2.2 Biological level of analysis: genetics and behaviour

Learning outcomes

- Outline principles that define the biological level of analysis
- Explain how principles that define the biological level of analysis may be demonstrated in research
- Discuss how and why particular research methods are used at the biological level of analysis
- Discuss ethical considerations related to research studies at the biological level of analysis
- Discuss the extent to which genetics influence behaviour
- Examine one evolutionary explanation of behaviour
- Discuss ethical considerations in research into genetic influences on behaviour

Behavioural genetics

**Behavioural genetics** deals with understanding how both genetics and the environment contribute to individual variations in human behaviour. It is interesting to note that humans share 93 per cent of genes with the rhesus macaque monkeys, even though humans do not look like these animals and do not behave like them. Although comparative psychology has revealed similarities between humans and monkeys, it is obvious that the 7 per cent difference in the genetic material accounts for a significant amount. This example demonstrates the complexity of genetics; although the basic premise of this field is that inheritance of DNA plays a role in behaviour, it is important not to misunderstand this. What is inherited are the genes that give rise to the development of specific physiological processes that contribute to specific characteristics and behaviour. It is not probable that a single gene is responsible for such complex behaviours as intelligence, criminal behaviour, altruism, or attachment. Instead, what is inherited may be one of the building blocks for such complex behaviours.

Psychologists argue that an individual may have a genetic predisposition towards a certain behaviour; however, without the appropriate environmental stimuli, this behaviour will not be manifested. For example, in the study of abnormal behaviour, the **diathesis-stress model** is used to explain the origin of depression. This model argues that depression may be the result of the interaction of a “genetic vulnerability” and traumatic environmental stimuli in early childhood. It is also known that not all people develop depression following a traumatic childhood, even if they have a sibling who becomes depressed. This illustrates the complexity of the problem and that there is no single cause-and-effect relationship between genes and behaviour.
Genetic arguments of behaviour are based on the principle of **inheritance**. Genes and their DNA are passed down from parents to their offspring. Humans have 23 pairs of chromosomes, with approximately 20 000–25 000 genes. In 1990, James D. Watson pioneered the Human Genome Project, with the goal of mapping the genetic make-up of the human species by identifying those 25 000 genes. This incredible project was completed in 2003. The mapping of human genes could be an important step in explaining human behaviour, as well as developing treatments. In spite of this spectacular accomplishment, however, the role of specific genes in specific behaviours remains unknown.

**Genetic research**

Genetic research in humans is to a large extent based on **correlational studies**. Researchers look at how different variables may co-vary. This means that a correlational study establishes that there is a relationship between variables, but the researcher does not manipulate an independent variable as in an experiment. Therefore, no cause and effect can be determined.

**Twin studies, family studies and adoption studies**

One of the most common ways to study the possible correlation of genetic inheritance and behaviour is through twin research. Researchers study twins because they share common genetic material.

There are two types of twins: **monozygotic (MZ)** and **dizygotic (DZ)**. Monozygotic twins are genetically identical because they are formed from one fertilized egg that splits into two. These twins are of the same sex and should look very much alike. Dizygotic means from two eggs. DZ twins will not be any closer genetically than brothers and sisters—they will have about 50 per cent of their genes in common. They are formed from two separate fertilized eggs. These twins are not necessarily of the same sex. This is important, because psychologists use these different degrees of genetic relationship as a basis for their hypotheses. It should be the case that the higher the genetic relationship, the more similar individuals will be if the particular characteristic being investigated is inherited. In twin research, the correlation found is called the **concordance rate**.

Another way that behavioural genetics is studied is through **family studies**. Unlike twin research, this is a more representative sample of the general population. A child inherits half its genes from the mother and half from the father. It follows that ordinary brothers and sisters will share 50 per cent of their genes with each other; grandparents will share 25 per cent of their genes with their grandchildren; and first cousins will have 12.5 per cent of their genes in common. In family studies, these different degrees of genetic relatedness are compared with behaviour. The notion is that concordance rates will increase if heritability is high and vice versa. For example, if the heritability of IQ (intelligence quotient) is high, there should be a strong correlation in IQ between children and their mothers, but a weak correlation in IQ between second cousins, and very little, if any, between strangers.
A final method used for genetic research is adoption studies. In principle, these allow the most direct comparison of genetic and environmental influences of behaviour. Adopted or foster children generally share none of their genes with their adoptive parents, but they do share 50 per cent of their genes with their natural mother. It would be reasonable to suppose, therefore, that if the heritability of a behaviour is high and environment has little part to play, then the behaviour of adopted children should correlate more strongly with the behaviour of their natural mother than their adoptive mother. If, on the other hand, the environment has the strongest role to play, the reverse pattern should be found.

Adoption studies are often criticized as these children are not representative of the general population. In addition, adoption agencies tend to use selective placement when finding homes for children, trying to place children with families who are similar in as many ways as possible to the natural parents. Consequently, the effects of genetic inheritance may be difficult to separate from the influences of the environment.

Overall, these approaches to the study of the relative influence of genetic make-up and the environment allow researchers to determine the extent of genetic influence. In spite of the weaknesses outlined here, it is clear that there is a correlation between several behaviours and genetic inheritance.

**Intelligence**

At the beginning of the 20th century, there was a great interest in the role of genetics in behaviour. Governments and schools sought to design tests that could indicate one’s genetically endowed intellectual potential—or IQ. Alfred Binet, a pioneer in intelligence research at the beginning of the 20th century, developed an intelligence test in order to improve the French education system. One of the main controversies regarding intelligence is whether it is inherited or is the result of environmental stimuli. At this point in time, no serious researcher would argue that genetics does not play a role or that the environment has no importance. Research has shown, for example, that poverty seems to have an important influence on the development of children’s intelligence.

Some intelligence research is controversial. In 1994, Harvard professor Richard J. Herrnstein published *The Bell Curve*. He claimed that the debate about whether and how much genes and the environment have to do with ethnic differences remains unresolved. The media furore over the idea that there may be intergroup differences in intelligence demonstrates the highly political nature of the topic.
Be a thinker

On the Internet you will find several free IQ tests. Go online and take at least three different tests. Each test should give you a score.

1. Do you think that these tests appropriately evaluate your intelligence?
2. Do you feel that the tests were adequate? Why or why not?
3. How would you change the tests to make them reflect more accurately what you consider to be your “intelligence”?

Give me a dozen healthy infants and my own specific world to bring them up in, and I’ll guarantee to take any one at random and train him to become any type of specialist I might select—doctor, lawyer, artist, merchant, chef and yes, even beggar and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors.

This quote from John B. Watson (1924) illustrates the purely “nurture” side of the debate. It is only recently that the interaction of biological and environmental factors has been considered.

One of the difficulties in determining the origin of intelligence is that there has been—and continues to be—much debate about the nature of intelligence. What is it, and how can it be measured?

Charles Spearman, an early intelligence theorist, found that student performance across different subjects was positively correlated. As a result of this, he argued that there is a general intelligence factor that is the basis for all intelligence—something that he called the “g” factor. Modern intelligence testing attempts to assess this g, rather than looking at specific school subjects. Instead of testing a student’s skill in history, mathematics, or art history, the test focuses on spatial ability, reasoning, divergent thinking, and verbal fluency. The question then is: where does g come from?

Research on intelligence

Bouchard and McGue (1981) reviewed 111 studies of IQ correlations between siblings from research studies on intelligence from around the world. This is what is called a meta-analysis—the statistical synthesis of the data from a set of comparable studies of a problem that yields a quantitative summary of the pooled results. They found that the closer the kinship, the higher the correlation for IQ. In order to investigate the role of genetics in intelligence, researchers have used identical twins who have been brought up separately from birth. This provides researchers with participants who have a 100 per cent genetic relationship, but have grown up in different environments. This is based on the assumption that any similarity between their IQs—beyond that expected by chance—must be due to genetics rather than the environment.

The Minnesota Twin Study (Bouchard et al. 1990) is a longitudinal study that has been going on since 1979. In this study, MZAs (identical twins raised apart) are compared to MZTs (identical twins raised together). This is the most cross-cultural study to date, with participants from all over the world. Another advantage of this
study is that the mean age of the MZAs was 41 years old (at the start of the study). Until this point, almost all intelligence research on twins was carried out with adolescents.

Each twin completed approximately 50 hours of testing and interviews. The concordance rates of intelligence from the study are shown in the table below.

<table>
<thead>
<tr>
<th>Same person tested twice</th>
<th>87%</th>
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<tbody>
<tr>
<td>Identical twins reared together</td>
<td>85%</td>
</tr>
<tr>
<td>Identical twins reared apart</td>
<td>76%</td>
</tr>
<tr>
<td>Fraternal twins reared together</td>
<td>55%</td>
</tr>
<tr>
<td>Biological siblings reared together</td>
<td>47%</td>
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Bouchard et al. determined a heritability estimate of 70 per cent—that is, that 70 per cent of intelligence can be attributed to genetic inheritance. This means that 30 per cent of intelligence may be attributed to other factors.

Much research has supported the findings of the Minnesota Twin Study. In addition, the size and nature of the sample has made it one of the most impressive twin studies ever carried out. In spite of this, there are some criticisms of the study.

- Bouchard relied on media coverage to recruit participants.
- There are some ethical concerns about the way he reunited the twins.
- There was no adequate control to establish the frequency of contact between the twins prior to the study.
- We cannot assume that twins who are raised together experience the same environment—this is called the "equal environment assumption".

One of the ways in which the final criticism has been challenged is by looking at adoption studies.

In adoption studies, the intelligence of the adopted child is correlated with the intelligence of the adoptive parent. Since there is no biological link between the adoptive parent and the child, the environmental influence should be evident.

Scarr and Weinberg (1977) and Horn et al. (1979) focused on parents who had raised both adopted and natural children. The assumption is that all the children had the same upbringing, in the same environment, with the same parents. Any significant differences between parent–child IQ correlations for adopted and natural children should be attributable to genes. The researchers found no significant difference in IQ correlations. This was very interesting, because in almost all the families in these studies, the adoptive parents were wealthy, white, and middle class, with high IQs, and the adopted children were from poor, lower-class backgrounds, with lower-IQ parents.

In other research, Wahlsten (1997) claims that well-controlled adoption studies conducted in France have found that transferring an infant from a family with a low socio-economic status to a home
where parents have a high socio-economic status improved childhood IQ scores by 12–16 points, or about one standard deviation. This seems to suggest that intelligence has a lot to do with the environment as well as genetics. An enriched environment may raise IQ in children. It is likely that there is a strong interaction between genes and the environment to produce intelligence level.

Some concluding thoughts on intelligence
There are some other things to consider when examining the genetic explanation of intelligence. One problem, as discussed earlier, is the definition of intelligence. Is intelligence only based on knowledge, or is it related to our ability to solve problems? Hainer et al. (1988) carried out a PET scan study which indicated that when solving a reasoning problem, individuals with a high IQ had lower metabolic rates than those with a low IQ. This difference was seen only in problem solving, and not in data recall. This may mean that those with higher IQs use less energy to think than those with lower IQs. This is known as the less effort hypothesis.

Plomin and Petrill (1997) found that correlations between parent and child IQs change over time. Between the ages of 4 and 6 years, they found a 40 per cent correlation; in early adulthood it rose to 60 per cent; and in older adults it was 80 per cent. They concluded that it is possible that our genetic disposition pushes us towards environments that accentuate that disposition, thus leading to increased heritability throughout the lifespan. Socio-economic class appears to be one of the most important environmental factors in the development of intelligence. Poverty—not genetic inferiority—is key to understanding differences in intelligence.

The Flynn effect refers to the rise of average scores on intelligence tests in most parts of the world over the last century. James R. Flynn tried to document this in order to create awareness of its implications. According to Ulric Neisser, who wrote an article on the phenomenon in The American Scientist in 1997, the average mean scores on standard IQ tests have been going up by about three points every 10 years, and the increase is even higher in measures of abstract-reasoning ability. The cause of these gains is unknown, but experts discuss whether they reflect a real increase in intelligence or an increasing ability to crack intelligence tests. Other possible factors include better nutrition, improved schooling, different child-rearing practices, and the increased use of technology in modern life. In fact, Neisser thinks that living in a highly visual environment may play an important role in the rise in IQ scores.

Did you know?
As part of the early research on intelligence, the US and other western countries began a branch of science called eugenics. This was the attempt to find “good genes” and to encourage “better” breeding in order to produce healthier, more intelligent offspring. The eugenics movement led to immigration restrictions and racial discrimination, founded on the theory that intelligence was based on genetics alone. It attempted to rate entire groups of people as “fitter” or “inferior”. In the US, eugenics led to the sterilization of women who were considered “feeble-minded”. The centre for eugemics research was in Cold Springs Harbor, New York. What the movement failed to recognize was that it was poverty which played a key role in poor school performance, not membership of a particular ethnic group.

To read more about eugenics, go to www.eugenicsarchive.org/eugenics/.

CAS
With the knowledge you have acquired in this chapter on how to improve intelligence, suggest how a CAS project could enhance learning possibilities for impoverished children in your community.