Research Article

COMPARATIVE EVALUATION OF IQ BASED ON BRAIN LATERALIZATION

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ABSTRACT

Brain lateralization is related to intelligence and it can be evaluated by studying individual preference to laterality markers viz; hand, foot, ear and eye. In this study the level of IQ was compared among the participants of age group 3-20 years based on the laterality markers. 300 participants (150 right handed and 150 left handed) were included. The assessment of handedness, footedness, earedness and eyedness was done using Edinburg Handedness Inventory, Chapmann Foot preference Inventory, Miles test and Lateral Preference Inventory respectively. The IQ was determined by RCPMT (Raven's Coloured Progressive Matrices Test) for 3-11 years and RSPMT (Raven's Standard Progressive Matrices Test) for 12-20 years. The IQ scores of left hand, left foot, left ear and left eye dominant participants were significantly high compared to their right side dominant counterparts. The level of IQ increased significantly with the increase in age but IQ was insignificantly different among males and females. This study shows that right brain dominant individuals are more intelligent than left brain dominant individuals.

INTRODUCTION

Lateral preference of an individual is determined by the brain dominance. Human brain structurally has two hemispheres both of which are dominant for specific activities. Each hemisphere is very precise and specific for complex activities like speech, cognition, reasoning, writing etc which are coordinated either individually or with the combined effort. This necessitates the requirement of well structured and regulating bilateral integrity of human brain which has flamed the concept of brain lateralization or Laterality [1].

Right brain (cerebral hemisphere) controls the left side of body and vice versa[1]. Lateral dominance can be especially observed in the symmetrically distributed body parts like eye, ear, hand and foot. As for example, the dominant hemisphere is right if the person is right handed and vice versa. Hence laterality may be described as the preferential utilisation of symmetrical body organs for accomplishing various tasks[2]. In the previous studies, handedness appears to be the most commonly preferred marker to study brain lateralisation. These studies have correlated IQ (cognitive abilities) of an individual with the hand preference and reported left handed people to be more intelligent which implied that the people with dominant right brain have intellectual superiority compared to the people with dominant left brain [3,4].

Left handed people, despite of higher intellectual capability are under the constant cultural, social and academic stress imposed on them. This is because the world is completely right dominant in terms of preference of hand (especially) and it is not ready to accept the fact of left handed people to more intelligent that right handed people. Further, there is social and cultural bias too in the used of had for various social and religious activities. Use of left hand is considered a bad omen, rude, unfavourable and undisciplined behaviour [5]. Due to this left handed children are under pressure of family and society to change the hand preference to right, not knowing the untoward consequences of such forced change of hand preference on the intellectual, physiological and academic development of a child [6].

Like dominant hand, the world is also dominated by right footed individuals. Thought foot preference is also affected by the social and cultural bias, it is less observed in comparison to hand preference. For example entering any religious place or a new house with left foot is considered auspicious[7]. Hence, compared to handedness, footedness is considered better indicator of brain lateralisation in some of the previous studies. There is also predominance of right eye and ear dominant individuals in the world; however the individuals are unaware of the preferential use of eye and ear compared to hand and foot. Further, they are not affected by any social and cultural beliefs. Therefore they can also serve as good markers tostudy

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brain lateralisation and their relation with IQ. Previous studies have considered eyedness to be more fundamental marker of cerebral laterality and intellectual development with respect to speech, reading and writingrequires proper coordination between eye and hand[8,9].

However, there is still an ungoing debate with the intelligence of left brain dominant individual (using right body side) is higher than the right brain dominant peers (using left body side), as the results in the literatures are controversial. Some studies are biased towards left brain dominance while others are towards right brain dominance. Further, some studies have shown intellectual equality irrespective of lateral preferences. Also, most of the previous researches have given priority to hand preferenceonly for evaluation of IQ based on lateral dominance while other markers (eye, ear and foot) have been neglected. Moreover, this type of study can be found very rarely in India. Hence, we framed this study with an aim to study effect on brain lateralisation in terms of preference of eye, ear, hand and foot on IQ of male and female individuals. This study also focus on the importance of eye, ear and foot as the marker of brain lateralisation as they are negligibly affected by social and cultural pressures.

MATERIALS AND METHODS

This is a cross sectional study comprising 300 participants of which 150 each were left and right handed. After the institutional ethical committee approval, the study was initiated. All the participants were explained about the research and informed consent were obtained. The participants were divided into four categories as:

- Group A: 3-7 years
- Group B: 8-11 years
- Group C: 12-15 years
- Group D: 16-20 years

Inclusion criteria

The individuals fulfilling following criteria were included:

- Age between 3-20 years
- No history of serious illness
- Absence of trauma in head neck region, developmental disorders, psychiatric disorders

Exclusion criteria

The following participants were excluded:

- Any illness affecting the intelligence
- Children with visual, hearing and speech impairment
- Participants with any gross congenital or physical deformity
- Individuals not consenting to take part

Assessment of handedness

Handedness was determined based on the Edinburg Handedness Inventory [10]. Ten questions pertaining to use of hand in carryout out various activities were included. The questionnaire included questions related to: Brushing teeth, Handling eraser, Match sticking, Hammering, Throwing, Opening a lid, Using spoon, Using Scissor, Holding knife and Holding broom. Scores ranging from +1 (right hand response), 0 (either hand response) and -1 (left hand response) was given

as per ASAI. The range of scale is +10 to -10 [11]. The participant is:

- Right handed: score between -4 to +7
- Left handed: score between -10 to -5

Assessment of footedness

Footedness was assessed using Chapman foot preference inventory [12]. The following questions were asked regarding the dominant foot: Step upon stool, Kicking a ball, Pick up object, Step on spade, Step forward, Hop, Stamp on object, Uppermost leg on crossing, Put on first shoe, Put on first stocking and Stand on one foot. Scale ranges from 11 to 33. Scores ranging from +1 (right leg response), 2 (either leg response) and +3 (left leg response) was given as per ASAI.

The participant is:

- Right footed: score between 11 to 16
- Left footed: score between 28 to 33

Assessment of eyed ness

It was evaluated by using Miles test [13]. The participants were asked to look into an object placed at a distance of 6 meter. The participants were instructed to make a small triangle with the first knuckle and thumbs of hand and look into the object through triangle, first with both eyes open. Then they were instructed to close left eye and observe. If the object can be viewed, dominant eye is right. If the hands move off the objects to the left, then dominant eye is left.

Assessment of earedness

For determining ear dominance 4 questions of lateral preference[14] were asked to each participant as follows:

- Which ear is preferred against a closed door to listen a conversation?
- Which ear is preferred if there is only one ear phone available in a portable device?
- Which ear is preferred against chest of an individual to hear heartbeat?
- Which ear is preferred against a box to check if the box contains ticking clock in it?

Assessment of IQ

The intelligence level of participants will be assessed by Ravens test.

- Ravens Colored Progressive Matrices test (age group 3-11 years)
- Ravens Standard Progressive Matrices test (age group more than 11 years).

Raven's Colored Progressive Matrices Test (RCPMT)

It has 36 problems divided into 3 sets namely set A, set Ab and set B; each set consisting of 12 questions. The participants were instructed to complete the testin 30 minutes. The data was recorded, converted to percentile and graded according to the Raven's Standard Progressive Manual.

Raven's Standard Progressive Matrices Test (RSPMT)

It has 60questionsunder 5 sets from A to E. Each set comprises 12 questions. The participants were instructed to complete the testin 40 minutes. The data was recorded and percentile was

generated. Grading of overall score was done based on Raven's Standard Progressive Manual[15].

Statistical analysis was done using SPSS software (version 20). The level of significance taken was 95% and a p value of <0.05 represented statistical significance.

RESULTS

This study included equal number of right and left hand dominant participants (50% each). The distributions of participants having dominant left and right foot were 53.1% and 46.9% respectively. 55.3% and 44.7% of participants respectively had dominant right eye and left eye while 70.9% and 29.1% of participants had dominant right and left ear respectively (figure 1).

Figure 2 shows the distribution of participants based on gender and laterality markers. In case of hand preference, 26.4% and 27.5% males were right and left handed while 23.4% and 22.5% females were right and left handed respectively. In case of foot preference, 26.9% and 27.2% males were right and left footed while 26.3% and 19.7% females were right and left footed respectively. In case of eye preference, 30.3% and 23.8% males were right and left eyed while 25% and 20.9% females were right and left eyed respectively. In case of earpreference, 39.7% and 14.4% males were right and left eared while 31.3% and 14.7% females were right and left eared respectively.

Figure 3 shows the distribution of participants with respect to RSPMT grades. It was observed that most of the participants had grade of III minus (23.8%) while 10%, 11.6%, 11.6%, 21.6%, 12.5%, 4.7% and 4.4% of the participants respectively had RSPMT grade I, II plus, II, III plus, IV, IV minus and V.

The IQ of participants with dominant left hand, left foot and left eye was significantly higher than that of participants with dominant right hand, right foot and right eye but in case on ear the difference was insignificant (table 1).

Table 2 shows the mean time taken by the participants to complete the RSPMT. The time taken by participants with dominant left hand and dominant left eye was significantly less than the respective right sided counterparts (p<0.01, p<0.05). It was not significant in case of foot and ear preference (p>0.05).

In table 3, comparison of IQ based on age and laterality markers is shown. It was found that IQ increased significantly with the increase of age.

In table 4, comparison of IQ based on gender and laterality markers is shown. Significant difference in the level of IQ among male and female participants was not observed.
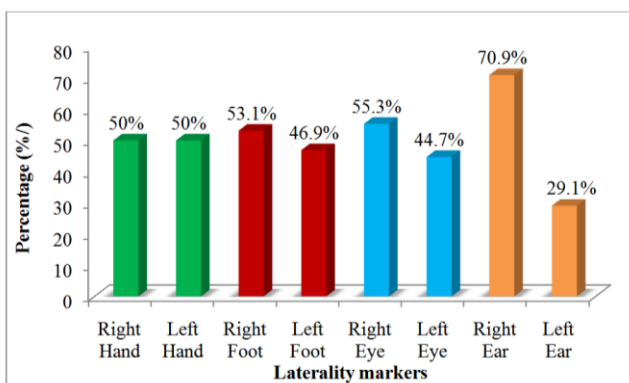

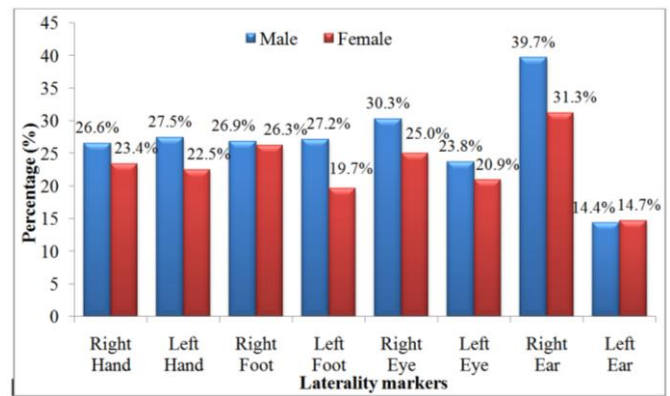**Figure 1** Distribution of participants based on markers of laterality

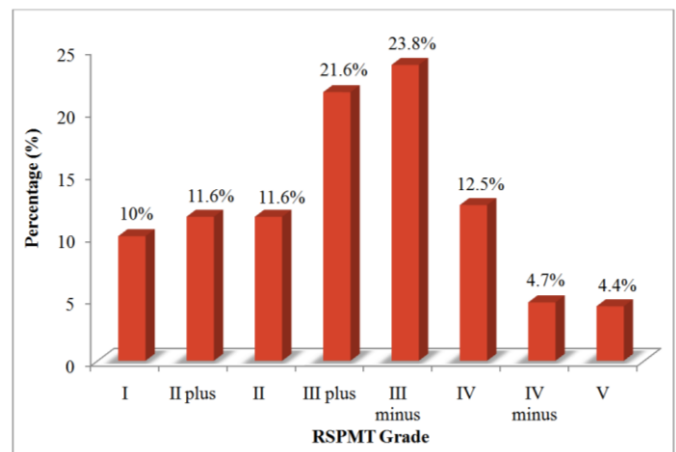**Figure 2** Distribution of participants based on gender

Figure 3 Distribution of participants based on RSPMT grade

Table 1 Comparison of RSPMT scores based on laterality markers

Laterality marker	Side	No.	Mean±SD	Median±IQR	p
Hand	Right hand	160	31.94 ± 15.46	31 ± 25	0.02*
	Left hand	160	35.7 ± 15.32	36 ± 25.5	
Foot	Right foot	170	31.55 ± 15.77	30 ± 27	<0.00 4**
	Left foot	150	36.4 ± 15.77	38 ± 24	
Eye	Right eye	177	32.06 ± 15.28	32 ± 26	0.017 *
	Left eye	143	36 ± 15.49	37 ± 26.5	
Ear	Right ear	227	33.44 ± 14.92	34 ± 24	0.443
	Let ear	93	34.76 ± 16.63	37 ± 27	

*: Significant (p<0.05), **: Significant (p<0.00)

Table 2 Comparison of time taken to complete RSPMT scores based on laterality markers

Marker	Side	N	Mean±SD	Median±IQR	p
Hand	Right	160	28.62±7.21	29.6±11	<0.001**
	Left hand	160	26.05±6.55	26±11.5	
Foot	Right foot	170	27.21±7.35	27.5±11	0.905
	Left foot	150	27.48±6.59	27±11	
Eye	Right eye	177	28±6.93	28±10	0.024*
	Left eye	143	26.1±7.07	27±13	
Ear	Right ear	227	27.05±7.08	27±12	0.337
	Left ear	93	28.03±6.78	28±11	

*: Significant (p<0.05), **: Significant (p<0.00)

Table 3 Comparison of RSPMT score with respect to age and laterality markers

Age in years		Hand Right	Hand Left	Foot Right	Foot Left	Eye Right	Eye Left	Ear Right	Ear Left
3-7	Mean±SD	11.9±5.2	16.1±6.2	12.9±5.6	15.±6.5	13.4±5.9	14.9±6.4	14.1±5.8	13.8±6.7
	Median±IQR	11±8	14.5±9.5	12±7	15±10	13±8.5	14±9	14±8.5	12±6.5
	p	0.002**		0.04*		0.446		0.484	
8-11	Mean±SD	24.7±3.7	28.1±5	24.9±4.4	28.±4.4	25.3±4.2	27.7±4.9	26.8±4.4	25.4±5.5
	Median±IQR	24±5.5	27.5±9	24±6.5	27±9	25±6	27±9	26±6	24±10
	p	0.002**		0.002**		0.04*		0.19	
12-15	Mean±SD	42.4±5.3	46.4±5.2	43.8±5.9	45.±5.3	43.3±5.2	45.6±5.8	43.3±5.4	46.±5.5
	Median±IQR	43±8	46.5±7	44.5±7	45.5±5.5	45±8	46±7.5	44±7.5	46±6
	p	0.001**		0.277		0.105		0.032*	
15-20	Mean±SD	48.6±6.3	52.±4.8	48.8±6.2	51.8±5.	48.5±6.1	52.5±4.6	49.4±5.9	53.5±4.2
	Median±IQR	48±9.5	52.±6.5	48.5±8	53±8	48±10	53±9	50±9	55±7
	p	0.013*		0.034*		0.004**		0.006**	
	p	<0.001**		<0.001**		<0.001**		<0.001**	

*: Significant (p<0.05), **: Significant (p<0.00)

Table 4 Comparison of RSPMT score with respect to gender and laterality markers

Markers	Side	No.	Male Mean±SD	Male Median±IQR	Female Mean±SD	Female Median±IQR	p
Hand	Right	160	31.09±14.58	30±24.5	32.9±16.44	38±26	0.434
	Left	160	`35.9±15.21	40±26.5	35.45±15.55	36±27	0.915
Foot	Right	170	28.76±14.98	27±27	33.07±16.19	36.5±26.5	0.129
	Left	150	35.77±14.62	38.5±25	35.6±15.77	36±27	0.93
Eye	Right	177	32.35±14.98	31±25.5	31.72±15.73	34±27	0.736
	Left	143	35.06±15.1	34.5±25.5	37.05±15.97	38±27	0.386
Ear	Right	227	33.03±14.76	32±25	33.95±15.36	36.5±24	0.665
	Left	93	34.93±15.91	38.5±25	34.59±17.47	36±34	0.978

DISCUSSION

The problem solving ability of a person to survive in the surrounding social and natural world may be considered as intelligence. Inter-individual differences can be observed in the level of intelligence and it can be evaluated based on preferences to dominant limbs (hand and foot), eye and ear; all of which are known as markers of brain lateralisation.

In this study the participants with dominant hand, foot and eye in the left side were found to be more intelligent which was implicated by high RSMPT scores. This shows that the individuals who are privileged with dominant right brain are more intelligent. The result of this study was supported by that of Rai R *et al* [16] and Ghayas S *et al* [17] who showed superiority of right brain in terms of intelligence. The present study also evaluated the time taken by participants to complete RSPMT and it was found that right brain dominant participants comparatively took less time to complete the IQ test, a result similar to the study of David SJ *et al* [18]. Likewise Nicholls MER*et al* suggested presence of high intellectual abilities in individuals with right sided asymmetry [19]. However, the study of Somers S*et al* showed insignificant difference of IQ between right and left handed participants [20]. As per previous studies, there is high blood flow, increase in brain waves and glucose uptake in right brain during the perceptual activities [17].

In this study, 26.4%, 26.9%, 30.3% and 39.7% of males had dominant right hand, right foot, right eye and right ear while 27.5%, 27.2%, 23.8% and 14.4% of males had dominant left hand, left foot, left eye and left ear respectively. In case of females, 23.4%, 26.3%, 25% and 20.9% of females had dominant right hand, right foot, right eye and right ear while 22.5%, 19%, 31.3% and 14.7% of females had dominant left hand, left foot, left eye and left ear respectively. In the study of Rai R *et al*, 48%, 51% and 55.8% of males had dominant right hand, right foot and right eye while 50%, 49%, and 44.2% of

males had dominant left hand, left foot and left eye respectively. In case of females, 52.3%, 56.2% and 55.9% of females had dominant right hand, right foot and right eye while 47.7%, 43.8%, and 44.1% of females had dominant left hand, left foot and left eye respectively [16].Likewise, in study of Syuichi O *et al*, the rage of left handedness in males and females was 13.9-14.7% and 12.3-13.7% respectively [21].

This present study did not document any significant difference in IQ among male and female participants which was in contrast to the report of Denny*et al* who reported males (left handed) to be more intelligent than females (left handed) [22]. The present study also documented significant increase in the intellectual abilities with increase in age. Mouse SE *et al* showed age depended increase in IQ as the performance of older children was better than the younger ones [23]. As per Korkman M *et al* [24] neurocognitive development occurs rapidly at an early age hence the effect of age on IQ is more pronounced during the first decade of life (5 to 10 years).

CONCLUSION

This study implies that thepeople with dominant right hemisphere are more intelligent. The cerebral dominance can be assessed by evaluating parameters like hand, foot, ear and eye. The world in which we are living is right side dominant which means most of the people of dominant right hand, right foot, right eye and right ear. Hence there is preponderance of attitude of neglecting left side dominant individuals and the world yet is not ready to accept the fact of left side dominant individuals being more intelligent. Since this study shows the intellectual advantages in left side dominant participants, it may act as an eye opener inchanging such negative attitudespresent in the society and facilitate survival of left side dominant people in right dominant world.

Conflict of interest: Nill

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