

# Nature and Nurture Basis of Intelligence of Twins from 3-6 Years: An Intervention Study

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## ABSTRACT

Intelligence is considered as most valuable phenotypic psychological and behavioral construct having both genetic and environmental substrates. The classical twin study provided robust information regarding the contribution of nature and nurture propensities on variations of intelligence of twins. The twin investigation has been planned with the objective to assess the influence of nature and nurture on the intelligence of twins. A twin study was conducted in two districts, namely, Bhiwani and Hisar of Haryana state. A sample of 150 pairs of twins in the age groups of 3-6 years was attained from 55 villages of Bhiwani district and Hisar district. The intelligence of twins was assessed with the help of Stanford Binet Intelligence Scale [1], whereas the home environment of twins was measured by using the Home Observation for Measurement of the Environment (HOME) [2] and preschool environment of twin's measure with the help of Early Childhood Environment Rating Scale [3]. The findings of heritability estimates revealed that the heritability estimates for intelligence ranging from 55-74% from 3-6 years in the Bhiwani district, whereas in the Hisar district, the heritability estimates for intelligence were 52-68 percent during 3-6 years. Analysis of variance results revealed that a significant difference in mean values was observed at ages 3-4 years among the gender of twins but no significant difference on ages 4-5 years and 5-6 years. The conclusion of heritability estimates showed that the influence of nature (genetic) on the intelligence level of twins was more than that nurture (environment). The contribution of nature on the intelligence level of twins increases with the increase in the age of twins and the influence of nurture decreases with the increase in the age of twins. The preschool environment of twins was also significantly associated with the intellectual of twins in both the Bhiwani and Hisar districts. The intervention programme also enhanced the intelligence of twins in the age group 3-6 years in both the Bhiwani and Hisar districts.

**Keywords:** GCMS, *Loranthus longiflorus*, Plant parasites, phytochemical constituents

## INTRODUCTION

Human biology and behavioral research primarily focused on the contributions of nature, including all the genes and the inherited characteristics that individuals are born with. Secondly nurture, means all the environmental variables that have influences on life after birth. However, nurture is the integration of external forces acting upon genetic material across the lifespan [4]. The intelligence of a person involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience [5]. Intelligence is important scientifically and socially. Intelligence

is one of the best predictors of key outcomes such as education and occupational status. People with higher intelligence tend to have better mental and physical health and fewer illnesses throughout their life course, and longer live [6]. Heritability is a statistic that describes the amount of variance in a trait that can be attributed to genetic differences in a given population [7]. It is not a constant value and varies for a trait depending on when in the developmental process like neonate, child, and adult [8]. Twin study design estimates the relative contribution of heritability in shaping the intelligence of twins. Intelligence differs from individual to individual similar to any other human trait.

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The twin study designs determine causal interrelationships between brain structure and function, and neuropsychological performance [9]. The manifestation of psychological traits, not only rely on genetic and environmental variances but also the interaction between genetic endowment and environmental circumstances [10]. Genetic studies have shown that intellectual abilities are heritable, and highly polygenic, and that shared genetic factors account for part of their observed co-variation [11]. Genetic influences are an important component of variation for almost all human traits. The intellectual abilities are heritable, genetic differences between individuals account for between approximately 20 per cent and 70 per cent of the variance in intellectual abilities [12]. The heritability of intelligence increases linearly from early childhood to young adulthood [13]. The genetic and environmental influences on intelligence are not static, rather they change and shift during development [14]. Both nature and nurture contributed to the development of intelligence throughout the first 16 years of life, whereas considerable genetic influences at each age and modest shared environmental influences were observed within and across ages [15]. The longitudinal twin design can answer a broad range of questions on the interplay between adverse genetic and environmental impacts and intellectual outcomes [16].

Furthermore, many of the same genetic influences that give rise to individual differences in general intelligence also impact academic achievement, helping to explain their strong relationship [17]. Both nature and nurture contribute to overall stability in intelligence to varying extents, and their relative contributions may change with age. The stability of individual differences in intellectual abilities over time results from consistent exposure to the same environments over time. The stability of intelligence results from the stability of social, educational, and economic contexts [18].

Most behavioural genetic studies, including comparing monozygotic and dizygotic twins, are often used to evaluate the extent to which variations in human abilities like intelligence are the result of the contribution of genetic material and environmental factors. [19] Suggested that twin studies provide a framework to estimate heritable contributions between pairs of

monozygotic twins, who share 100 per cent of their genetic material, and dizygotic twins, who on average share 50 per cent of their segregating gene.

Early childhood is a very important time for brain development, which comprises cognitive, physical, socio-emotional and language development. The early childhood period is most important for intellectual development, later educational performance as well as for lifelong learning and well-being [20]. Early childhood is as a period in development in which the flow of gene-environment transactions is likely to begin. The interventions during early childhood development are designed to promote intellectual development that is implemented before the child was eight years of age. The differences in early intellectual performance have long-lasting consequences for later intellectual performance [21].

## MATERIALS AND METHODS

**Study Design:** The twin investigation was conducted using the descriptive and experimental research design. The objective of the twin study design was to analyze the genetic and environmental impact on the intelligence level of twins. To conduct this study mainly two districts were selected randomly namely: Bhiwani (N = 174) and Hisar (N = 126) of Haryana state. To assess the intelligence of twins, total of 150 pairs of twins were selected from two districts with the age group 3-to-6 years. Total 55 villages of Bhiwani and Hisar district were selected to conduct a twin investigation.

**Data collection:** For data collection, various methods of data collection were used namely, assessment, interview, observation, and questionnaire method from the twins, parents of twins, and teachers of twins to gather relevant information. The snow ball sampling was also used to collect the twins in the required age group of twins.

**Tool:** Stanford Binet Intelligence Scale [1], Home Observation for Measurement of the Environment (HOME) [2], and Early Childhood Environment Rating Scale [3] were used to measure intelligence level, home environment, the preschool environment of twins respectively. The intervention programme was self-developed with

various activities as per the test of the Stanford Binet Intelligence scale and implemented in home-based settings to improve the intelligence level of twins.

**Statistical Analysis:** The software SPSS (Statistical Package for the Social Sciences) was used to analyze the data and draw inferences. Mean, Standard Deviation, z-test, ANOVA (Analysis of Variance), Paired t-test, Chi-square test and heritable estimate were used to meet the objectives of the twin investigation. Heritability estimates ( $h^2$ ) were calculated by the following formula given by [22],  $h^2 = 2(RMz - RDz)$  Where,  $h^2$  is the heritability estimate, RMz is the correlation coefficient for monozygotic twin pairs and RDz is the correlation coefficient for dizygotic twins.

**Research findings**

The results obtained from the present twin investigation have been summarized under the following heads:

**Comparison of intelligence level of twins from 3-6 years in two districts**

As data presented in Table 1 there were highly significant (0.01%) differences in mean values observed on age 5-6 years ( $Z=2.72^{**}$ ) for the intellectual level of twins. The significant (0.05%) difference was found between twins of the Bhiwani and Hisar districts on ages 3-4 years ( $Z=2.08^*$ ), but no significant difference was found in the remaining age namely, 4-5 years ( $Z=1.12$ ) over districts. The intellectual level of twins was more in the Bhiwani district as compared to the Hisar district.

**Table 1:** Comparison of intelligence level of twins from 3-6 years in two districts (N=300)

Age (in years)	Bhiwani (n=174) Mean±SD	Hisar (n=126) Mean±SD	Z Value
3-4	(n=56)	(n=44)	2.08*
	69.48±21.66	62.86±23.31	
4-5	(n=58)	(n=42)	1.12
	63.31±20.25	66.26±16.66	
5-6	(n=60)	(n=40)	2.72**
	65.32±19.99	57.37±21.29	

\*\*Significant at 0.01% level of

significance; \*Significant at 0.05% level of significance

**Analysis of variance for various parameters among gender of twins**

ANOVA was used for various parameters namely, 3-4 years, 4-5 years and 5-6 years of twins revealed that there was significant difference in age 3-4 years ( $F=4.95^*$ ) among gender of twins but no significant differences were observed on remaining age of twins namely, 4-5 years ( $F=0.68$ ) and 5-6 years ( $F=0.05$ ) among gender of twins.

**Table 2:** Analysis of variance for various parameters among gender of twins (N=300)

Age (in years)	Source of variations	Sum of Square	df	Mean of Square	F Value
3-4	Between Groups	2400.831	1	2400.831	4.95*
	Within Groups	47491.919	98	484.611	
	Total	49892.750	99		
4-5	Between Groups	241.114	1	241.114	0.68
	Within Groups	34717.636	98	354.262	
	Total	34958.750	99		
5-6	Between Groups	23.858	1	23.858	0.05
	Within Groups	42758.182	98	436.308	
	Total	42782.040	99		

\*Significant at 5% level of significance

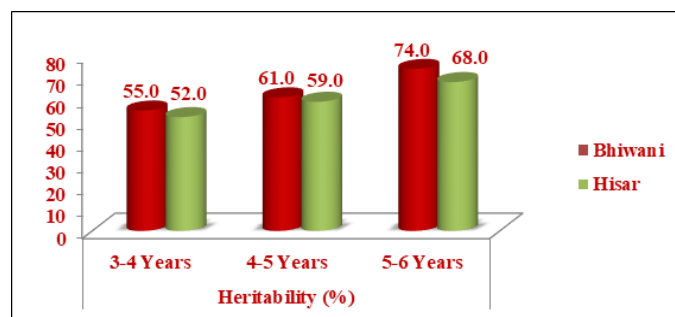
**Heritability estimates for intelligence level of twins with age in Bhiwani and Hisar district**

As data presented in Table 3 revealed that the heritability estimates for the intellectual level of twins with the age group 3-4 years in the Bhiwani district was 55.00 per cent. The interpretation of data indicated that the remaining 45.00 per cent variance in intellectual level in the Bhiwani district was attributed to environmental factors. Further, the data in this table indicated that the heritability estimates for the intellectual level of twins in the Hisar district was (52.00 %) and the remaining 48.00 per cent variance in intellectual level was due to environmental circumstances in the group age 3-4 years. The findings on heritability estimates showed that the genetic influence on the intelligence of twins in the Bhiwani district was

more than the environment. Similar results were obtained in the Hisar district. Further, this table also revealed that the heritability estimate for intelligence was 61.00 per cent in the age group 4-5 years which indicated that 39.00 per cent variance in the intelligence of twins was attributed to environmental circumstances in the Bhiwani district. In the Hisar district, the heritability estimates for the intelligence of twins was 59.00 per cent in the age group 4-5 years and remaining 41.00 per cent variance in the intelligence of twins was due to environmental situations. Further, this tables portrait that heritability estimates for the intelligence level of twins was 74.00 per cent in the age group 5-6 years in Bhiwani district. The interpretation of data indicated that the remaining 26.00 per cent variance in the intelligence of twins in the same age group was attributed to environmental factors, while in Hisar district the heritability estimate was 68.00 per cent in the same age group. The interpretation of data indicated that the remaining 32.00 per cent influence of environmental factors on the intelligence of twins in the same age group. On the conclusion of heritability estimates showed that the genetic influence on intelligence of twins as increasing scores on heritability estimates with increasing age of twins.

**Table 3:** Heritability estimates for intelligence level of twins with age in Bhiwani and Hisar district

District	Heritability (%)		
	3-4 years	4-5 years	5-6 years
Bhiwani	55.00	61.00	74.00
Hisar	52.00	59.00	68.00



**Fig. 3.1:** Heritability estimates for intelligence level of twins with age in Bhiwani and Hisar district

**Association of intelligence of twins with the preschool environment**

As data presented in Table 4 revealed that there

was an association between the intelligence of twins and with preschool environment ( $\chi^2=15.95^*$ ) in Bhiwani district. Further the data in this table also indicated that preschool environment ( $\chi^2=10.69^*$ ) was associated with the intelligence of twins in Hisar district.

**Table 4:** Association of intelligence of twins with preschool environment

Preschool environment	Intelligence				
	Bhiwani				
	Low	Moderate	High	Total	$\chi^2$
Low	29 (16.67)	24 (13.79)	13 (7.47)	66 (37.93)	15.95*
Moderate	26 (14.94)	35 (20.11)	13 (7.47)	74 (42.53)	
High	5 (2.87)	13 (7.47)	16 (9.20)	34 (19.54)	
Total	60 (34.48)	72 (41.38)	42 (24.14)	174 (100.00)	
<b>Hisar</b>					
Low	8 (6.35)	7 (5.56)	5 (3.97)	20 (15.87)	10.69*
Moderate	38 (30.16)	27 (21.43)	11 (8.73)	76 (60.32)	
High	5 (3.97)	16 (12.70)	9 (7.14)	30 (23.81)	
Total	51 (40.48)	50 (39.68)	25 (19.84)	126 (100.00)	

\*Significant at 5% level of significance; Figures in parentheses denote percentages

**Impact of intervention on intelligence of twins during 3-6 years**

As data presented in Table 5 revealed that the highly significant differences in mean values were found on all ages of twins namely, 3-4 years ( $t=12.23^{**}$ ), 4-5 years ( $t=15.77^{**}$ ) and 5-6 years ( $t=5.67^{**}$ ). Further the data in this table also showed that the highest increase in mean percentage was observed on age 3-4 years (53.91%) followed by 4-5 years (50.83%) and 5-6 years (27.45%).

**Table 5:** Impact of intervention on intelligence of twins during 3-6 years (N=90)

Age (in years)	Pre-test (n=90) Mean±SD	Post-test (n=90) Mean±SD	Increase in mean (%)	t Value
3-4 Years				
4-5 Years				
5-6 Years				

continued...

3-4	(n=30)	(n=30)	25.77	12.23**
	47.80±12.95	73.57±10.88	(53.91)	
4-5	(n=30)	(n=30)	22.94	15.77**
	45.13±7.99	68.07±8.71	(50.83)	
5-6	(n=30)	(n=30)	11.07	5.67**
	40.33±9.61	51.40±15.32	(27.45)	

\*\*Significant at 0.01% level of significance; Figures in parentheses denote percentages

## DISCUSSION

The mean score on ages, namely, 3-4 years, 4-5 years and 5-6 years for intelligence level of twins at over the Bhiwani and Hisar district as the difference was highly significant on age 5-6 years of twins, while the difference was significant on age 3-4 years but no significant difference was found on remaining age 4-5 years of twins in both Bhiwani and Hisar district. The results agree with [23] research found that twins regularly score nearly a standard deviation below the mean score on standardized measures of intellectual development and rapid gain in mean score in early childhood years. The findings were also in line with [24] in which the researcher assessed the contribution of genetic and environmental influence in the intelligence of twins and estimated that intelligence test scores are life-long stable traits. The present study results were in congruence with another twin study of [25] conducted twin study and revealed that the variability in intellectual abilities among different individuals is due to the interaction of genetic and environmental factors.

The results analysis of variance indicated that the significant difference was observed on age 3-4 years of twins among gender of twins but no significant differences were observed on the remaining ages of twins, namely, 4-5 years and 5-6 years. The results of the present study congruent with similar study of [26] concluded that gender differences are small to negligible in most intellectual traits. Another study revealed that some measures of intelligence show differences between males and females [27]. [28] found that males and females are quite similar in most-but not all-psychological traits.

The findings on heritability estimates showed that the impact of genetics on the intelligence of twins

was more in the age group 5-6 years followed by 4-5 years and 3-4 years [29]. Supported that heritability estimates for intelligence were moderate in early childhood and increased across development. The similar study provided supportive evidence that genetic influences on intelligence are highly stable and heritability estimates indicated that the genetic contribution on the intelligence of twins increases with age. Moreover, concluded that the impact of genes on intelligence overlaps largely in early childhood. [31] Eemphasized that the heritability of intelligence varies from 22 per cent to 80 per cent from early childhood to adulthood. The twin study also concluded that the substantial effect of shared environment is more during infancy, but not later in life. [32] Found that the contribution of genetics for variation in the intellectual level of twins was 50 per cent to 70 per cent. The study also indicated that the genetic influence on intelligence increase from infancy to adulthood. Genes account for intelligence maximized in a high advantaged socio-economic context. Further, twin classic study also revealed that the impact of genetics increases with the increase in age and increase environmental opportunity.

The preschool environment was associated with the intelligence of twins in over Bhiwani district and Hisar district. The present study related to another study [33] supported that the intellectual skills of twins are influenced by the preschool environment of twins. They also suggested the relative influence of genetic, shared family environment, and non-shared environment on individual differences at and across different stages of development. [34] Revealed substantial environmental influences on intelligence across the development. [35] Reported that monozygotic twins control for genes, gender, age, and aspects of the home and school environment shared by twins and observed that any difference between identical twins in academic outcomes can be attributed to the unique environment experienced by each twin.

The results of the present study highlighted that the intervention packages highly significantly improved the intelligence of twins in all ages of twins, namely, 3-4 years, 4-5 years and 5-6 years in both Bhiwani and Hisar districts. Another study also conducted an intervention study and revealed that intervention boosts the

intellectual level of twins [36]. [37] Revealed that individual differences in intelligence can be easily overcome with effective interventions that improve the intelligence of children by focusing on the strength and weaknesses of children. [5] revealed that improvement in the intelligence of twins produced by the most effective early childhood interventions and also suggested that early childhood interventions had remarkable effects on academic achievement and life outcomes. Another study provided similar results to present intervention study [38] revealed that the educational intervention provided during preschool years tends to boost the development of intelligences in the early years of life. Moreover, interventions have long-lasting influence on young children with respect to academic achievement, economic productivity and higher education.

## CONCLUSION

Genes account for approximately 55-70% of variations in the intelligence level of twins. The intelligence of twins was more influenced by genetic factors than the home environment of twins over districts. Genetic contribution on the intelligence of twins increases as an increase in age of twins. The significant difference in the intelligence of twins among gender of twins was observed on age 3-4 years but not in 4-6 years of twins. The robust and consistently sized association between intelligence level and preschool environment boosted the intelligence level of twins in early years and that significantly positively affect the later life of children. Intervention programme in the early years of life significantly improves the intelligence level of twins.

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