

Impact of Genetic and Environment on Cognitive Proficiency of Twins: Early Childhood

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ABSTRACT

The aim of the present twin study was to analyze the influence of genetics and environmental propensities on the cognitive proficiency of twins. This investigation was performed in the Bhiwani and Hisar districts of the state of Haryana. A snowball and random sampling was used for the sample of 150 pairs of twins in the age group of 3-6 years from 55 villages of two districts, Bhiwani and Hisar. Results of heritability estimates showed that the influence of genetics on cognitive proficiency was ranging from 46-68% for 3-6 years of twins. The conclusion of heritability estimates indicated that cognitive proficiency was more influenced by genetic material than environmental circumstances. Monozygotic twins were more correlated with each other in cognitive proficiency than dizygotic twins in both districts.

Keywords- Cognitive Proficiency, Genetics, Environment, Monozygotic Twins, Dizygotic Twins.

Introduction

Advanced neuroscience research has sharpened focus on the importance of the classical twin study in understanding brain structure and cognitive proficiency [4]. Twins are nature's living laboratories. The twin study provides important information regarding the genetic basis of composite character. Cognitive development may be defined as the development of thinking across the life span. The vast majority of heritable traits, such as, height, cognitive functions and Intelligence Quotient are highly heritable and very complex [5].

The heritability estimates from identical and fraternal twins are used to estimate the extent to which early genetic influences on cognition were amplified over time [7]. Genetic influences seem to be the main driving force behind continuity in general cognitive proficiency [6]. There was evidence that genetic effects on patterns of brain change over time and the magnitude of relative genetic versus environmental influences may increase over the course of development [8].

Most behavioral genetic studies have used the twin design for estimating heritability and environment through the comparison of monozygotic (MZ) and dizygotic (DZ) twin interclass correlations. Twin studies provide a framework to estimate heritable contributions between pairs of monozygotic twins, who share 100% of their genes, and dizygotic twins, who on average share 50% of their genetic endowment. Identical (monozygotic) twins' pairs showed closer similarities than non-identical (dizygotic) twin pairs at later ages. Behaviour genetics emphasized the fact that the most important and influential genes vary at different age levels and genetic influences are of different importance at different ages. According to monozygotic and dizygotic twin studies cognitive levels and cognitive abilities are influenced by an individual's genetic background [9].

The study of twins provided compelling evidence of the ubiquitous influence of genetics, as well as environments, on important human traits including physiological, psychological, and behavioral traits and disorders [11]. The study observed the genetic architecture of diverse cognitive abilities in children and adolescents including the magnitude of common genetic effects and patterns of shared and unique genetic influences [10]. Heritability estimates from twins were moderate (0.50), while estimates from the family adoption design was significantly low (0.20). The reason might be the prevalence of the non-additive genetic effect or high gene-to-gene interactions in adoption design, while the narrow sense heritability estimate may be represented only by additive genetic influences [12].

Methodology

Study Design: The twin investigation was conducted by using the descriptive research

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design. Study has planned with aim to analyze the role of genetic and environment on cognitive proficiency of twins. 150 pairs of twins with age group 3-6 years were selected from two districts i.e. Bhiwani (N = 174) and Hisar (N = 126) of state Haryana.

Data collection: The data was collected through various methods of data collection like questionnaire, interview and observation method to collect appropriate information from twins.

Tool: Cognitive proficiency of twins was assessed by using Stanford Binet Intelligence Scale [13].

Statistical Analysis: The data was analyzed and inferences were drawn through SPSS software. Correlation coefficient and Heritability estimate (h^2) were calculated to come across the aim of study. Heritability estimates (h^2) were calculated by the formula of [1], $h^2 = 2(RMz - Rdz)$

Results

Heritability estimate for cognitive proficiency of twins with age over districts

The data in Table 1 indicated that heritability estimate for cognitive proficiency of twins with the age group 3-4 years in Bhiwani district was 50% and the remaining 50% variance in cognitive proficiency of twins in the Bhiwani district was attributed to environmental circumstances. Further, the data in this table showed that the heritability estimate for cognitive proficiency twins in Hisar district was (46%) and the remaining 54% variance in cognitive proficiency was due to environmental situations in the group age 3-4 years. Result showed that genetic influence on cognitive proficiency of twins for the Bhiwani district was more than the environment. Further, the heritability estimate for cognitive proficiency was 58% in the age group 4-5 years that clearly indicated that 42% variance in cognitive proficiency of twins was attributed to environmental situations in the Bhiwani district. In Hisar district, the heritability estimates for the cognitive proficiency of twins was 53% in the age group 4-5 years and the remaining 47% variance in cognitive proficiency of twins was due to environmental situations. Further, heritability estimates for cognitive proficiency of twins was 68% in the age group 5-6 years in the Bhiwani district and remaining 32% variance in cognitive proficiency of twins in the same age group was due to environmental situations, while in Hisar district the heritability estimate was 61% in the same age group and remaining 39% influence of environmental factors on cognitive proficiency of twins in the same the age group. On the conclusion of heritability estimates showed that the genetic influence on cognitive proficiency of twins as increases scores on heritability estimates with increasing age of twins.

Table 1: Heritability estimate for cognitive proficiency twins with age over the district

District	Heritability Estimate (%)		
	3-4 years	4-5 years	5-6 years
Bhiwani	50	58	68
Hisar	46	53	61

Table 2 Correlation coefficient among monozygotic and dizygotic twins for cognitive proficiency twins from 3-6 years in both districts

Age (in years)	Correlation Coefficient (r) for Cognitive Proficiency			
	Bhiwani		Hisar	
	Monozygotic	Dizygotic	Monozygotic	Dizygotic
3-4	0.75	0.50	0.71	0.48
4-5	0.80	0.50	0.78	0.52
5-6	0.85	0.51	0.83	0.52

Discussion

The result of the heritability estimate stated that the influence of genetic on cognitive proficiency of twins ranging from 46-68 percent from 3-6 years of twins. The cognitive proficiency of twins was more influenced by genetic factors as compared to environmental factors. A similar study stated that [14] suggested that genetic factors influenced level of cognitive proficiency and specific cognitive abilities changed differently with age. [13] Analyzed the environment and heritability estimates of cognitive abilities and found that 30% of variations in cognitive abilities were due to environmental factors and 70% of variations due to genetic factors. The genetic and environment both contributed to the development of cognitive proficiency 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 [16]. [15] Another study concluded the contribution of genetics in cognitive traits and found that human cognition was strongly imprinted by heritability. [17] Indicated that general cognitive abilities were highly heritable (86%) and genetics affected the specific cognitive domains.

The findings of the correlation coefficient indicated that identical twins were more correlated with each other for cognitive proficiency in both the Bhiwani and Hisar districts. [2] Examined correlations of intelligence heritability in identical and fraternal twins, and in adopted children as well and observed that the correlation is relatively higher in MZ twins than in DZ twins.

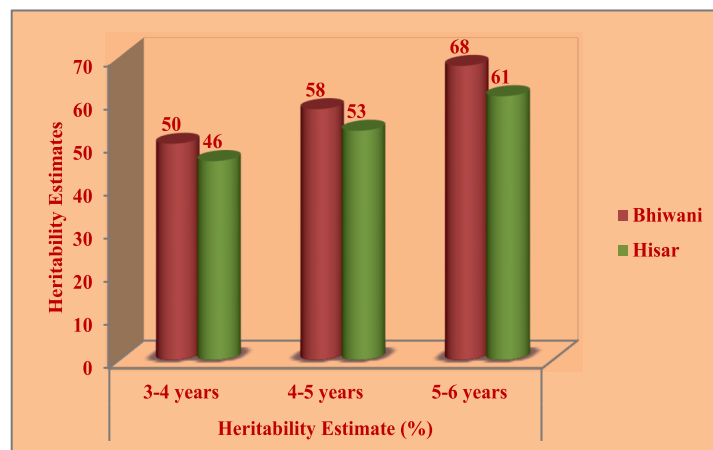


Fig.1: Heritability Estimate for Cognitive Proficiency of Twins in both Districts

The correlation coefficient among monozygotic and dizygotic twins for cognitive proficiency twins from 3-6 years in both districts

The data in Table 2 showed that the correlation coefficient among monozygotic twins for cognitive proficiency at age 3-4 years was $r=0.75$ in Bhiwani district and $r=0.71$ in Hisar district. Among dizygotic twins, the correlation coefficient for cognitive proficiency at age 3-4 years ($r=0.50$) and ($r=0.48$) in Hisar district. Further, the correlation coefficient among monozygotic and dizygotic twins for cognitive proficiency at age 4-5 years was $r=0.80$ and $r=0.50$ respectively in Bhiwani district. In the Hisar district, the correlation coefficient among monozygotic and dizygotic twins for cognitive proficiency at age 4-5 years was $r=0.78$ and $r=0.52$ respectively. At age 5-6 years, the correlation coefficient among monozygotic and dizygotic twins for cognitive proficiency was $r=0.85$ and $r=0.51$ in Bhiwani. In Hisar, the correlation among monozygotic and dizygotic twins for cognitive proficiency was $r=0.83$ and $r=0.52$ respectively. The data clearly indicated that the correlation coefficient of identical twins was more than that of non-identical twins for cognitive proficiency.

Conclusion

The variations in cognitive proficiency of twins were due to genetics ranging from 46-68 per cent in both districts. Cognitive proficiency was more influenced by genetic material than environmental situations in both districts. The stability of genetics for cognitive proficiency increased with an increase in the age of twins. The monozygotic twins had similar cognitive proficiency than dizygotic twins in both districts.

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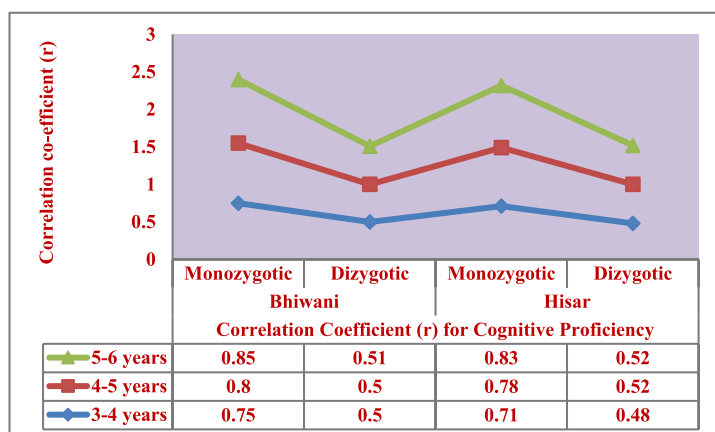


Fig.2: Correlation coefficient among monozygotic and dizygotic twins for cognitive proficiency of twins from 3-6 years in both districts

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