

Venerable Chancellor,  
Venerable Mahasanga and the Clergy of Other Religions,  
Vice Chancellor, Deans of Faculties,  
Members of the University Council and Senate,  
Members of the Academic, Administrative and Non-academic Staff,  
Invitees, Parents, Well-wishers and Graduates.

I consider it a great honour to be invited to deliver the convocation address of the Faculty of Graduate Studies. I thank the Dean and the Faculty Board of the Faculty of Graduate Studies for this honour.

It is indeed a pleasure to return to this University in which I spent the last fourteen years of an academic and professional career of nearly forty two years. I consider this the most productive part of my career and the part in which I came in to contact with a much broader cross section of the academia than I had done before. It was my good fortune that I had the opportunity to be associated with this seat of learning which in spite of its tumultuous history, has made an indelible imprint on our national identity and character.

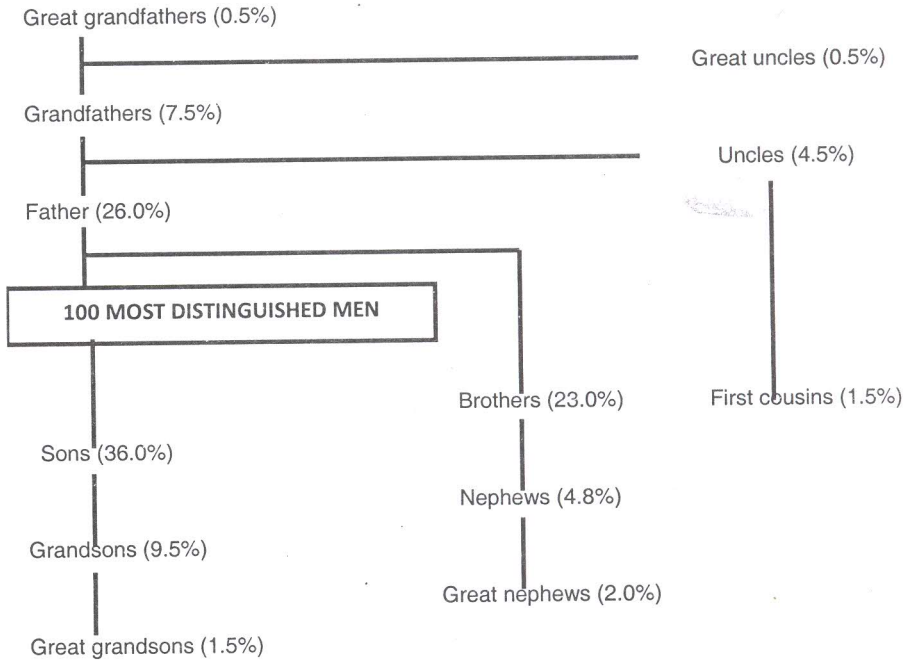
The Faculty of Graduate Studies though relatively young has contributed immensely to its post graduate programs and research. Having organized an academically impeccable 50<sup>th</sup> anniversary research conference it has progressed in the recent past in its infrastructure and in the content and quality of its programs. I am happy to note the establishment of a multidisciplinary board of study. I was pleasantly surprised at the high quality of participation and discussion at the recently conducted symposium on "Chronic kidney disease of unknown etiology in the North central province". To me it epitomized the intellectual discourse sans boundaries that we expect from a Faculty of this calibre.

As diplomates and graduates of this Faculty I consider you to be a relatively elite group even in the present Sri Lankan context cluttered with convocations of numerous state and private higher educational institutions. I wish you well in your future academic or professional career. I hope that you have acquired mastery not only of your subject but of your self, in order to guide your destiny as a productive member of this knowledge based society.

This afternoon I will be speaking on a question which has interested me as a paediatrician and a teacher for quite some time. Is cognitive ability inherited or acquired? During the next twenty minutes or so I will take you through the history of this debate and conclude with what appears to be the current consensus.

## HEREDITARY GENIUS

Francis Galton



Cognition is defined as the mental act or process by which knowledge is acquired, including perception, intuition and reasoning. Intelligence is defined as the capacity for understanding, ability to perceive and comprehend meaning. In my address I will be focusing on general cognitive ability and I will treat it as synonymous with intelligence.

It was Francis Galton, a British polymath and a cousin of Charles Darwin who initiated the controversy on the relative role of “nature” or heredity and “nurture” or environment in determining human ability and behavior.

In an article in Macmillans magazine published in 1865 entitled “Hereditary Talent and Character” and in an expanded discussion published four years later under the title “Hereditary Genius: An Enquiry into its Laws and Consequences” he demonstrated that a greater number of able individuals is found among relatives of persons endowed with high mental ability than would be expected by chance. He also showed that closer the relationship higher was the incidence of superior individuals. On the basis of this data Galton concluded that nature or heredity prevails enormously over nurture or environment in determining human ability and genius.

In retrospect, it is clear that Galton overstated his case and that his conclusion was not warranted on the basis of the data he presented. Searching for a method to disentangle these two sources of influence he introduced both twin and adoption studies. Galton was the first to attempt measuring of intelligence. He also described the method of correlation, variants of which still underlie most twin research. Galton can thus be considered the founder of quantitative behavioral genetics.

The view of intelligence being an innate or inherited characteristic which could not be modified or changed held sway amongst scientists and intellectuals during the latter part of the 19<sup>th</sup> century and the early part of the 20<sup>th</sup> century.

This view led to the development of the Eugenic movement. Galton was the founder of the British Eugenic society. The word "Eugenics" which is derived from Greek, means "Good in birth". Eugenicists believed that human society could be improved by selective breeding. The American Eugenic movement convinced the governments of twenty American states to enact legislation which enabled compulsory sterilization of the "mentally unfit". The prevailing sentiment was stated in a judgment of the US Supreme court in 1927. "It would be better for all the world, if instead of waiting to execute degenerate offspring for crime or let them starve for their imbecility, society can prevent those who are manifestly unfit from continuing their kind." They urged the Federal government to restrict immigration of "undesirable" races and to submit prospective immigrants to intelligence testing at the point of entry. No nation practiced Eugenics as enthusiastically as Nazi Germany whose program culminated in "euthanasia" or "good death" of mentally and physically disabled as well as of people of so called "undesirable races".

It was in the 1930s with the emergence of behaviorism that the pendulum began to swing to the other extreme. According to the behaviorists all behavioral traits including intelligence were exclusively determined by the environment or culture with little or no contribution from inheritance.

In 1930 John Watson the founder of behaviorism proclaimed "Give me a dozen healthy well formed infants and my own specific world to bring them up in and I will guarantee to take any one of them at random regardless of his talent, ability or the race of his ancestors and train him to be any type of specialist I might select, doctor, lawyer, artist, merchant and yes even beggar or thief"



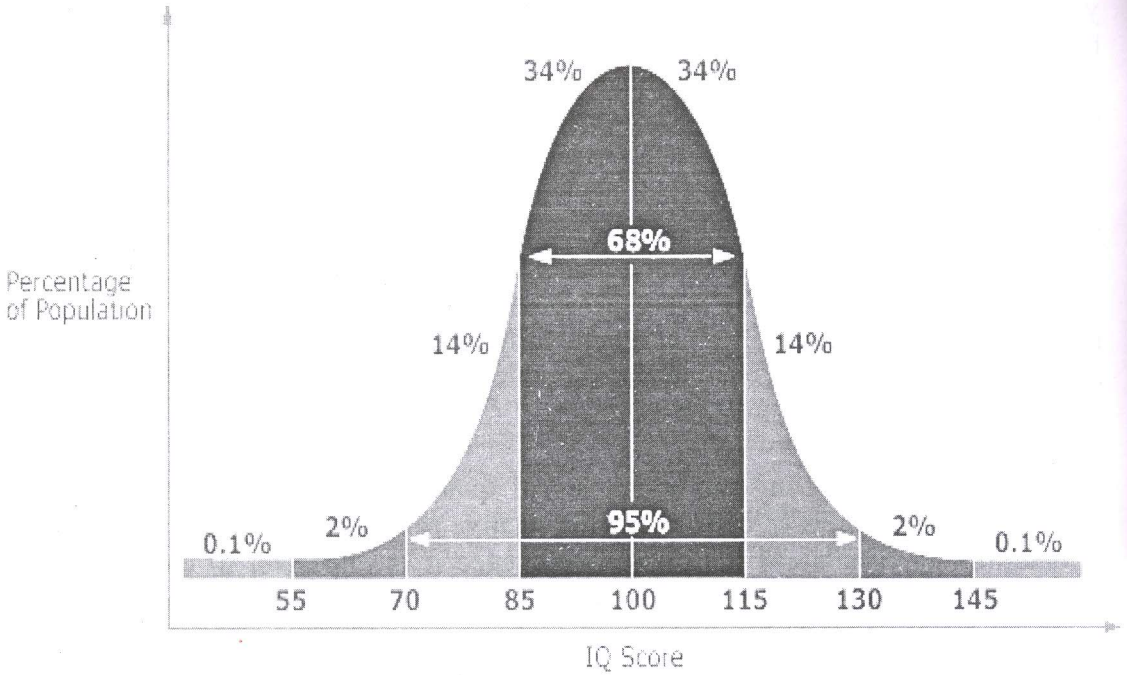
Revulsion of eugenics due to Nazi atrocities as well as its racist and "classist" overtones enabled the behavioral view point to reign for nearly forty years as the dominant explanation for individual differences in human ability and behavior. Sigmund Freud's theory of development which had enormous impact in the 1950s in terms of the belief that origins of mental illness lay in childhood experiences added further credence to the behaviorist or environmental view point.

However in the latter half of the Twentieth century the tide began to turn. A survey of 1000 social and behavioral scientists in 1987 showed that by then a majority accepted some role for inheritance in determining intelligence. This change of attitude was influenced by two developments. Firstly there emerged from animal research fairly strong evidence for genetic influence on behavior. Secondly there was accumulation of results from twin and adoption studies in humans which suggested a strong genetic influence on intelligence.

Before considering the principles of quantitative behavioral genetics, the science which attempts to disentangle the relative role of heredity and environment in determining behavioral traits like intelligence it is important to consider some fundamental concepts regarding the nature and measurement of intelligence. At the outset it needs to be emphasized that there is no clear consensus amongst psychologists and psychometricians about the nature of intelligence or IQ. However a majority agree on the existence of an overarching general cognitive ability also referred to as "g" factor and its measurability using conventional tests of intelligence or IQ. There is also some agreement on the ability of these test scores to predict school performance and academic achievement. There is less agreement about their ability to predict, by themselves, success in one's occupation or in life in general. As most of these tests have been derived based on western populations living in developed countries there is also a lack of consensus on their cross cultural validity.

We must also appreciate that intelligence scores are a continuous variable which is distributed quantitatively in a normal bell shaped curve. Inheritance of intelligence is postulated to be multifactorial or polygenic i.e. many genes with a small effect cumulatively interact with environmental factors to produce differences among individuals. It is unlikely that any single gene accounts for major part of variance in the population. Rare single gene disorders such as phenyl ketonuria which can cause severe defects in cognitive ability in an individual contribute negligibly to the variance within the normal range of individual differences. The same applies to Fragile X syndrome which is caused by an abnormality in the long arm of the X chromosome or Down's syndrome or Mongolism which is due to the presence of a third chromosome (Trisomy) at position 21.

IQ Score Distribution



Quantitative genetic theory is used for the study multifactorial (polygenic) traits in order to delineate the relative contributions of heredity and environment. There are four fundamental propositions in this theory. Genetic differences among individuals can lead to phenotypic (observed) differences. Environmental differences among individuals can also produce phenotypic differences. If genetic differences are important for a particular trait phenotypic similarity among relatives should vary according to their genetic similarity. If shared environmental factors influence a particular trait phenotypic similarity will be seen among relatives who have lived together.

The study of twins has contributed significantly to determining a genetic causation. Twins are of two types. Monozygotic twins are from a single zygote which divides into two embryos. They are identical and have the same genes. Dizygotic twins result from two ova fertilized by two separate spermatozoa. They are called fraternal twins. They are genetically as similar as siblings and on average share one half of their genes in common. By comparing the concordance(similarity) of a trait in identical twins to the concordance in fraternal twins, it is theoretically possible to estimate genetic influence on the trait. Both types of twins are usually reared together and therefore share many environmental exposures and cultural



factors. If a trait was determined completely by genes, identical twins would be concordant (both have the trait) 100% of the time while fraternal twins would be concordant not more than 50% of the time, depending on mode of inheritance.

Another approach is to study identical twins who are separated at birth and raised in different households. The assumption is that any differences between identical twins are caused by the environment and similarities are due to their shared genes. The heritability of a trait can be estimated by these means.

The separation between genetic and environmental factors that occur when a child is removed from the biological (natural) parents and raised in another environment by adoptive parents provides the basis for adoption studies. The similarity of child under study (proband) with respect to a trait, to adoptive and biological parents is compared. A genetically determined trait would show greater similarity between the child and the biological parents.

Both twin and adoption designs are used to estimate the heritability of IQ. Heritability is the proportion of variance between individuals for trait under study (IQ) that is due to genetic reasons. It quantifies the extent of genetic influence.

For twins reared together i.e. brought up in the same environment covariance in identical twins will be due to all genetic influence plus shared environment. Covariance for fraternal twins is due to half genetic influence plus shared environment. The difference in correlation between identical and fraternal twins would thus equal half of the heritability. If the difference is doubled it would give an estimate for heritability.

Similar calculations are made for all other study designs. The following is summary of heritability estimates of intelligence (IQ) using different study designs. It is taken from a monograph on the subject by Robert Plomin. Heritability is expressed as a decimal (.xx)

**HERITABILITY ESTIMATES FOR IQ**

<b>Source</b>	<b>Estimate</b>
<ul style="list-style-type: none"> <li>• Doubling the difference between correlations for identical and fraternal twins reared together</li> </ul>	0.52
<ul style="list-style-type: none"> <li>• Doubling the correlation for biological parents and their adopted way offspring</li> </ul>	0.44

- Doubling the correlation for biological siblings adopted apart 0.48
- Doubling the difference between correlations for nonadoptive parents & offspring & adoptive parents & adopted offspring 0.46
- Doubling the difference between correlations for nonadoptive sibling & adoptive siblings 0.30
- The correlation for identical twins reared apart 0.72

The mean estimate for heritability of IQ based on these studies is  $0.50 \pm .$

There are some distinguished biologists who question the validity of heritability estimates. They feel that it does not make allowance for interaction between heredity and environment. The methodology assumes that they are acting independently of each other. There is a difference in the impact of the shared environment and the non shared environment. It is also possible that nature may influence how you experience nurture. Turkheimer using the twin methodology showed that the shared environment had a greater impact than heredity on IQ scores in lower socio economic groups while the reverse was true in the higher socio economic groups.

In 1994 Richard Herrnstein and Charles Murray from Harvard University created a storm in the debate on heritability of IQ by the publication of their book "The Bell Curve" in which they claim that separated twins studies represented the

“purest “of the measures of heritability and that inheritance is strongly heritable with a heritability estimate of  $0.60 \pm 0.20$ . They also go on to state that social intervention can do little to raise IQ. The book’s main thesis is that an individual’s intelligence which is inherited genetically from his or her parents has more effect than the socio economic background on future life experiences and thereby on socio economic success in society. In short they suggest that low IQ leads to poverty and not vice versa. They also imply that the 15 point difference between black and white IQ scores are due to genetic reasons.

To say that the book caused a storm in the scientific world is an understatement. What it caused was a category 5 hurricane! There was a furious and immediate response from those with an opposing view point. No less than five scholarly responses have now been published.

In “Intelligence, Genes and Success ” Daniel, Devlin and Roeder suggest that in studies of identical twins reared apart at birth, the possibility that sharing a uterus for nine months may account for some later similarities has been ignored. According to them this effect appears to be substantial and a statistical analysis to compensate for it produces a lower estimate of heritability around .48.

The contention in the book that irked most scientists was the implication that IQ was immutable and that social interventions like affirmative action (positive discrimination) and early childhood care and education were of no benefit. In their view a heritability estimate does not in any way constrain the effects of a changed environment. This view was nicely summarized by Jay Gould “The hereditarian fallacy is not in the simple claim that IQ is to some degree heritable but in the equation of heritability with inevitability”

The notion that the black white differences in IQ were due to hereditary reasons was also rejected by the majority. The American Psychological Association (APA) convened a task force of main stream psychologists who rejected a genetic interpretation of this difference.

No discussion of genetic influence on intelligence in the present day can be complete without reference to molecular genetic approaches. With the completion of the human genome project, there was much expectation that genes related to intelligence and other human talents were soon to be discovered. James Watson the Director of the project and the Nobel prize winning co-discoverer of DNA is on record as saying “We used to think that our fate was in our stars. Now we know that



to a great extent it is in our genes.” However this has proven to be a false expectation. As much human behavioral traits like intelligence are due to multiple genes with small effects rather than one or two major genes, the search for these genes is more difficult and has not yet been successful.

Though there have been several reports for discovery of genetic markers for some cognitive abilities and learning disorders none of these have been confirmed by other workers. In fact some have been retracted by the original claimants.

Thus in the nature vs nurture debate regarding intelligence the pendulum has now swung to the middle. Both are important. This is what you and I have always thought from a purely common sense point of view. The experts at the two extremes have confused us with their “scientific zealotry.”

Now I would like to deal briefly with some of the environmental determinants of cognitive ability. A variety of environmental factors are known to affect IQ. These include socio economic status, early childhood care, maternal responsiveness, schooling and nutrition. The role of the intra-uterine environment too is under study.

The impact of nutrition on cognitive ability has been studied extensively during the last two decades. In spite of certain methodological weaknesses the sheer quantity of data overwhelmingly establishes a role for nutrition in influencing cognitive ability. There is good evidence now to show that iron deficiency anemia in infancy is associated with a significant and sustained impairment of cognitive development. Intervention studies have shown that this can be prevented by appropriate and timely supplementation.

Although we are familiar with the effects of severe iodine deficiency causing endemic goitre in the mother and endemic cretinism in the child it is only recently that the effects of mild and moderate iodine deficiency on cognitive ability are becoming evident. Recent meta analysis of 18 studies showed a large effect with a difference of 13.5 IQ points between iodine deficient and iodine adequate population. This problem is now largely dealt with by universal salt iodination programs.

As for severe protein energy malnutrition in early childhood there is no doubt that it is associated with cognitive deficit compared to age and sex matched controls who were not malnourished. What is not clear is whether the deficits are caused by nutritional deficiency per se or by the usually concomitant socio cultural deprivation which these children are subject to.

The few intervention studies that are methodologically adequate support the view that multi focal intervention which includes nutritional supplementation, social inputs and education are more likely to succeed than purely nutritional interventions. There is no scientific evidence for the much hyped claim in recent advertisements that fortification of milk formula for children aged one year or more with DHA will enhance their cognitive ability. However there is some evidence that exclusive breast feeding during the first six months of life may be beneficial in this respect. As a paediatrician I will take this opportunity to re emphasize the critical importance of a nurturant environment in the early years of life for a child's developmental trajectory and life course.

I would like to end this talk on a positive note. There is clear evidence that IQ scores have risen steadily and dramatically ever since they were introduced early this century. This phenomenon has been documented in about 20 countries mostly from the developed world. This is similar to the positive secular trend in stature (height) that has been documented in the developed world. There is a general consensus that this is more likely to be due to environmental rather than hereditary factors.

In conclusion I would like to stress that though there is evidence for substantial genetic influence on cognitive ability, it does not imply that differences amongst individuals are immutable and irremediable. In fact there is more than ample evidence that environmental factors could make a difference. Science does not deny the benefits of a nurturing environment or a helping hand.

**Prof. Narada Warnasuriya**  
**Former Vice Chancellor**  
**University of Sri Jayewardenepura**