into account from the beginning, experience tempered by such emotionally induced attitudes can be properly evaluated. The researcher in this field must deal with it, for he needs the braille expert to give him the subject matter or content of his investigation, while he contributes the methodology of the study.

The tests for what constitutes a qualified research specialist and well-designed research are generally known and accepted. As to what constitutes a "braille expert" is not so clearly a matter of record. Since there must be fruitful collaboration between the two for any meaningful research and development project or program to be formulated, the following characteristics of a braille expert have been suggested for consideration: (1) The braille expert possesses a complete knowledge of the present braille codes from the standpoint of symbols provided, rules for their use, and the whys and wherefores for the rules and symbols provided; (2) the braille expert has a complete knowledge of the history of the development of the various codes, from the time that braille was invented to the present and; (3) the braille expert knows the principles and methods of teaching braille to children and adults and, therefore, has a general knowledge of problems involved in touch reading for the beginner and for the more experienced braille reader.

If the well-qualified braille experts, as defined above, are relatively rare, so are the well-qualified research scientists working on the problems of blindness. More will be attracted to the field as its problems are set forth as challenges that attract their imagination. That is to say, this paper (and any subsequent plan) is more likely to attract research scientists if it is formulated and set forth in large problem areas rather than in the conflicting details that so often pass as plans among braille experts. The intent here is not to write specific proposals on braille research but to engage the curiosity and interest of scientists who can see the extent of the complexity of the topics involved in the hope that they may then wish to reduce them to orderly investigation (which is, after all, one of the pleasanter experiences of a researcher). Therefore, the treatment in this paper of the major problems associated with braille can be characterized as broad stroke rather than pin-point detail; some attempt at relative priority and relative difficulty of topics will be made.

Braille: Its Characteristics

There are several excellent impressionistic accounts of braille as a system for reading and writing by severely visually impaired people who cannot use vision as their principal sensory channel for obtaining information. When more exact studies are made, the findings often apply only to parts of the blind population. For example, we are told that for greatest legibility for the adult readers in one study, the specifications are: .090" between dots within cells, .160" between cells, .220" between lines of braille, dot height .015", base diameter .055"[1(p.11)]. Whether these specifications for greatest legibility apply to child readers or to newly blinded adults over 50, we don't know from this investigation, though it can be interpreted as being applicable to all ages with only small changes in cell spacing needed. Whether these specifications do in fact assure that the greatest number of braille users are being served by them needs to be answered. This topic breaks down into some researchable problems that involve experiments with various specifications with various age groups within certain intelligence levels, general health levels and motivational levels. Allowing for different experimental levels, do the present embossing specifications further handicap the already handicapped young blind student?

The same question can be asked concerning the reproduction of nonverbal or graphic materials and of the special codes for mathematics and music. Can they be described as affording the best media for the collecting of information by blind people of various ages and health levels (not to mention intelligence and motivational factors in this larger screening)? The work of the Uniform Type Committee of the AAWB, of Bürklen, Wundt and others needs to be continued and refined if optimal legibility of braille is a characteristic to be attained. Because a system has worked for years does not mean necessarily that it is the best possible system, particularly when not much scientifically derived data supports it. With possible vast technological advances, and predictable population increases in the near future, and increased emphasis being given to independence in the daily existence of impaired persons, it becomes the more imperative to arrive at optimal characteristics of the system through scientific data.

Braille: Its Actual Uses

The first step in the establishing of an optimal braille system (if, in fact, it does not already exist) is to evaluate its present usefulness. Braille is an important medium for reading and writing used by a relatively small number of severely visually impaired people and has to be judged accordingly. The kind of reading and the number and characteristics of its users cannot be determined with any accuracy from existing research reports and statistical compilations. However, enough information exists to identify some questions which need to be asked without waiting for further research or statistics. By far the most widespread use of braille is for textbook reading in primary and secondary schools. To a less extent, adults use braille for reacreational reading, and lastly (here we are reduced to a pure surmise) some adults make vocational uses of braille.

These claims are suggested by some fragmentary figures. A recent study[3] identified 8,175 school children using braille which represents 58 per cent of all known (that is, registered with the American Printing House for the Blind) legally blind children in residential schools for the blind and in local public day schools for the 1959-60 school year. It must be said at once that this 58 per cent represents nothing like a true percentage of legally blind children using braille since its base is 14,125 students known to the U.S. Office of Education which, of necessity, deals with the known or reported blind. There are expert opinions that an unknown and unreported number of legally blind children exists in public school systems at least as great as the reported number of legally blind. Indeed by one set of official estimates of the Public Health Service of the Department of Health, Education and Welfare, the number of legally blind under 20 was 24,605 in 1960[4]. Another more recent national estimate by the U.S.

National Health Survey* lists the severely visually impaired under 14 years of age as 21,000 and aged 15 to 24 also as 21,000. It therefore seems more realistic to estimate that probably not more than one-third of the visually impaired school population within the legal definition of blindness now use braille.

Who are this estimated one-third of the population? 5,186 or about 63 per cent of them are enrolled in residential schools and 2,989 or about 37 per cent are enrolled in local day schools. Further, as to amount of vision, those with no useful vision (totally blind, light perception only) number 3,347 or roughly two-thirds of residential school braille users; and with no useful vision in local day schools 2,240 or roughly three-quarters of all local school braille users. The tendency in residential schools to stress the teaching of braille regardless of students' useful vision is worth noting. The three top categories of vision (20/200, 15/200, 10/200-- 14/200 central acuity distance) show the following distributions:

Braille Users

Vision Category	Percentage Using Braille	
	Residential School	Local Day School
I (20/200)	35	5
II (15-19/200)	62	13
III (10-14/200)	58	16

(Source: Jones, p. 32)

How many of these students with useful vision find sustained print reading fatiguing and as a result prefer braille reading is unknown. Fatigue might well be a mitigating factor in teaching braille to children with useful vision.

To summarize then, about two-thirds of all known young blind braille users (which is most likely the statistical universe of young braille users) are in residential schools where braille is taught to children with some useful vision, in marked contrast to local day school practice which seems to stress print reading with these same age groups.

This practice is further noticeable in those young adults who are using braille as an educational tool. In a recent as yet unpublished study[5] of 445 legally blind students in full-time attendance at 263 colleges and universities throughout the country, the 37 per cent who were graduates of residential schools almost entirely knew and could use braille. A very important point, however, is that a large majority of them did not prefer to use it for textbook reading. When the whole group of 445 were asked about their principal method of study, 4.2 per cent said that they used braille; 12 per cent said they preferred textbook materials in braille; 25 per cent disc recordings; 30 per cent tape recordings and 24 per cent used sighted readers. Even when those students who had no useful vision (totally blind or light perception only) were asked their reading preference, there was no marked preference for braille even though they had been using it before age 10, or at least 10 years. About 42 per cent of all students said they had no preference for braille for any purpose, 10 per cent preferred it for note-taking, 46 per cent preferred it for "scientific, mathematical and analytical reading," and 2 per cent preferred it for recreational reading. Compared with recordings, two-thirds said they preferred recordings, but whether they preferred them or

* See Chapter I of this BULLETIN.

not, 45 per cent said they make braille notes often and 20 per cent occasionally made braille notes with only the remaining one-third saying seldom or never do they take notes in braille. Also 50 per cent voluntarily expressed a desire for braille supplements of tables and formulae which they can go back over while studying.

These statistics strongly suggest that this group of young adults who are perhaps one of the most strongly motivated group of adults to use braille prefer it as an educational tool only for very difficult or specialized materials and note-taking, and they stress its importance for such purposes. Their overwhelming choice for recreational reading was recorded sound or sighted readers. Whether the variable quality of materials, the relatively poorer selection of recreational materials in braille and their being available long after inkprint materials have influenced this choice can only be a subject for conjecture. Also, whether "preference" does or should dictate actual practice can only be a subject of opinion. It can be safely surmised that other young adult and employable age blind adults make even less regular and sustained use of braille as a principal means of obtaining information or of making a living.

In older adults, there is some evidence that "braille use declines with age"[1(p.59)]. In at least one as yet unpublished study of blind adults in four states a sample of 380 readers (i.e., people who read books regularly) say their preference and practice in reading is discs and/or sighted readers, with only about 8 per cent using braille; here, preference seems closely related to practice. In one area where the respondents' ability to read braille is very high (42 per cent), only one-quarter of them are braille readers presently. In no instance of braille readers in this study do they exceed more than 10 per cent of the total sample and in most instances are around 7 per cent of the total sample. This study suggests (and it can only suggest, not clearly demonstrate) that blind adults, like sighted adults, are predominantly not regular readers, but those blind adults who are regular "recreational" readers overwhelmingly prefer recorded sound and sighted readers to braille as their primary mode of reading. Their secondary uses of braille (note-taking, special materials for reference or study) were not recorded in this study which was primarily concerned with other topics.

When one seeks verification of this finding in larger samples or in a national statistic which is generally accepted, the result is confusion. One authority claims 30,000 "engage in reading braille books and magazines" with "a steady increase in both circulation and borrowers over the past several years"[1(p.68)]. The circulation of the bi-monthly Braille Book Review, with its announcement of new titles available, is about 8,500. How many of these subscribers are active braille book users is unknown. The Library of Congress through its annual report estimates that about 11,000 persons were provided braille books through regional libraries for the blind in 1961. The type of book and the amount of reading among this group are unknown. If it is true, however, that the number of persons provided braille books through the regional libraries for the blind has remained at about 10,000 over the past 15 years (as figures seem to indicate) at the same time that the total number of blind persons has increased from 250,000 to almost 400,000, there can be no question that at least as far as this major service is concerned, the relative proportion of blind adults using braille books is steadily decreasing, and will continue to decrease if this trend continues. Again, the facts need to be mentioned that braille materials are sometimes printed on inferior materials and in nonstandard braille, which may affect reading habits. Also, it is well known that braille readers do not have the choice of the sighted readers and that considerable delays are experienced in transcribing selections into braille, an important factor in recreational reading.

In summary, as far as blind adults (beyond the small population enrolled in institutions of higher learning) are concerned, something between 3 to 10 per cent of them are braille readers with probably the lower end of that continuum operative in the case of blind adults whose primary mode of reading is braille. Since a much larger percentage of blind adults have been taught braille, their secondary uses of it (note-taking, occasionaly study or reference to special materials) may considerably exceed their use of it as a primary mode of reading.

To summarize the actual uses of braille from the fragmentary data available, it appears that the principal use of braille is in primary and secondary education, especially in residential schools for the blind, where in contrast to local day school practice, a considerable number of children with residual vision are taught braille. Young adults in college overwhelmingly prefer general textbook materials in other than braille, though a majority of them would like braille supplements to specialized materials. Beyond their preferences, only a small number of them actually use braille in general textbook reading, about half use braille for specialized materials and three-quarters use braille for note-taking. Only 2 per cent use braille for recreational reading.

In the larger older blind population, use of braille as a primary mode of reading decreases even more, probably since most reading among older adults is recreational. Use of braille with specialized materials (cookbooks for housewives, gauges on instruments for workers, correspondence in offices and the like) and use of braille for note-taking are probably more extensive, though no data on these points exist. With the data that do exist, it seems fair to hypothesize that braille use is proportionately decreasing among the blind population, particularly among the adult blind who comprise about 80 per cent of the known legally blind population. This is not to deny the extreme usefulness of braille to many blind people nor the satisfaction they derive from it; on the contrary, it is to say that their numbers should be increased, since braille is so useful to blind people who wish to do their reading independently.

Braille: Its Potential Uses

As in every service for blind people, the first statistic any planning group needs to consider is the age distribution of the estimated population. Contrary to popular belief, there is no reason to believe that within the next 10 years at least, the prevalence of blindness will decrease. Blindness is a function of general population and increases as the general population increases. By combining the general population estimates of the U.S. Bureau of the Census[6] and one set of prevalence rates released by the U.S. Public Health Service for 1957[4], the following population estimates are derived.

Estimate of Legally Blind Persons in U.S.

Age Group	1960 Estimates	1970 Estimates
0-19	24,605	30,461
40-64	44,270	49,400
65+	189,763	229,400
Total	354,854	417,504

These estimates seem quite conservative when the figures released by the U.S. National Health Survey of the Public Health Service are consulted:*

* See Chapter I of this BULLETIN.

Estimate of "Severe Visual Impairments" in the United States, 1962

Age	Average Number in Thousands	Per cent Distribution
0-14	21	2.1
15-24	21	2.1
25-34	28	2.8
35-44	37	3.7
45-54	88	8.9
55-64	131	13.3
65 plus	662	67.0
Total	988	100.0

The difference between these estimates have been discussed elsewhere[7] and are not relevant to this present discussion except to indicate that even the most conservative estimates show the prevalence of blindness increasing in all age groups.

In the 0-19 age category where the major uses of braille can be expected, the estimated increase of about 600 to 1,000 a year can hardly be considered unwieldy. Of this number perhaps 150 to 300 a year can be expected to be blind, that is, to have no useful sight and to be largely dependent on braille as a primary mode of reading. In the middle age brackets, estimated increases are not as noticeable as in the upper age brackets (where little or nothing is known about the use of braille); there a substantial increase in the legally blind population takes place whatever estimate is used. There is, therefore, some reason to believe that general population growth in the next ten years will accentuate the extent to which braille is used if existing conditions prevail.

Any program, then, that pretends to answer the question as to whether braille is serving the greatest number of blind persons possible will have to assess the prevailing conditions under which it is used today, which suggests three questions: (1) Is it viable as a code?, (2) Are there technological developments that can be expected to extend its uses?, and (3) Are the existing materials and methods of instruction adequate? An inquiry into each of these three interrelated major areas constitutes a research and development program that will, of necessity, be long-range and costly, but which can, if properly conducted, provide answers to the usefulness (and possibly increased usefulness) of braille to that portion of the severely visually impaired population that can benefit from it.

The discussion follows in three sections: the code, technological developments and methods of instruction.

The Code

Braille is a code for transmitting information. To say that it resembles the Morse code for telegraphy is misleading. Both are codes, but the braille code, unlike the Morse code, must be used by an individual for sustained periods of time to obtain many varying kinds of information. The important property of any code is its legibility, that is, those properties which facilitate (or inhibit) the transmission of the desired information. This assumes optimal uniformity in physical characteristics and clarity (or lack of ambiguity) in form and characterization. Braille then as a successful code must be tested as to physical properties and orthographic characteristics.

There seems to be no doubt at all on the part of experts that braille is a successful code, though certainly not a perfect one. However imperfect it may be, it gets the job done it professes to do for many blind people and has for many years. It is not to detract from its success to say that many blind people are so highly motivated to be independent in their information-seeking that they would learn any system, however cumbersome or burdensome, but this fact does introduce a sobering thought that braille's success as a code or a system may be in some part due to the high motivation in persons using it, and that improving the code might also increase motivation to use it. To evaluate this charge properly is to attempt to evaluate braille as a code, as a system, without the motivation factor entering in. Practically, of course, this is impossible, but as nearly as possible the psychological element should be held constant if a code or system is to be evaluated on its own merits.

Even a cursory glance at the literature makes it clear that much of the present system has been derived from a priori reasoning, not from scientifically tested problems. There is candor on this point, like the statement of the Braille Committee of the American Association of Instructors of the Blind made in 1950: "Perhaps the 'backyard' research of our grade 2 braille project, as it has been so aptly named, would never be accepted by any universal measurements of research. It certainly was not scientific, ponderous in movement and voluminous in words; it was not even set up on norms, indices, controls or with extensive study of finger perception."[1 (p.13-14)]

Taking into account the work of this and previous committees, it must be said that much of the braille system has never been scientifically tested to see if its physical characteristics and its orthographic characteristics are optimal for the people it purports to serve. That it works as a system does not mean that it might not work better. Some such assumption seems to have motivated the calling of a conference on "nine-dot-braille" by AFB on July 6, 1962 to examine a new braille system proposed by Mr. Robert Strom of Harvard College. This conference of braille experts and totally blind braille readers recommended a "gradual and thorough investigation, evaluation and data gathering of the proposed system, with emphasis on technical needs for the benefit of the blind student of higher mathematics in particular and technical training in general."[8] Another development in braille reproduction is further evidence that constant experimentation with physical aspects of braille is taking place, in fact or in theory. This is the solid dot system used in Britain and described in part as follows:

> The early assumption that Solid Dot Braille would be better for the blind reader because the dots are far less destructable and therefore more consistent and easier to read, has been proved beyond doubt by the majority of opinions received both from British and overseas readers, the added factor of reduced bulk that has been found possible coupled with the fact that the process, in these early days, should be comparable in production cost with that of a long-established process, is regarded as highly satisfactory.[9]

About the only conclusive evidence presented through research on physical properties of braille in the past has been on horizontal and vertical alignment, when in 1909 the finding was corroborated: "the vertical position offers greater advantages in legibility than the horizontal."[1 (p.8)] Research on the height of the characters was inconclusive. Research into spacing values has been the subject of one study[1 (p.11)] that opens this topic to considerable speculation as to whether the accepted specifications (.090" between dots within cells; .160"between cells; .220" between lines of braille; dot height .015" and base diameter .055") are in fact optimal for both children and adults. A reasonable inference is that the younger children with smaller fingertip surfaces to employ cannot use the standard braille to fullest advantage. Whether this might be true among the aged blind or diabetics with possible lowered tactile thresholds is worth asking also. Whether graphic information (maps, graphs, charts, illustrations) is presented optimally has been the subject of some study[1] (p.32) with school children and hopefully will continue until tactual symbols of clearcut discrimination are demonstrated for different kinds of displays. An adult sample might well be tested also, particularly college students whose need for graphic materials is acute.

A pioneering study in braille teaching problems[1] (p.16) has uncovered some orthographic anomalies that need considerable further study. Reading errors attributed to abbreviations, multiple meanings, contractions, and word-form deviations have been identified in at least one group of school children. There is doubt whether certain of these errors might persist in older school children or in adults. Certainly this very important topic of orthographic characteristics needs much scientific investigation.

In brief, then, we need to know a good deal more about how legibility is affected by both the principal physical properties of braille and its orthographic characteristics. Code revision is not the province of research personnel, but it certainly is the responsibility of research personnel to make findings on the adequacies of the code and to make their recommendations accordingly to the authorities concerned with code revision.

Technological Developments*

In the assessment of braille as an optimal informational code, some note has to be made of technological developments which may in the future affect the availability and the legibility of braille. Technological research and development has proceeded in the past, or research is planned for the near future on reducing or eliminating certain problems in the production of braille material. These problems may be divided into the following areas: (a) automating the production of braille material in large quantities (30 or more copies), thus reducing costs; (b) facilitating the duplication of braille in small quantities (usually less than 10 copies of specialized material for educational and vocational purposes); (c) reducing the need for highly trained human transcribers; (d) providing direct access to typesetting tapes produced for the publishing industry; (e) developing braillewriters which are at the advanced stage of development now reached in the electric or portable typewriters for print; (f) developing special braille teaching aids and psychophysical research tools; (g) developing cheaper storage media for braille and readout devices.

The following technological developments are taking place in each of the above areas:

(a). IBM and American Printing House for the Blind have collaborated to produce completely automated tape-controlled braille production equipment. The braille is produced from punched cards prepared by a skilled transcriber with all other steps in the process done automatically

At a special conference at M.I.T. on October 9 and 10, 1962, the braille Ad Hoc Committee (members from the American Printing House for the Blind, the Veterans Administration, the Massachusetts Institute of Technology, International Business Machines and the American Foundation for the Blind) and 14 other technological and social science researchers decided that the machine translation of braille has reached the production feasibility stage. The group recommended that APH explore with IBM

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* I am indebted to Mr. John Dupress, Director of Technological Research, American Foundation for the Blind, for this information.

and appropriate funding organizations the possibility of producing 100 books using the 704, 709 or 7090 computers to go from English to Grade II English braille. Should this special project be undertaken, a thorough evaluation of the economic factors, the incidence of rule usage and the optimizing and minimizing of human intervention will also be studied to provide comprehensive data for members of the braille authority and others in the work for the blind. In addition, future technological research would benefit.

Tape control systems for the production of braille on a small scale have undergone some development at Systematics-Adelphi Research Center and are being pursued at a more advanced level at M.I.T., Colorado State College and Perkins School for the Blind.

(b). Vacuum forming equipment for producing small quantities of duplicates from the original braille copy was developed in industry, at AFB and on a production basis at American Printing House for the Blind. Recently American Thermoform Corporation in California has made a relatively inexpensive vacuum forming unit which can be used in transcribing centers by an unskilled person. The plastic material also has a paper-like finish.

(c). Computer programs on the 704 at IBM and the 650 at Wayne State University have resulted in Grade II English braille with a transcribing accuracy of better than 95 per cent. In recent months compatability programs have been written at IBM so that the 709 and 7090 computers can be used for the original 704 program. The newer computers are faster and less expensive per unit of translation. It is not necessary that a sighted transcriber know Grade II English braille because the computer does most of the work. A special computer which is cheap and much more efficient than the large digital computers mentioned previously will be developed in the next three years at M.I.T. It will be necessary then to have the braille produced by such means evaluated by braille readers.

Mr. Gerald Staack (Research Assistant, M.E. Department, M.I.T.) wrote a computer program to study the incidence of contractions in English braille literature. He also determined comprehension rates and accuracy using blind subjects and a modified form of Grade II braille. There were no rule changes, but many infrequently used contractions were left out. Studies of this kind will continue at M.I.T.

(d). Although only one attempt has been made to develop a code converter (Veterans Administration Prosthetic and Sensory Aids Research), a study is now being made at M.I.T. to determine what kinds of typesetting tapes are used for textbooks, professional journals and other publications which are used in educational and vocational pursuits of blind persons. Following this study, monotape, typesetter and other relevant code conversion programs will be written for the computer to permit direct access to the published materials without the intervention of a sighted transcriber. The vast literature available on typesetting tape can be converted to Grade I or Grade II braille without the intervention of the skilled braille transcriber except for the initial research proofreading.

(e). The Lavender braillewriter which is very portable and relatively inexpensive is now off the production line at the American Printing House. A versatile, high-speed electric braillewriter is nearly ready as a working prototype at M.I.T. The electric braillewriter can be coupled to an electric typewriter with switching and decoding units which have also been developed at M.I.T. Simultaneous braille and print copies can then be generated. The same electric braillewriter can operate from one-hand keyboards, the output of computers, tape or other storage sources for braille and can also serve as a small scale braille duplicator.

In order to make the electric braillewriter an extremely versatile instrument, the prototype will operate at speeds as high as 14 braille cells per second and will emboss zinc plates as well as all kinds of braille paper. The decoder and switching circuitry which couples the electric braillewriter to the typewriter will also operate fast enough to permit a human typist to go as fast as 180 words per minute while the braillewriter is capable of as much as 225 words per minute of Grade II braille.

(f). Line-at-a-time and moving braille displays, variable braille-like tactile stimulators (1-100 stimulus probes adjustable in area) and other tactile instrumentation are being developed at M.I.T. These devices will soon be used to study the most effective information transfer methods for braille or braille-like codes, perception problems and the relative merit of active versus passive sensing by blind and deaf-blind persons.

(g). During the third year of a research program of the Mechanical Engineering Department at M.I.T., an instrument will be developed which will take advantage of high density photographic and magnetic storage with special retrieval techniques. The cost of producing braille material is so high that the amount of material available is far less than printed material for sighted persons. Blind people cannot have their own personal libraries. It is proposed, therefore, to develop cheaper storage media than the braille page, but at the same time to permit the human to have quick access to any portion of a page or any specific page in a book.

In conclusion, the impact of these technological developments is just beginning to be felt in the area of braille. A competitor for braille is sound-recorded media. Technological developments in embossed discs, high density storage tape recorders and other instrumentation reduces the need for braille for certain uses. Anyone planning a program in the area of braille research must consider these technological developments.

These and other developments in the technological field depend not only on engineering reliability, but on solutions to many orthographic problems suggested above. In fact, the basic research suggested above on the code becomes the more necessary if full advantage is to be taken of technological developments.

Methods of Instruction

It is generally assumed that the greatest deterrent to a wider use of braille is the relatively slow reading speed that it involves. While there is no generally accepted reading rate, there are figures that illustrate the dimension of the problem. In one study of 250 school children the average reading rate for braille readers was 70 to 80 words per minute[2] (p.44). Another study reports the mean braille reading rate for blind high school students as 90 words per minute[10]. Contrast this to the median silent visual reading rate of senior high school students of 251 words per minute[10], of the reading rate of professional readers for talking books of 175 words per minute[10], which rate is "satisfactory" to 90 per cent of 445 blind college students in another study[5]. How much higher this rate can be pushed without noticeably affecting comprehension or retention of material has been claimed by one study on compressed speech[10] to be 275 words per minute for both "scientific and literary" materials by grade school children.

These comparative figures, though very tentative, suggest the plight of the <u>average</u> braille reader. (It must be constantly kept in mind that this discussion is mainly concerned with the average braille reader, not the unusually expert and fast reader, who has little or no difficulty in using braille for recreational reading.) Where speed is desirable, as in recreational reading, the average braille reader is at a disadvantage and this probably explains why only 2 per cent of a sample of 445 blind college students preferred braille for recreational reading. For specialized materials, the discrepancy in reading rates is probably not so important, though even here it must still be a significant difference.

If it is so, is this general handicap of slow reading speed (which seems to be fairly widespread among the small minority of blind people who regularly read braille) inevitable, immutable? This is perhaps the key question to be answered by inquiries aimed at promoting an optimal use of braille. The answer must, of course, be No, if braille is to be brought to greater usefulness and to more blind people. It is claimed sometimes that the ability to read independently or without the voice of another person interfering is more important to some blind readers than speed, but it is likely that most such readers have achieved a relatively satisfactory braille reading speed. Under some reading conditions speed is not as important as accuracy, in which case the braille reader is at an advantage, as has already been suggested by the use of braille by college students. In recreational reading, however, speed is likely to take place over accuracy as the over-riding concern.

Already in the discussion above some suggestions about inhibitions to greater use of braille have been made. There are the physical properties of braille that may inhibit usage like spacing values for certain age groups, some graphic materials symbols that do not permit the necessary tactual discrimination, and orthographic difficulties like abbreviations, multiple meanings, contractions and word-form deviations that promote ambiguity and hinder comprehension. The negative attitudes about blindness and braille as a "badge of blindness" cannot be ignored even if they are unconscious and indirectly expressed. And, beyond doubt, there is another very important factor (some would say the important factor): instructional methods. To quote two authorities:

> (1). Children learn to read in braille and to read quite well in view of the many problems. Significant opportunities to improve their reading even more and to reduce the number of errors in reading can be found in teaching practices, in the preparation of appropriate materials, and in possible changes in the braille code.[1] (p.30)
>
> (2). One sees frequent references to the fact that only one out of four persons read braille: in recent years this has become "only one out of four is capable of." There is a big distinction between the number of people who do not read braille and the number who are incapable of learning to do so. The low percentage of nonreaders is due primarily to the fact that, until recent years, relatively few adults made an attempt. As a nation, we seem far more interested in reiterating this fallacy than we are in making an intelligent attempt to raise the number of readers. Our poor record does not harm the value of the braille system; it is a severe condemnation of our methods for teaching it and our attitude toward it in general.[11] (p.26)

As Ashcroft[1] (p.17) and others have clearly pointed out, braille reading involves the same psychological processes as sight reading. The mind perceives information through a symbol, comprehends it and retains it. Perception, comprehension and retention are the fundamental processes in all reading. The unique problem in braille, however, concerns what has been called the perceptual span. A sighted reader can very quickly scan several characters and decide what they mean, how they relate to each other as parts of words, as whole words, or as groups of words. The braille reader, through touch, must go more slowly over the characters until he relates them meaningfully. It is not at all clear from the literature or from the welter of conflicting expert opinion what this perceptual span should be in an average braille reader or whether it can be significantly lengthened by special training, thus speeding up the braille process. Ashcroft has said on this point:

> Teaching reading in braille should apparently emphasize the development of an optimum attention or anticipation span. Since both the meaning of the reading matter and the meaning assigned to braille configuration is dependent upon context, judgement must be suspended until contextually appropriate closure can be achieved. Missed dot errors, added dot errors, and ending problems seemed to be related to problems involving premature closure and should be amenable to prevention or amelioration through the development of appropriate anticipation span.[1] (p.30)

Important problems of perceptual span are undoubtedly the tactual area employed and the tactual threshold of the reader and his finger movements or orientation, that is, whether the movements are purposeful and disciplined, not random "scrubbing" and wasteful. Then, of course, as discussed earlier, the physical properties of braille, the excellence of the materials presented and orthographic problems all contribute to the central problem of perceptual span. It is not unreasonable to believe that if proper controls were introduced and experiments in teaching methods systematically introduced that a great deal more could be said about the possibility of the perceptual span being lengthened, at least for some braille readers, without lowering comprehension and retention levels. Since most of the discussion in previous sections impinges in some way on the problem of perceptual span, a comprehensive research program can be worked out on it. Suggestions and recommendations on this central problem of braille reading follow in the next section.

In summary, the potential uses of braille depend on our knowing a great deal more about the efficacy of braille as a code and how technology and instructional methods can contribute to its being a more effective medium for that small minority of severely visually impaired people who now use it as well as for some of that large majority of severely visually impaired people who do not use it. Research and development can help in this assessment.

A Research and Development Program on Braille

A research and development program addressing itself to as complex a problem as has been outlined in the previous section must have several characteristics if it is to succeed. First, it must employ the best current research theory and procedures. Second, it must be comprehensive; it cannot be comprised of a small project here and a small project there, concerned with peripheral and not central problems. Third, it must be coordinated by some central group who understand the interrelation and interdependence of separate projects, so that meaningful data on the central problems are obtained. Fourth, the research phase must be long-range; there can be no hasty or superficial findings tolerated. Fifth, full responsibility must be taken for the development phase when research findings are subjected to further experimentation, if needed, and to demonstration programs. Research without development is an exercise in futility. Sixth, the research must be in the hands of highly qualified research scientists who are protected as much as possible by the advisory or sponsoring group from the necessity to raise funds and the emotionality surrounding the subject of braille. A research "climate" must be maintained if competent researchers are expected to be kept involved. Lastly, there should be no illusions on the part of anyone involved in this research and development program on braille (at least as recommended here) about its being costly, long-range and fraught with the administrative problems that any cooperative project involving several interested parties and organizations must deal with. These conditions for a successful research and development program on braille do not differ from any other research and development program. A point is made of them here so as to insure that any person or group considering this program does so in a businesslike and realistic manner. The rules of the game should be quite explicit in this complex and difficult endeavor.

Proposed Research Projects

The discussion in preceding sections suggests at least one major project and several ancillary projects of smaller dimension.

The central problem of the major or master project is to increase braille reading speed without lowering comprehension and retention levels, this to be done, if possible, through experimentation with the code, with media, with products of technological developments and with experimental instructional methods.

In order to conduct experimentation there must be a norm against which the results of experimentation can be measured. Proposed here are two groups (a control group and an experimental group) who are rigidly controlled for the following characteristics:

Age: recommended are sub-samples A-1 (the control group) and A-2 (the experimental group), 100 primary school children in possibly grades 2 and 3 in residential schools; sub-samples A-3 and A-4, 100 primary school children in grades 2 and 3 in local school systems; sub-samples B-1 and B-2, 100 secondary school children in possibly grades 7 and 8 in residential schools; sub-samples B-3 and B-4, 100 secondary school children in grades 7 and 8 in local schools; sub-samples C-1 and C-2, 100 young adults in the 20-30 age group; and D-1 and D-2, 100 adults over 50. Control and experimental sub-samples should not be in the same institution, so there is no "contamination." These figures are intended to be suggestive. Further investigation might outline further younger age groups, sampling problems and problems attendant to maintaining rigid controls.

Vision: that no more than half of each sub-sample of 50 have any useful residual vision, that is, more than total blindness or light perception. As far as possible, each sub-sample should include a maximum number of persons with no useful vision, but where sampling problems make this unrealistic, persons with some useful sight could be included, preferably in two categories: (1) less than 10/200 categories distance or (2) severe impairment near. Since both Maxfield and Loomis draw attention to the differences in learning braille by the newly blinded and the congenitally blind, where possible the two groups should form distinct sub-samples.

Health: that general health level at least be the established norm for the institution or age group. Persons should have no additional impairments, and particular care should be taken to screen out persons suspected of neurological damage or emotional instability.

Braille: that all persons have a reasonable proficiency in reading braille, which, for example, based on one study might be 70-80 words per minute for the 7th and 8th grade group. Particular care should be taken to exclude very slow and very fast readers (who can be studied on a case study program), keeping the initial sub-samples at least to comparable small ranges of proficiency.

Learning aptitude: that all persons be in a range set up as normal for a test of learning aptitude specifically for the blind. Recommended for the three younger sub-samples is a test now undergoing final standardization study: the Blind Learning Aptitude Test[1 (p.40)] developed by Dr. T. Ernest Newland at the University of Illinois. Its main advantage is that it is relatively "culture-free" and though not standardized for older adults, might with its author's agreement, be used for testing them. Older Hayes and Wechsler tests might also be used, though as verbal tests, they are not "culture-free."

Light touch threshold: that all subjects have an acceptable light touch threshold level, much as performed in Axelrod's experiments[1 (p.52)] so as to eliminate persons with low thresholds.

Other factors suggested for control are sex, socio-economic status, length of blindness (age of onset), teaching techniques and emotionality. Certainly, the more rigorous the controls, the more reliable the data. Whether these controls make sample selection impossible or not would require a great deal more investigating. Sampling must ensure that adequate numbers for statistical analysis are obtained. That is the first consideration and will dictate the number and types of controls used in any study.

Controlling then for age, vision, health, braille proficiency, learning aptitude, light touch threshold and other factors as practical, the following program is recommended: In the course of one year, using standardized materials appropriate for age levels, Ashcroft's experiments[1 (p.16)] on the type, frequency and level of reading errors be repeated for all 600 subjects, using standard Grade II braille. Concurrently, discrimination tests on presentation of graphic materials such as undertaken at the American Printing House for the Blind should be given all 600 subjects. Third, all subjects should be tested for what Nolan[1 (p.74)] has called "thresholds of recognition of individual letters, for words, for phrases," using the Tachistoscope which is being developed at the Printing House.

During the first year of data collection then all sub-subjects are given (under standard conditions and using standard materials) reading error tests, graphic materials discrimination test and perceptual threshold test. The errors test and the perceptual threshold test should contain both literary and scientific materials.*

During the second year of data collection after several months lapse, the battery of three tests should be repeated. Between tests the control groups (A-1, A-3, B-1, B-3, C-1, D-1) have pursued their studies in their usual way. Between tests the experimental groups (A-2, A-4, B-2, B-4, C-2, D-2) have been given special intensive training in orientation (finger and hand movements); group A-2 has been given instruction in micro-cell braille (such as used in England or Japan); and groups B-4 and C-2 are given special instruction in Grade I or braille with a minimum of abbreviations, contractions and multiple meanings. The experimental groups would, of course, be tested at the end of the second collection year by the same tests used for all 600 subjects the previous year. These tests, it goes without saying, would be subjected to the soundest test construction procedures.

Among topics for experimental treatment, Ashcroft has proposed: use of specially prepared (subject matter) materials; use of special methods, like attack skills, speeded rates, suspended judgement, programmatic introduction of signs, abbreviations and contractions; delayed instruction for increased readiness; intensive experimental development in young children; and attitudinal manipulation. Others have warned about

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* At this writing, Dr. Richard W. Woodcock, Associate Professor of Special Education, Colorado State College, was also developing "a battery of tests for measuring the braille skills needed in reading and number work," for which support was being sought from the U.S. Office of Education's Cooperative Research Program.

adequately assessing the variables caused by differing instructional methods.

These suggestions highlight the need to proceed slowly and with care on any program of experimentation; making sure that only qualified experts participate with research personnel in the planning of the program. This present paper can only suggest a few topics that need to be carefully considered, among others, in the development of a specific research plan.

In the third year of data collection, the process would be repeated with control groups normally pursuing their studies and experimental groups being given instruction in an experimental code which would incorporate possible remedies of constantly recurring errors in tests on the existing code. These experimental changes would have to come from analysis of errors found in the data of the two previous tests. At the end of this third year of data collection, the following tests would be given: to the control groups, the same or equivalent three tests on errors, discrimination of graphic materials and perceptual threshold; all would be literary and scientific selections using standard Grade II braille. The experimental groups would have similar tests using the experimental braille.

Reading rates at acceptable comprehension rates could then be computed group rates compared by various standard statistical tests.

(The above discussion has been concerned with the braille literary code. Whether similar meaningful experiments could be devised for the mathematical, scientific and music codes requires further study and planning.)

A project of this dimension would involve a full-time research director, an assistant director and secretary. Consultants in years 2, 3 and 4 to work with the experimental groups and an advisory committee would be added costs. Travel to locate the sample in the first year and to test them in subsequent years would be heavy. Data processing costs and housekeeping costs would complete a budget that might well run to an average $100,000 a year or a total of $500,000 for the project. The likely sponsors for such a project would be the U.S. Office of Education and the U.S. Office of Vocational Rehabilitation, with somewhat less direct interest on the part of the National Institute of Neurological Diseases and Blindness and the Childrens Bureau. Cooperative financing would probably be necessary and desirable, despite the administrative problems which it raises.

Ancillary Projects

In addition to the master project described above, there are several less ambitious projects that could give us a considerable body of data on topics and issues concerning braille that today are merely matters of opinion. These topics lend themselves to individual graduate study as theses or dissertations and could very well be financed in part through training grants of the U.S. Office of Education or the U.S. Office of Vocational Rehabilitation or through the fellowship program of the American Foundation for the Blind.

This list of topics for study is not by any means a complete listing. Hopefully, it may suggest other topics of similar nature and value. The first few studies that suggest themselves are most likely to be Ph.D. dissertation subjects, since they involve considerable ingenuity in data collection and considerable judgement in interpreting the data.

(1). Case studies: The master project above is an attempt to set norms which has meant screening out a number of characteristics so that variables contributing to reading speed could be more clearly identified. Another way of gaining insight besides the experimentation technique of the master project is the case study technique in which several far better than average braille readers (judged by speed, comprehension and retention) are studied intensively for the factors that seem to contribute to their success, such as, for instance, finger and hand movements, use of both hands, history of practice, intelligence, motivation to use braille and so on. Also through case study method, poor readers might be studied as might braille teachers who are acknowledged by their peers and by their students as effective teachers. Also, case studies of the left-handed reader, the right-handed reader and the ambidextrous reader might reveal whether all or only certain readers can be trained to be ambidextrous, which probably increases the perceptual span.

An exciting possibility for gaining insight into braille through case studies would be the pooling of three or four dissertations into a book as was recently done by three doctoral candidates and their advisor (University of Rochester) on parental sttitudes toward blindness in adolescents.[12] In the braille case, one dissertation on good readers, one on poor readers and one on good braille teachers might serve as separate dissertations and be combined into a publication preferably under the direction of a single advisor who might act as senior author.

(2). Attitudes: This same technique of combining several dissertations into a single publication would be particularly advantageous to attitude studies, as has been demonstrated by the Rochester group. The complex of attitudes about braille need to be considered in the larger contexts of attitudes toward blindness and those which seem the most relevant to braille and braille users studied more intensively. Several such studies might be combined into a single publication.

Attitudes toward braille by the uninformed are assumed to be largely negative, such as the story carried in the New York Times of January 29, 1962 illustrates. An honor student active in campus affairs at Columbia College lost much of his sight through glaucoma a year ago. He listens to broadcasts and writes his notes in large script by black crayon on rolls of shelving paper. He now has to study eight to ten hours a day to keep up. The article continues: "Although he concedes that knowledge of braille would ease his study problems, Mr. Greenberg balks at taking lessons. 'Braille instruction would mean defeat,' he said yesterday in an interview. 'I'm not blind.'"

How much "defeat" and "being blind and helpless" enters into the attitudes of students and teachers of braille, we don't know, but we can get insight from some well designed attitude studies. One might involve a comparison of several residential school teachers of braille, several local day school resource room teachers of braille and several teachers of braille in rehabilitation centers for the blind.

A comparison of attitudes of students in these same three settings might be instructive. Any studies involving students should be particularly careful in sample selection. The congenitally blind and the adventitiously blind should not be mixed together; and neither should those with no useful sight and those with some residual vision. Age and braille experience should be fairly constant in any three settings study of students. Of course, separate studies can be made of the congenitally versus the adventitiously blind, the totally blind versus the partially sighted, those with considerable braille experience versus those with little braille experience and so on, but in all cases samples should be expertly matched so that extraneous variables do not cause spurious results.

Another attitudes study that suggests itself is a comparison of parents and teachers of students who have residual vision (i.e., legally blind) and whose principal mode of reading is print as against parents and teachers of students who have residual vision (i.e., legally blind) and whose principal mode of reading is braille. The experience of the Stanislaus County, California school system on this subject suggests that it is often parental and teacher-attitudes rather than student motivation that causes resistance to the idea that a student's residual vision should be fully utilized with effective print reading (with or without low vision aids) so that the student becomes less differentiated from his peers, an important point in school children. The trend, as Jones' compilation shows, has been away from "sight-saving" in the past 10 years, but it still obviously exists in some places and undoubtedly influences attitudes toward both braille reading and print reading by visually impaired children and adults. The "sight-saving" influence on attitudes of adults recently blinded could well be looked into also. Longitudinal studies of attitude changes among poor and good readers might suggest important factors.

Several of these attitude studies (and others that these might suggest) grouped together into a book or two would be fascinating and instructive reading.

(3). Teaching machines and practice routines: Certainly the claims of promoters of autoinstructional devices in general and their assumption that the blind have no unique characteristics on this score need to be thoroughly investigated. This might be done through several doctoral dissertations which could be used as working papers for a conference to lay out the parameters of uses of autoinstructional devices with the visually impaired. Central to the problem is the programming of the device. Ashcroft in programming braille instruction for teachers of braille speaks of "emotional behavior"[1 (p.90),13] a reaction that should be looked into and evaluated in several studies. Little can be done in this paper (due primarily to my ignorance on the subject) but to suggest a thorough investigation be made of autoinstructional devices, particularly as they afford the opportunity for more intensive training and practice in braille reading with the possible result of speeding up braille reading.*

The subject of the training and practice in braille reading with or without autoinstructional devices needs considerable study. Some say that the slowness of braille reading compared to sight reading is largely a matter of the availability of so relatively few braille instructional materials and the lack of intensive training and practice which the sighted student gets. A comparative study or two of the materials available and the training and practice routines of sighted readers and braille readers within a local day school system that affords no special remedial program for the visually impaired and a study within a school system that does afford recognized remedial programs might point out the relative effectiveness of the braille reader in different situations involving instructional materials and practice routines.

(4). Diabetics: It is commonly said that the light touch threshold of the diabetic is too low to permit him to read braille. We need conclusive data on this subject, data that takes into account light touch thresholds of successful and unsuccessful braille readers, age differences, motivational differences, braille cell size differences, and intensive training and stimulation differences. The focus of such a study or studies should not be entirely that of experimental psychology because the social-psychological

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* At this writing, a conference on autoinstructional devices for the blind is planned for September 28, 1962 in New York by the AAIB Research Advisory Committee.

factors cannot be ignored. For this reason, it is probably the subject for a dissertation, rather than a master's thesis of tables of light touch thresholds.

There are other less complicated subjects than diabetics, autoinstructional devices, attitudes and case studies, and these less complicated subjects should not be overlooked or downgraded in any attempt to obtain a comprehensive overview of braille. Several suggestions are made here with the hope that they will suggest others equally valuable. All are suitable topics for master's theses and training grants as mentioned above.

(5). Recreational reading: In the master project above, an assumption was made that recreational reading in braille was less frequent especially among visually impaired students. One study was quoted that said only 2 per cent of a sample of 445 college students used braille for recreational reading. This seems deceptively low. A survey of different kinds of braille readers (students, adults, retired persons, totally blind, partially sighted, etc.) might throw more perspective on the amount of recreational reading done in braille. Also, inquiry might be made about the importance of varying physical qualities of reading materials, the use of bastard braille, the recency of braille publication and range of selection as compared to inkprint materials, and other similar factors that may encourage or inhibit recreational reading in braille.

(6). A similar follow-up survey might be made of recent and older graduates of residential and/or local day schools who used braille reading and writing in school. Do they use it now, how frequently and for what purposes are the principal questions. Age differences, vocational differences and differences of vision should enter into any such follow-up survey.

(7). Tests. It is occasionally said that few or no diagnostic tests are used with braille students and that psychological, educational or achievement tests on reading normally used with sighted readers have no equivalents for blind students. A survey of several residential schools and local school systems might throw some light on this charge. While such a survey is straight-forward, a mail questionnaire would probably be a mistake for two reasons: overworked school personnel are reluctant to fill out questionnaires from strangers and a great deal of depth material might be gained from interviews. If, as charged, few tests are used, probing for reasons would increase the value of the survey.

(8). It is also occasionally said that the reason that braille readers are relatively slower readers than sighted readers in the same grade is that blind children cannot be fairly compared to sighted children. Often they have not had the extra stimulation a blind child needs, so that their level of experience is lower. They are often old for their grade because they have repeated grades. They are poorer achievers for their age, it is said. A survey of age, grade and achievement levels of blind and sighted children might give some valuable data on this point. Then, if experience level does seem to relate to braille reading achievement, a significant hypothesis has to be added to our program of assessing factors that may contribute to more effective use of braille.

(9). Except for one cursory survey by the North Carolina School for the Blind, there seems to be a lack of general information on the relative effectiveness of methods of teaching braille writing and whether these compare favorably or not with instructions in handwriting for sighted students. A survey of a few residential and local day schools on writing instructional methods may yield some valuable information, especially when it is assumed that many adults who have given up reading in braille still take braille notes.

(10). A subject that causes some controversy and certainly raises questions is whether the assumption that the sense of touch is able to recognize orthographic forms which have been learned through the sense of sight. Whether raised regular print letters help in teaching braille characters need to be studied.

(11). Studies of spatial problems of the congenitally blind, particularly whether flat representations of three-dimensional objects are efficient teaching aids, need to be undertaken.

(12). Last in this list of surveys is the availability of brailled materials for the blind public that uses braille. It is frequently said that the blind persons must wait months to get the same book his sighted friends are discussing. This time lag in talking books is probably less than the time lag in brailled books. An analysis of the inkprint book's publication of any one year as against the date of its availability in recordings and in braille may account for some obvious reluctance to use braille as a medium for recreational reading. If this is so, the promise of machines that convert paper tape (from which inkprint books are published) to braille in one process may cause the time lag of publication to be shortened and general satisfaction in the availability of timely materials in braille to increase. It is necessary to evaluate what feeling prevails now, however, if some idea of the potential market of braille readers is to be estimated for the technological research and development in tape converters to braille. Such knowledge may well encourage that program.

(13). The whole range of problems of deaf-blind braille readers needs to be considered in another exploratory paper like the present one. It is for reasons of competence, not interest, that this paper makes this ommission.

In summary, these are some of the surveys and studies that suggest themselves to any comprehensive program on braille. They would be invaluable supplements to the experimental program of the master project.

Implementation of this Program

It would be of no service to the field if this suggested program were to be left without one explicit requirement being set forth: it requires central direction. It requires central direction for several reasons, the two most important of which are for fund raising and for integration of the various findings into some rational and comprehensive body of data on which further developments in braille can rest. This program as recommended is expensive. It envisages an expenditure of $150,000 to $200,000 per year for a minimum of five years. To raise that money and to provide stewardship for its proper expenditure, a permanent, highly responsible group must exist. That steering committee must not only raise money. It must interest competent research and development personnel in executing its program. Some will have to be new to the field. Others (like the research team at the University of Louisville and the American Printing House for the Blind) will have to be encouraged to expand their program. Then finally, the steering committee will have to evaluate the research findings from all projects for their technical competence and their implication for action, after which their recommendations are printed and subjected, like all research, to comment and criticism. Before completing their task, they may wish to make rejoinders. With that, their job is done, except for the occasional consultation they may give to the parent body whose responsibility it is to effect all action.

The parent body must be an effective one if the research and development steering committee is to have any reasonable hopes of discharging its duties properly. Both the parent body and the steering committee must be assured of continuity both financially and organically. The leadership of neither group can be part-time, even though its membership may well be. Finally, this report recommends a permanent secretariat for the research and development programs to ensure its proper execution. The raising of the effectiveness of braille communication is not a part-time job. It will not be serving the visually impaired population well to look at this effort in any other way than as a mission that will take time, money and the considerable effort of many men. In that spirit it can succeed.

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