pISSN: 2454-7107, eISSN: 2455-4189

Indian Journal of Law and Human Behavior
Volume 8 Number 2 / July - December 2022
DOI: http://dx.doi.org/10.21088/ijlhb.2454.7107.8222.6

Review Article

Genetic and Psychology: How Far have we Reached

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How to cite this article:
Neha Sethi, Saquib Ashaq, Surabhi Verma, S P Subashini/Genetic and Psychology: How Far have we Reached/Indian J Law Hum Behav 2022;8(2):81-85.

Abstract

Much of what we thought we knew about genetics needs to be modified in light of recent discoveries. What are the implications of these advances for identifying genes responsible for the high heritability of many behavioural disorders and dimensions in childhood. Although quantitative genetics such as twin studies will continue to yield important findings, nothing will advance the field as much as identifying the specific genes responsible for heritability. Advances in molecular genetics have been driven by technology, especially DNA microarrays the size of a postage stamp that can genotype a million DNA markers simultaneously. The ultimate goal of GWA is to sequence each individual's entire genome, which has begun to happen.

Keywords: Genetic; Heridity; Therapies; DNA; GWAS.

INTRODUCTION

GWA studies suggest that for most complex traits and common disorders genetic effects are much smaller than previously considered: The largest effects account for only 1% of the variance of quantitative traits. This finding implies that hundreds of genes are responsible for the heritability of behavioural problems in childhood, and that it will be difficult to identify reliably these genes of small effect. Another discovery with far-reaching implications for future genetic research is the importance of non-coding RNA (DNA transcribed into RNA but not translated into amino acid sequences) which redefines what the word gene means. Non-coding RNA underlines the need for a genome wide approach that is not limited to the 2% of DNA responsible for traditional genes that are translated into amino acid sequences. The only safe prediction is that the fast pace of genetic discoveries will continue and will increasingly affect research in child psychology and psychiatry. DNA microarrays will make it possible to use hundreds of genes to predict genetic risk and to use these sets of genes in top down behavioural genomic research that explores developmental change and continuity, multivariate heterogeneity and co-morbidity, and gene environment interaction and correlation. A crucial question is whether the prediction of genetic risk will be sufficiently robust to translate into genetically based diagnoses, personalised

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Received on 27-04-2022

Accepted on 28-05-2022

treatments, and prevention programmes.[1]

Ronald Wilson presented the first clear and compelling evidence that the heritability of IQ increases with age. We propose to call the phenomenon 'The Wilson Effect' and we document the effect diagrammatically with key twin and adoption studies, including twins reared apart, that have been carried out at various ages and in a large number of different settings. The results show that the heritability of IQ reaches an asymptote at about 0.80 at 18–20 years of age and continuing at that level well into adulthood. In the aggregate, the studies also confirm that shared environmental influence decreases across age, approximating about 0.10 at 18–20 years of age and continuing at that level into adulthood. Dizygotic twins became less concordant with age and eventually matched their singleton siblings as closely as one another. The overall results suggested that the course of mental development is guided by the intrinsic scheduling of the genetic program acting in concert with maturational status and environmental influence. The first is that IQ is significantly heritable beginning at least at age 7. The second is that by age 10 genetic variance is larger than shared environmental variance. Third, the heritability increases with age until late adulthood when it reaches the mid-seventies and higher for some populations. Contrary to the widespread belief that 'the slings and arrows of outrageous fortune' accumulate over time (a version of the spun glass theory of mind; Schofield, the brain appears to be a robust and resilient mechanism. It may be that the effect is real in childhood and young adulthood but fades in adulthood. It may also be that different genes are at work in adulthood and the processes they mediate do not interact with SES. The fundament point is that different genes are in play at different times and the manner in which they influence an organism's transactions with the environment also varies with time.[2]

METHODS OF STUDY

Heritability can be estimated using a number of methods. These include twin, family and adoption studies, in addition to or in combination with, molecular genomic analysis either of particular genes or via genome-wide association studies (GWASs), which allow us to associate the phenotype of interest with the genetic sequence of individuals. GWASs are observational studies of a genome-wide set of alleles in different individuals to see if any variant is associated with the trait analysed. GWASs typically focus on associations between different single nucleotide polymorphisms (SNPs), which are the most common type of genetic variation among people. Each SNP represents a difference in a single nucleotide within the DNA molecule. There are roughly 4–5 million SNPs in a person's genome, which may be unique or occur in many individuals. In the context of heritability calculations for cognitive functions, SNPs can be used as biological markers or they may play a direct role in the characteristic analysed. Heritability captures how much of the variation of a trait between individuals within a population is due to genetic differences, and as mentioned, it must be used only as a parameter of the population.[2]

As continues, Although quantitative genetics such as twin studies will continue to yield important findings, nothing will advance the field as much as identifying the specific genes responsible for heritability. Advances in molecular genetics have been driven by technology, especially DNA microarrays the size of a postage stamp that can genotype a million DNA markers simultaneously. DNA microarrays have led to a dramatic shift in research towards genome wide association (GWA) studies. The ultimate goal of GWA is to sequence each individual's entire genome, which has begun to happen estimate the net effect of genetic and environmental factors on individual differences in any complex trait, including behavioral traits. In addition, molecular genetic methods are used to identify specific genes responsible for genetic influence. Research is carried out in both animals and humans; however, studies using animal models tend to provide more-accurate data than studies in humans because both genes and environment can be manipulated and controlled in the laboratory.[7]

So, as continues By mating related animals such as siblings for many generations, nearly pure strains are obtained in which all offspring are genetically highly similar. It is possible to screen for genetic influence on behaviour by comparing the behaviour of different inbred strains raised in the same laboratory environment. Another method, known as selective breeding, evaluates genetic involvement by attempting to breed for high and low extremes of a trait for several generations. Both methods have been applied to a wide variety of animal behaviours, especially learning and behavioral responses to drugs, and this research provides evidence for widespread influence of genes on behaviour.[3]

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have been driven by technology, especially DNA microarrays the size of a postage stamp that can genotype a million DNA markers simultaneously. DNA microarrays have led to a dramatic shift in research towards genome-wide association (GWA) studies. The ultimate goal of GWA is to sequence each individual's entire genome, which has begun to happen.[1]

The seven conditions selected for study are all common familial diseases of major public health importance both in the UK and globally4, and for which suitable nationally representative sample sets were available. The control individuals came from two sources: 1,500 individuals from the 1958 British Birth Cohort (58C) and 1,500 individuals selected from blood donors recruited as part of this project (UK Blood Services (UKBS) controls)[8]

Relate Knowledge

Behaviour genetics, also called psychogenetic, the study of the influence of an organism's genetic composition on its behaviour and the interaction of heredity and environment insofar as they affect behaviour. The question of the determinants of behavioural abilities and disabilities has commonly been referred to as the "nature-nurture" controversy.

History of Research

The relationship between behaviour and genetics, or heredity, dates to the work of English scientist, who coined the phrase "nature and nurture." Galton studied the families of outstanding men of his day and concluded, like his cousin, that mental powers run in families. Galton became the first to use twins in genetic research and pioneered many of the statistical methods of analysis that are in use today. In 1918 British statistician and geneticist published a paper that showed how Gregor Mendel's laws of inheritance applied to complex traits influenced by multiple genes and environmental factors. The first human behavioural genetic research on intelligence and mental illness began in the 1920s, when environmentalism (the theory that behaviour is a result of no genetic factors such as various childhood experiences) became popular and before Nazi Germany's abuse of genetics made the notion of hereditary influence abhorrent. Although genetic research on human behaviour continued throughout the following decades, it was not until the 1970s that a balanced view came to prevail in psychiatry that recognized the importance of nature as well as nurture. In psychology, this reconciliation did not take hold until the 1980s. Much behavioural genetic research today focuses on identifying specific genes that affect behavioural dimensions, such as personality and intelligence, and disorders, such as autism, hyperactivity, depression, and schizophrenia. In contrast to traditional molecular genetic research that focused on rare disorders caused by a single genetic mutation, molecular genetic research on complex behavioural traits and common behavioural disorders is much more difficult because multiple genes are involved and each gene has a relatively small effect. However, some genes identified in animal models have contributed to an improved understanding of complex human behavioural disorders such as reading disability, hyperactivity, autism, and dementia.[3]

Present Research

In the context of current concerns about replication in psychological science, we describe 10 findings from behavioural genetic research that have robustly replicated. These are 'big' findings, both in terms of effect size and potential impact on psychological science, such as linearly increasing heritability of intelligence from infancy (20%) through adulthood (60%). Four of our top-10 findings involve the environment, discoveries that could only have been found using genetically sensitive research designs. We also consider reasons specific to behavioural genetics that might explain why these findings replicate. Psychological domains that have traditionally focused on individual differences are those that have been studied most using genetically sensitive designs, primarily the twin method that compares resemblance in pairs of identical and fraternal twins: cognitive abilities and disabilities, psychopathology, personality, substance use and abuse, and health psychology. Traits in these domains have consistently shown significant genetic influence in adequately powered studies which has led this to be described as the first 'law' of behavioural genetics. (As discussed later, model-fitting analyses emphasize estimation of effect sizes and confidence intervals, which also provides evidence for statistical significance.) Although ubiquitous genetic influence is now widely accepted, this finding should not be taken for granted because it was a battleground in psychology even a few decades ago and remains controversial in some areas such as education.

As an example, a review of the world's literature on intelligence, which included 10,000 pairs of twins, showed that identical twins are significantly more similar than fraternal twins, with twin correlations of about 0.85 and 0.60, respectively, with

corroborating results from family and adoption studies, implying significant genetic influence. Although most of this research was conducted in the United States and western European countries, significant genetic influence has been found in countries such as Russia, the former East Germany, Japan, and rural and urban India. Recent studies continue to report similar results, as seen for example in a report of 11,000 pairs of twins from six twin studies in four countries. We are not aware of a single adequately powered study reporting nonsignificant heritability. Although heritability estimates are significantly greater than 0%, they are also significantly less than 100%. As noted above, heritability's are substantial, typically 30% - 50%, but this is a long way from 100%. Again, we are unable to find any exception in which the heritability of a behavioural trait is near 100%. This is not a limitation of the methods because some traits, such as individual differences in height, yield heritability's as high as 90%. However, it should be noted that behavioural traits are less reliably measured than physical traits such as height and error of measurement contributes to uninheritable variance. Many others have noted that no traits are 100% heritable. Powerful but overlooked evidence that many genes affect complex traits including behaviour comes from selection studies in nonhuman animal research. If only a few genes were responsible for the heritability of a trait, selected lines would separate after a few generations and would not diverge any further in later generations.

Pending Research

In contrast, selection studies of complex traits show a linear response to selection even after dozens of generations of selection, as seen for example in one of the largest and longest selection studies of behaviour that included replicate selected and control lines. Another overlooked point from selection studies is that genetic effects transmitted from parents to offspring can only be due to additive genetic effects (the independent effects of alleles and loci that 'add up'), in contrast to nonadditive genetic effects in which the effects of alleles and loci that interact. This is important information because it would be difficult to identify specific DNA differences responsible for heritability if genetic effects on behaviour were caused by interactions between many loci (epistasis).[4]

RESULT

The study confirms that genes a person inherits directly are most likely to contribute to their achievements in education. But parent genes that aren't directly inherited, yet have still shaped parents' own education levels and subsequently influenced the lifestyle and family environment they provide for their children, are also important and can affect how well a person does at school and beyond.

Children resemble their parents because of nature (the genes they inherit) and nurture (the environment they grow up in). But nature and nurture effects are intertwined.

Mothers and fathers each pass on half of their genes to their children, and although the other half of their genes are not passed on, they continue to influence the parents' traits and ultimately influence the traits in their children. For example, parents with a higher genetic propensity for learning may have a greater interest in activities such as reading that, in turn, nurture learning in their offspring.

This concept - when parents' genes influence outcomes for their offspring by shaping the environment that they provide for them is called genetic nurture. It describes how parents' genes indirectly their children's characteristics.

For the current paper, researchers reviewed and analysed 12 studies in several countries and used a method called polygenic scoring to study the influence of millions of genetic variants on educational attainment in nearly 40,000 parent and child pairs.

The researchers found that genetic nurture had about half as much impact on education success as genetic inheritance.

Genetic nurture effects captured by polygenic scores in the studies explained at least 1.28% of variance in educational outcomes, while direct genetic effects explained at least 2.89% of variance in educational outcomes. The researchers say the findings are underestimated given that polygenic scores only capture a fraction of heritability in educational outcomes; the actual genetic effects could be multiple times higher, but direct genetic effects would probably still be roughly double those of genetic nurture effects.[5]

So as continues the result, By application of a whole genome tiling path BAC array CGH technique, pairwise comparison of DNA samples from 95 unrelated individuals against a single reference DNA sample identified a total of 14,711 CNV BAC clones, averaging 155 per individual (array CGH data for all hybridization experiments have been made publicly available at the Gene Expression Omnibus (series accession number GSE5442).

This resulted in 5,132 unique clones that span 3,654 loci throughout the mapped autosomes. To determine a confidence level for our CNVs, we first calculated the probability of an event occurring repeatedly within our sample set. On the basis of our false-positive rate of 0.23%, calculated from repeat hybridization experiments, the probability of a random false-positive event occurring twice or three times by chance within our sample set of 95 was calculated (p=0.02089 and p=0.001479, respectively).[8]

Evidence

We discovered genetic nurture has a significant effect on a child's educational achievement. The effects were mainly down to their parents' education and how it influences the environment they provide. We also found that fathers and mothers had similar genetic nurture effects, suggesting both parents are equally important in shaping and fostering an environment favourable for a child's learning.

"This study illustrates how complex the relationship between genes and the environment is. Although our study uses genetic methods, it provides strong evidence that, as well as genetics, the environment really matters when we talk about education.

"Two aspects are complementary here. First, some of it depends on the genetic lottery, so parents do not have complete control and not everything is down to what they do. That said, what parents do and their choices do seem to matter. Our findings show that socio-economic status and parental education are probably key.

"It is really important to understand how educational attainment (years of education, highest degree obtained) and achievement (scores and grades achieved) are passed on through families, and how this knowledge could help us break cycles of disadvantage across generations."[5]

CONCLUSIONS

In the fast moving technologies we are still running to find out what specifically has affected us. What gene has mutated, or what changes in our genome structure has affected the changes we are facing today. With multiple therapies and millions of researches going around the world. The world still strives to know the deeper mechanisms of our genetics with our mental health.

ABBREVIATIONS

- GWA: Genome wide association
- SNP: Single nucleotidepolymorphism

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