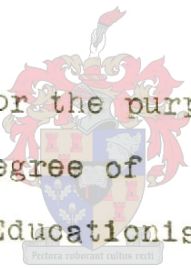


THE ATTAINMENT
OF APPROXIMATE AMBIDEXTERITY IN THROWING
AND ITS RELATION
TO PHYSICAL AND MENTAL EFFICIENCY
AS WELL AS SYMMETRY OF POSTURE.

By

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INTRODUCTION.

Activities such as throwing are, as a rule, carried out only with the better arm. Mostly this one-sided execution is due to mere convenience. If attempts are made to justify it, in the main two arguments are advanced: In the first place, it is taken for granted that the inferior arm cannot make appreciable progress anyway, and it is therefore considered as not worthwhile exercising it. In the second place, it is believed that, if the inferior arm should improve by such a practice, this happens at the expense of efficiency in general, and may have detrimental consequences in some regard or other.

The thesis on hand deals with these two arguments. The underlying research has been undertaken in order to ascertain, first, to what extent an approximate ambidexterity in throwing can be attained by means of a regular practice with both arms, and, second, how such an attainment affects the organism in other respects, viz: with regard to the throwing ability in general, the symmetry of posture and the mental development as far as it can be inferred from marks obtained at school.

The first part of the thesis will give a brief survey of the problem of handedness as it appears from the available literature, the second part will describe material and method employed in the research, the third part will state its results concerning the two aspects of the topic, and the conclusion will set forth some implications ensuing for Physical Education.

I. SOME ASPECTS OF HANDEDNESS IN LITERATURE.

As far as could be found out, there is hardly any literature pertaining to our topic proper: Those writers who have dealt with handedness have been concerned chiefly with the problem of left-handedness, its essence, its causes and its effects, as well as possibility, advisability and procedure of reversing such hand preference. Nevertheless, though not absolutely relevant to our topic, such trends of research are apt to elucidate the question of whether, from other points of view, the experiment undertaken for our purposes is justified.

The essence of handedness: There is general agreement that, although nearly all human beings give distinct preference to the one hand and genuine ambidexterity is very rare, handedness is a matter of degree rather than of marked contrast: Some people show preference of the one hand in more regards than others, and these regards are various. Therefore left-handedness is generally not defined as the predominant use of the left hand in this or that particular activity (e.g. writing or throwing), but as a consistent tendency to undertake new dexterities with the left hand rather than with the right. (Cyril Burt: *The Backward Child*, London, 1942, p. 271, & Norma V. Scheidemann: *The Psychology of Exceptional Children*, Boston, 1951, p.137.)

Burt states that about 5.2 % of school children are left-handed, and that left-handedness is more frequent among boys than girls (quoted above, ps. 281 & 300), which is more or less in accordance with Norma V. Scheidemann's findings (quoted above, ps. 138 & 139).

Whereas Burt insists on a differentiation in the

function of the hands (quoted above, p.292) and, without adducing evidence, asserts that often the left hand makes up for what it lacks in skill by surpassing the right one in strength (p. 285), N. V. Scheidemann (quoted above, p. 149) expounds findings which clearly show that usually the preferred hand is not only more skillful, but also stronger than the other one.

Whereas, furthermore, Burt (quoted above, p. 295) contends that a difference in the employment of the arms or forelegs, respectively, can be observed also in higher animals, this is decidedly denied by both N. V. Scheidemann (quoted above, p. 140) and B. S. Parson (Lefthandedness, New York, 1924, p. 68).

Causes of handedness: Various theories have been advanced in order to explain the prevalence of right-handedness: primitive warfare, pre-natal position, position of infant on the mother's arms, visceral unsymmetry, blood supply of brain, etc., but none of them is considered as satisfactory. (L. Katscher: Why are we right-handed?, in "Knowledge", June, 1913) B. S. Parson (quoted above) explains handedness in general as an effect of "unilateral sighting" in binocular vision. However this may be, it seems certain that the dominance of the left cerebral hemisphere accounts for both right-eyedness and right-handedness (Burt, quoted above, p.310, and N. V. Scheidemann, quoted above, p.132), and that handedness - left and right - is inherited in most cases (L. L. Burlingame: Heredity and Social Problems, New York, 1940, p. 126), though the hereditary bias appears to be relatively slight. (Burt, quoted above, p. 301, and J. M. L. Frank: Die Probleem van Linkshandigheid op skool, Skripsie, Stellenbosch, 1943, p. 16)

Effects of left-handedness: As to the question of whether left-handedness involves any inferiority,

there is disagreement. Burt (quoted above) contends that left-handedness, although not necessarily involving intellectual inferiority, often leads to difficulties in almost every form of finer muscular co-ordination (p. 287), temperamental disabilities (p. 287) as well as liability to speech defects, in particular stammering or stuttering (p. 288) and tends seriously to impede a child's general progress at school (p. 318), although he admits that ~~such~~ such backwardness may often be owing to the child's being made to feel (!) that he is peculiar (p. 319). Norma V. Scheidemann (quoted above), on the other hand, states that no perceptible difference between left-handed and right-handed children with regard to the mean intelligence quotient (p. 148) or school achievement (p. 149) can be discovered, and that, as far as school adjustment is concerned, left-handed pupils sometimes fare even slightly better than right-handed ones (p. 157). Also J. M. L. Frank (quoted above, p. 80), R. Haefner (The Educational Significance of Left-handedness, reviewed in "Psychological Abstracts", Vol. IV) as well as R. G. Wetmore & G. H. Estabrooks (The Relation of Left-handedness to Psychoneurotic Traits, reviewed in "Psychological Abstracts", Vol. V) deny that there is any connection between left-handedness and such drawbacks.

Reversal of handedness: As far as the possibility of a reversal of handedness is concerned, all writers agree that it is comparatively easy, especially in early stages. The advisability of such an undertaking, however, is a moot point: Liley Blanton and Margaret Gray Blanton (For Stutterers, New York/London, 1936, pp. 86 & 87) ^{hold} that such attempts are often apt to cause stuttering, and therefore most emphatically state

that "it is against all good hygiene to train a left-handed child to use its right hand". Norma V. Scheidemann shares this standpoint to some extent, advocating that a child be permitted to use for writing the hand that by nature he can use most efficiently (quoted above, p. 143), though, according to her, a reversal of handedness in writing seldom results in stuttering or other speech defects (p. 142). Also H. St. John Rumsey (*Your Stammer and How to Correct it*, London, 1937, p. 48) doubts that a reversal of handedness will have such detrimental effects, and J. E. Morsh (*The Development of Right-handed Skill in the Left-handed Child*, reviewed in "Psychological Abstracts", Vol. V) denies it definitely. Parson (quoted above) alleges that during experiments lasting four years not a single case of defective speech could be traced to reversal of manual habit (p. 102), and he holds that, although an impairment of speech may happen in adult life when the cerebral processes have become fixed, it is unlikely to happen in childhood (p. 27/28). Burt (quoted above) denies that, except for neurotic children, any disadvantage for speech will accrue from such a reversal (p. 323), and decidedly demands that, as a general rule, every child should be taught as far as possible to use the right hand (p. 322). - At any rate, a reversal of handedness may be absolutely necessary after severe injuries of the preferred side, and therefore the question arises how it is to be undertaken. In this respect there is general agreement: One should begin with gross activities, i. e. with movements of the arm rather than of the fingers, and then the finer manipulations should follow. (Burt, quoted above, p. 339, and N. V. Scheidemann, quoted above, p. 132)

The attainment of ambidexterity: Both Burt (quoted above, p. 312) and N. V. Scheidemann (quoted above, p. 181) deprecate an aspiration after ambidexterity, as they suppose such a state to result in hesitancy and confusion, though no evidence whatsoever is adduced for this very vaguely worded assertion. A. Schott (Zum Problem der Linkshändigkeit, in "Zeitschrift für angewandte Psychologie", Vol. 43), on the other hand, recommends the attainment of ambidexterity warmly. He states that the objections raised by medical men as well as the anatomical facts are ambiguous and unconvincing, and that the successes achieved with sane children in Germany have been fully satisfactory. Even if only part of the described results were true, he writes, the work would have been worth while; injurious effects have never been observed. He also refers to the statements made by Liberty Tadd in America, according to which the attainment of ambidexterity exerts a favourable influence on posture, profits also the dominant hand and promotes mental development. According to Schott, hand-work and physical exercises (such as throwing) play the main part in the procedure of acquiring ambidexterity. If, however, like Liberty Tadd, he demands that also finer skills such as writing and drawing be practised with the inferior hand, he probably goes too far, and he has to admit that in the case of insuperable difficulties with certain persons one will have to give up the attempt.

Implications.

At the outset it should be understood that the experiment underlying this research has in no way aimed at attaining a perfect ambidexterity, i.e. a both-hand-ness with regard to the fine manipulations of the fin-

gers, but only an approximate ambidexterity, i.e. a state in which the naturally inferior arm is more or less a match for the superior one in such activities as chiefly involve the larger muscles. If, as appears from the divers researches, even a reversal of handedness (from left to right) is possible, one can presume that it will be comparatively easy to reach such a state. If, furthermore, according to the bulk of the available evidence, even a reversal of handedness, as a rule, involves no disadvantages, in particular to speech, the attainment of a merely approximate ambidexterity can certainly be supposed to be completely undangerous. As, lastly, also a reversal of handedness commences with a practice of coarse activities, our attempt, as far as it goes, is in conformity with such a procedure. -

That the attainment of an approximate ambidexterity is most desirable for the symmetry of posture, appears from the simple fact that in most people the dominant arm is not only, as Burt asserts, more skilful, but, according to N. V. Scheidemann's findings and those adduced by Parson, also stronger than the other one. Hence, namely, most people actually use the dominant arm with preference not only for skilled activities, but also for such as require brute strength, and thus continually impose an undue strain on the one side of the body. This can easily be verified by everybody, if, on the way to the railway station, he counts the vast number of persons who carry their suitcases with their right hands.

II. MATERIAL AND METHOD.

a) Test Persons and Conditions.

Two groups consisting of twenty-five children each of both sexes, ranging from the sixth to the thirteenth year, were selected. Group I comprised nine girls and sixteen boys (average ages $7\frac{1}{2}$ and $8\frac{1}{2}$ years respectively) to be coached in throwing with the left as well as the right arm. They were living together in a hostel catering only for them. Their parents, on the whole, were well-to-do farmers or professional people, somewhat fastidious in their attitude and having only one child. This perhaps accounts for the fact that the children were rather reserved and inclined to indulge in restful pastime rather than in romping about. Some of them were obviously lacking in sense for movement, and much encouragement was needed to induce them to attend the practice arranged for our purpose regularly.

As far as was practicable, the children chosen for group II corresponded to those of the first group in age, physical development and school standard. There were thirteen girls and twelve boys (average ages 7 years 10 months and 9 years 7 months respectively). These children continued using the better arm for all and sundry activities. Group II comprised the more natural type of child, whose throwing skill was superior at the outset. (See Appendix.) The selection of the children ^{for both groups} was made in July, 1943.

In the immediate vicinity of the hostel were the vast school playgrounds, where the practice took place. Cricket and soccer balls as well as tins suitable as targets were available. The qualified physi-



cal education instructor of the school undertook the training of the children.

b) The Training of the Children.

From July, 1943, to December, 1943, group I was gradually made conscious of the inferior arm¹⁾ they were being prepared for the regular practice that this arm was to undergo. For the rest, both groups played ball games in the ordinary physical education classes. Then followed six months' training proper - three hours per week - for group I: Under the instructor's supervision minor ball games, such as Corner Spry, Moving Target and Rounders, were played, and competitive distance throwing as well as aiming at targets were practised. This claimed four periods of forty-five minutes each per week, the children using left and right arm equally. The zeal was sustained by little rewards occasionally awarded for attendance and attainment. (In the case of two participants the attendance was insufficient on account of illness and injury.)

Group II meanwhile played similar ball games and competed in distance and target throwing in bi-weekly practice, employing the dominant arm only. Records concerning the instruction of both groups were kept.

c) The Testing of the Children.

The testing as well as the measuring of the children took place in July, 1943, viz. at the outset, in December, 1943, and, finally, in July, 1944. The testing pertained to both distance throwing and aiming at targets. The former was done on a lawn 120 feet long, marked off at intervals of 10 feet. The run-up was approximately 8 feet of plain earth, and

1)

e.g. reminded of carrying their school books with this arm.

the children were instructed not to overstep the mark. Each, irrespective of the group to which he belonged, had a total of six throws - three left and three right - carrying out one throw at a time. The participants were encouraged to attempt underhand as well as overhand action. The best of the three attempts with either hand was recorded.

As for aiming, four gallon iron tins, suspended from a crossbar, served as targets. On them the youngsters had painted colourful caricatures. These targets hung three feet above the ground, which, incidentally, proved a more difficult aim than targets lying on the ground. The aiming was done from a distance of sixteen feet eight inches from either side of the target, arcs being marked on the ground. (At the final test this distance was by mistake increased to eighteen feet.) Six attempts - three left and three right - were made in rounds. The hits and misses were recorded.

In both tests a hockey ball (weight $5\frac{1}{2}$ ounces) was used.

d) The Measuring of the Children.

The measuring took place on the dates mentioned above. It pertained merely to the symmetry of body-build. In particular the shoulder height, the half-shoulder width, the half-chest girth and the upper arm circumference of either side were measured. (Mention should be made here that the length of either arm was inadvertently omitted. This is regrettable.) In a special room, where the lighting, natural and artificial, was correct, the measuring appliances were conveniently placed. (The light fell symmetrically on the test person, and so did the shadow of a suspended plumb line.)

Behind the child, along the wall, were parallel, vertical lines in pencil. These aided the use of an improvised instrument to project the acromial notches. This instrument consisted of a set square fitted vertically into a flat, rectangular block of wood (6"x 6"x $\frac{1}{4}$ ") with bevelled edges. The rest of the measuring apparatus were a steel tape for flat areas and a cloth ^{tape} ~~one~~ for circumferences. A difference of three sixteenths of an inch existed in the units over one yard, but this discrepancy was accounted for in the calculations. Whenever any doubtful data were obtained, the child concerned was re-examined at the earliest convenience. The anthropological points determined and marked were the acromial, supra-and meso-sternal and the spinous processes from the 7th cervical to the first lumbar vertebrae. The principles of the antropometric method were strictly observed.

Apart from the actual measurements, visual impressions of the symmetry of the body were also recorded. A medical practitioner assisted ~~me~~ with his authoritative opinion in the first few cases. In order to judge the correctness of the spine, the sharp shadow of the plumb line was projected along the centre of the back, and if necessary, the child had to bend to steep-standing position with the arms hanging limply. (In the latter case the spine appears in marked relief). Secondly, the shoulder blades were scrutinised as to their level, position from the spine and degree of protrusion. Lastly the waist triangles were compared.

A general estimation of the symmetry of posture accrued from the actual measurements supplemented by visual impressions. An index was formed to express this total estimation. The index was the sum of the numerical differences resulting from the measurements of left and right sides on the one hand, and, on the other, the observed unsymmetries, each of which counted one unit,

Example: - Case M. F., the ninth boy in the second group at the final testing: -

Index $4\frac{3}{16}$: The component values here are: -
 one and three-sixteenths (being the numerical total of differences,
 and
 three (a scoliosis, unequal scapulae and waist triangles, counting one each).

(In the case of perfect symmetry the index would be zero.)

(e) The Ascertainment of the Children's Progress at School.

The school teachers provided the average marks that the test children had obtained in formal class tests from June, 1943, to June, 1944, as well as the average marks of the whole class. The marks of the tests coinciding with the beginning and the termination of this experiment were recorded. In two cases - one in each group - there were great differences between the first and the last data, without any known cause underlying the drop. Two more children did not write all the subjects, two were absent during one and both of the tests respectively, and the kindergarten pupils had no tests at all. All these cases were omitted when the average for the group was calculated. A remark in catchwords was entered in the work-table opposite the child's name in the column dealing with "mental achievement".

It might be advisable to point to the fact that the class marks are known to drop from Sub B to Standard 1, for the average child. The other class averages that played a part were those of Standards 1 and 2. The averages for the two years in question of the various classes of the same standard were calculated. With these figures the average marks of the two groups were then compared. (Graph 4)

(f) The Correlation of the Findings.

In order to expound the results clearly, the various findings have been correlated in the following way: - Firstly there were averages calculated of the initial and the final findings pertaining to age, handedness, physical and mental achievements and symmetry of posture of the boys and the girls within each group as well as of the two groups

as such. 2) Accordingly the following data would apply to the average child of (a) Group I: -

July, 1943: 8 years 2 months old, right-handed; throws 31 ft. left and 50 ft. right, hits a total of $\frac{33}{32}$; index of symmetry one and eleven-sixteenths; has 77% aggregate in Standard 1.

July, 1944: 9 years 2 months old, right-handed; throws 44 ft. left and 63 ft. right, hits a total of $1\frac{1}{8}$; index of symmetry one and one-eighth; has 78% aggregate in Standard 2.

Correspondingly the data applying to the average child of (b) Group II would be as follows: -

July, 1943: 8 years 8 months old, right-handed; throws 34 ft. left and 60 ft. right, hits a total of $\frac{13}{32}$; index of symmetry one and one-half; has 77½% aggregate in Standard 1.

July, 1944: 9 years 8 months old, right-handed; throws 40 ft. left and 68 ft. right, hits a total of $1\frac{1}{8}$; index of symmetry two and one-sixteenth; has 77% aggregate in Standard 2.

Secondly the improvements were ascertained by subtracting the first from the last data, excepting the columns under "Symmetry of Posture", where the subtraction was done vice versa. Under the "Girls" and "Boys" sections these actual improvements were enumerated, but omitted as redundant at the end of the whole group. (The mental arithmetic is easy, and the differences are shown in the graphs.)

Thirdly each improvement was expressed as a percentage, and appeared in the work-table for the average boy and the average girl of each group as well as for the total average of each group. These improvements per cent could then be compared.

All the results, showing actual (absolute) and comparative (relative) improvements, have been illustrated graphically on leaflets covering page 17: -

Actual improvements in Throwing: (a) DistanceGraph 1a;
(b) TargetGraph 2a;
Symmetry of postureGraph 3a;
School marks Graph 4a;

Comparative improv. in Throwing: (a) DistanceGraph 1b;
(b) TargetGraph 2b;
Symmetry of postureGraph 3b;
School marksGraph 4b;

Comparative improvement in all three regardsGraph 5.

III. RESULTS.

(a) The Attainment of Approximate Ambidexterity.

The degree of bimanual skilfulness reached by the first group can be inferred from Graphs 1,2 and 5, where the actual improvements in both throwing (Graph 1a) and aiming (Graph 2a) as well as a correlation of the respective improvements of either arm in the two groups (Parts "b" of Graphs 1 and 2 and Part "1" of Graph 5) are graphically illustrated.

	Initial test.	Final test.	Improvement.
Inferior arm of Group II	Throwing 34ft Hitting 11/25	Throwing 40ft Hitting 11/25	6ft on 34 i.e. 18% 0 on hits " 0%
Inferior arm of Group I	Throwing 31ft Hitting 9/25	Throwing 44ft Hitting 12/25	13ft on 31ft " 42% 3/25 " 9/25 " 33%
Better arm of Group I	Throwing 50ft Hitting 14/25	Throwing 63ft Hitting 21/25	13ft " 50ft " 26% 7/25 "14/25 " 50%

The inferior arm of Group I has improved almost twice as much as its better arm and two and one-third times as much as the inferior arm of Group II in distance throwing; in aiming it has not kept pace with the improvement of the better arm, but surpassed that of the inferior arm of Group II.

The degree of ambidexterity achieved by Group I is considerable, and that in activities implying energy is more marked than in those implying skill.

(b) The Relation of Approximate Ambidexterity to

1) Physical Efficiency.

From Graphs 1a and 2a the actual improvements in distance and target throwing for the better arms can be verified: (Percentage comparisons in Graphs 1b,2b and 5)

Group I improves by 13ft. on 50ft., constituting 26%;
" " " 7/25 hits on 14/25 hits, " 50%;
Group II " " 8ft. " 60ft., " 13%;
" " " 1/25 hits " 17/25 " " 6%.

The better arm of Group I has improved twice as much as the better arm of Group II in distance throwing and more than eight times as much in aiming.

The total improvements in distance and target throwing for the two groups respectively are as follows:

(Actual values in Graphs 1a and 2a and the comparative ones in Graphs 1b, 2b and Part "1" of 5)

2) In calculating the average of ~~(a)~~ Physical Achievement boy, I.W.4 of Group I was omitted from "distance throwing" because he was outspokenly left-handed. In the cases C.R., JvN. and I.G., girls 3,4 &7 of the same group and girls S.W. 3, A.K.8 and A.P.9 of group II the handedness was doubtful. As two of these in each group showed left superiority and one in each, right at the subsequent tests, their distances were counted.

Besides, with regard to aiming averages a few remarks should be made: Three attempts are too few, but time did not permit of more; however, when a near hit was scored another attempt was always awarded; other unfavourable factors were the mentioned height of targets and the increase of the initial distance made by mistake and, primarily, the type of test: Such a target as would admit of a gradation of skill should have been chosen - e.g. a wide target consisting of many, coloured, concentric circles around a bull's eye.

Lastly, as to symmetry of posture, just a reminder that the length of right and left arms should certainly have been included and that the utmost care was taken with the measurements and impressions, will be enough.

(Under "e" above, the precautions taken in the calculation of the average of the aggregate school marks, have been mentioned).

Group I	improves by	26 feet	on	81 feet,	constituting	32%;
"	"	"	$2/5$ hits	"	$23/25$ hits,	" 43%.
Group II	"	"	14 feet	"	94 feet,	" 15%;
"	"	"	$1/25$ hits	"	$11 & 3/25$ hits,	" 4%.

Group I has improved more than twice as much as Group II in distance throwing and over ten times in aiming.

At the outset of the experiment Group II was superior to Group I in every single respect - at the conclusion Group I has the better achievements excepting in distance throwing with the better arm, where Group II maintains the absolute lead (but considerably decreased) by 5 feet.

2) Symmetry of Posture.

The index of symmetry of the average child of Group I decreased from one and eleven-sixteenths to one and one-eighth, constituting an improvement of thirty-three and one-third per cent. Group II on the other hand became more unsymmetrical: Its index grew from one and one-half to two and one-sixteenth, constituting an impairment of thirty-seven and one-half per cent. (The actual differences in inches between the left and the right sides plus the observed unsymmetries that make up the index are graphically shown in Graph 4a.)

In comparison the children that have exercised both hands for one year, have improved seventy and one-half per cent more than the one-handed group as far as symmetry of posture is concerned. (Graph 4b and Part "2" of Graph 5 show the contrast in details.)

3) Mental Efficiency.

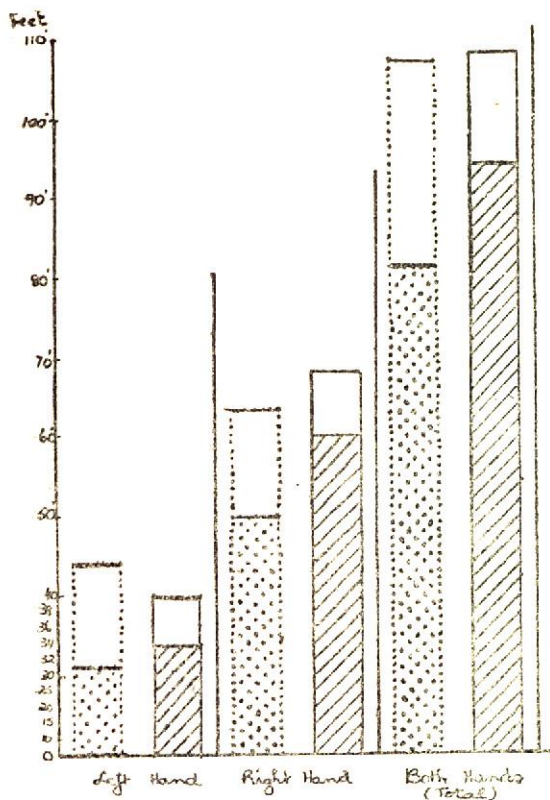
The average marks of Standard I were 73%. The average child of Group I has 77% and Group II 77½%. In Standard 2 the marks were 69% for the average child, with Group I scoring 78 and Group II 71. (See Graph 4a for actual averages.)

In comparison with each other, the both-handed group was the winner: It had one-half per cent less than Group II initially, improved with one per cent over the year - into Standard 2 - whereas Group II dropped six and one-half per cent (Graph mentioned above). The superiority of Group I finally was nine and three-tenths per cent (Graph 4b and the third part of Graph 5).

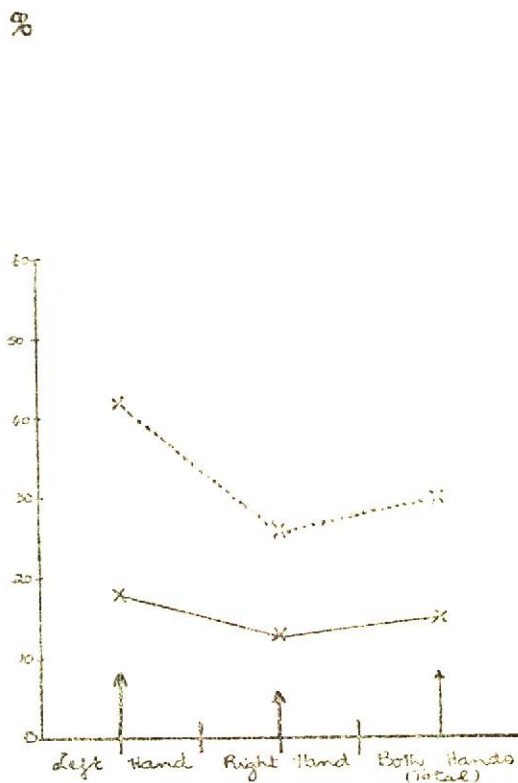
Let us resume the interpretations of the findings:
It is remarkable that at the beginning of the experiment it was Group II that surpassed Group I in every respect, and finally the tables were turned. And in every regard the first group ipso facto made the greater improvements. (See the whole of graph 5.)

- 5.
- 4.
- 3.
- 2.
- 1.

N.B. The symbols for the attainments of Group I (both-handed group) are throughout dotted; those for group II have solid lines. The whole length of the columns represents the final attainment in distance throwing; the shaded height symbolises initial distances reached (∴ unshaded part of column = actual improvement.)



Distance Throwing:
I. (a) Actual Achievement.

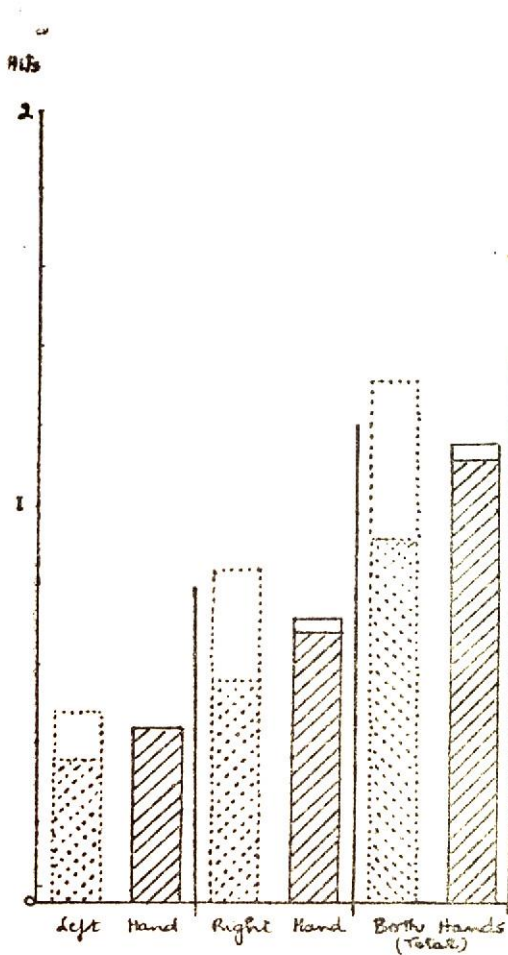


Distance Throwing:
I. (a) Comparative Improvement %

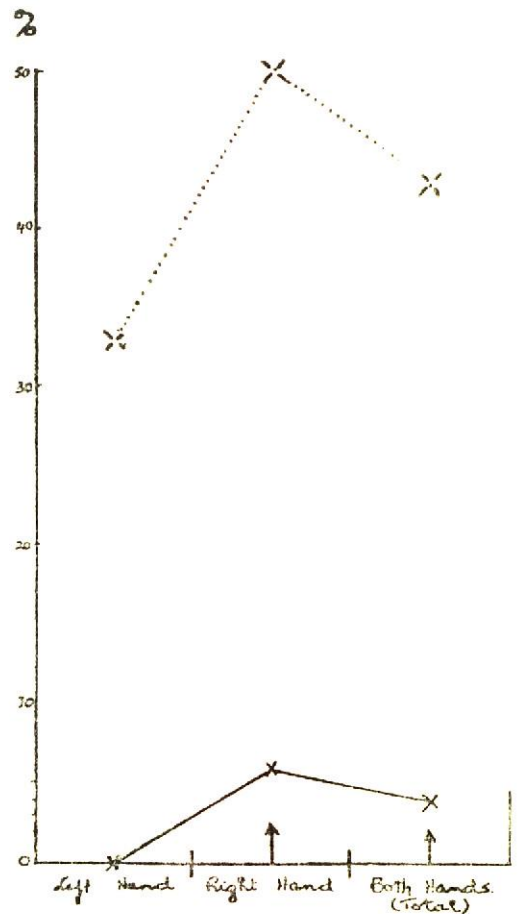
Let us resume the interpretations of the findings:
It is remarkable that at the beginning of the experiment it was Group II that surpassed Group I in every respect, and finally the tables were turned. And in every regard the first group ipso facto made the greater improvements. (See the whole of graph 5.)

- 5.
- 4.
- 3.
- 2.

N.B The total height of columns represents the final hits scored; the shaded part stands for initial hits
∴ Unshaded part = actual improvement.



Aiming:-
(a) Actual Achievement.

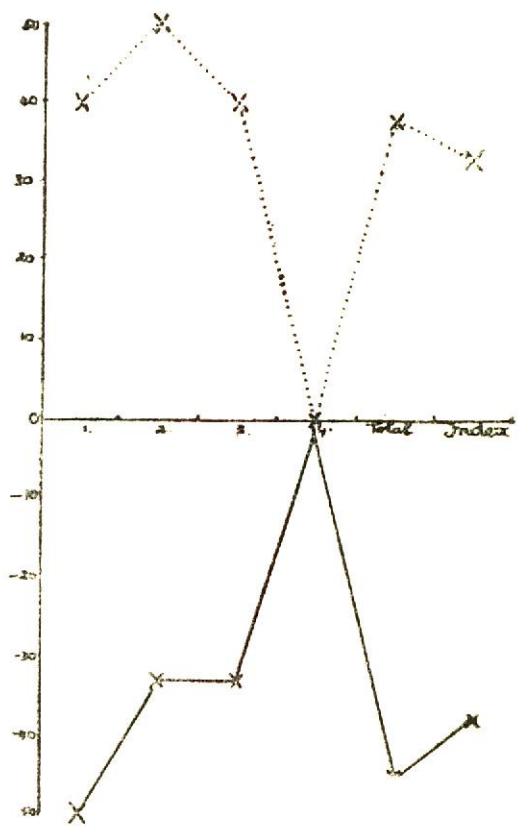
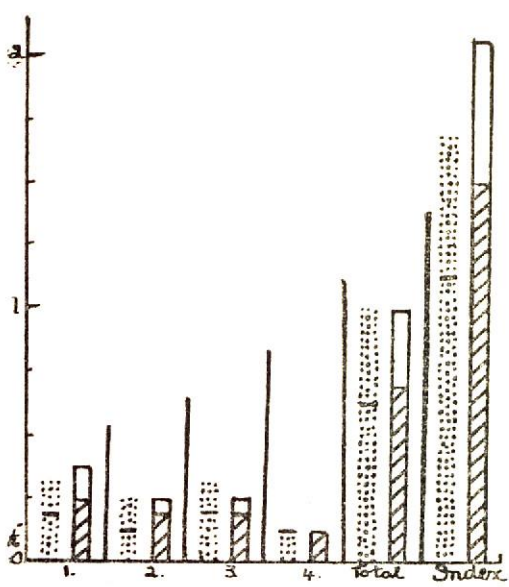


2. Aiming:-
(b) Comparative Improvement %

Let us resume the interpretations of the findings: It is remarkable that at the beginning of the experiment it was Group II that surpassed Group I in every respect, and finally the tables were turned. And in every regard the first group ipso facto made the greater improvements. (See the whole of graph 5.)

- 5.
- 4.
- 3.

N.B. In the dotted columns the final unsymmetry co-incides with the thick line within the column, viz. the unsymmetry has decreased; (the interpretation of other symbols like the previous graphs)
The unshaded parts in solid columns signify increased unsymmetry.



- 1. Differences in left & right shoulder heights in $\frac{1}{8}$ "
- 2. do " " $\frac{1}{8}$ shoulder widths do.
- 3. do " " $\frac{1}{8}$ chest circumference do.
- 4. do " " upper arm do.
- Total: Total of these differences (in $\frac{1}{8}$ ")
- Index: The numerical values pertaining to the Index are, of course, not to be referred to any measuring unit.

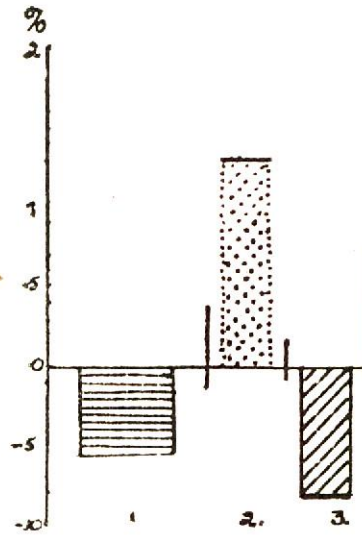
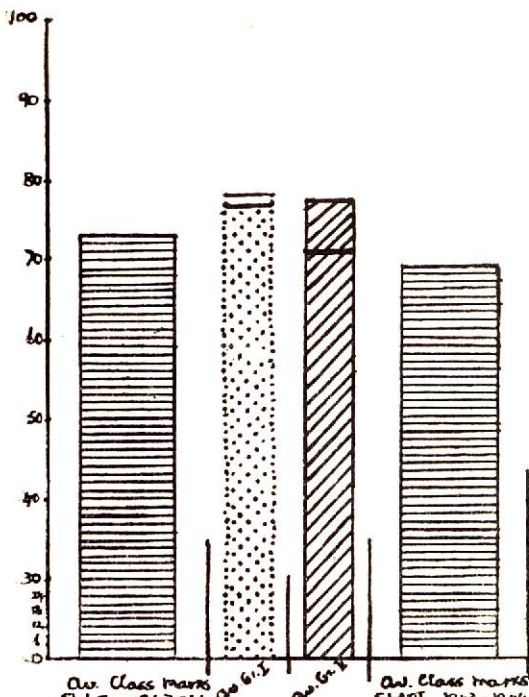
Symmetry of Posture

(a) Actual Unsymmetry Measured 3. (b) Comparative Improvement %

Let us resume the interpretations of the findings:
It is remarkable that at the beginning of the experiment it was Group II that surpassed Group I in every respect, and finally the tables were turned. And in every regard the first group ipso facto made the greater improvements. (see the whole of graph 5.)

5.
4.

NB. The dotted symbols stand for data belonging to Group I as aforesaid;
" obliquely striped ones stand for data belonging to Group II - like before;
" horizontally " " " " " " " " " averages of Stds. I + II.



1. From Stds I to II the average dropped;
2. " Stds I to II Group I improved;
3. " Stds I to II Group II deteriorated.

Average Class Marks

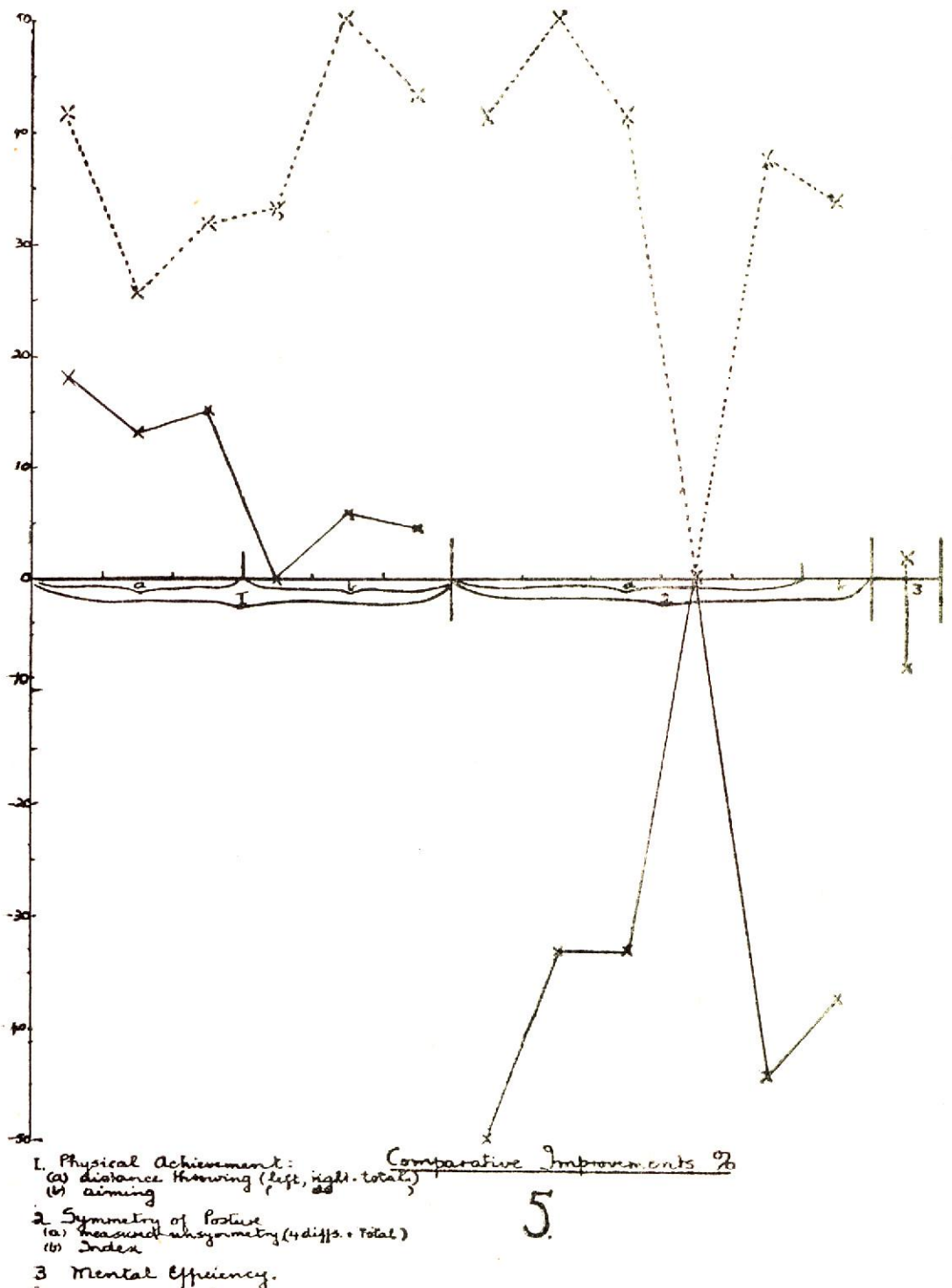
(a) Actual Attainment

4.

(b) Comparative Improvement %

Let us resume the interpretations of the findings:
It is remarkable that at the beginning of the experiment it was Group II that surpassed Group I in every respect, and finally the tables were turned. And in every regard the first group ipso facto made the greater improvements. (See the whole of graph 5.)

5.



CONCLUSION.

The results of this research prove clearly that none of the objections mentioned in the Introduction is tenable: Neither is it not worth while to exercise the inferior arm, nor does such an improvement of the inferior arm - if attained- happen at the expense of efficiency in general. On the contrary, as has been shown, the inferior arm improves very considerably and, as has also been expounded, the general efficiency profits too.

These facts have far-reaching implications for the practice of Physical Education. From infancy on one should foster symmetrical development. Refrain from carrying the toddler on the arm and leading him by the hand - this forms a habit of handedness too easily. When going to school the youngster should wear a satchel, and avoid carrying things with the dominant arm^{only}. Teachers and parents would do him a good turn if they would see to it that he sits and stands squarely behind his work.

In swimming the stroke par excellence for our purpose is the breaststroke; fencing should be omitted, and games such as tennis should not be indulged in too early or exclusively. In other games, such as Volley and Fist Ball and Tennikoits, the service should be made compulsory with the inferior arm. In apparatus gymnastics and tumbling all unsymmetrical exercises should be carried out both ways. The same principle applies to athletic puts and throws. (In Scandinavian Countries even the testing is done left end right.) In jumping one has to make a compromise: Use in the take-off the one leg for high jump, but the other for long jump!³⁾

Symmetry of posture is desirable for aesthetic as well as hygienic reasons - and here it is just for the taking!

3)

These recommendations have been taken from Mr. Schrecker's article "Corrective Gymnastics for Schools" in "Physical Education", No. 1. Volume VI.

BIBLIOGRAPHY.

Books.

1. Blanton, Margaret and Lily:
"For Stutterers", New York, /London, 1936.
2. Burlingame, L.L.:
"Heredity and Social Problems", New York, 1940.
3. Burt, Cyril:
"The Backward Child", London, 1942.
4. du Toit, Dr.C.A.'s chapter: "Intra-uterine Ontwikkeling"
in "Menslike Physiologie - Deel II" by Dr.H.Brink,
Pro Ecclesia, Stellenbosch, 1944.
5. Franck, M.L.:
"Die Probleme van Linkshandigheid op Skool",
Thesis, Stellenbosch, 1943.
6. Parson, B.S.:
"Lefthandedness", New York, 1924.
7. Rumsey, St. John:
"Your Stammer and How to Correct it", London, 1937,
8. Scheidemann; Norma V.:
"The Psychology of Exceptional Children", Vol.1,
Boston, 1937.
9. do Vol.II, Boston, 1937.

Articles.

- a) Haefner, R.:
"The Educational Significance of Lefthandedness"
reviewed in "Psychological Abstracts", Vol.IV.
- b) Morsh, J.E.:
"The Development of Righthanded Skill in the
Lefthanded Child", reviewed in "Psychological
Abstracts", Vol.V.
- c) Estabrooks, G.H. and Westmore, R.G.:
"The Relation of Lefthandedness to Psycho-
neurotic Traits", reviewed in "Psychological
Abstracts", Vol.V.
- d) Katscher, L.:
"Why are WE Righthanded?", in "Knowledge", June,
1913.
- e) Kepath, O.W. and Wickens, J. Stuart:
"Common Postural Defects of College Freshmen", in
"Research Quaterly", March, 1942.
- f) Schott, A.:
"Zum Problem der Linkshaendigkeit" in
"Zeitschrift für Angewandte Psychologie", vol.43.
- g) Schrecker, K.A.:
"Corrective Gymnastics for Schools", Chapter 111,
"Physical Education", No. 1, Vol.VI.
- h) Wilson, D. A.:
"The Lighter Side of Science" in "Knowledge",
June, 1913.