

EYEDNESS AND HANDEDNESS IN RELATION TO
CERTAIN DIFFICULTIES IN READING.

by

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ABSTRACT OF THESIS TO BE PRESENTED FOR PH.D. EXAMINATION BY HELEN C. DALBY.

Eyedness and Handedness in relation to certain difficulties in Reading.

- I. Handedness - Different types of handedness. Eyedness - the nature of eye-dominance. The relation between eye-dominance and handedness. Theories concerning this relationship. Left-handed children and those subnormal in reading. Possibility of connection between this subnormality and eyedness of the left-handed child. Possible nature of the connection between "eyedness" and retardation in reading (if such connection exists) Types of difficulties in reading experienced by left-handed children which may be due to "eyedness".
- II. Experiments with left-handed children; 1st set, with results and conclusions.
- (a) Description of experiments and subjects.
- (b) Results of experiments showing:-
- (1) Incidence of left and right eyedness in unselected group.
 - (2) Incidence of left or right eyedness in group of left-handed children
 - (3) Reversals of forms (in words and groups of letters)
 - (4) Transposition of letters in words and groups of letters.
 - (5) Children's remarks with any pertinent introspections.
- Suggestion of difficulty or orientation arising from these results.
- Further analysis and conclusions.
- III. Experiments with adults; 1st set, with results and conclusions.
- (a) Description of experiments.
- (b) Description of subjects as to eyedness and handedness.
- (c) Results of experiments analysed.
- (d) The prominence of reversals of forms in the case of left-eyed subjects.
- (e) Other results of the analysis:-
- (i) Type of reaction to exposures.
 - (ii) Subjects, introspections and suggestions arising from these.

IV. Further experiments with children.

- (a) Left-eyed and left-handed group.
- (b) Left-eyed and right-handed group.
- (c) Right-eyed and left-handed group.
- (d) Left-eyed and left-handed group.

These experiments are tachistoscopic in character. They are designed to reveal the disability (or otherwise) experienced by left-handed children as regards orientation of forms and position in space.

V. Further experiments with adults.

- (a) Right-handed and right-eyed.
- (b) Left-handed and left-eyed.
- (c) Left-handed and right-eyed.

These experiments should confirm the results of the first set of experiments as to the characteristics of form most frequently reversed.

- VI. (1) Experiments with adults and children to prove whether the incidence of reversals of forms, or of orientation with regard to position in space, is affected when the objects perceived tachistoscopically are in motion.
- (2) Analysis of these experiments.

VII. General observations and conclusions.

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EYEDNESS & HANDEDNESS IN RELATION TO CERTAIN DIFFICULTIES
IN READING.

HANDEDNESS: Handedness has occupied the attention of psychologists for a period of more than two centuries. The subject is of very great interest both to scientists and laymen. The scientist seeks the causes and effects of a condition so universal as unilaterality, the layman requires a solution of the very practical problems which may arise, for instance, from a peculiarity of manipulation so general as the use of the left hand for activities usually assigned to the right. Handedness is usually attributed to ^{physiological} ~~psychological~~ causes, and these ^e ~~here~~ ^{have} ranged from complete structural inequalities of the left or right side of the organism to superiority of functioning of certain parts of the brain controlling the motor-coordination of the limbs.

It was Humphrey and La Conte, however, who drew attention to the very close connection between ^{and} the interdependence of ^{the} two systems of motor coordination involved when movements of the eyes are required to guide the manipulatory activities of the hands. They stated that people are left or right-eyed as well as left or right-handed. The dependence of movement upon vision must exercise very great influence upon the development of habits of motor coordination. Some investigators, notably Parson^{x 17}, regard it as the real key to the secret

of handedness. Ocular dominance would, on this theory, unquestionably be placed amongst the main causes of right or left handedness. Further, an experimental study of the handedness of large groups of individuals has established the fact that no such phenomenon as clear-cut right or left handedness exists. There are degrees of handedness likely to vary and be interchanged according to the variations in the age, circumstances and habits of the individual. Heinlein⁹ found, in ~~his~~^{her} experiments with pre-school children that in simpler bi-manual activities it is the convenient hand rather than the preferred hand which is most used. In spite of this flexibility, definite motor habits do become established, and methods by which the hands will be employed in motor activities become rapidly sufficiently constant for the individual concerned to be designated right or left handed. Rife¹⁸ has classified individuals into six dextrality types on the basis of the following usages:

Right handed.

1. R. H. in all unimanual activities and the "business end" of all bi-manual activities.
2. R. H. in all unimanual activities and L.H. in the "business end" of all bi-manual activities.
3. R. H. in unimanual activities and in the "business end" of all bi-manual activities of the first rank such as

batting or golf, but left handed in lesser acts such as shovelling or sweeping.

Left handed.

4. L. H. in unimanual activities, and the "business end" of all bi-manual activities.
5. L. H. in all unimanual activities and R.H. in the "business end" of all bi-manual activities of the first rank.
6. L. H. in unimanual activities and "business end" of all bi-manual activities of the first rank, but R.H. in bi-manual activities of the lesser rank.

Classified according to these types, Downey⁶ has found a percentage of 16.7 of left handed people out of 1500. The description of these types, together with the possibilities concerned in the classification of various activities as of 'first' or of 'lesser' rank, and even the description^{of} a motor activity as unimanual or bi-manual, imply considerable flexibility in the matter of handedness, and would conform to the findings of Woo^{and} Pearson²¹ on the more general question of laterality, that "dextrality and sinistrality are not opposed alternatives, but quantities capable^{of} ~~to~~ taking values^{of continuous interaction} and passing one into the other."

EYE DOMINANCE: The visual habits of some people give clear evidence to any observer of the presence of a "master" eye, controlling the motor co-ordination concerned in fixation. It is possible to conclude in such cases, either by noticing differences in expression, in brightness or in size between the two eyes, which one plays the subordinate part in fixation. People who have a dominant eye by reason of very unequal vision show this by certain mannerisms, and especially by the position of the head when careful visual attention is being given. Most people, however, give no indication of ocular dominance, and the habit must be demonstrated by experiment. The tests usually employed have the disadvantage of introducing to the situation a number of subjective factors so that the tester is enabled to discover the object of the experiment. The experiment has therefore been under the necessity of either repeating the tests, or of devising some way of corroborating conclusions, the accuracy of which he was doubtful. The various experimental investigations ^{have} here, however, established the fact that about ⁽¹⁹⁾ 85% of a normal group of people show a distinct preference for the use of one eye in fixation. Though this method of functioning of the motor co-ordination system of the two eyes does place people into a left-eyed or right-eyed group according to their 'eyedness', it cannot be regarded as analagous to the motor

(19) Snyder A. M. M. loc. cit. 19

co-ordination of the two hands whereby people are right or left-handed. There is no conscious experience of right or left eyedness comparable to the experience of right or left handedness. We do not in general know with which eye we see. *Snyders*'¹⁹ investigations amongst students lead him to conclude that eye preference is cortically rooted, and not infra-cortical as are the various monocular and binocular adjustments, and that it is an implicitly acquired visual habit subject to modification.

It is a little difficult in these circumstances to describe what exactly is the significance of a 'dominant' eye. *Parson*⁽¹²⁾ has advanced the theory that it has survived because, in spite of the many superiorities of binocular vision, there are certain activities more conveniently preferred by one side of the organism rather than both; and in those cases a dominant eye, controlling the movements on that side, is of greater use to the organism than equal vision. The probability is that though the motor co-ordination of the two eyes does tend to make the vision of both of equal value in a common/^{visual}field, there are still occasions when a leading eye is desirable. The habit of eye preference has therefore survived.

The relationship of ocular dominance to the general question of physical development of the organism, or of efficiency of motor habits, has yet to be investigated.¹⁵ It seems demonstrable, however, that whether or not it can be proved

15. *Miles W. R., Journal of Gen. Psych. III. 3 412-450*

to be a cause of handedness, there is some evidence for the interdependence of the two motor co-ordination systems of handedness and eyedness. That being so, it is possible to classify people according to eyedness as well as handedness. They would fall into the following groups:

- 1) Those who are right eyed and right handed (R.E.R.H.)
- 2) Those " " " " " left " (R.E.L.H.)
- 3) Those who are left eyed and right handed (L.E.R.H.)
- 4) Those who are left eyed and left handed (L.E.L.H.)

LEFT HANDED CHILDREN AND THOSE SUBNORMAL IN READING: Sufficient experimental work has been done in children's reading to demonstrate the existence of the child who, while of normal or even of superior intelligence, is the victim of a disability in the matter of learning to read. This disability in the child of average capacity often exists on the sensory level. It may be caused, for instance, by defective visual or auditory imagery. If there exists a visual defect on the sensory level, the child may be incapable of the fine discrimination necessary for the analysis of letter forms, and the association of these with sound, or with the small kinaesthetic feelings sensed in speech. He may be unable to retain those kinds of perception. Such a child may fail for years in reading, and may at last reach a stage of retardation where he appears "word-blind". There are,

moreover, certain common difficulties in reading which may be definitely due to eyedness of the child. These difficulties are more common among left-handed children than amongst those who are right-handed. They tend to persist longer amongst such children. Dearborn^(4a) writes: 'There is an uncertainty about the correct square of letters in words because of conflicting tendencies of head and eye. The result is that faulty word images with letters interchanged are stored up in the mind which later make the prompt and special recognition of words difficult or impossible'. While it is common for any children when learning to read or write to reverse letters and words, or to write them in inverted form, this phenomenon quickly disappears in the normal child. It would seem that for some reason the confusion between right and left lateral relationships persist longer amongst the left-handed children than the right-handed, and the particular kind of discrimination necessary for spatial orientation is in their case made less promptly and with more errors. Spatial relationships require close visual and motor co-ordination.

We are thus led to the conclusion that some defect in visual perception may be in part responsible for the persistence of these difficulties. They have been correlated hitherto with the handedness of the child. Now that the question of eyedness has^{involved} become with that of handedness,^{and} some definite relationship, whether it be that of cause and effect or of interdependence, can be assumed to exist between the two, it would-

be profitable to investigate the incidence of reversals, and other anomalies of lateral spatial relationships, and the eyedness of the child, while at the same time not neglecting the undoubted ^{influence} ~~interest~~ of hand co-ordination on this question.

The act of reading demands from the child a more controlled functioning of the perceptual processes, and a finer discriminative capacity than he has hitherto employed. Letters and words must be orientated horizontally in the left to right direction of printed matter. Possession of a 'master' eye on the right hand side of the body would be an advantage to the individual. In that case, the greater margin of the peripheral visual impressions would be towards the right, and the fixation of the eyes would naturally progress in the left to right direction. Left eye dominance would imply that the horizontal movement of the eyes would tend naturally to be from right to left, rather ^{than} from left to right. The child would be required to form a motor habit requiring an adjustment as to eye co-ordination opposed to his natural tendencies, in order to read from left to right. This might act as a disadvantage according to the extent to which left eye dominance was present.

The experiments in the second section are designed to investigate the question of the probable influence of eye dominance. It has been found that there is a greater proportion of left eyed children among the left handed than among right handed children. In order to ensure a sufficient number of left eyed children, the subjects of the experiments, therefore, are mostly left handed children or adults.

SECTION II.

EXPERIMENTAL STUDY.

PRELIMINARY INVESTIGATIONS.

Experiments were carried out with groups of children and adults in order to discover whether the particular difficulties in reading which have been discussed, have in fact, some relation to eyedness.

Subjects.

The subjects used for the experiments with children were:-

- (1) An unselected group of 190 pupils attending a girls' Elementary School. Ages $8\frac{1}{2}$ to 14 years.
- (2) A group of 23 left-handed girls attending the same Elementary School as the unselected group. ($9\frac{1}{2}$ to 13 years) One right-handed girl (10) and one right-handed boy (9) were also tested with this group, making 25 children in all.
- (3) A group of 20 left-handed children (11 boys & 9 girls), attending a Junior Elementary School. (Ages 8 to 11 years)
- (4) A group of children consisting of the whole of group (3) and a selection of 27 children from the first group. This group was classified according to handedness and eyedness.
- (5) A group of six adults, who were University students. Three of these were right-handed, three left-handed.

There were also the following groups of adults:-

- (6) A group of nine adults (University students), two of whom were right-handed, two ambidextrous, and five left-handed.
- (7) A small group of people who took part in the experiments, but did not complete them.

Test for Eye dominance.

All subjects were tested for eyedness. The instrument

used for this purpose is similar to the manoptoscope described by Parsons in his book on Left-handedness. It consists of a cone-shaped hood which fits the forehead and face at the wider end and has a round hole $1\frac{1}{4}$ " in diameter at the narrower end. It is about 9" long. In the adaptation of the manoptoscope, used in this experiment, the cone is divided by a partition down the centre. The subject, sighting a small object a short distance from the cone, see two semicircles back to back, the object appearing in one of them. If he sees it in the left hand semicircle he is fixating with the right eye, whereas one who sights with the left eye sees the object in the right semicircle. By carefully adjusting the instrument and repeating the tests, it is possible to discover whether the subject has a dominant eye, or whether he fixates with both eyes.

For the test the cone was fixed on a stand so that it could be rotated slightly to the left or right and was clasped to the table or desk. It was fixed directly in front of a black spot not more than 2' distant. The subject sat in a chair, and putting his face to the cone, looked through it directly at the spot. He was obliged to move the cone slightly out of line (to right or left) in order to do this. The vision of what appeared to the experimenter to be the dominant eye was then shut off and the subject was asked what

had happened. If he was not clear on the point he was asked if he still saw the spot.

Group I. were tested in this fashion partly in order to see whether the method was effective.

The results are shown below.

TABLE I.

Test for Eye dominance.

	No. & Description of children.	Right-eyed. (R.E.)	Left-eyed. (L.E.)	No Ocular Dominance.	Totals.
I.	Right-handed 170	133(78%)	32(18%)	5	
	Left-handed 19	12(65%)	5(26%)	2	
	Ambidextrous 1		1		
	Totals 190	145	38	7	
II.	Left-handed (Girls) 11	4	7		
	Left-handed (Boys) 9	3	4	2	
	Totals 20	7	11	2	
	Right-handed (I. & II.) 170	133(78%)	32(18%)	5	
Left-handed (I. & II.) 39	19	16	4		
Ambidextrous 1		1			
Totals 210	152	49	9		

Group II. were also tested, yielding the results in II. of Table I.

RESULTS OF THE TABLE.

Putting these results together it will be seen that out of 210 children tested 201 showed eye dominance. With regard to the handedness of these 201 children, 35 (17.4%) were left-handed, 165 (82%) were right-handed, one was ambidextrous. With regard to eye dominance, 152 (75.6%) were right-eyed, 49(24.3%) were left-eyed. .X.

The proportion* of left-handed children is rather large than in a normal adult group in this combined result, as a group of 20 left-handed children has been added to the first unselected group of girls.

The children were ~~given~~ given no special test for handedness, but those described as left-handed habitually used the left hand for ^{finer} given movements such as writing, drawing and needlework, and also for larger movements such as sweeping, throwing, catching ball. Two cases call for a special note, one a girl of 10 years, who was originally produced as left-handed, had made during two

.X. Miles (The Journal of general Psychology, July 1930) gives the following figures for a much smaller group of children (38) R.H. 26; L.H. 12. Of these 26(68%) were found with Right-eye and 12 (32%) with Left-eye dominance.

* See section I p. 3

years, determined and successful efforts to use the right hand; another, E.B. was using both hands for writing in 1931, but at the time of this experiment (February 1933), she had reverted to the left hand "because it was easier". The two girls are both left-eyed, the one appears above as right-handed E.B. is described as left-handed.

First series of Experiments.

This series was designed to see whether the tendency to reverse or to transpose letters and words was greater in the case of left-eyed than of right-eyed children. (Group I.) were used for this experiment. The right-handed girl who is included in this group constantly reversed short words in her written work. She is an intelligent child of 10 years. The boy was nine years of age, and was described by his parents and teachers as a "bad" speller. Five of the children were in a retarded class. All of them could easily read the simple words used in the test. Sixteen were left-eyed, seven were right-eyed. The instrument used for the test for eye-dominance with this group was the same as that described in the previous test for eye dominance except for the omission of the partition down the centre of the cone. It was fixed on a stand directly facing a black spot on a screen about 6' distant. The subject fixated the spot by directing the cone

to the right, if they were right-eyed, to the left if left-eyed. The eye test was repeated on each occasion on which the child was seen.

A Reading and Picture test consisted of:-

- (1) 8 Three or four words and their reversals - saw; was; pins; snip.
- (2) 6 Four letter words of which the transposition of the consonants made other words - care - race.
- (3) 14 letter combinations which included reversals.
- (4) 4 pictures of a ^{conventional} ~~conversational~~ type:-
 - (a) Man with suitcase in one hand, umbrella in the other.
 - (b) Man leading dog, going left.
 - (c) Woman leading dog, going right.
 - (d) Woman with suitcase in one hand, umbrella in the other.

~~Next~~

Using the manoptoscope, the child, after fixating the spot directed her vision towards a picture placed on the ^{(left} ~~(right~~ side of the screen, if she were ^{(right} ~~(left~~ eyed. The word was placed at the extreme ^{(right} ~~(left~~ of the screen, so that she had to swing the instrument from ^{(left} ~~(right~~ to ^{(right} ~~(left~~ if she were ^{(right} ~~(left~~ eyed. That part of the visual field of the ^{(right} ~~(left~~ eye which lies to the ^{(right} ~~(left~~ of the area of fixation was thus cut off by the instrument f during the swing over from ^{(left} ~~(right~~ to ^{(right} ~~(left~~ .

The non-fixating eye would by this means be the first to receive visual impressions of the word, letter, group or picture shown. The word or picture was removed the instant the child had ceased rotating the instrument, and had seen it.

Mistakes were noted. This procedure was adopted for 12 out of the 23 left-handed children. Exactly the same experiment was tried with the other 11 left handed children and the right-handed boy and girl. For this second set, when the spot had been fixated, the vision of the dominant eye was definitely cut off by a small shutter in order to see whether the incidence of reversals would be affected by the slight disturbance in the co-ordination of the two eyes which would be likely to result from this method.

The results are almost equal for the two groups. The objects shown in the Group 4 were transposed or reversed as to direction, but with far less frequency than the letters and words. The results in terms of letters reversed or transposed in Groups 1, 2, 3 and of transposition of objects in Group 4 can be expressed as follows for the two groups.

TABLE II.

I. Both eyes open, but vision of fixating eye interfered with by instrument.

No. of Children.	Transposition of letters.	Reversal of letters.	Reversal of Words.	Transposition or reversal of objects.
8 L.E.L.H.	20	22	10	4
4 R.E.L.H.	4	6	1	None

II. Vision of fixating eye cut off by shutter.

8 L.E.L.H.	19	21	7	5
3 R.E.L.H.	4	10	1	1
1 L.E.R.H.	3	3	1	1
1 R.E.R.H.	None	4	None	None

The following types of response may be noted.

1. Many of the words were read by the children without hesitation.

2. Where there was a moment's hesitation, the correct word was usually forthcoming in the case of children who gave evidence of being the more intelligent of the group. These children made every effort to interpret what they had seen. In fact the whole of the strong conative impulse induced by the experimental situation appeared to be concentrated on giving "meaning" to the word and letter groups. They were at times hindered by this tendency when reading the letter combinations into which they inserted vowels in order to be able to pronounce them as words. Hesitation in other cases led to hopeless confusion, the child being unable to give a correct rendering. When hesitation did occur the child was always asked how she finally decided on the right word (this whether she was right or not). Various answers were given to this question:- "I thought them again"; "I knew the first two letters and could nearly see the others, so I guessed them". Perhaps the most interesting remark was "I put the letters back in my mind again to see if I knew them". The child who described her reaction thus was left-handed and left-eyed.

3. Sometimes the letters were mentioned in the wrong order and then corrected. In such cases the child was asked which letters she had really seen first. Having once discovered

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the correct order, the child insisted that she had seen the letters in that order.

4. Words and order of letters were said incorrectly without hesitation, or words and groups of letters were reserved. An occasional correction would occur which the child would explain by saying that she did not see the letters at first, but knew that her correction was right.

There is a wide difference in number between the reversals and transpositions of groups of letters and that of words, the latter number being the less. This fact, in conjunction with the constant effort made by the children to attach meaning to their readings, would seem to suggest that the strong urge to interpret familiar material easily overcomes the tendency to record reversals, but that where the application of meaning is not essential, ^{and} _π interpretation stops as it were at the stage where the perception is still hardly more than a visual pattern, reversals are recorded. The wider the gap between the visual representations of the stimulus and the attribution of meaning, the more likely are reversals and transpositions to occur. It is probable that during this "gap" there occur those processes by which the undefined pre-fixational visual impressions become clarified until the stage of clear perception is reached. These physical processes are accompanied by concurrent mental

activities. - The organisation of the sensory elements in-to a perceptual unit, their disassociation from irrelevant sensory material, the spatial orientation of the unit.

Whwn the material is familiar, these processes may be much telescoped because of the ease of interpretation. When ~~it~~ was found,,therefore, that the children were so strongly^g₂ influenced by an urge to interpretation, it was decided that, in the case of adults the possibility of successfully assigning "meaning" to the visual impressions they were to receive must be minimised as much as possible.

Tachistoscopic experiments with unfamiliar material offered the best solution of the problem.

SERIES II.

I. Tachistoscopic Experiments with Adults.

In their experimental study* of the comparison of "Illusions of horizontal and vertical lines", Hicks and Rivers found that, while the answers of the subject given in the case of prolonged exposures were complicated by cognitional factors such as knowledge of the nature of the "illusion", or experience in instruction in drawing, the answers to the shorten exposures were based on more purely sensory data. It was therefore decided that if subjects of this experiment were given very short exposures which were comprised of unfamiliar material which could be easily grasped and readily reproduced it could be justifiably concluded that their reproduction of the exposures were relatively free from non-perceptual elements.

A series of lantern slides on which the unfamiliar forms were arranged in groups of 5, were exposed above the eye level of the subject - tachistoscopically. They were projected on to the screen from a lantern. The time of the exposure was controlled by a "Compur" shutter. The subject was seated directly in front of a small spot of light thrown on to the screen from a loose lamp, behind the lantern, and exactly covering the middle point

*The Illusions of Compared Horizontal and Vertical Lines.

G. Daves Hicks, and W. H. R. Rivers. Brit. Journal of Psy: Vol. 2 P. 257

of the exposure. The screen was about 6 ' in front of the subject, who sat at a small table. She had a shaded candle which she could turn towards her in order to get sufficient light to draw her records. She was asked to fixate the spot, Then the slide was shewn three times each for .01'', .02'', 1''. After each exposure the subject drew what she had seen. Three sets of slides were shown:-

- 1st. Those in which every form was different (Series (a) in photograph.
- 2nd. " " " the middle form was alike in each slide being a) A horizontal rectangle (b)
b) A vertical cone (c)
- 3rd. Those in which colour was introduced (d). There were six forms in these slides either green or black in colour. The centre of the exposure was left blank. The colour was arranged so that half the forms were coloured in each slide. This series was found considerably harder than the other two.

I

Row a 1 * 1 2 3 4 5	2 1 2 3 4 5	3 1 2 3 4 5	4 1 2 3 4 5	5 1 2 3 4 5
Row b 1 1 2 3 4 5	2 1 2 3 4 5	3 1 2 3 4 5	4 1 2 3 4 5	5 1 2 3 4 5
Row c 1 1 2 3 4 5	2 1 2 3 4 5	3 1 2 3 4 5	4 1 2 3 4 5	5 1 2 3 4 5
Row d 1 1 2 3 4 5	2 1 2 3 4 5	3 1 2 3 4 5	4 1 2 3 4 5	5 1 2 3 4 5

Length of Exposure 30"
Height of Forms 2"-6"

First set of exposures for Tachistoscopic Experiment
with Adults, Series II

Subjects. The adults in group 6 (Page I) took part in this experiment.

These subjects were tested for eye-dominance. Two of them were found to be right-eyed and right handed, one used either eye indifferently and was right handed, and three were left-eyed and left handed. During the test for eye dominance, no reference was made to the object of the test. F (R.E.R.H.) remembered that she had a very weak left eye as soon as she saw the apparatus, H (L.E.L.H.) said that she used the left eye for the telescope, L.H. knew that she was left-eyed, R. asked which eye she was uncertain to use. As the test seemed ~~wasted~~ in her case, a simple experiment, involving the shifting from binocular to monocular vision was tried. R. focussed a small object some feet away through a small finger-ring. The visual image moved very little whichever

TABLE III.

Numerically considered the results are:-

Subjects	% of Reversals to figures drawn	No. Reversed on right side of Fixation point	No. Reversed on left side of Fixation point.	Right hand shewn first or more accurate than left.	Left hand shewn first or more accurate than right	General impression of whole in early exposure
F. (R.E.R.H)	7.7	39	17	18	15	85
K.R. (R.E.R.H)	6.8	25	12	9	5	102
R. (uses both eyes, R.H.)	4.6	16	9	30	57	33
L.H. (L.E.L.H)	10.9	19	34	86	4	9
H. (L.E.L.H)	8.1	26	40	44	27	48
B.W. (L.E.L.H)	8.8	43	63	8	20	92

The first six exposures only used for these calculations.

eye she covered. She ^{remarked} ~~remembered~~ during this experiment that she could not decide which eye to use. It depended which one "got there first". The three left handed, left-eyed subjects were given a perimeter test to see whether recognition of forms was superior in the peripheral vision of the dominant eye. One right-handed subject (K.R.) was also given this test. In the ^{case of the} three left-handed subjects the forms given were recognised by the left eye more quickly than ^{by} ~~with~~ the right eye, In the case of the right-eyed subjects the right eye was slightly superior to the left.

Results, Reversals and Transpositions.

The drawings produced by these people showed a greater tendency on the part of the left-handed, left-eyed people to reverse forms, and to transpose them. Further two distinct types of reaction are discernible in the earlier exposures.

Order of discernment of forms.

In the case of two left-eyed subjects, the centre and right hand forms appeared first (L.H. AND H.). In the case of R. (no dominant eye) the left side usually appears first. Two subjects (K.R. and F.) appear to receive a general impression of the whole, and to record all the forms almost from the first exposure with tolerable accuracy. One (B.W.) apparently does this at first, changes during the course of the experiment and in later slides sees either left or right hand forms first though the right side is often reproduced more exactly than the left.

The tendency to reversals is ^{here shown} ~~thus seen~~ to be greater for left-eyed, left-handed subjects than for those who are right-handed and right-eyed. The reversals occur not only in respect of single forms, but also as to position in the series. Forms so far apart as 2nd. or 5th. being occasionally transposed. We seem justified in believing that the tachistoscopic exposures reveal a visual-motor tendency in these subjects which has been superceded by the acquisition of habits of visual co-ordination which are more useful for proficiency in reading and writing from left to right in horizontal ^{fashion} ~~localising~~. These conclusions were based on a careful study of the ^{records} ~~researches~~ and from observations of the individual subjects while making their drawings,

Characteristics of the individual subjects.

B.W. The work of B.W. illustrates particularly the gradual breakdown of the acquired visual habits, and the reversion to an earlier method. In her earlier drawings she records a general impression of the whole, and her work is fairly free from reversals. The latter protocols shews definitely a clearer more accurate view of the ~~m~~ left side of the exposure and reversals are more frequent. There are also instances of the right side being seen first. It has been found impossible to record the impression given by her protocols in terms of figures. The same set of drawings sometimes shows both modes of reaction.

L.H. sees the centre and right hand side first in every Protocol and every drawing is accurately and carefully done. There is no hint given of more having been seen than appears in the drawing. L.H. refuses to guess the unknown. She uses the right hand for drawing and writing, but during the experiment she most frequently drew from right to left.

K.R (R.E.R.H.) shows a general impression of all forms from the earliest exposure. One or two figures, however, generally the central form, and that on the left or right of the centre are seen more clearly than the others, in many of the protocols all the figures are attempted from the beginning.

F (R.E.R.H.), generally sees the middle form first, and then those to the right side. Her most frequent tendency is towards a general impression. This subject has a very weak left eye, and was not able to see any forms with the left eye in the shortest exposures.

R. (R.H. (no dominant eye)). Sees beginnings or ends of slides first. There is a fluency and looseness about some of R's protocols which is very suggestive of motion - round figures seem to roll, those with "legs" appear to be walking.

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Occasionally two figures have run into one another, and are drawn down as one.

H. (L.E.L.H) reproduced the forms with very great care and accuracy. She shows a tendency to reversals and usually sees the right side first, though these tendencies are not nearly so pronounced as in the case of L.H.

Introspections.

The subjects were generally able to say whether they saw the right or left side of the exposure first. In some cases they have even been able to number the forms in the order in which they were seen. Those who had from the beginning a general impression of the whole found this much more difficult than those who could state definitely which side they saw first.

V.H. who does not appear in the tables. (right-handed and right-eyed) and who did only a few of the slides gave interesting introspections about her experiences. She had a general impression of all the figures from the beginning, but could not draw them all as she forget all but one or two immediately. She then took those she had first seen for granted and in succeeding exposures looked for something else. She did not do this deliberately, but knew that she was doing it. On another occasion she did not see the left side when a somewhat striking figure on the right of the centre suddenly arrested

her attention.

There are indications that other subjects sometimes saw only one or two of the figures after having gained some knowlege of them. Nearly everyone asked at some stage of the experiment, if she should draw all she remembered, or only what she had just seen.

F, (R.H.R.E.) found it difficult not to look deliberately for forms she has not seen clearly previously. She found this possible when she was asked to look fixedly at the light spot and think only of it, in between the exposures. Subjects differed in their methods of retaining the forms.

K.R. (R.E.R.H.) could not retain them until she had attached names to them, which she did from the earliest exposures.

H. (L.E.L.H.) only gave names to those subjects which strongly suggested something familiar to her.

In his experiment on the perception of simple designs and patterns, Professor Bartlett has found that even with very simple figures names are commonly used and that in those which are more detailed the importance of "naming" is greatly increased, not only helping in the matter of recall, but also adding to the observer's representation. (Cf. Bartlett's "Remembering" pp 18 & 19).

The characteristics of forms usually reversed were investigated by an analysis of the protocols of these 6 subjects.

Characteristics of figures with reference to reversals and non-reversals.

It was found that these consisted of

- 1) Spirals, or partial spirals (13 instances L.E.L.H. 11 R.E.R.H.)
see photograph I(a) (b)3 (d)2 & 5.
- 2) Asymmetrical forms (4 L.E.L.H, 1 R.E.R.H)
see I (a) 4 (2). 2 (4)
- 3) Similar figures (position reversed) (5 L.E.L.H. 4 R.E.R.H.)
see I (d) 5 (4 & 5), (b) 3 (2 & 4)
- 4) Figures whose apex is wider than base (2 L.E.L.H)
see I (d) 1 (3). (b) 1 (5)
- 5) Curvilinear figures (4 L.E.L.H. 5 R.E.R.H.)
see I (d) 1 3 & 4., 3 (2) & (5)

Figures which were not reversed were of a kind:-

- 1) Easily acquire some meaning.
- 2) Recall some familiar form.
- 3) Attract attention by their particular formation
- 4) Give rise to comparison, rather than confusion with some similarly constructed figure.

It will readily be realised that figures of these kinds easily stimulate mental processes other than perception. These ~~natural~~^{mental} processes aid in the reproduction of a more accurate representation of the perception than would otherwise occur. Reversals, therefore, of these types of figures are not produced. There is a certain instability about some of the forms that are more commonly reversed (e.g. the spiral, in figures on a narrow base)¹/₂. There is also an appearance of movement in some of the protocols. It is obvious

that the idea of a moving object has occurred to R. in several cases. She has representations of a man walking, an engine, a bird, and a dancing figure. F. also records a spinning figure in one of her protocols. These two facts suggest that motion, apparent or real, might have some influence on the incidence of reversals.

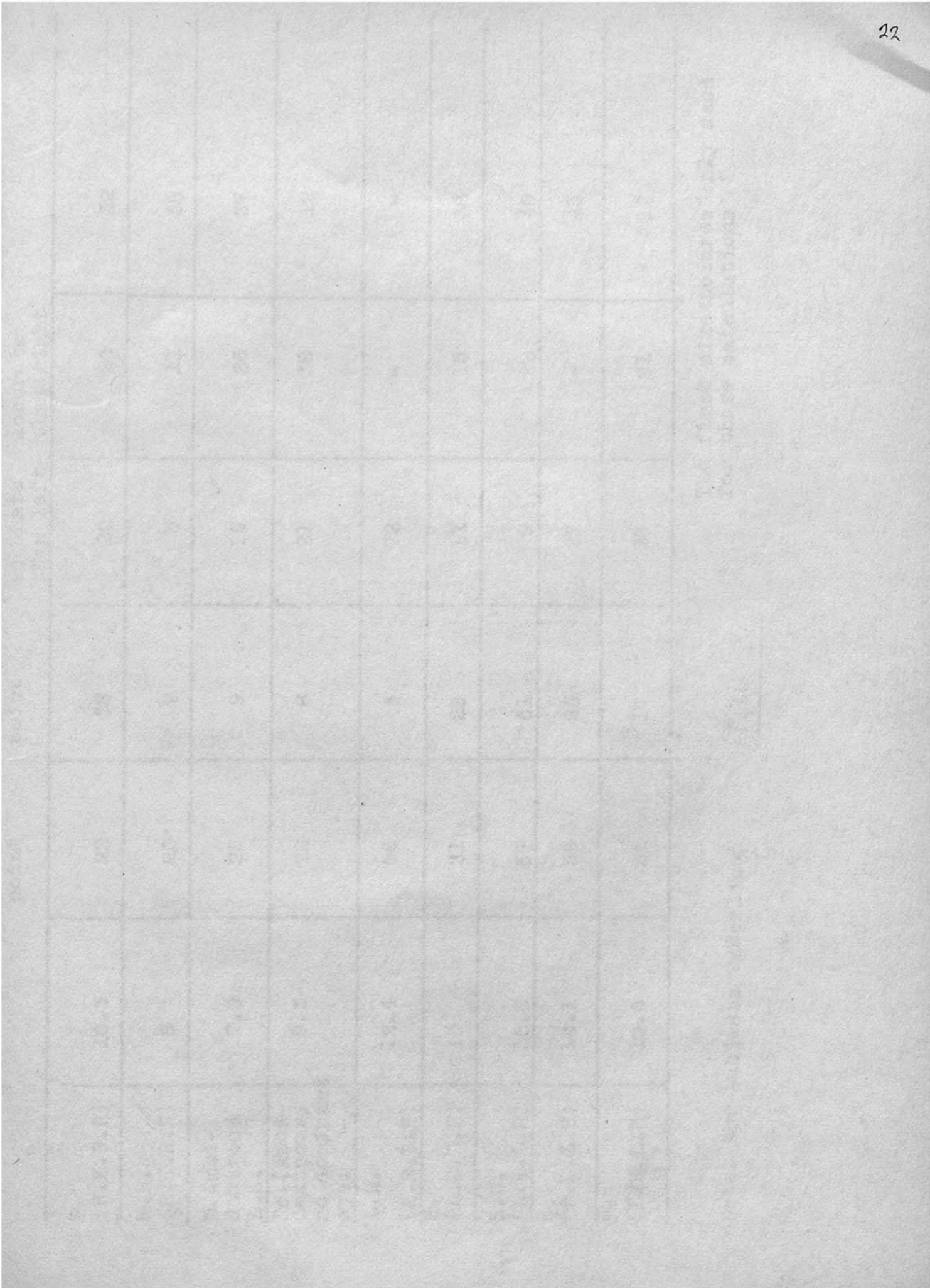
Two further sets of experiments were therefore conducted with adults.

- 1) A set of 18 slides, the forms of which were more rigidly classified than those of the first set.
- 2) Experiments in which movement played a part.

These experiments were also tachistoscopic.

The second set of slides comprised:-

- 1) Three slides of asymmetrical figures.
- 2) Five slides in which the figures were mainly curvilinear.
- 3) Six slides which had forms either to right or left of the fixation point, but not both.
- 4) Four slides of similar figures.



Subjects	% of Reversals to no. of figures drawn	No. reversed of right of fixation point	No. reversed of left of fixation point	Right side seen first or more accurate than left	Left side seen first or more accurate than right	General impression of whole in early exposures.
F (R.E.R.H)	10.3	22	38	20	20	32
K.R. (R.E.R.H)	8	20	9	3	11	58 ^T
D. Ambi-dextrous L.E.	7.0	25	9	19	26	27
Rc. (Ambi-dextrous) no dominant eye.	9.3	22	8	21	38	12
L.H. (L.E.L.H)	12.4	56	5	72	-	-
H. (L.E.L.H)	10	21	28	11	15	38
B.W. (L.E.L.H)	16.8	57	61	9	22	40
P. (L.E.L.H)	14.1	38	25	27	-	45
P. (L.E.L.H)	10.6	24	17	38	21	12

The first six exposures only used for these calculations

Table IV

Note. New subjects underlined

SERIES III..

(a) If the theories suggested by the ~~former~~ former experiments as to the characteristics of forms which are likely to be reversed are correct, the proportion of reversals in the protocols of this second set of slides should be greater than that of the first group. (Group 6 on page 1. took part in these experiments).

The slides were exposed in the same manner as those of the first set. Four new subjects (two ambidextrous, one of whom was left-eyed, the other showed no dominant eye, and two others (both left-handed and left-eyed), and five of the previous six subjects tried the experiments. The number of reversals in each set of slides was as follows:-

TABLE IV.

(1) Asymmetrical Figures (27 exposures for each subject)	96(19.3% of all reversals)
(2) Curvilinear figures (45 exposures for each subject)	255(51.9% " " "
(3) Forms either to right or left of fixation point (54 exposures for each subject)	53(10.8% " " "
(4) Similar forms (36 exposures for each subject)	87(of these 20 are transpositions) (17.6% of all reversals)

~~1. The right-handed and ambidextrous group again~~

The curvilinear figures proved the most difficult, while there were comparatively few reversals of position in the fourth set. The tabulated results show also the following points:-

1. The right-handed and ambidextrous group again shows a small^{er} proportion of reversals than the left handed set.

2. ^{An} ~~The~~ increase in the percentage of reversals for all those who took part in the first experiment.

3. The number of reversals is greater on the left side than the right in 2 out of the 6 left-eyed subjects,

4. A comparison of the figures in the last three ~~columns~~ columns in both sets of experiments is of interest. In The case of B.W. the breakdown of the acquired visual habit of receiving a general impression, and a reversion to that of seeing the left side, or in some slides the right side first, is again illustrated. The work of F. who in the first experierment seemed to have a general impression almost from the earliest exposures in some slides, shows the same attitude. In the second experiment however, her numbers are much more even than those of the first set. L.H. and K.R. conform rigidly to the type of reaction they used in the first experiment, one seeing always the right side, the other ^{receiving a general impression.} ~~the left~~. The figures of H. are fairly even in both instances, showing a bias towards a general impression of the whole. L.H. However, had no drawings on the left

side in her earlier exposures. B. has a very weak right eye, and could only see her earlier exposures with the left eye. She also prefers the right side to the left in her earlier exposures except where she records a general impression. Even in those cases she has as a rule a slightly clearer and more accurate drawing of the right-hand side. P. also has a greater proportion of right side impressions. D. is ambidextrous.

Introspections.

The introspections were of a similar character to those of the first experiment. D. did not attempt to describe *mentally* or attach names to the forms, but drew rapidly directly from her visual images. R.C. remembered all objects accurately but the moment he began to draw them, forgot what they were like. The very short interval of time necessary for putting up the light for him to see to draw, or turning the candle towards his paper, was sometimes sufficient to allow his visual impression to fade. He sometimes attached descriptions to objects, but did not always find this helpful. During the exposure of series III., each subject was asked whether it was found easier to see and draw the right hand exposure or the left. The right-eyed, right-handed people, declared for the left hand side, two of the left-handed people preferred the right side and the others were

SERIES III.(b) Tachistoscopic experiment with words. (Group (3) Page 1.)

A group of left-handed children was used. Eleven of these, 4 boys and 7 girls were left-eyed; 3 boys and 4 girls were left-eyed; 2 boys ^{showed} ~~had~~ no eye dominance.

These children were shown the words and groups of letters which were used with Group (2) in the experiment with words of pictures in Series I. tachistoscopically for 5". The child was seated about 18" in front of a photographic shutter behind which the word was shown. The word was placed precisely behind the word "set" printed upon the blind of the shutter and the child was required to fixate the word "set". It was at eye level and was adjusted when necessary. The word or letter combination was shown and the child read it aloud. The object was to see whether ^{when} ~~when~~ the word was exactly behind the fixation point, and the time of the exposure was shortened, and movement of the eyes or head to right or left were not required, reversals were more or less frequent than in the previous experiment.

The results are substantially the same, the reversals of letters being more frequent in the previous experiment and ~~Experiment I. with Group 3.~~

TABLE VI.

No. of children.	Transposition of letters.	Reversals of letters.	Reversals of words.
11 L.E. L.H.	29	7	30
7 R.E. L.H.	12	4	11
2 Using both eyes.	1	1	3

Experiment II.

A tachistoscopic experiment with Group (4) arranged in sets according to eyedness and handedness. The experiment was given in order to compare the instances of transposition of order of objects in space, which might follow a short exposure of a few small objects arranged in a horizontal pattern.

The experiment was tried because in the earlier experiments with adults and children, not only were forms completely or partially reversed about their own axes, but transpositions occurred, that is to say, letters or figures would be interchanged. A teacher reported that one girl who was right-handed and left-eyed constantly reversed smaller words in composition though her work gave signs of intelligence. This reversal of words might be due to the conception of the whole as a unit being reversed, or might mean that single letters were interchanged. This indicated an orderly process.

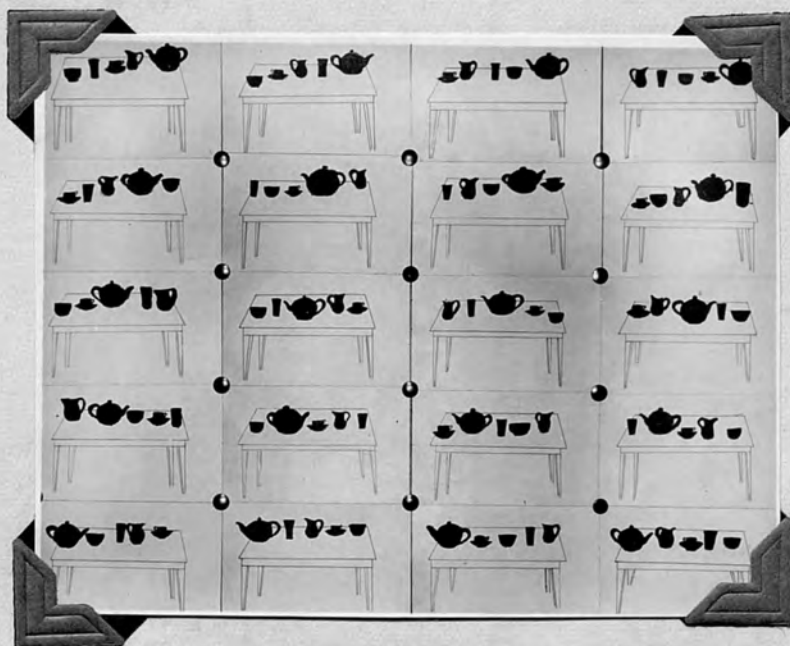
Apparatus^{.X.} and Material

For the experiment the children were shown a ~~conversational~~ ^{conventional} picture of a table set with five objects (tea pot; sugar basin; jug; cup & saucer; glass) These objects were arranged in 20 different ways, each one of which was shown to the child for 5". It was placed, as were the words in the previous experiment, immediately behind the word "set" on the blind of the shutter. The child had in front of her^{im} a picture of a table and on this he was required to arrange duplicates of the objects made by cutting a stencil, in the order he had just seen them. There were on each occasion 120 different ways of doing this, one of which was correct. Of the 119 possible errors, only 30 could be accepted as clear transpositions. It was also found that the cup and saucer, and basin were often confused and interchanged. This also happened, though less frequently, in the case of the jug and glass. As these mistakes could be regarded as due to faulty discrimination certain arrangements on each card were rejected. On the other hand the two objects adjacent to one another on each side of the centre were so frequently interchanged that these were not accounted transpositions unless there was considerable difference in size or form between the two. These rejections and acceptances

.X. This apparatus was suggested by one of the "Decroly" matching games for the training of "vision".

exactly cancelled each other, leaving the possible number of transposition at 30 - one quarter the number of possible arrangements.

III



Cards for Tachistoscopic Experiment in Orientation for Children
Series IV (b).

The results of these considerations are tabulated below. (See Table VII)

TABLE VII.
Transposition of objects in series of 20 cards.

Type & No. of Children.	Average of Transposition.	% of Transposition to other mistakes.	Ratio of Transposition to correct position.	% of Transpositions to other mistakes & correct position.	AVG Average.
<u>Left-handed.</u>					
R.E. L.H.(11)	7	66	3.00	53	2
L.E. L.H.(19)	6	44	2.50	37	2
<u>Right-handed.</u>					
(4)R.E. R.H. (Retarded)	3	17	3.00	16	1
(4)R.E. R.H. (Retarded)	4	32	.63	23	5
(7)L.E. R.H.	4	28	1.20	21	3

The figures show that the average number of transpositions is about one-third higher from the left-handed than for the right-handed, and that the average of correct positions for the right-handed is one-third higher than for the left handed.

Manipulation and introspective remarks of children.

The various methods of manipulating the objects to be arranged was interesting. Some manipulated steadily from left to right, as in reading or writing, others worked just as steadily in the opposite direction. Some tried to reproduce the order in which objects were seen. (This was not deliberate). The method of attack showed this tendency quite clearly. The child would seize the objects immediately the shutter had closed, placing as quickly as possible the centre object, or perhaps the extreme right or left hand object. A pause would occur when two or three objects had been placed, and the child would try to recall his visual impression. Again the fourth and second object would be placed and the arrangement would proceed from the middle outwards. Other children manipulated in a haphazard manner which was not easy to analyse. Transposition and correct renderings were more likely to occur if the child maintained some order in manipulation.

It was possible to corroborate the observations of the experiment with adults. The child gave indications both in manner of manipulation and in introspections of the two different types of reaction described there. Either the right or left side was seen first, or the child received a general impression of the whole. Some could quite definitely state that they saw one side or the other, or the middle object first. Others would say that they did not know which one they saw, or would say that they saw "all of them together". These two latter types of reply were so frequent that ^{they} would both appear to be indicative of a general impression..

During the experiment each child was given opportunities to correct his own result. In this way introspections were obtained. It was found that while some made efforts to correct by means of analysis, other definitely recalled their visual images and judged by "sizes" which meant that they noticed the positions of the taller objects, also, though less frequently those of the greatest bulk. They placed these and as one child expressed it "just chanced" the others. There were some five or six who used mental imagery, murmuring to themselves the names of the objects as they placed them. One boy devised an elaborate plan which resulted in the jug and glass, or the cup and saucer and teapot being always in juxtaposition because they "poured into one another". Others

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worked directly from those they knew were right, changing over the two or three of which they were uncertain. Others again, completely confused, merely complicated their errors instead of being able to correct. If the child could rely on his visual impressions, he was usually able to correct his errors. An adult who tried five of the cards, ^{and} worked with extreme rapidity, getting four out of five correct, said she would not possibly have given the order of the objects in words.

The children were asked whether they could say what kind of mistakes they made in spelling. Various replies ^{ie} ~~replies~~ were given. These are the children's own accounts of their spelling difficulties:-

1. Letters correct, but transposed, particularly at ends of words.
2. Word thought correctly, but written wrongly.
3. Easy words are written wrongly.
4. Mistakes can be corrected.
5. Words known remembered, but cannot be spelt if they are strange.

All the children who described their mistakes except those in the fifth category could correct their errors in the experiment.

The following are the numbers for type of visual reaction:-

TABLE VIII.

	R.E. R.H.	L.E. R.H.	L.E. L.H.	R.E. L.H.
General impression of whole.	3	5	7	4
Right or left of centre first.	4(L) 1(R)	2(L)	8(R)	5(L)

S E R I E S I V .

I. EXPERIMENTS INTRODUCING MOVEMENT:

In the opinion of Witasek* movement is not a perception, but a judgment due to a comparison of estimates of different positions of objects at different times. Parsons, however, regards the perception of movement as of so great a biological value to the individual, that it is not likely that it depends upon such highly differentiated mental processes. Perception of movement is rather a new kind of perception distinct from that of form. But how does the perception of movement affect the perception of form when the two are simultaneous? It is not surprising that movement, or apparent movement whether centrally or peripherally perceived, should excite interest. The reproductions, however, of some of the shorter exposures in the tachistoscopic experiment described in Series II, suggest that the subjects were easily impressed with the idea of a familiar object ^{often} ~~after~~ seen in motion. The exposures were all stationary in this experiment, but the perception of them would not be quite clear in these ~~early~~ exposures.

* Psychol. d. Raumwahrnehmung des Auges p 325. Heideberg 1910.

It was decided, therefore, to provide a moving stimulus in order to see what would be the characteristics of the reproductions of forms actually in motion, and whether the incidence of reversals would be affected. It was not found possible to arrange these experiments on exactly the same lines as those in Series II & III, but by exposing ^{the} /slides"episcopically", and interposing the photographic shutter between the mirror and the screen, it was found possible to get exposures $\frac{1}{2}$ " in duration. Each exposure was shown to the subject once only, and the subject drew or wrote what she had seen. For the first part of the experiment, the exposures were rotated on a dial, which was covered by a black screen, which only allowed a small rectangular band of light to appear on the screen to the right of the fixation point. The fixation point was, as before, a small spot of light from a box-lamp. All exposures appeared in this rectangle.

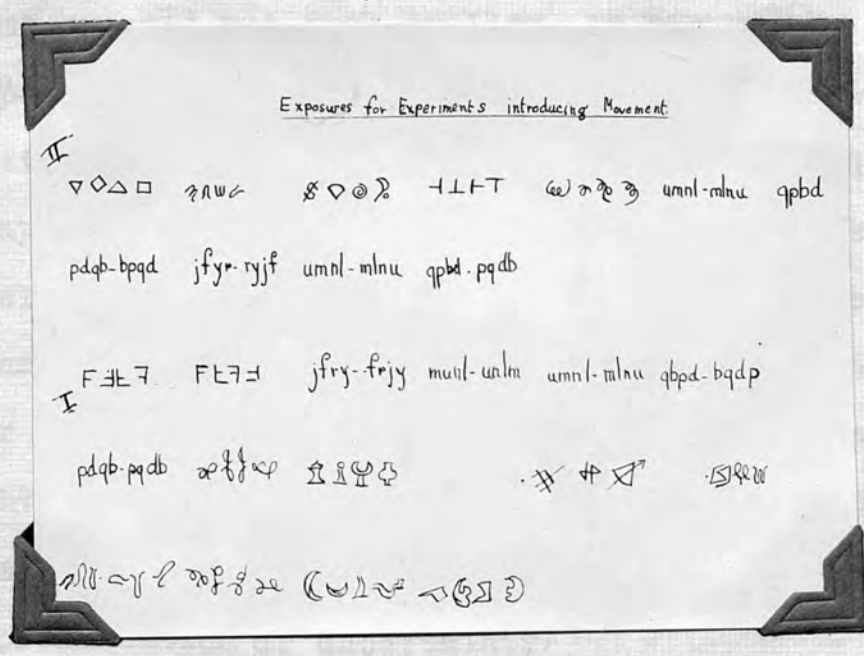
Subjects: The subjects used for the experiment were those in group 6 on page 1.

Procedure: The subject sat, as before, at a table exactly in front of the fixation spot. The exposures were thrown on to the screen about 6' in front, and above the eye level. The experimenter released the lid of the shutter, turning the dial at the same moment, so that the exposure rotated

in an anti-clockwise direction, and the subject saw it for 1/2". She then drew or wrote what she had seen.

The designs which were rotated are shown in the photograph below.

III.



I Disc

Size of rectangle 15" x 6"
Exposures 15" from fixation point
Length 6"-10"
2" high

II

Size of rectangle 32" x 6"
Exposures 7 1/2" x 12"
2" high

Tachistoscopic Exposures for Adults Series IV

CHARACTERISTICS OF THE RESPONSES:

It was obvious that the movement engaged the attention of all the subjects. They all enquired why it should be introduced. K.R. has represented it in her drawings. The forms actually produced are fairly accurate and, except in the case of K.R., there is less guesswork. Forms which would be seen in peripheral vision

are not reproduced in the representations or, in one or two cases, (B. & R.) are occasionally drawn in very faintly. The proportion of reversals is actually higher than in the two previous experiments with the slides, but as the number of forms exposed was much smaller, it may not be justifiable to compare these percentages. The ^{higher} number of reversals of the left-eyed people ~~in the matter of reversals~~ ^{not maintained} disappears. This may be due to the fact that the exposures were in the right side of the fixation point, and their images might be clearer than those of the right-eyed people whose clearer images would appear on the left hand side. Often it might definitely be a result of the perception of movement combined with that of form. The absence of guesswork, or ^{about} any **representation of uncertainty**/the reproductions may suggest that the effect of the movement was an increased concentration on the form, so that the actual perception of the figures was clearer than it would otherwise have been. It may, on the other hand, be due to an increase of effort on the part of the subjects in response to a more vivid impression of the forms shown.★

In her experiments on the peripheral perception of movement, M.D. Vernon found that there was a tendency for the subjects to concentrate on the form rather than the

★These experiments were devised and begun before the article by M.D. Vernon in "The Perception of Movement in Peripheral Vision" in the British Journal of Psychology Vol. XXIII, Section 3. had been published.

movement when they were presented simultaneously, partly because it was more difficult to apprehend than the movement, and partly because it was more interesting.

TABLE IX.

Result of Experiments I & II in Series IV.

Subject	Forms on rotating disc.	Reversals.		%
		Forms drawn towards fixation point.	Forms drawn away from fixation point.	
B.W.(L.E.L.H.)	11	12	16	15.7%
H. (L.E.L.H.)	2	6	9	21.4%
P. (L.E.L.H.)	5	6	6	15.4%
L.H.(L.E.L.H.)	6	18	18	22%
B. (L.E.L.H.)	6	20	21	31.7%
F. (R.E.R.H.)	8	16	22	24.6%
K.R.(R.E.R.H.)	3	15	8	30%
D. (L.E. ambidextrous.)	6	10	13	26.7%
R. No dominant eye L.H.)	7	7	7	13.3%.

* The designs on Part I of Photograph III were drawn across the screen firstly, towards, secondly, away from the point of fixation.

II. EXPERIMENT IN MIRROR-SPEECH^{ch} WITH GROUP 6.

Group 6 were also tried with a very simple experiment involving the co-ordination of kinaesthetic and visual imagery in an unusual way.

Closely connected with mirror writing³ and the reversal of words and letters in reading is the phenomenon of mirror-speech^{ch} which occurs in certain pathological states. Words and sentences are completely reversed, and syllables are transposed in this phenomenon. The notion of combining the small kinaesthetic sensations experienced in speech with the type of visual perceptions which occurs with tachistoscopic exposures arose because of the problems raised by two children during the course of the experiments. The one mentioned earlier, a girl of ten, (L.E.R.H.) constantly spelt words in composition and dictation in reverse form. A second, a girl of six (L.E.L.H.) was very retarded in reading and writing. This child reversed many of her letters, and unless prevented began her written work at the right hand side, and wrote mirror hand. It was noticed that both these children, while not defective in speech^{ch}, were not as clear as most children of their age.

In order to increase the difficulty of the co-ordination of the motor and visual processes, it was decided that simple reversible words should be used and the subjects be required

3. MacDonald Critchley. loc. cit.

to reverse them. The following list was devised:

<u>Word.</u>		<u>Reversal.</u>
Warsaw	-	was raw
mace	-	came
room	-	moor
shag	-	gash
laid	-	dial - dail
laconic	-	conical
animal	-	lamina
tender	-	rednet
what	-	thaw

It will be seen that by means of various processes of reversal and transposition, these words can be easily changed into other words or phrases. The subjects were shown the words in motion on the dial previously described. The various ways in which it might be necessary to transpose the words were explained to them, and they were asked to effect the change as quickly as possible, to say and then write them. Extremely clear visual imagery is required to reverse words in this fashion readily. The subjects were very slow at first, but quickened their pace considerably for the last three words, unless the word 'lamina' happened to be strange to them. It was not possible to time every word, but in the case of three subjects this has been done.

A table of the results follows:-

TABLE X.

Results in Reversals of Words by Speech.

	L.H.	H.	R.	B.	K.R.	P.	B.W.	D.
Warsaw	25"	raw saw (write but said correctly)	saw war was raw	1.5		was war	25"	written not said correctly for some time
lever	5"			2.5			5"	
mace	14"			9"				
room	6"			4"			4"	
shag	8"		--	3"			7"	
laid	dial 12"	dial	--	dial 4"	dial		--	dial
laconic	60"	--		lacuna 4"		inserted as after- thought	--	
animal	7"	--		in mail 20"			--	
tender	12"	tender	--	4"			35"	--
what	10"	--	--	"			5"	

R's very Responses
slow at very
first slow

The res-
ponses of
this sub-
ject con-
siderably *increased*
in rapidity
of the last
three words

Respon-
ses very
slow at
first

L.H. and K.R. have the most correct, and except for the word "laconic", the of L.F. after the first word compared very favourably with the two others who were timed. K.R. preserved a fairly even rate all through. B.W. responded fairly quickly, or not at all.

The reactions of the subjects were interesting. R. was the slowest. He made several attempts vocally with the words he misread, but was unable to make anything of them. B.W. was not willing to attempt those she could not immediately do. K.R. only stumbled with 'animal' and 'laconic', keeping a fairly even pace with all the other words. There was a great difference in pace between the earlier and later responses of P. and D.; B. was the most versatile in suggesting alternatives: she made several guesses before she finally stated the ones she has set down. L.H. (L.E.L.H.) and K.R. (R.E.R.H.) may be considered to have done the experiment the most readily. L.H., however, was decidedly the quicker.

The capacity for mirror speed^{ch} does imply the unusual clarity of visual imagery which is suggested by L.H.'s consistent reproduction of the right side of the impressions, and K.R.'s equally decided maintenance of the attitude of seizing upon a general impression of her whole

visual percept. Undoubtedly this clarity would be of great value in the co-ordination of the visual and kinaesthetic imagery of speech. It may be that the two children before instanced are deficient in that capacity, or have some other slight visual defect.

III. EXPERIMENT WITH CHILDREN INTRODUCING MOVEMENT:

These experiments were tachistoscopic in character.

It has been said that the left handed child is usually of the type interested in kinaesthetic imagery, probably because of his peculiar difficulties in motor-co-ordination when he is confronted with the need for an adjustment most suitably adapted to the righthanded, as ⁱⁿ ~~one~~ reading or writing. It has also been stated that the left-handed person has more difficulty in spatial orientation than the right handed, and that when hand and eye preference ~~are~~ in accord, this difficulty is still more noticeable. ^(b)

The results of the experiment with children on spatial orientation in Series III suggested that the right handed and right eyed had the advantage as to orientation, and the left handed and left eyed showed most confusion; but that there was very little difference between the right eyed and left eyed dextrals, and the right eyed and left eyed ^{rals} ~~sinisters~~. The experiment introducing movement for children combines an opportunity for displaying an interest in kinaesthetic imagery, and of the increased clarity of visual impressions which the movement of the stimulus appears to induce. The children were shown two series of pictures.

These were placed upon a roller which was rotated in an upwards direction simultaneously with the release of the blind of the photographic shutter which was used before. The roller was immediately behind the shutter, which was fixed about 18" directly in front of the child at eye level. The child sat in front of the word "set" and fixated it. The blind was released and he saw the moving stimulus. He had in front of him two puppets made of thin cardboard, the limbs of which could be moved. He arranged the limbs like those of the picture he had just seen. The first set required only two limbs to be moved for each figure; the second set three.

Reversals were noted. These were of three grades: arms, legs or both can be reversed, and the right and left

figures can be changed as to position, and the latter and former can be combined. In the calculations below, each reversal is reckoned as one point.

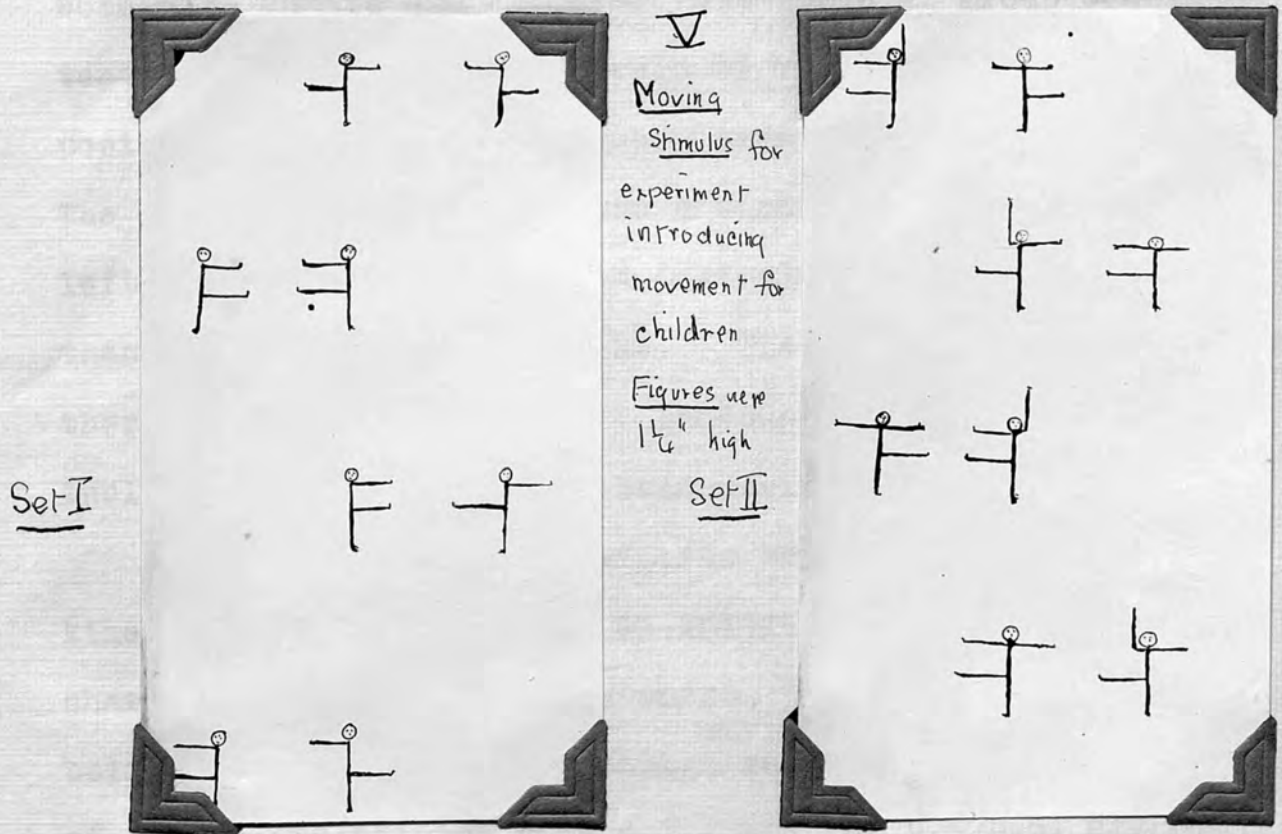


TABLE XI.

Reversals for Experiment III in Series IV.

No: type of children.	Reversals.		Noted	Average
	Left hand figure	Right hand figure		
R.E. L.H. (7)	28	32	60	8.5
L.E. L.H. (10)	43	58	101	10.
R.E. R.H. (9)	51	47	98	10.9
L.E. R.H. (6)	37	33	70	11.6

These figures seem to suggest ^{that} eyedness and an interest in kinaesthetic imagery are both influential in the matter of correct orientation. In previous experiments, both with adults and children, the L.E.L.H. group ^{generally} ~~consis-~~ ~~tently~~ show the highest average of reversals and transpositions. The R.E.R.H. group show the lowest average. The right eyed ~~sinisters~~ ^{rals} show a higher average than the left eyed, and the left eyed dextrals show a higher average than the right eyed ~~sinisters~~ ^{rals}. The previous figures suggest, therefore, that eyedness and handedness both influence the incidence of reversals and transpositions.

This experiment affords scope in the exercise of kinaesthetic imagery. If an interest in such imagery is characteristic of the left handed, there is reason to believe that it ^{maybe} ~~is~~ an advantage ^{may in} ~~be~~ the correct reproduction of spatial relations, as the figures for L.E.L.H. and R.E.L.H. are, in this instance, nearly even, while, where there are conflicting tendencies of hand and eye-coordination, that is in the case of the L.E.R.H. and R.E.L.H. groups, the difference between the averages is the greatest, the R.E.L.H. being the smallest number, showing ^{that the} ~~interest~~ has been of advantage in the case of the left handed group; and that in the case of the right handed group who are left eyed,

and who may not have developed it so highly, the influence of eyedness has had more sway.

An examination of the results shows further that the reversals, in the case of the left eyed dextrals, are mainly transpositions of the position of the objects. This is an interesting feature of the results. The lateral arrangement of objects in space depends upon the firmness of the associations between the individual units forming the percept and the configuration of the perceptual structure itself. These associations are a part of the clarifying process in the perceptual situation, but differ in nature from the reversal of the perceptual units themselves. The latter may be regarded as a production of the more purely sensory processes of the earliest stages of perception. The protocols ^{of those} who took part in the series of tachistoscopic experiments show both these aspects of disturbance ~~and~~ ^{of} spatial relationships.

SUMMARY OF THE RESULTS OF THE EXPERIMENTAL STUDY:

Series I.

The main issues arising from the results of the word and picture experiments with children were in respect of the ^{number} ~~rules~~ of reversals of words and letters, and trans-
of letters in words and groups of letters. These show that reversals and transpositions
positions occur with greater frequency in unfamiliar combinations of letters than in words whose meaning is easily assimilated. Although the non-fixating ^{eye} ~~age~~ received the first visual impression in the case of each group of children (R.E.L.H. and L.E.L.H.), the average number of reversals and transpositions for left eyed children is higher than that for right eyed. This result suggests that eyedness may be, at any rate, one of the causes contributing to the reproduction of reversals and the confusion of spatial relations in the case of the left handed child. The introspection and behaviour of the children revealed the fact that every effort was made to give interpretation to the unfamiliar material. The strong urge to give meaning to the visual percept overcomes the tendency to reversals, in the case of a familiar percept; but the wider the gap between the visual representation of the stimulus and the attribution of meaning, the more likely are reversals to occur. It would seem that the form of the percept is clear, while its orientation is still a matter of doubt.

Series II. (a) TACHISTOSCOPIC EXPERIMENTS WERE CARRIED OUT WITH ADULTS

in order to obtain responses which might be expected to be more purely sensory than those given by the children. The results again showed an advantage in the case of the left eyed, left handed people in the matter of reversals and transpositions. An analysis of the forms reversed shewed that in fact those forms which most easily acquired meaning were never reversed by either right or left handed subjects. Again the forms that were reversed were those which give rise to a suggestion of movement, or which could be easily turned upon an axis.

Two kinds of reactions to the stimulus were discernible. Subjects received a general impression of all five forms shown, or saw first those upon left or right hand side of the centre.

From the introspections of the subject it was concluded:-

- (1.) That in some cases the forms acquired meaning from earliest exposures.
- (2.) That some forms were easily retained without having meaning attached.
- (3.) That as a general rule, it is more difficult to reproduce accurately the forms which do not acquire meaning easily.

The two kinds of response are significant, as in the case of those who ^{see} ~~see~~ one side rather than the other

first, an inequality of clarity of the image as a whole is implied. This might be due to variations of sensitivity of different parts of the retina, or it might be the result of subjective factors such as attention or purpose. If the left eyed are more prone to see the right side of the stimulus first, reason may be found in this fact for their tendency to reverse images.

A further series of forms more rigidly classified were given to these subjects, and to four others. The results of this series were a confirmation of the foregoing.

Series III. TACHISTOSCOPIC EXPERIMENTS WITH CHILDREN:

(a.) Following the above experiments with adults, Tachistoscopic experiments were tried with children, partly in order to test whether the same differences in response were characteristic of the children in short exposures.

Word Test. The incidence of reversals in this experiment was greater for left eyed children than for right eyed, the left eyed having on an average two more per head than the right eyed. These results are substantially the same as in the word and picture test, the results of which have been given.

(b) An experiment in orientation was given with a group of

children classified according to eyedness and handedness, into R.E.R.H., L.E.R.H., R.E.L.H., L.E.L.H. It could be justifiably concluded from the observation of the subjects that the same types of responses were occurring as in Series II with adults. The subjects saw one side or other of the exposure, or gathered a general impression. In this experiment all the left-eyed people who preferred one side saw the right hand side first; all the right eyed people except one saw the left side first. It was noticed that those who worked rapidly from a keen visual impression were more likely to place the objects ^{accurately} than the ^{next} slower ones. The ~~results~~ in order were those who could recall their impression by some definite means of comparison, such as size. The inaccurate were those who hesitated and became confused, or who, by reason of poor motor co-ordination were not able to maintain any constant order of manipulation. These people were not prone to reversals. The experiment showed again the largest number of transpositions for L.E.L.H. people, the order being:-

R.E.L.H.	(Av. 7, ratio to correct positions)	3)
L.E.L.H.	(" 6, " " " " " " "	2.5)
L.E.R.H.	(" 4 " " " " " " "	1.2c)
R.E.R.H.	(" 4 " " " " " " "	'6B)

The manipulatory movements required in this experiment do not need quite such fine accuracy as those of writing, and give scope for a variety of directional control. The records show that the L.E.L.H. kept less consistently to the left-to-right direction than the R.E.L.H. They relied more easily upon a visual impression, & manipulated in accordance with it. This may be supposed to be partly accountable for their lower number of reversals here. The conflicting tendencies of hand-eye were preserved in the case of R.E.L.H. by their consistency in manipulating from left to right

Series IV. EXPERIMENTS INTRODUCING MOVEMENT:

These experiments are tentative in character, and have not yielded the clear-cut results of the previous sets. Table IX is unsatisfactory from this point of view. The proportion of forms reproduced in relation to the possible number is smaller than in the previous experiments. It seems significant, however, when the perception of movement is combined with the perception of form, the difference between left-eyed and right eyed people as regards the incidence of reversals disappears. While proportionately fewer forms were drawn in this than in the previous experiments, those actually reproduced were on the whole clearer, and more accurate.

Though the forms seen were considerably smaller than the previous ones, they were exposed episcopically for an interval of .5". This longer interval must have influenced the accuracy of the results. The fact that proportionately fewer forms were drawn seems to suggest that an increased accuracy of reproduction would be ~~done~~^{we} rather to the more intense concentration of the subject in an effort to ^sgrasp the moving percept, than an increased vividness of visual impression.

The general slowness of the subjects' responses to the words in the experiment on mirror-speed^{ch} shows the extreme

firmness of the association, of the kinaesthetic imagery required in speech, and the arbitrary character of the nature and direction of letters and words in printed form. There was in most cases a definite increase in facility intransposing the words and syllables towards the end of the experiment, however, which suggested that practice would very quickly make a difference in the adaptability of the subjects to the situation. The two who managed the changes with some measure of success were those whose previous results suggested ~~slowness~~^{clearness} and consistency of visual imagery.

An interest in kinaesthetic imagery seemed to be of help to the left eyed children in Experiment III. This interest was noticeably present in the attitude of the children to the experiment. The younger children, those under $9\frac{1}{2}$, displayed it in a marked manner and were, in many cases, more successful than the older ones.

S E C T I O N I I I .

VISUAL PERCEPTION. No study of reading difficulties would be complete without some account of visual perception. ^{Visual} ~~Mind~~ perception begins in the organisation of the sensory units of a visual stimulus into what may be described as a visual pattern. It is probable that this organisation takes place apart from the central processes of the later stages. It is only as the percept becomes more specific, and can be realised as having form, that the higher mental processes become operative. The most important of these is imagery of various kinds, chiefly visual, though kinaesthetic and auditory - kinaesthetic imagery often occurs. Later still in the process thought without imagery may be present followed by a definite affective tone. This serves to clarify the perception so that it can be recognised and named. There are thus three main stages of perception:

- (1.) Organisation of sensory material.
- (2.) A clarifying process.
- (3.) Attribution of meaning.

The processes must not be regarded as successive; they take place concurrently and overlap very frequently.

It will be seen that the important function of imagery is to bring the percept into the field of clear consciousness so that it may be known. The percept has then to be related to the ~~first~~^{past} experience of the subject, and to be given meaning. It is at this stage that the percept is given a name.

The various stages have been elaborated as follows:-

- (1.) Perception of gradually increasing specificity, as the salient parts stand out from the background.
- (2.) Kinaesthetic and organic sensations either general or localised, or both.
- (3.) Imagery, predominating visual, but sometimes also kinaesthetic or auditory-kinaesthetic.
- (4.) Associated imageless thought.
- (5.) Feeling of familiarity, ^{ease} ~~use~~ of apprehensive ^{on} affective
- (6.) Attribution of meaning and complete assimilation. (tone. *

The sixth stage may precede any of the others, except the first; the more familiar the stimulus object, the more speedily will this stage occur.

These stages are not evident in the normal perceptual process, but have emerged by means of a study of the introspection of those undergoing tachistoscopic experiments. Normal perception is so rapid and complex, that under ordinary conditions it is impossible to analyse it. The short exposures of the tachistoscope have enabled experimenters partially to break up the

* Vernon M.J. loc. cit. 20. p103.

single process, and to analyse its different stages. By such means normal perception has been separated into above distinctly defined stages. It is not possible, however, to accept the results in their entirety, because of the artificial nature of the experiment. If the object perceived is familiar, the steps are ordinarily much telescoped, and the cognitive and interpretive processes assume a higher value. If the percept is unfamiliar, the imagery has a large share in the "^{clearing}closing-up" process. Its function is to elaborate the meaning of the percept and to give interpretation to it. A complex percept relates itself to ^{past}first experience, and excites imagery of a rich and varied type. A more simple percept easily acquires a meaning which may be in accordance with past experience, or may add some simple new element to the body of cognition.

Concerned with this stage are those kinaesthetic processes which give kinaesthetic imagery an inherent place in the processes of visual perceiving. Judd holds that the organisation of the sensory data into units, and the general organisation of the percept, is a motor fact. Past perception has been accompanied by bodily reaction, and these give rise to similar reactions in the present.

Judd J. Phil. Psych. Scientific Meth. (1909) 6. 26.

The spatial arrangement of perception depends upon eye movement made as a response to peripheral ~~material~~ retinal stimulation. These movements are reflex, and tend to bring the optical image of the percept to the fovea. The first perceptions following these reflex eye movements are likely to be confused and to give inaccurate estimations of form and extensity.

NATURE OF PERCEPTUAL PROCESSES IN READING: In adult reading the processes are considerably modified. The following activities are employed in reading:-

- (1.) A fine visual discrimination of form.
- (2.) An equally fine auditory discrimination of sounds, and the association of these with the appropriate visual symbols.
- (3.) Various slight manipulative movements.
- (4.) Comprehension of the written word.

Comprehension and visual perception have the most important functions. The visual perception necessary for the early stages of reading is of a somewhat specialised character. It implies not only a discrimination of fine differences of letter forms, but a ready translation of visual symbols into auditory and kinaesthetic imagery. Comprehension implies the immediate interpretation of the groups of letters and words into meaningful language forms.

The perceptual stages of the act are much telescoped and comprehension is immediate. Those mental processes which succeed the earlier stages of perception, imagery and the associative thought processes, are also rapid and very meaningful. They are a part of the continuous stream of verbal and other images, and trends of thought roused directly by the immediately previous impressions.

MODIFICATION OF PERCEPTUAL PROCESS IN CHILDREN'S READING:

There is a further modification of the perceptual process in the case of children's reading. The young child's perception of form is less clear and accurate than that of the adult. He is more concerned and absorbed with the need for developing a fine discrimination. His recognition of language forms is as yet undeveloped, and he has not yet attained the capacity of rapidly and easily converting his visual impressions into auditory and kinaesthetic imagery. The associative and assimilative processes vary considerably for those of the adult. While the adult brings to the printed page a vast experience of the meanings of the language forms he is perceiving, and his imagery and thought are enriched by a background or a more or less ordered system of knowledge, the child is absorbed in definitely

associating the visual symbols with the other forms of imagery necessary to give his percept its language conformation. Until he has become facile in this activity, the ~~fourth~~^{further} interpretation of the written forms as meaningful language is not possible to him. Thus intermediate stage of perception is implied^{ed} in the reading attitude of the adult, but long experience has enabled him to pass directly from the visual perception of the words to the meanings and processes of thought they suggest.

The child, more absorbed in the partial perception, and less experienced in the conformation of linguistic patterns, with all their various shades of meaning, passes to the stage of comprehension more gradually than the adult.

It follows that for the child the stage of the early perceptive processes is very important. The imagery concerned here is mainly visual; it is accompanied by associated auditory imagery and small kinaesthetic sensations called up by the visual pattern. The tachistoscopic experiment with adults in the preceding section, and the experiment on spatial orientation with children illustrate the various types of reaction that may occur in response to the visual percept of a word or phrase.

It was noticed that subjects, both among children

and adults, either received a general impression of the whole percept, or saw more clearly the impression to the right or left of the centre. It seems probable that in the latter case the optical image was clearer on that side which ^{im} pressed itself upon the vision of the subject.

These types of response have their counterpart in the response of readers to the written word. I found that even among children there are two distinct types of readers:-

(1.) The fluctuating. These readers ^{ob} obtained a general impression of the whole word shown in tachistoscopic experiments. They did not know where they had fixated, and would guess at the letters they had missed, trying to build the word as a whole.

(2.) The fixating. This type could specify the part of the word ^{fixated} and read a definite part of the word in the direction of the fixation point. They refused to guess the word if they had not seen ^{the whole} it. They are characterised by objective fidelity. A distinct time interval elapses between the visual apprehension of the word and its interpretation and ^{these} ^{readers} ^{can} distinguish the two factors.

The fluctuating type is ^{also} a subjective reader. He

"Vorlesungen zur Einführung in die experimentelle Pädagogik."

reads whole words and guesses where his apprehension has been incomplete. He is unable to distinguish between objective perception and subjective additions.

The two types appear to be endowed with very different sorts of mental equipment.

NON-READERS: "Any single mental function (visual memory, a memory for sounds) that enters, even as a subordinate component, into the total process of reading may by its ineffectiveness render ineffective the large process in its entirety." ☆

Children are found who apparently possess normal abilities who do not learn to read. Left-handed children provide a larger proportion of these children in the normal group than right-handed. It is sometimes due, in their case, to the fact that they reverse letters such as 'p' and 'q', 'b' and 'd', and words such as 'saw', 'not'. In cases where this habit is sufficiently serious to interfere with the child's progress, letters in other words are transposed, and longer words are also reversed in writing. There may be many reasons for this type of error, but it seems likely that faulty visual imagery, or some peculiarity of motor co-ordination, or both, are at the roots of it. Most

☆ British Scholastic text.

Burt. Quoted from Joint Report of Board of Education and Board of Control on Mental Deficiency

children who show signs of a specific disability merely, and are not lacking in mental capacity, are wanting in either auditory or visual discrimination ~~or both~~

POSTURE AND VISUAL FIXATION: "Posture is the solid foundation upon which perception is built."[☆] In any change of position or of equilibrium, the whole of the perceptual patterns are immediately also changed. Unless these changes in the perceptual patterns still preserved relations with one another that were sufficiently like his immediately previous experience to ensure a certain continuity of perception, the animal would no longer be able to keep either mental or physical stability. These co-relativ^{ons}ness of pattern are preserved by the posture of the body.

Posture then decides the orientation of the animal to the things around it, and its outlook upon the world. Whatever position the animal assumes, the head at once rights itself. ¹⁶ Posture is subserved by five groups of righting reflexes acting upon head, neck, trunk and limb musculature. The fifth group arise in the retinae; they are not present unless the animal has some measure of binocular vision. They are, therefore, served by the cortex, probably the visual cortex. There is, therefore, a very delicate

[☆]Parsons "Introduction to the Theory of Perception." P. 137

¹⁶ Parsons. loc. cit. P. 140

adjustment possible between head and body movement. This is influenced by movement of the eyes, for the changes in perceptual pattern which would ensue, for instance, by reversing the animal are most easily observed by the eyes.

The converse is also true. Every movement of the head or limbs alters the direction of the eyes. Dodge has asserted that, even in fixation, the opposed muscular tension is never quite balanced. The slightest lack of rigidity in head or body, and compensatory movements of the eyes occur in order to maintain the point of regard within the area of fixation. Variations in these adjustments must ensue from the use of a dominant eye in fixation. Slight bodily adjustment will follow any change in the position of the fixating eye in following the area of fixation. So that we may say the whole organism is involved in very slight and delicate differences of poise according to the eyedness of the person.

Posture, however, is of such importance to the organism that, slight as they are, the differences may be of moment.

Eye and hand co-ordination, as has been said, are not analagous motor systems. The two eyes are concerned,

though not necessarily equally concerned, in any visual act. The hands are often used singly. Again, the attitude of a person concerned in an act requiring hand and eye co-ordination will depend upon the nature of the adjustment of the eyes in fixation, as well as the adjustment of the hands in movement. There is not the absolute rigidity about the attitude of fixation which the word would seem to imply.

Dodge⁶ writes: "Notwithstanding the delicate co-ordination between head and body movements, and the eye movements, there still exists in the adult, probably in the pulse movements, and surely in the irregular head and body movements, entirely normal and continuous physical disturbances of visual fixation."[☆] There are, then, during fixation eye movements of a continuous nature. [These movements cover an area which varies in extent. The scope of the movements will vary with the character of the objects of regard, and with the individual, and according to differences in the visual capacity, and the direction of the glance is different for different eyes, of the same individual.

The question of the combined influence on posture, and the motor co-ordination system of the eyes, when firstly, the general position of the body may be the

These movements cover a certain area which varies in extent. The scope of the movement will vary with the character of the object of regard, and with the individual, and according to differences in the visual capacity, and the direction of the glance, it is different for different eyes of the same individual. The question of the combined influence of the general position of the body and the motor co-ordination of the eyes in an act requiring fixation when, firstly the general position of the body may be the dominant factor in the inception of the visual activity, or secondly, the impinging on the retina of an optical image may cause the activity of the motor system of the eye, so that the general position of the body follows the eye movement, becomes a highly complex physiological problem. It seems probable, however, especially in view of the unequal movement of the two eyes, that a habit of monocular fixation will influence the reflex muscular responses which determine posture.

SPATIAL ORIENTATION: "It is significant that spatial displacement is apt to occur most frequently among those children who are of a ^{marked} ~~mental~~ visual type. These children have a more intense experience of spatial form as such, than those less endowed visually. ☆

☆ Stern - "Über verlagerte Raumformen." p.525.

The cause of spatial displacement is not clear. It has been thought to depend upon the innervations of the muscles, or the ^(h v) ~~in~~version of the image on the retina. It seems probable that the main reason is to be sought in the comprehension of space, which is the result of our experience, and the connection of images. It is a matter learned and not inborn.^(q) It is important to distinguish between the indifferent orientation which is characteristic of a general lack of comprehension of spatial relationships, and the more specialised and definite reversal of forms, either laterally or vertically. It would seem that there is definitely a better organisation of the visual percept when the direction of the displacement is consistent.

As soon as the child reaches the stage of reading he must realise that words and letters proceed in an arbitrary fashion from left and right. The normal child passes through a period of indecision when letters and words are occasionally reversed. Reading and writing demand of the child a more intense and specialised concentration on form than he has hitherto encountered. To this concentration on the form of the percept spatial relationships are sacrificed for the moment. If the child has a

marked interest in form, his grasp of the details of the perceptual unit is likely to be ahead of his comprehension of spatial relationships, and again displacement occurs. The left handed child is under the necessity of modifying his ordinary adjustments of hand and eye co-ordination in order to conform to the auditory nature of the perceptual patterns presented by ^rprint. His experience of kinaesthetic imagery and, especially if ^{he} _{is} left eyed, of visual imagery is different from that of the right handed child.

These differences concern very delicate adjustments of hand and eye co-ordination. They may be so slight that their influence is insignificant. On the other hand the degree of left handedness varies considerably from one individual to another. The experience of an experimenter ^{wh} tests subjects for the presence of a dominant eye shows that eyedness is also of varying extent in different individuals. The differences, therefore, may be so gross as to cause the individual concerned considerable inconvenience when he begins to read and write.

[The case for the influence of a 'dominant' eye in the matter of spatial relationships rests partly on the fact that motor factors are concerned in the whole matter of ~~spatial~~ perception. The retina is a surface upon

Two different types of reversal can be discerned in this particular type of error in orientation. Small unit forms are reversed as a whole, and parts within the perceptual structure are transposed. These two kinds of reversal are the products of different mental processes. The one ^{would} ~~which~~ seem~~ed~~ to be a product of an early stage in the process of perception, probably immediate succeeding the first visual impression. The form of the percept is clear. It has been produced, therefore it must be assumed that some mental process, for instance, visual imagery, is concerned in the product. ~~There-are-motor-factors-present~~ There are motor factors present in the retina which are concerned with the order of spatial images on the surface of the retina. These appear in consciousness as spatial relations. With regard to transposition within the perceptual structure, it seems likely that the child's whole perceptual experience plays a greater part. **More organisation is needed** /requiring a comprehension of spatial relations of a higher order. Associations must be formed between the various units of the percept and the surrounding space. The whole, therefore, is not dependent upon the present perceptual pattern, but upon past experience.

The child's whole perceptual experience depends

upon his outlook upon the world, and this outlook, the structure of his perceptual patterns, is dependent upon his posture. Spatial relationships are ordered by the child with himself as point of reference. The whole attitude of the left handed child must differ sufficiently from that of the right handed to make a difference to his relations to his perceptual patterns. When those perceptual patterns consist of relationships between small units, such as letters and words, the difference is of moment, because these relationships are definitely arranged for the convenience of a right handed attitude. It is not surprising that in regard to these small patterns, the finer adjustment of the co-ordination system of the eye should also make a difference. The existence of a dominance of left or right eye ~~xxxx~~ is likely to affect the attitude of the child towards this material, as much as left handedness affects his attitude towards manipulatory activities.

The experiments in Section II have investigated a type of response in relation to small perceptual units, which has hitherto been regarded as typical of the left handed. These experiments were, however, conducted with reference to the eyedness of the children. The results seem to show that eye dominance makes a difference to them. In ~~sp~~ the experiments except those introducing movement,

generally
 it is the ^A left eyed, left handed child who produces the greatest average of reversals in relation ~~to~~ to other types of error, and the right handed right eyed child who, on an average, produces the fewest. The left eyed, right handed child and the right eyed, left handed fall ~~constantly~~ between these two extremes. In the experiments on orientation where this has not happened, it is suggested that the L.E.L.H. child has reacted with a hand co-ordination in accord with his visual response. In the small number of units which made up the perceptual structure presented to him, this was a help towards correct reproductions. The visual impressions of the L.E.L.H. (in the case of both children and adults) were on the whole found to be more vivid on the right of the fixation point. This will affect the visual and verbal imagery of these children, & will influence their sense of direction. Not only co-ordination, but also eyedness will affect the tendency for reversals and transpositions to persist in their case. The experiments with a moving stimulus indicate that increased concentration or visual imagery, and a development of an interest in kinaesthetic imagery will be helpful in overcoming the tendency.

A study of the records of introspections, and the reproductions of the earlier exposures of the subjects of the tachistoscopic experiments indicates that not only ~~reproduction~~ ^{co-ordination}, but visual imagery is at the bottom of the productions of reversals. Eyedness seems to affect imagery. There is therefore reason to believe that in the eye-hand co-ordination system, the influence of eyedness is of more importance than has been thought.

EYEDNESS AND HANDEDNESS IN RELATION TO CERTAIN DIFFICULTIES
IN READING.

B I B L I O G R A P H Y.

1. Bartlett, F.C. Remembering. Cambridge Psychological Library. 1932.
2. Bühler, K. Mental Development of the Child. 1931.
3. Critchley, Macdonald. Mirror Writing. Psyche Miniatures, Medical Series. 1932.
4. Dearborn, W.F. (a) The Psychology of Reading. Baltimore. 1906.
(b) Motor Sensory Development. " 1910.
5. Dodge, R. An Experimental Study of Visual Fixation. Psychological Review Monograph. (Vol.VIII, No:4.) 1907.
6. Downey, J.E. Types of Dextrality and their Implications. Amer: J.Psychol. (P.319-363.) 1927.
7. Ewing, A.G. Aphasia in Children. c.1930.
8. Eng, Helga The Psychology of Children's Drawings. Kegan Paul. 1931.
9. Heinlein, J.H. Preferential Manipulation in Children. Comp. Psych. Monograph, No:4. 1930.
10. Gesell, A. Infancy and Human Growth. New York Mac 1928.
11. Head, H. Aphasia and Kindred Disorders of Speech. Camb. Univ. Press. 1926.
12. Huey. The Psychology and Pedagogy of Reading. New York. 1910.

13. Koffka, K. The Growth of the Mind. London
Kegan Paul ? 1928.
- 13.a. Köhler, W. Gestalt Psychology. London, G. Bell
& Sons, Ltd. 1930.
14. Lord, Carmichael, Special Disabilities in Learning
Dearborn. to Read & Write. Harvard Monograph
in Education.
Series I, Vol. 2,
No: 1. 1925.
15. Miles, W.R. Ocular Dominance in Human Adults.
J. of S. Psychol. 1930.
Vol.III, No: 3.
pp.412-430.
16. Parsons, H.J. An Introduction to the Theory of
Perception. Camb. Psychol.Library. 1927.
17. Parson, B.S. Lefthandedness - A New Interpretation.
New York. Mas. 1924.
18. Rife, J.W. Types of Dextrality. Psychol. Review. 1922.
P.474.
19. Snyder, A.N. & M. Eye Preference Tendencies. J. of
Educ. Psych. Vol.XIX. 1928.
20. Vernon, M.D. Experimental Study of Reading.
Cambridge Univ.Press. 1931.
21. " " The Peripheral Perception of Movement.
Brit. J. of Psychol.
Vol. XXIII, p.3.
pp. 209-232. 1933
22. Woo T.L. & Pearson, K. Dextrality and Sinistrality
of Hand and Eye. Biometrika, Vol.XIX.b. 1927.
& Vol. XX. 1928.
23. Woolley, H.T. The Development of Righthandedness
in a Normal Infant. Psychol.Review.
17-37. 1910.
24. Rusk, R.R. Introduction to Experimental
Education. Longmans & Co. 1913.
25. Moore, T.V. The Process of Abstraction.