International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182, Print ISSN: 2349-5979, Impact Factor: RJIF 5.72
www.allsubjectjournal.com
Volume 4; Issue 6; June 2017; Page No. 411-414

Impact of heredity and environment on IQ: An investigation

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Abstract
Heredity is the process of transmission of characteristics from one generation to another. Genes are the suppliers of specific traits. Environment is the sum total of all the external conditions that affects an individual. It includes social, cultural and life experiences. Twin studies explain variations in individual intelligences. Family studies, adoption studies and ethnic differences provide evidences of heritability. The physical and social environments provided by parents, education and schooling influences IQ development. Differential exposure of specific genotypes to specific environment produces different results of variation of IQ on different individuals. Influence of environmental evidences on IQ explains that biologically unrelated children, reared under same environment may show similarities in IQ content. Childhood illness, lead poisoning and other hazardous diseases may be caused both due to genetic and environmental interaction. Both heredity and environment affects development of intelligence and other cognitive abilities. More research work and case studies are required in this field to resolve controversies related to heredity and environmental effects on intelligence among individuals.

Keywords: heredity, IQ, environment, intelligence measure, correlation, schooling etc.

Introduction
Having reviewed the evidences of case studies, we can be left in no doubt that both heredity and environmental factors have an important influence on IQ. The genetic materials transmitted to us from our parents make a contribution. Both genetic and environmental factors combine in determining IQ. Both are essential and IQ development is impossible without one another. To illustrate how the two factors combine, it was found that, a child who has learning difficulties due to genetic error, may never be able to attain a high IQ, no matter how stimulating be the environment. But, this does not mean that the child's IQ could not be improved. Appropriate beneficial programmes could prove to beneficial IQ increment. On the contrary, it can also be said that, a child who has potential for very high IQ may not reach his level if he lives in a severely impoverished environment.

Debates about how much of IQ is due to genes and how much due to environmental factors ultimately seem to be futile for the simple reason that it is difficult to envisage how we could even arrive at a definite answer. Perhaps the most useful approach is to accept that both are important. Besides bringing about changes in genetic components, it is better to channelize our energy towards investigating what might be the most intellectually beneficial environment.

Heredity is a process of transmission, by genes, of specific traits from ancestor (parents) to descendant (infants). Hereditarianism emphasizes the importance of the role of genetic factors. Heredity plays important role in identifying ability. It gains ground from the fact that some families produce eminent persons, generation after generation.

The environmental influence on a person is the sum of all exterior conditions (society, culture, and life experience) that may affect the life of an individual.

Heritability of intelligence
Heritability is a mathematical estimate that indicates how much of a trait's variation in a population can be attributed to genes. Estimates of the heritability of intelligence vary, depending on the methods used. Most researchers believe that heritability of intelligence is between 60 percent to 80 percent. However, we do not know much about the quantity and character of genes responsible for mental abilities. Twin studies on intelligence were carried out in 1920s. Later animal studies on maze-bright and maze-dull rats investigated individual differences in intelligence. The study of intelligence genetics examines how much and by what manner mental abilities are affected by genes. Since many genetic and environmental factors influence intelligence, it is considered a complex trait.

We can investigate the heritability of IQ by testing identical twins, known as monozygotic twins (MZ). They develop from the union of a single sperm with a single egg. Shortly after conception, the fertilized egg splits to form two separate individuals who are genetically identical. Identical twins have identical IQs since their genetic constitution is same, or it could be because they have the same experiences. A little bit variation in IQ could be attributed to different environmental factors.

But in case of formation of dizygotic twins (DZ), the mother has two eggs, both of which are fertilized by different sperms. Genetically these twins are just like ordinary brothers and sisters, sharing 50% genetic constitution, and they are only special in that they share the mother's womb.

Evidences of influence of heredity on intelligence
Evidence for hereditary influences on intelligence comes from

the following observations:

- Family studies show that intelligence tends to run in families.
- Twin studies show a higher correlation between identical twins in IQ than between fraternal twins. This holds true even when identical twins reared apart are compared to fraternal twins reared together.
- Adoption studies show that adopted children somewhat resembles their biological parents in intelligence.

A few well-known proponents support hereditary explanations for cultural and ethnic differences in IQ

- In the late 1960s, researcher Arthur Jensen created a storm of controversy by proposing that ethnic differences in intelligence are due to heredity. He based his argument on his own estimate of about 80 percent heritability for intelligence.
- In the 1990s, researchers Richard Herrnstein and Charles Murray created a similar controversy with their book, *The Bell Curve*. They also suggested that intelligence is largely inherited and that heredity at least partly contributes to ethnic and cultural differences.

Environmental influences on IQ

Environmental influences on IQ can take a variety of forms. The physical and social environments provided by parents affect IQ of learners. External variables, such as level of education and schooling, is the cause of enhanced IQ. Frustration, repeated failure, drop out from schools etc. can lower IQ of individuals. It is widely recognized in the domain of child development that effects of socialization and environmental interaction affects IQ development.

Genotypes of higher intelligence respond more to increasing favorableness of the environment than do genotypes of lower intelligence. Differential exposures of specific genotypes to specific environment expresses different results of variation of IQ on different individuals. If intelligent parents provide a favorable trait-relevant environment for development of intelligence of their children, and less intelligent parents provide a less favorable trait-relevant environment, children in natural biological families will experience similar genotype environmental interactions.

Evidences of environment influences on IQ

Many researchers believe that environmental factors primarily cause cultural and ethnic differences. Evidence for environmental influences on intelligence comes from the following observations:

- Adoption studies demonstrate that adopted children show some similarity in IQ to their adoptive parents.
- Adoption studies also show that siblings reared together are more similar in IQ than siblings reared apart. This is true even when identical twins reared together are compared to identical twins reared apart.
- Biologically unrelated children raised together in the same home have some similarity in IQ.
- IQ declines over time in children raised in deprived environments, such as understaffed orphanages or circumstances of poverty and isolation. Conversely, IQ improves in children who leave deprived environments and enter enriched environments.
- People's performance on IQ tests has improved over time in industrialized countries. This strange phenomenon, which is known as the *Flynn effect*, is attributed to environmental influences. It cannot be due to heredity, because the world's gene pool could not have changed in the past years or so since IQ testing began.
- Although some investigators contend that there is "compelling evidence that early malnutrition is a contributing factor in the incidence of mental deficiency" (Kaplan, 1972), others feel that "it remains a rather open question whether, to what extent, in what way, and by what means malnutrition lastingly influences psychological development" (Warren, 1973). Progress has been made in this area, although most of the important questions are unresolved.

Review of related literature

The physical and social environments provided by parents are, in turn, correlated with characteristics of the parents, such as their IQs. Consequently, correlations between environmental measures and IQs obtained in such setting are confounded with genetic variance.

"Organism is a product of its genes and its past environment" (Anastasi, 1958, p. 197). This is true at the level of development for the individual. Interactions, in principle, can take a variety of forms (Haldane, 1946; Vale, 1980) [5, 11]. In this scheme, genotypes for higher intelligence respond more rapidly (steeper slope) to increasing favorableness of the environment than do genotypes for lower intelligence. There is very little convincing evidence for any genotype X environment interaction (Bouchard, 1976; Jinks & Fulker, 1970), but this is due in part to the lack of adequate date to test for it.

Genotype and environment correlations refer to the differential exposure of specific genotypes to specific environments. Plomin, Defries, and Loehlin (1977) [11] discuss three types of genotype and environment correlation.

Plomin, Defries, and Loehlin (1977) [11] have outlined a number of research strategies of assessing genotype and environment correlation, but they remain unimplemented.

Sternberg states in his article, Myths, Countermyths, about intelligence, is "intelligence could be partially or even highly heritable and, at the same time, partially or even modifiable".

Also, in his review of Sternberg & Grigorenko's book, 'Intelligence, Heredity, and Environment', Akamatsu says, "both heredity and environment contribute to intelligence, and [they] both interact in various ways" (Akamatsu, p. 84). On the basis of such statements, it is very obvious that each side has its own evidence and its role in effecting intelligence. However, both heredity and environment are very important in determining the level of one's intelligence.

In the past years, genetics were able to persuade most psychologists that heredity plays an effective role in influencing intelligence (Plomin & DeFries, 1998).

In 1948, a study was conducted by McCall *et al.* found that children who obtained high IQ scores are raised in families that value and take education into a significant consideration. On the other hand, some families place more emphasis on primary and survival learning skills. Those families' children are anticipated to gain low IQ scores because there is neither motivation, stimulation, nor encouragement from their

families (McCall and *at el.* 1973). Bruner says, "intelligence depends on the incorporation of culture" (Burner in Singh, 1996) [12]. Therefore, it is obvious that educational opportunities and experiences will not be equal, which finally affect intelligence. In addition, there are others factors that somehow affect intelligence. These factors, (Neisser *et al.* 1995) listed in the report of the Board of Scientific Affairs of the American Psychological Association, are as follows -

a) Social Variables including occupation, schooling, interventions, and family environment;
b) Biological Variables including nutrition, lead, perinatal factors, and alcohol;
c) Continuously rising test scores; and
d) Individual life experiences.

Jay(1972) has shown that while normal children have higher IQ, malnourished children show signs of psychomotor retardation.

The interrelationship of IQ and family background, social-class, socio-economic status has been studied by many social scientists and researchers. The meta-analysis of this literature by White (1982) reveals that some measures of socio-economic status correlate to a great extent.

Educational histories of parents are equally related to IQ and yield an average correlation of about 0.30. Correlations between parental socioeconomic status measures and child's IQ of biological families are also studied in large scale research works.

Evidences of heredity and environmental interaction on IQ

Some of the evidences related to effect of heredity and environmental interaction on IQ are as follows:

a) Childhood illness: Investigation of the relationship of childhood illness to latter IQ explains that childhood illness may cause retardation in IQ content. Required preventions include proper selection of maternal age, birth status, social class and so on. This kind of result is obtained through an extensive study of verbal scores of 43,820 Birmingham (England) children (mcKeown & Record. 1976).
b) Lead poisoning: Lead poisoning poses a serious problem in some central cities (Oberle, 1969) [9], due to the widespread use of leaded paints prior to 1940. Both the collaborative study and a large-scale longitudinal study in Hawaii (Werner, Bierman & French, 1971) strongly suggest that the effects of perinatal stress exist on intellectual functioning. Joffe's (1969) review of the previous literature reaches to a similar negative conclusion.
c) Twin study tests: One of the most common research methods is twin studies (Scott, 1998). Twin studies are used to estimate the influence of genes and environment on individual intelligence. For instance, Monozygotic (MZ) refers to identical twins (either Shared Environment or Non-Shared Environment) that share 100% of their all genes, but Dizygotic (DZ) refers to fraternal twins (Shares Environment) that share only 50 % of their genes (Hughes & Cutting, 1999). In 1981, a study was conducted by Bouchard and McGue, which showed the following findings:

Table 1

Intelligence Measure	Correlations		
IQ	MZT	DZT	MZA
	N=4672	N=5546	N=29
	.85	.58	.73

MZT= Monozygotic reared together. DZT= Dizygotic reared together. MZA= Monozygotic reared apart

The correlation of test scores for MZT and MZA twins are high whereas the correlation scores of DZ twins is generally around 50% i.e. fifty-fifty chance. Whatever be the chances 'there is a consistent indication that heredity has an influence and the anatomical and biochemical differences can surely be expected to have behavioural consequences" (Cronbach, 1977). Researchers working on the same area may give different correlation values of coefficient of heritability which may be due to their treatment of genetic dominance or the correlational share of either heredity or environment.

Schooling and IQ

Schooling is an important factor that affects intelligence. By schooling, one can improve knowledge of specific facts for intelligence tests, familiarity with testing practices, concentration and attention span, and verbal problem solving skills. Therefore, there is no doubt that schooling helps raise one's IQ. Research has indicated that children who do not attend school or who attend intermittently eventually have poorer scores on IQ tests than those who attend regularly. At the same time, children who move from low-quality schools to high-quality schools are more likely to show improvements in IQ scores.

The correlation between adult IQ and amount of schooling completed is quite high. Matarazzo (1972, p. 373) reports the full-scale correlations for three age groups in the WAIS standardization sample as .69 (ages 18-19), .66 (ages 25-34), and .72 (ages 45-54, N = 300).

Different surveys and research also reveal the following factors:

- Staying in school itself can raise IQ or prevent it from dropping.
- IQ is affected by delayed schooling. A drop in IQ is seen when schooling is delayed.
- Each additional month a student remains in school may increase her/his IQ above what would have been expected had he dropped out.
- In short, schooling has a long-term effect on the level of intelligence. Studies repeatedly show that performance on intelligence test is correlated with school achievement (N. Brody, 1997; Gustafsson & Undheim, 1996; Sattler, 2001). IQ scores and other measures of cognitive ability provided by school experiences often increase over time when children are highly motivated, independent learners and when adults provide stimulating activities and a variety of reading materials (Echols, West, Stanovich, & Kehr, 1996;

Sameroff, Seifer, Baldwin, & Baldwin, 1993; Stanovich, West, & Harrison, 1995).

Areas of further research

The argument is whether heredity or environment has the most influence on intelligence. The heritability and environment factors are extremely complicated and strictly interacting with one another. Research can be carried out in this field on basis of review of previous studies.

Research can be conducted to predict whether good home environment or poor environment accounts for differences in intellectual development of a child. Influential developmental factors like parental attitude and child rearing practices can affect intellectual development.

Research can be conducted to find out the correlational values between parental socioeconomic status measures and child's IQ content to study the effect of environment on child's development of mental ability.

Research work can be organized to find out the most appropriate school environment suitable for child's mental growth.

Research and surveys may also reveal why rural children or children from remote regions or children less exposed to advanced modes and methods, on an average earn lower scores of standardised IQ tests than more advantageous group of urban and metropolitan children.

Research can be conducted through various case studies to find out to what extent heredity accounts for differences in IQ content through study of different traits or characteristic behaviour of child.

Researches may also predict different remedies and environments suitable for mentally retarded children with low IQ content, who are affected by hereditary disorders.

Conclusion

The literature dealing with the influence of heredity and environmental factors on IQ is quite large. A large number of books have focused on the heredity environment controversy. Modern research indicates that a combination of heredity and environment constructs us all. Both external and internal variables combine to create personalities and behaviours of human beings having unique characteristics. There are different debates regarding the contribution of specific percentages of heredity and environmental factors in developing IQ of learners. Family studies, twin studies and adoption studies help to get idea about the factors affecting intelligence. Chatacteristics of human beings are diverse in nature. Even in some cases genes seems to dominate, while in other cases, environment effects total cognitive behaviour. More investigations need to be done and more research projects should be created to resolve arguments regarding effect of heredity and environment on IQ upliftment of individuals.

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