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CONTENTS

Topic

Intelligence (Biological)	3
Pre-Adult Brain Development (Biological)	9
Perceptual Development (Cognitive)	15
Cognitive Development and Education (Cognitive)	21
Development of Attachment (Social)	27
Impact of Advertising on Children (Social)	33

INTELLIGENCE (BIOLOGICAL)

Specification: Background - What psychologists mean by intelligence and what biological factors could affect intelligence. Key research - Van Leeuwen et al. (2008) A twin-family study of general IQ. Application - At least one method of assessing intelligence.

WHAT YOU NEED TO KNOW

- Describe what psychologists mean by intelligence.
- Outline biological factors that could affect intelligence including:
 - a) sex differences
 - b) genetic factors
- Describe Van Leeuwen et al.'s (2008) research examining twin families' general IQ.
- Discuss methodological issues and debates in relation to the topic of intelligence.
- Apply knowledge of intelligence to explain methods of assessing intelligence.

What Psychologists Mean by Intelligence

There are many different ways to define intelligence, and definitions are often linked to how intelligence is measured. In simple terms, intelligence is often described as the ability to acquire and use a variety of cognitive skills and knowledge. More complex ideas defining intelligence include:

- **Fluid intelligence (gf):** the ability to think and reason abstractly and solve problems. Fluid intelligence is understood as a biological, or innate, ability which is considered fairly static and rarely influenced by the environment. Some psychologists argue that this type of intelligence peaks in early adulthood and then declines.
- **Crystallized intelligence (gc):** learning from past experiences. It derives from acquired knowledge and language use. Some psychologists argue that this kind of intelligence strengthens as we age and accumulate new experiences.

Regardless of how it is defined, many psychologists take a **quantitative** or **psychometric approach** to intelligence. In this approach, the emphasis is on measuring intelligence to compare and differentiate among people. However, because intelligence is so difficult to define, measuring it also proves difficult.

Intelligence encompasses a variety of skills, including creative ability, logical and numerical reasoning, verbal comprehension, practical intelligence and the ability to make judgements; intelligence can develop over time in response to our environment or to cultural differences. Therefore, both defining and measuring intelligence are difficult tasks.



Biological Factors That Could Affect Intelligence: Sex Differences

One main area of debate between psychologists has been about the nature of intelligence and whether or not it is affected by sex. Many researchers have investigated the possibility of differences between males and females. **Halpern (1997)** reviewed a large body of research into this area and although the findings were not conclusive, there have been a number of trends. Females, on average, perform better on tasks that require rapid access to long-term memory, language production and comprehension, fine motor skills, and perceptual speed. Males, on average, perform better on visual-spatial tasks, motor skills involved in aiming, fluid reasoning, and tasks requiring abstract mathematical and scientific skills. Although there are no average differences in overall intelligence, an over-representation of males with intelligence deficits, including mental retardation and delayed speech, exists. A biological explanation for these differences is the way male and female brains are organised. Tests have revealed that the volume of grey matter was higher in the frontal parietal lobe (the area of the brain responsible for spatial tasks) of those males tested; while the volume of grey matter was found to be higher in the Broca's area (associated with language) of the brains in those females tested. Despite these particular differences, males and females display similar intellectual abilities overall.

Genetic Factors

At the most basic level there are two possible reasons why some people are more or less intelligent than others: heredity and the environment.

Heredity is the concept that children inherit a set of characteristics or traits from their parents. According to this assumption, intelligence could also be passed down. Many psychologists have been interested in researching differences in intelligence resulting from different genes and environments. The best way to test the biological explanation of intelligence is to study twins, especially identical twins. Identical twins are **monozygotic** (one egg) and they share 100% of their genes. **Dizygotic**, or non-identical twins, only share around 50% of their genes. If identical twins are found to have the same level of intelligence, this can be said to be due in part to genetics; if their intelligence level differs, the environment may be responsible for the difference.

Plomin and Defries (1998) compared identical and non-identical twins on measures of spatial and verbal skills and found that identical twins, who were raised in shared environments, had scores of significantly greater similarity to each other than the scores of the non-identical twins raised in shared environments. Other studies have indicated that even when reared apart, the scores of identical twins still have greater similarity than those of non-identical twins who were raised together. These findings demonstrate the importance of biological factors on intelligence.

The importance of biological factors was investigated by **Bartels et al. (2002)** who found that twin studies have estimated the contribution of genetic effects to the variability in intelligence at between 25% and 50%. Part of the remaining variance is a result of environmental factors shared by children reared in the same family. However, one issue with many twin studies is that they do not often measure the interaction between genes and the environment. They also do not consider **assortative mating**: that is, that people with similar traits and IQ levels may be more likely to have children together. This can lead to the influence of genetics on intelligence being over or under-estimated.

Key Research: Van Leeuwen, Van den Berg & Boomsa (2008)**A Twin-Family Study of General IQ**

Aim: To investigate the contributions of shared genetic and shared environmental influences on IQ variance; and to explore the reasons for spousal resemblance in intelligence. The study used twins, their siblings and parents to assess the relationship between family members and IQ. Van Leeuwen et al. hypothesised that individual differences in intelligence are a result of genetic factors.

Method: The sample consisted of 112 families drawn from the Netherlands twin registry. The families consisted of two parents and either MZ or DZ twins, plus a sibling aged between 9-14 years. All the families were **volunteers** and gave **fully informed consent**. The mean age of the twins was 9.1 years and there were 23 male MZ twins, 23 male DZ twins, 25 female MZ twins and 21 female DZ twins. There were also 20 DZ mixed-sex twins. The study only included those families whose children were without self-reported psychiatric problems, mental illness, special educational needs or other disabilities.

The study used an **extended twin design** that compared the intelligence test results of the MZ and DZ twins with those of their biological parents and siblings. This design allowed for the assessment of the influence of heredity and of cultural transmission simultaneously. Parents were compensated for their travel costs and children were rewarded with a present for participating. Families provided biological (DNA) data via a cheek swab to check whether the twins were identical or not.

All of the children were individually tested in separate rooms with the **Raven's Standard Progressive Matrices (SPM)** IQ test which they were allowed to complete at their own pace after being given verbal instructions. The test covered a range of cognitive tasks, from identifying missing puzzle pieces to completing analogies. Using written instructions, the parents completed a more advanced version of the test designed for adults, the **Raven's Advanced Progressive Matrices (APM)**. Questions within these IQ tests become progressively more difficult and provide an index of general intelligence.

A psychometric model, the **Rasch model**, was used to analyse the results of the Raven's Progressive Matrices. This model considers the difficulty of each question and calculates the probability of the testee being able to score high or low depending on their individual ability. Therefore, the individual IQ scores were achieved irrespective of which items had been answered.

Results:

- Correlations on scores of IQ were higher for MZ twins than for siblings, parents and DZ twins.
- No statistically significant sex differences were found among the whole participant group nor within individual groups (parents, twins, siblings).
- The correlation of IQ level between couples was significant, which suggests that individuals are more likely to mate with people of a similar intellectual ability.
- Environmental factors were found to be more important for children with a genetic predisposition for low IQ. This suggests genetic and environmental factors can influence each other to determine intelligence levels.
- The results suggest that genetics accounts for 67% of intelligence, with the remainder being explained by random environmental factors.

Conclusions: Biological factors affect intelligence. Individual differences in intelligence can largely be explained by genes that are passed from parents to offspring. Parental influence on children's IQ can be

explained by the transmission of genes, while cultural transmission from parents does not have an effect. Although the main influence on IQ levels is genetic factors, genes do interact with environmental factors to influence intelligence levels in significant ways, particularly in certain groups of individuals. This is evidenced by the intelligence of those with low IQ being more influenced by environmental factors.

There is no indication that intelligent parents provide stimulating environments to promote their children's intelligence. Rather, children predisposed to a high IQ will seek out stimulating environments, and those predisposed to a low IQ will not.

Evaluation

- Issues and Debates: To ensure **ethical responsibility**, Van Leeuwen et al.'s research addressed a number of potential issues. Firstly, participants volunteered to participate in the research and **informed consent** had been obtained not only from the parents, but also from the children. The participants did not appear to experience any **stress or distress** whilst taking part in the tasks for the study. They were all tested separately and could take as long as they needed to complete their IQ test. This means that the participants would not have felt pressured to complete the test in a certain amount of time nor embarrassed if others finished their test before them.
- Van Leeuwen et al.'s research and other twin studies may be considered **useful**. This type of research, especially that which uses identical twins, is one of the only ways to measure the relevant contributions of both environment and genetics to an individual's IQ level. If psychologists can determine the factors that may increase or inhibit an individual's IQ, then practical applications could be developed to improve it. For example, exposing individuals who are genetically predisposed to a low IQ to intellectually stimulating environments in order to raise their IQ level.
- However, Van Leeuwen used an **unrepresentative sample** of 112 twin families on the twin register from the Netherlands. There are multitudes of other twin families in other countries with different ethnic origins, cultures and environmental and genetic influences. Therefore, the results from this sample - about relative intelligence and the contributions of shared genetic and environmental influences in IQ variance - cannot be confidently generalised to other populations. Therefore, the sample lacks **population validity**. Further research is required to determine which is the more important in affecting intelligence, genetic factors or environmental effects.
- Moreover, as a method of assessing intelligence, the **validity** of intelligence tests, in general, can be questioned. Van Leeuwen et al. concluded from their results that the main influence on IQ levels is genetic, that the environment has greater effects on lower IQ, and that there is no indication that intelligent parents provide stimulating environments to promote their children's intelligence. However, the test they used (Raven's Progressive Matrices) measures **fluid intelligence** which assesses an individual's ability to think on the spot and reason about new situations. It would be difficult for an individual to prepare for such test, thus their score will be determined by their innate cognitive ability. Van Leeuwen et al. might have found different results had they used another IQ test. On other tests, those that measure **crystallised intelligence** which rely on linguistic ability or cumulative knowledge, individuals have more control over the outcome. Revision or external environmental influences could greatly improve performance on this type of IQ test. For example, families who take part in knowledge enhancing activities together, such as visiting science museums, could improve their individual crystallised intelligence. Thus, the **validity** of a test's conclusions is affected by the type of test used.
- The IQ tests used by Van Leeuwen et al. are also **reliable**, with test-retest reliability of 0.88 for the child's version and 0.91 for the adult version. This means that if the test was taken again a similar score would be achieved; such consistency is important. Zygosity was also tested by taking DNA swabs, which

is a method consistently used within science. However, it must be noted that not all participants took their IQ tests at the same time. This was done on two separate days, raising the possibility that the test conditions may not have been the same.

- Van Leeuwen et al.'s findings support the genetic explanation of intelligence and therefore the **nature** side of the nature/nurture debate. 67% of intelligence was found to be due to genetics and parental influence is due to genes. However, although the nature argument is stronger, 33% of intelligence is due to environmental factors and those who are biologically more likely to have a low IQ are more heavily influenced by **nurture**. The research by Plomin and Defries (1998) found that identical twins raised in shared environments had scores of significantly greater similarity to each other than the scores of the non-identical twins raised in shared environments which further supports the role of nature. Bartels et al. (2002) argues that intelligence may be more an interaction between **nature and nurture**: the genetic effects of the variability in intelligence are between 25% and 50%, while part of the remaining variance results from the nurture of children brought up in the same family.
- There is little evidence from the key research that intelligent parents will provide a more intellectually stimulating environment than less intelligent parents, therefore the home environment would not necessarily support the development of intelligence or support the **situational explanation**. However, more intelligent children may seek out such environments, which would positively influence intelligence. This would support both the situational and **individual** explanations as intelligent individuals put themselves in situations which enhance their intelligence further.

Exam Hint: Be careful when evaluating this research that you do not say it fully supports the nature side of the nature versus nurture debate. Although Van Leeuwen et al. did find a strong correlation between genetics and IQ, they state in their research that genes interact with environmental factors to influence intelligence levels in significant ways.

Critical Thinking

Are the results from taking an intelligence test a valid indicator of an individual's IQ? Theories of intelligence assume that an individual's IQ is stable over time and correlations have been found between IQ scores of the same individuals at different ages. This implies that if we are intelligent as a child we will still be intelligent as an adult. For the most part this is probably true. However, what if other variables resulted in a low score one day? Does this mean that an individual has lost their intelligence, or that certain situations have influenced their score? Can you think of any confounding variables which might cause a person to get a low score on an intelligence test?

Application: Methods of Assessing Intelligence (Raven's Progressive Matrices)

To test your skills of application, the exam may require you to know two methods of assessing intelligence (three versions of an IQ test will be covered here). As discussed previously, intelligence is defined and measured in different ways. Therefore, a variety of different IQ tests is available, each with a variety of questions for testing different cognitive abilities. **Raven's Progressive Matrices** is one of the most commonly used nonverbal tests of intelligence and is the IQ test that will be discussed in this section.

John C. Raven developed the **Raven's Progressive Matrices** test. The test is designed to measure "educative reasoning" which is the ability to work out the answer based only on the information provided. This is a test, therefore, of **fluid intelligence**. The test presents a number of incomplete, novel, pictorial patterns, each of which participants complete by selecting the missing design from a group of possibilities. There are three versions of the test that have been developed, all designed to meet the needs of different abilities. The items on the test become progressively more challenging throughout. Therefore, scoring is subjected to calculations that take difficulty into account, such as the **Rasch model** used by Van Leeuwen et al. (2008).

The three versions of the test are as follows:

	RECOMMENDED GROUP	LENGTH AND PRESENTATION
COLOUR PROGRESSIVE MATRICES	Children 4-7 years, the elderly, some groups with mental or physical difficulties	36 items (three sets of 12) mostly colour; may include some black and white items
STANDARD PROGRESSIVE MATRICES	Children and young people aged 7-18 years	60 items (five sets of 12) in black and white
ADVANCED PROGRESSIVE MATRICES	Adults aged 18+	48 items – Set 1 has 12 items, set 2 has 36 items

The items in the test do not rely on language; therefore, this test is commonly favoured in research with children. Instructions for the test can be provided orally, and due to the nonverbal nature of the test it can be used with individuals with language or perceptual difficulties. The test also has relative cultural neutrality and this has allowed comparisons to be made across diverse populations over time.

The problem with Raven's Progressive Matrices as a test of IQ is that although it does give some indication of intelligence levels, it does not produce stable results over generations. This could be explained by educational influences. If schools and colleges place a greater emphasis on teaching patterns and mental rotation of shapes, then naturally, over time, students' skills will develop, not as a result of innate intelligence but as a result of learning. Therefore, the extent to which the test measures innate intelligence may be somewhat limited.

Possible Exam Questions

- Using the research by Van Leeuwen et al. (2008), explain the relationship between intelligence and genetics. (10)
- Assess the usefulness of research into intelligence. (15)
- Jackie's four-year-old son Jake was born three weeks early and he seems to have been late for each developmental milestone so far. Jackie is now worried that Jake may also have a low IQ and might struggle at school.

Discuss one way in which an intelligence test could be used on Jake to assess his IQ level and subsequent school performance. (10)

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