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CONTENTS

DEVELOPING SPATIAL ABILITY AMONG VISUALLY IMPAIRED CHILDREN – AN INTERVENTION APPROACH

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INTRODUCTION:

Vision is the most obvious source of information we have. But it is paradox to note that persons without sight from birth can be excellent at game like chess which depend essentially on thinking about movement and locations in space.

According to Linn and Petersen (1985) spatial ability refers to "skill in representing, transforming, generating and recalling symbolic, nonlinguistic information". Spatial ability is the possession of a coherent interval representation of space in which all activities, events and objects having a relation to the physical world can be mentally placed, manipulated and understood Such a representation is often of a visual nature in man but not necessarily so. In the shower with soap in our eyes we find the towel with closed eyes because we have a representation of our surroundings which is not necessarily of a visual nature. We are living in the same physical world, blind or sighted, and through evaluation man has developed a brain to cope with this world through various senses.

SPATIAL ABILITY OF VISUALLY IMPAIRED CHILDREN:

Millar (1994) expressed that like vision, touch and movement together provide information about shape, configurations and the relation between the surfaces. Children without sight tend to use body-centered surface frames as well as memory for movement information. Vision is not, of course, the only modality that provides the reference cues which spatial coding demands. Almost all sensory systems contribute to the information on different forms of spatial organization depend. Scheneekloth (1989) states that the physical environment is of great significance for the spatial development of the congenitally blind persons.

RATIONALE OF THE STUDY:

Aleman et al. (2001) explored the ability of totally blind people who were contrasted with age, sex and education matched with blindfolded sighted subjects, to perform tasks which are mediated by visual mental imagery in sighted people. The results showed that although blind participants made significantly more errors than sighted participants, they were well able to perform the spatial imagery task as well as the pictorial imagery task. These results shed new light on the question whether early visual experience is necessary for performance on visual imagery tasks, and strongly suggest that vision and haptics (recognizing objects through touch) may share common representations.

The review of literature suggests that in case of blindness, visual representational disorders can partially or completely be compensated by other sensory modalities as well as by cortical reorganization. Vecchi et al (2004) suggested that lack of vision does not impede on the capacity to generate and transform mental images. This ability can be viewed as a unique type of intelligence distinguishable from other forms of intelligence, such as verbal ability, reasoning ability, and memory skills. Spatial ability is not a monolithic and static trait, but made up of numerous subskills, which are interrelated among each other and develop throughout one's life. Cornoldi et al., 1988, Hatwell, 2003; Vecchi et al., 2001 agree on the fact that the mental images of visually impaired persons partly share the same structural and functional characteristics as those of sighted individuals with specific differences. A blind person can access visual spatial imagery by organizing information sources differently given that his/her mental image is mostly based on haptic, vestibulary and verbal spatial information.

Spatial ability is of paramount importance to visually impaired children to learn science and mathematical concepts, verbal and phonemic fluency, Orientation & Mobility and problem solving. Hence an attempt was made to study the spatial ability of Visually Impaired students which intended to bring about specific information on the spatial tasks which require mental spatial recognition.

The main goal of the study was to compare the spatial ability of visually impaired students (Experimental Group) and Blind folded sighted (Control Group) with respect to spatial skills through various tests viz., Distance Estimation, Mental rotation, Delineation, Assembling, and Rotational Displacement.

METHOD AND DESIGN :

SITE DESCRIPTION:

The site selected for the present study was Inclusive Schools and Residential Schools of Coimbatore and Madurai districts in Tamil Nadu, India.

SAMPLE :

The study was experimental in nature. The sample selected for the study consisted of two groups of students namely Blindfolded Sighted and Visually Impaired. The first group of 30 Blindfolded Sighted students with 15 individuals in each gender was considered as Control Group and the next Group of 30 Visually Impaired Students with 16 boys and 14 girls as Experimental Group.

DESIGN:

The layout of the design carried out in this study is given below.

Experimental = R: O X O
Control = R: O O

Here **R** means Randomization

O means Pretest or Posttest

X means Treatment

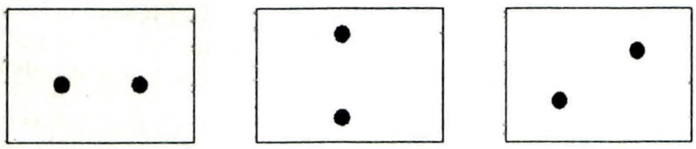
CONSTRUCTION OF THE TOOL:

The dependent variables measured in this study were performance in Distance Estimation, Ment-' Rotation, Delineation, Assembly, and Rotational Displacement. The investigators developed tools f each test.

DISTANCE ESTIMATION:

Distance Estimation ability of the samples was tested with two tests with 5 items in each. The researchers used a Magnetic Board of 35 × 25cm and three pieces of magnets for testing.

In the first test, two magnet pieces were fixed on the board with a distance of 10cm, 15cm, 20cm, and 25cm and in the positions Horizontal, Vertical, Diagonal, Near to student and Far from the student.



10cm Horizontal — Fig 1.1 (a)   20cm Vertical — Fig 1.1 (b)   15cm Diagonal — Fig 1.1 (c)

Each distance was fixed to each position (i.e.) 10cm for Horizontal, 20cm for Vertical and 15cm for Diagonal. Same distance (25cm) was fixed for Far and Near distances. The student had to estimate the

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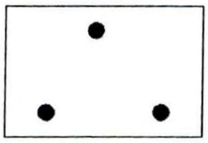
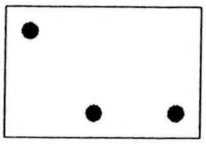
distance approximately. If the subject could estimate the distance with 80% accuracy he was given one score, if not zero score. A maximum of five score was given to this test.

In the second test three magnets were fixed on the board so as to form an angle or triangle. The student had to identify the type of angle (acute, obtuse or right angle) or the type of triangle whether right triangle or equilateral triangle.



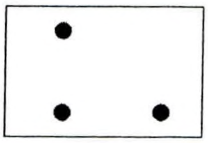
Acute Angle

Fig 1.1 (d)



Obtuse Angle

Fig 1.1 (e)



Right Angle

Fig 1.1 (f)

For every correct response, one score was given and for wrong response zero score. Since this test had five items the maximum score was five. The maximum score for the Distance Estimation comprising of two tests was ten.

MENTAL ROTATION:

Mental rotation is the ability to rotate mental representation of two dimensional and three dimensional objects.

The investigator constructed a test to assess the Mental Rotation Ability of the samples after a thorough study of the related literature. Based on the stimuli of Klatzky et al. (1995) the investigators developed the test items in the shapes required in the wood. The stimuli used to test the Mental Rotation Ability were based on five shapes shown in as shown in Fig 1.2(a). The shapes were approximately 6 × 6 × 0.8cm and were mounted on a board of 35 × 25cm.

In the first subtest the subject was given a stimulus and asked to rotate the shape to any of the angles 45, 90, 135, 180 and 225 about their major axis. An example of rotated shape is given in the following Fig 1.2 (b)

Fig. 1.2. (a)

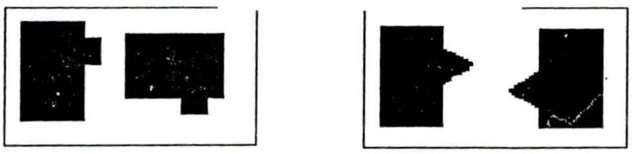


Fig. 1.2. (b)

Among the five stimuli each stimulus was fixed to each degree. If the student could rotate the stimulus to the given angle correctly, one score was given if not the score was zero. Since this subtest had five items the maximum score for this subtest was five.

In the second subtest two copies of the same stimulus were used in each item. The two stimuli were fixed on the board. The second stimuli would be rotated to a particular degree and the student had to find the angle of rotation. The following figures illustrate the angle of rotation. For this, the subject has to mentally rotate the image. If the student could rotate the stimulus to the given angle correctly, one score was given if not the score was zero. Since this subtest had five items the maximum score for this subtest was five.

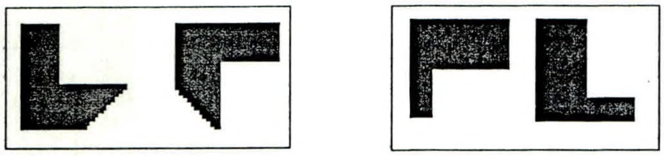


Fig. 1.2. (c)

In the third subtest one stimulus was fixed on the board and the copy of the same stimulus was given to the student. The student was asked to fix the reflected image of the fixed shape on the board. An example is given in Fig. 1.2 (d).

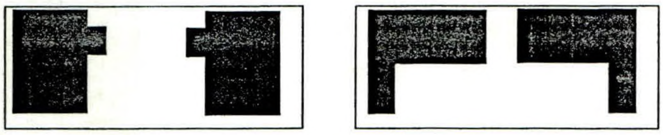


Fig. 1.2. (d)

If he/she could fix the correct image one score was given, if not the score was zero. Since this subtest had five items the maximum score for this subtest was five.

DELINEATION:

Delineation involves operation by spatial images with change in spatial image position only.

This test is based on the operation by spatial images position. It consisted of four items. The figures shown in Fig. 1.3(a) are pasted with threads on the board of size 20 x 12 cm. In the first item Fig (1.3 a maximum of 9 rectangles can be selected and 07, 06 and 13 triangles can be selected in items as shown in Fig (1.3b), Fig (1.3c) and Fig (1.3d) respectively. The student had to select all rectangles and triangles on delineation. For this purpose it was necessary to change the reference point so that the demanded figure became clear visible. One score was given for each selection. Thus this test had a total score of 35.

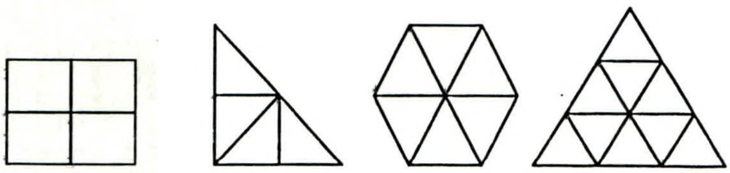


Fig 1.3(a) Fig 1.3(b) Fig 1.3(c) Fig 1.3(d)

ASSEMBLING:

Assembling means putting together of the parts to make a completed product. It is the act of constructing something. The investigator developed the test based on the test items given by Klatzky et al. (1995). This was to identify the Assembling ability of the samples. The stimuli were Triangular, Diamond Shaped and Square Tiles of 5cm on the shortest side. On each trial the student was given three tiles to inspect as long as he or she desired and then was given a completed shape that could be constructed from two of them. The task was to build the completed shape using only two of the tile. The

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four shapes and corresponding tiles are shown in Fig. 1.4. Timing for the trial started when the subject was handed the tiles and stopped either when the subject indicated completion or at the end of 2 minutes. The time taken by the student for each trial for completing the shape was noted with help of a stop watch

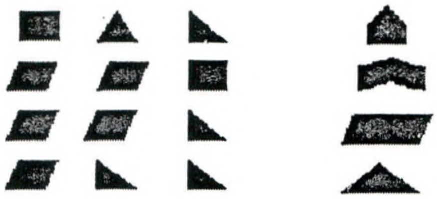

Fig 1.4

ROTATIONAL DISPLACEMENT:

Rotational Displacement required operation by spatial images with change in spatial image structure only. This test consisted of five items. The series of tasks required operation of spatial image structure. It was necessary to construct new figures (square, triangle, rectangle & rhombus) from four equilateral triangles. The subjects should mentally constitute new figures and assemble them using the blocks. Timing for the trial started when the subject was handed the triangles and stopped either when the subject indicated completion or at the end of 2 minutes. The time taken by the student for each trial for completing the shape was noted with help of a stop watch.

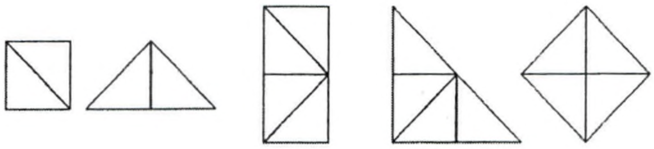

Fig 1.5(a) Fig 1.5(b) Fig 1.5(c) Fig 1.5(d) Fig 1.5(e)

ADMINISTRATION OF TESTS AND INTERVENTION STRATEGIES:

Pretest was administered on Distance Estimation and Mental Rotation tests to both visually impaired students and blind folded sighted students. After pretesting, intervention was given only to the visually impaired students.

Training in concepts such as direction, shapes, sizes, using raised line drawings and three dimensional objects was given to the students. A maximum of 20 minutes was spent for each student for five days and thus each student received a maximum of one hour forty minutes training. After intensive training posttest was conducted on the same components Distance Estimation and Mental Rotation to both groups of students using the same tools used in pretest.

Posttest was conducted to other components such as Delineation, Assembling and Rotation Displacement. There was no pretest to these their components. In order to identify the effect of Intervention pretest and posttest were conducted only to Distance Estimation and Mental Rotation. The Intervention may impact on the performance of other spatial ability testes also.

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Results: 1

Comparison of test scores of visually impaired and blind-folded sighted students in Distance Estimation and Mental Rotation

Test Item	Testing	Group	Mean	SD	df	t-value
Distance Estimation	Pretest	Blind-folded Sighted	7.03	1.88	29	10.35**
		Visually Impaired	2.30	1.76	29	
Distance Estimation	Posttest	Blind-folded Sighted	7.17	1.94	29	5.09**
		Visually Impaired	8.97	1.1	29	
Mental Rotation	Pretest	Blind-folded Sighted	8.63	2.36	29	19.32**
		Visually Impaired	0.17	0.46	29	
Mental Rotation	Posttest	Blind-folded Sighted	8.80	2.58	29	3.03**
		Visually Impaired	10.57	1.89	29	

*****Significant at 0.01 level***

COMMENTS:

- **In Distance Estimation, the pretest mean scores of visually impaired students is 2.30 but it has increased to 8.97 after intervention and the 't'value is significant at 0.01 level and similar result was observed in mental rotation indicating that intervention was efficacious.**
- **There was no difference between the pre and post mean scores of blind-folded sighted.**
- **The interesting result was that visually impaired students performed better than blind-folded sigh(in the post test in both distance estimation and mental rotation.**

Result:2

Comparison of test scores of visually impaired and blind-folded sighted students in Delineation

Test Item	Group	Mean	SD	df	t-value
Delineation	Blind-folded Sighted	27.10	4.05	29	0.59 Ns
	Visually Impaired	26.40	5.09	29	

Ns: Not Significant

COMMENTS:

The total score for delineation test was 35. The't' value indicates that there is no significant difference between blind-folded sighted and visually impaired students. But the average score of visually impaired students was close to 27. The training in distance estimation, mental rotation and training in tactile skills may be helped to perform as equal as blind-folded sighted.

Result: 3

Comparison of test scores of visually impaired and blind-folded sighted students in Assembling

Test Item	Shape Formation	Group	Mean	SD	df	t-value
Assembly	I	Blind-Folded sighted	21.27	13.63	29	0.93Ns
		Visually Impaired	24.33	11.78	29	
Assembly	II	Blind-Folded sighted	48.73	18.86	29	0.35Ns
		Visually Impaired	50.90	27.94	29	
Assembly	III	Blind-Folded sighted	58.03	25.02	29	0.27Ns
		Visually Impaired	56.03	31.58	29	
Assembly	IV	Blind-Folded sighted	54.17	24.50	29	1.06Ns
		Visually Impaired	60	28	29	

Ns : Not Significant

COMMENTS:

The t value for all shapes formed by both the group of students revealed that there is no significant difference between these groups in terms of time taken to complete the tasks and hence it may be concluded that the average time taken to complete the tests was almost equal in both the groups except a few minutes more among visually impaired students.

Group wise Mean, SD, df and correlated t-value of Rotational Displacement –I test

Test Item	Shape	Group	Mean	SD	df	t-value
Rotational Displacement-I	Square	Blind-Folded sighted	15.70	8.42	29	0.27Ns
		Visually Impaired	16.30	8.63	26	
Rotational Displacement-I	Triangle	Blind-Folded sighted	51.37	21.53	29	1.26Ns
		Visually Impaired	58.76	23.45	28	
Rotational Displacement-II	Rectangle	Blind-Folded sighted	66.83	35.82	29	0.10NS
		Visually Impaired	65.93	32.04	26	
Rotational Displacement-II	Rhombus	Blind-Folded sighted	92.78	21.81	8	0.19Ns
		Visually Impaired	94.80	14.17	4	

Ns: Not Significant

COMMENTS:

The t value for all types of rotational displacement performed by both the group of students revealed that there is no significant difference between these groups in terms of time taken to complete the tasks and hence it may be concluded that the average time taken to complete the tests was almost equal in both the groups except a few minutes more among visually impaired students.

In forming square and Rectangle, only 27 visually impaired students could complete but in forming Rhombus shape only 8 students among blind-folded sighted and 4 in the case of visually impaired could complete the tests.

DISCUSSION:

This study corresponds to the study by Christen Garbir (1978) who claimed that spatial information is coded in an analogue mode. Evidence from research with blind people indicates that they can perform mental rotation and that analogue spatial cognition does not depend on visual information. It is therefore proposed that if the blind person can perform spatial representation in an analogue mode, there exists a common mode, for processing spatial information, which is not modality specific.

Thus the study demonstrated that lack of vision does not impede capacity to generate and transform mental images but the visual element is being replaced by a representation based on haptic (touch) experience, they need intensive training in raised line drawings, estimation of distance mentally and manipulation of two and three dimensional objects.

The study results suggest that representation of perceptible objects can be derived from all the sensory modalities. The findings are in line with Paivid(1986) who pointed out that blind people could form mental images of objects based on their intact with sensory modalities especially audition and touch. Carpenlin and Eisenberg (1975), Kerr(1983), Marmar and Zaback (1976), Zimler and Leenan(1983) in their studies found that in general visually impaired participants perform very similarly to sighted participants with the exception that reaction times tend to be rather slower for blind participants. The results may have educational implications that intensive training in distance estimation, mental rotation, raised line drawings and diagrams may lead to increased ease in mental spatial representation.

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