**TOPIC 3: BIOLOGICAL PSYCHOLOGY**

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| Definition and key terms | CNS, neurotransmitter, nature-nurture, hormones, evolution, genes, aggression, addiction |
| Methodology | PET, MRI, fMRI, twin and adoption studies, correlations |
| Content | CNS and synaptic transmission, neurtotransmitters and hormones, effect of drugs on CNS, brain structure and function, evolution, psychodynamic and aggression. |
| Theories of aggression | Biochemical theory of aggression (hormones and neurotransmitters)Evolutionary theory of aggression (genes)Psychodynamic theory of aggression (emotions) |
| Two studies in detail | Raine et al (97)-Brain abnormalities in murderersBrendgen et al (2005) twin study on genetic and environmental effects on social aggression |
| Key Question | What are the implications for society if aggression is found to be caused by nature not nurture? |
| Practical | Correlation study to see if there is a relationship between masculinity and aggression |

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**CENTRAL NERVOUS SYSTEM**

The central nervous system (CNS) consists of the brain and spinal cord. It is the central processing and control point for all human behaviour. The brain processes all incoming information from the senses and is then responsible for controlling behaviour that may result from this information. The spinal cord connects the brain to the rest of your body, and allows messages to be passed from the body to the brain, and also from the brain to other parts of the body in order to get them to respond. The cells in the central nervous system are known as neurons and these cells communicate with around 1000 other cells at a time in huge networks.

THE NEURON

The cell body of the neuron contains the cell nucleus, which houses the genetic material for that particular neuron.

Attached to the cell body are dendrites that receive messages from other neurons in order to trigger an action potential (an electrical impulse) within the cell.

Also attached to the cell body is the axon, an extension of the cell body that passes the electrical impulse towards the axon terminals. At the top of the axon, attaching the axon to the cell body is the axon hillock, which is where the nerve impulse is triggered from. Around the outside of the axon are layers of fatty deposits called myelin sheath that provide an insulating layer to the axon and help to speed up the rate of message transmission.

At the very end of the axon are the axon terminals, and on the ends of these are terminal buttons (also known as terminal boutons). Action terminals pass nerve impulses from the cell body to the parts of the body that they control or activate - this could be another neuron, or it could be something like a muscle or a gland. These bulb-shaped structures contain tiny sacs called vesicles that store neurotransmitters ready for the next stage of neural transmission.

SYNAPTIC TRANSMISSION

* The cell's electrical impulse/action potential starts as small electrical impulses generated at the axon hillock, but once the message reaches the terminal button it turns into a chemical message.
* When the impulse reaches the axon terminal, the neuron can pass its chemical message to further neurons across the synaptic gap (also known as the synaptic cleft) - the space between two adjacent neurons. The neuron that is sending the message is referred to as the presynaptic neuron, while the one receiving the message is the postsynaptic neuron.
* Each neuron is responsible for producing a certain chemical, or neurotransmitter, and when the action potential reaches the axon terminal, calcium channels will open - flooding the terminal button with calcium ions. Vesicles containing the neurotransmitter substance will then be released and travel down to the outer membrane of the terminal button, where the casing of the vesicle will fuse with the membrane. This allows the neurotransmitter to be released from its vesicles into the synaptic gap/Cleft.
* The receptors on the postsynaptic neuron are designed to bind to a specific neurotransmitter, and when they detect it the neurotransmitter molecule will then be absorbed by the postsynaptic neuron. Any neurotransmitter molecules that have not been absorbed by the receptors of the postsynaptic neuron will be destroyed by enzymes in the synaptic gap/cleft, or they will be absorbed again by the presynaptic neuron in a process known as reuptake. These reabsorbed molecules will be destroyed by enzymes within the neuron in order to 'turn off' the neuron in preparation for a future action potential.

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| NEUROTRANSMITTER | FUNCTION |
| Acetylcholine | Stimulates muscle contractions. Used in cognitive functions. Involved in expressing emotions of anger.  |
| Noradrenaline | Associated with emotion especially mood control. |
| Dopamine | Related to emotion and cognitive functions. Associated with dependency and addictions.  |
| Serotonin | Associated with mood control in the limbic system. Involved in regulating body temperature, hunger, pain and sleep.  |

**THE EFFECT OF RECREATIONAL DRUGS**

Recreational drugs are those that are used in the absence medical grounds, but are taken by users for personal enjoyment. These are often referred to as psychoactive drugs because they alter brain function, which changes our mood, perception or conscious experience. Such drugs include caffeine, nicotine, alcohol, cannabis, amphetamines, LSD, cocaine and heroin, but there are others. It has long been recognised that the use of such substances leads to an altered state of consciousness, but only fairly recently has it been possible to investigate the effect of drugs on the nervous system.

The brain contains a 'reward pathway', which when activated unsurprisingly causes us to experience a pleasant and rewarding feeling. This encourages us to repeat the behaviour that activated pathway and is a key component in learning: if we do something that leads to the activation of this pathway we feel good and are likely to do it again. Being rewarded for specific behaviours has adaptive function, for example, the reward or enjoyment we feel after eating high-calorie foods would ensure we store enough fat on our bodies, in preparation for periods of famine. Drugs hijack this reward system and produce pleasurable feelings without any adaptive function.

Drugs act by changing the way neurotransmitters operate in the brain. Most psychoactive drugs of addiction work on the dopamine system. For example, heroin increases the amount of dopamine in the reward pathways of the brain by boosting the activation of dopaminergic synapses, causing an intensely pleasurable experience or feeling of euphoria while it lasts. However, the brain naturally reacts to the sudden increase in dopamine and reduces (or down-regulates) its own natural production of dopamine, so when the drug effects on the dopamine system wear off the person now has less dopamine than they would have for normal brain functioning. This causes an unpleasurable experience (dysphoria) and that motivates the person to take more heroin to stop them feeling bad and to reproduce the high they felt when they first took the drug. Repeated use of the drug causes further down-regulation of dopamine production; this makes the person physically dependent on the drug in order to avoid the negative experience of withdrawal, which is caused by the lack of dopamine now produced by the brain and so leads to addiction.

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| DRUG | MODE OF ACTION |
| Alcohol | This has a depressant effect on the nervous system by inhibiting neural transmission. (increases the action of GABA which is an inhibitory neurotransmitter) |
| Opioids e.g. heroin and morphine | Over-activity of neurotransmitters in the reward pathways of the brain. (reduces the action of GABA) |
| Amphetamines | Increases dopamine and noradrenaline in the synapse by changing the reuptake process.  |
| Cocaine | Increases the activity in the dopamine pathway by blocking the reuptake of dopamine.  |

HOW DO THESE PROCESSES LEAD TO ADDICTION?

Withdrawal occurs when a drug is no longer active in our system. This can result in withdrawal symptoms that are often unpleasant and can be dangerous. Withdrawal happens when the brain adapts to the changes imposed by the drug so that it no longer operates normally without the drug.

This also leads to tolerance, where the user has to take ever-greater doses of the drug to get the same effect as on previous occasions when they took it. The brain adapts to the high level of dopamine caused by the drug and down regulates its own natural production of it; this means that the baseline measurement of dopamine is now lower than before, so in order to get the same ‘high’ the user now needs more dopamine and so more of the drug.

**BRAIN STUCTURE**

In 1848 Phineas Gage suffered an unfortunate accident when a tamping iron set off the explosive and blew the iron rod up through Gage's face and out the top of his head. For the remaining 11 years of his life after the accident, his personality had a fundamental change; from being a reliable sort of person he became irresponsible and aggressive. His doctor concluded that the damage done to his brain, which included severing the prefrontal cortex, had led to the change in his character. The case of Phineas Gage was one of the first investigations into how the structure of the brain affects behaviour. Over the years psychologists *have* built a functional map of the brain using research such as HM on the role of the hippocampus in memory. With modern neuroimaging techniques this task has become easier as we no longer have to rely on **lesion studies** to understand the link between a brain area and behaviour.

**EXPLAINING AGGRESSION**

The Phineas Gage study showed that damage to the frontal lobes seemed to cause an increase in aggression; this was an early research finding showing a possible biological basis for aggression. This could not initially be done under experimental conditions on humans for ethical reasons so typical studies into the biological structures that underlie aggression had to be done using lab animals, typically rodents and cats.

Studies show three different and specific types of aggressive behaviour in these animals:

*•* Offensivebehaviour, where they physically attack another animal

• Defensive behaviour shown in response to threat of attack

• Predatory aggression, which *involves* attacking another species to gain food.

**BRAIN AREAS ASSOCIATED WITH AGGRESSION**

* **The midbrain**

The midbrain contains an area called the periaqueductal grey matter (PAG),which links the amygdala and hypothalamus with the prefrontal cortex. It has a role in coordinating and integrating behavioural responses to perceived internal and external stressors such as pain and threat. Lesions to the PAG in rats that have recently given birth show an increase in aggression when the rats are confronted with potential threat in the form of unfamiliar male rats being introduced to the cage (Lonstein and Stern. 1998).

* **The amygdala**

The amygdala is the centre for emotions, emotional behaviour and motivation. It integrates internal and external stimuli and every sensory modality has an input, which when combined gives us an instinctive feeling or reaction to the environment that will include aggression. The prefrontal cortex also connects to the amygdala and it is this connection that may lead to the expression of aggression. Charles Whitman, a sniper who killed 14 innocent people and wounded 31 others, had his brain examined after his death. An autopsy showed that he had a temporal lobe tumour pressing on his amygdala. Blair et al. (2001) studied aggression in humans that had been institutionalised due to psychopathic tendencies and suggested that their behaviour had been caused by damage to the amygdala.

* **The hypothalamus**

The role of the hypothalamus is to maintain homeostasis through the regulation of hormones,including those that regulate sexual function. This is linked to aggressive behaviour in males via theproduction of testosterone.

* **The prefrontal cortex**

The prefrontal cortex is an area of brain that sits right behind the forehead. It is influential in governing social interaction and regulation of behaviour. The ability to delay gratification of an impulse is associated with this area. The prefrontal cortex has connections to the amygdala and to the hypothalamus. Damage to this area often leads to problems with anger management, irritability and impulse control.

**EVALUATION**

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| STRENGTHS | WEAKNESSES |
| * Some researchers argue that the basics are the same between the species and therefore animal experiments are worthwhile.
* Ethical issues- cost-benefit analysis is always completed to see the benefit to humanity.
* Raine et al (1997) study showed in the use of PET scans that different parts of the brain are responsible for aggression.
 | * Issues with the use of lab animals- generalisability across species.
* Ethical issues- immoral to use animals and conduct lesions studies on them
* Phineas Gage is a single case study- cant generalise to all humans
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**EVOLUTION**

Evolution happens by natural selection. This is the process in which organisms better adapted to their environment are healthier, live longer and reproduce more frequently passing on the genes that made them reproductively fit to their offspring. For example, an animal, such as a giraffe, that depended on foliage from trees as their main source of food would be better adapted to that environment if they had the ability to reach more foliage higher up the tree. There is a variety of neck lengths, caused by series of random mutations. Every now and then a genetic mutation would occur causing a change in the organism, the giraffes that have slightly longer necks have an advantage over the shorter ones when searching for food, making them more likely to live to reproductive age. Because they were more reproductively successful, their genes were passed on, and because the shorter-necked giraffes were unsuccessful, their genes died out. Over time, the frequency of certain genes in a population changes. This is known as sexual selection. Evolution has been described as a 'series of lucky accidents' because successive mutations that conveyed some kind of adaptive advantage for the animal would come to dominate the gene pool evolutionary psychologists would argue that the mind evolved much like the body and that some aspects of human behaviour result from evolutionary adaptations that served a purpose in our ancestral past.

**HOW DOES THIS EXPLAIN BEHAVIOUR?**

The brain is the organ of behaviour. Just like any other physical part of our body it is built according to the genetic blue print we inherit from our parents. The structure and function of our brains have evolved to serve an adaptive function in the **environment of evolutionary adaptation** (EEA).

In the EEA, successful humans were, like any other animal, those who were best suited to the environment in which they lived. Evolutionary psychologists look at fossil records in order to understand the EEA and speculate about the type of behaviour that would be adaptive. They then try to match that behaviour to current universal behaviours shown by modern-day humans in order to argue that the behaviour is genetically determined through our brain structure and chemistry.

**HOW DOES THIS EXPLAIN AGGRESSION?**

In evolutionary terms success is measured by the production of offspring that survive to reproductive maturity. In the EEA, successful males were physically bigger and stronger and so would be those most capable of providing food and protecting their mates plus their offspring. Psychologically, males who were naturally more aggressive when their resources were threatened, or when out hunting, would also have had an adaptive advantage. Such men might also have been prepared to attack other humans and take their resources in order to provide for their families.

This gave them an advantage in terms of mate choice. Successful females chose mates who provided good genes, so big, strong men were favoured. Such men were also more likely to provide better resources in terms of food and protection, suggesting that those who displayed aggressive traits would be more successful than those who did not. Thus, competition for mates has driven masculine aggression. This theory would also suggest that females would be less physically aggressive as it would be an evolutionary disadvantage for females - who spend long periods of time pregnant, breastfeeding and looking after vulnerable young children in order to ensure their survival- to put themselves and their children at risk by engaging in conflict and hunting. According to evolutionary psychology this has led to female aggression being less physically violent and more verbal and emotional in nature.

Buss (1999) proposed that females would still be in competition for the best mates, but achieved victory by belittling other females to potential mates so as to make these other women appear less attractive. This hypothesis has been tested experimentally and found some support.

**EVALUATION**

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| STRENGTHS | WEAKNESSES |
| * Male brains do have minor differences in structure compared to females, partially due to a much higher exposure to testosterone before and after birth.
* Experimental evidence from Mazur (1983) suggest that testosterone levels are associated with aggression; as there is a marked increase in inter-male fighting around puberty when it is known that there is also a rapid increase in testosterone.
 | * Evolutionary theory is ‘post-hoc’ argument where the theory is developed to fit the facts.
* It is difficult to prove these ideas as they can’t be scientifically tested; there are limited fossil records for behaviour so although they make sense and can explain the observed facts they can’t be empirically tested as we cannot access the environment of evolutionary adaptation (EEA).
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**HORMONES AND AGGRESSION**

Hormones are chemical messengers that transmit information around the body. However, unlike neurotransmitters, they are carried in the blood and operate all around the body - not just in the central nervous system. This means they take longer to work than neurotransmitters and tend to be used to effect longer-term changes. They are produced and excreted by glands and the system of glands is called the endocrine system. Hormones affect behaviour and cause physical changes in the body. Testosterone is an androgen; this means it is a chemical that develops or maintains male characteristics. We all have testosterone in our bodies but it is present in a much greater degree in the average male compared to females.

Antenatal exposure to testosterone has an organising effect on the developing brain, leading to increased spatial ability and (arguably) competitive aggression. There is also a critical period immediately following birth when testosterone sensitises certain neural circuits, for example, it stimulates cell growth in areas of the hypothalamus and amygdala (Naftoli, Garcia-Segura and Keefe, 1990), which later sets up the action of testosterone as an adult to effect aggression.

Studies that support this tend to come from research carried out on rodents. Typically male rodents will be castrated (which effectively stops the production of testosterone) and their behaviour will be compared with control rodents under various conditions, including threat and competition for mates. Castrated rodents show little or no aggressive behaviour, however, if their testosterone is replaced, for example, by injection, then they will show typical aggressive behaviour. Differences emerge according to the age of rodent at the time of castration. If the rodent is new-born, then testosterone injections have a limited effect on their aggression; whereas if they were over 10 days old the replacement testosterone quickly brings their levels of aggression back up to normal for uncastrated rodents (Motelica-Heino, Edwards and Roffi, 1993). Injecting neonatal female rodents with testosterone made them act much more aggressively when given testosterone as adults compared to control females (Edwards, 1968). This supports the idea that testosterone is implicated in aggressive behaviour and that the sensitisation of neural circuitry after birth is an important factor in the effect of testosterone release.

Testosterone influences aggressive behaviour by effecting changes in neurotransmission, but this is complex. For example, a modulating effect on aggression is produced by serotonin (a neurotransmitter associated with, among other things, mood regulation), increased activity of serotonergic synapses inhibits aggression and low levels of serotonin will increase aggression, (Goldman, Lappalainen and Ozaki, 1996).

Human studies generally support the link between testosterone and aggression: for example, boys are, on average, more aggressive than girls; boys have higher exposure to testosterone both pre- and postnatally (D'Andrade, 1966). Testosterone levels increase during the early teens and there is a strong positive correlation with aggressive behaviour and inter-male fighting (Mazur, 1983). However, correlation does not indicate causality and-it might be that other variables such as socialisation affect these factors. However, there have been cases where convicted sex offenders have been castrated and this led to a removal of aggression and a loss of sex drive (Hawke 1951).This seems to lend support to the hypothesis that testosterone is influential in aggressive behaviour, but these studies lack appropriate scientific rigour such as having a control group and fully objective measures of aggression; current ethical standards would prevent such studies taking place.

**EVALUATION**

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| STRENGTHS | WEAKNESSES |
| * Lots of empirical research from various psychologists over time.
* Case studies from convicted sex offenders giving detailed information however this can’t be generalised.
 | * Causality is a problem with the research findings as we don’t know if increased testosterone levels cause aggression or if aggression causes more testosterone to be produced.
* Animal research limits generalisability however more ethical than using humans. (cost-benefit analysis)
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**FREUD'S PSYCHODYNAMIC EXPLANATION**

Freud's psychodynamic explanation of aggression begins with two innate drives that he believed were the motivation for all human behaviour: Eros (the life instinct) and Thanatos (the death instinct). The energy of Eros (known as libido) is focused on the preservation and enjoyment of life. This instinct has to balance out Thanatos, which is a drive towards death and destruction, initially directed towards the self. Human behaviour is seen as an interaction between these two opposing forces and consequently to prevent us from hurting ourselves; the energy of Thanatos will often be redirected away from the person and towards others, resulting in aggression. However, we know that humans are not uncontrollably aggressive all the time; this is due to something Freud referred to as catharsis. Catharsis is a way of satisfying our urges without resorting to violent impulses by watching violence or taking part in minor aggression such as playing video games or sports.

These two innate drives (Eros and Thanatos) form the first part of personality that all humans have from birth until the age of about two years: THE ID. The id is the most primitive part of personality that is completely driven by the impulses of Eros and Thanatos with no thought for consequences. The id operates on the pleasure principle, demanding the immediate gratification of its urges. Then around the age of two years, a new aspect of personality emerges, which Freud termed THE EGO. This is driven by the reality principle and the urges of the id begin to be controlled and delayed. At this stage in the development of personality, the norms and rules of society are learned and, although the ego does not understand right from wrong, there is some appreciation of when and to what extent it is appropriate to show certain behaviours, such as aggression. At some time between the ages of three and six years, the third and final aspect of personality emerges: known as THE SUPEREGO. The superego operates as the morality principle and takes the role of the ego to the next level by developing an understanding of right and wrong. This means that the urges of the id are now not only delayed until an appropriate time or place, but also the child begins to feel pride for acting correctly (the ego-ideal) or feel guilty for incorrect behaviour (the conscience). At this point, aggressive impulses should be well controlled, assuming the superego is well developed in the individual.

Any issues in the development of either the ego or the superego could result in problems in managing the impulsive urges of the id and therefore aggressive behaviour could be frequent. Thankfully, for most people, the ego and superego are well developed, and the urges of the id remain in the unconscious mind and out of conscious thought so we are unaware of the violent urges we feel. The only time we may be at all aware of them is through the behaviours we show that act as catharsis, such as having a love of violent films or enjoying watching boxing.

**COMPARING FREUD'S PSYCHODYNAMIC EXPLANATION TO A BIOLOGICAL EXPLANATION**

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| FREUD’S EXPLANATION | BIOLOGICAL EXPLANATION |
| * Distinct lack of evidence to support Freud’s views.
* Freud’s ideas on the id, ego and superego, it is impossible to physically see these things, making the design of scientific research to test his ideas very difficult.
* Freud's concepts are more subjective and so far more difficult to test as they cannot be seen. The id, for example, is thought to reside almost completely in the unconscious mind - so that even the person is unaware of what it contains or feels.
* Freud considered the role of personality factors such as the Id, ego and superego, which are naturally occurring elements of personality dependent on maturation.
 | * Lots of scientific evidence to support the role of biological factors in aggression.
* Easy to design scientific studies that will allow a link to be established between biology and behaviour because we would be looking at objective data such as the amount of brain activity in different brain areas.
* It is possible to test biological factors objectively, because they are things that can be seen and measured
* Biological psychologists look at the role of genes and brain function in aggression, which are clearly factors of nature
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| But both of these explanations agree that the development of aggression is not completely determined by nature. Brain damage can easily be caused by external factors such as abuse in childhood or a car accident, and the way that genes are expressed can be affected by the environment children are raised in. So while the cause of aggression by both genes and brain dysfunction are natural, the role of nurture cannot be completely ignored. Likewise, Freud felt that the development of the id, ego and superego could be affected by events that occurred during the first six years of life while the personality was maturing. This draws a similarity between Freud's theory and the biological explanation of aggression. |

**INDIVIDUAL DIFFERENCES**

* Individual differences are those characteristics that make each person unique. It is important to recognise that that we have as many differences with people as there are similarities.
* Damage to the brain may be affected by individual differences, in case studies of brain damaged patients when it is assumed there are no individual differences.
* Freud's view of the personality shows it develops individual differences as everyone’s experience is unique to them therefore differences are found in everyone personality.

**DEVELOPMENTAL PSYCHOLOGY**

* Developmental psychology scientifically investigates how and why human beings develop over their life course.
* The role of evolution in human development focusses on the ‘survival of fittest’. Those who had an adaptive advantage survived and therefore passed on their genes to their offspring. In the case of humans, aggression was an adaptive advantage as it ultimately meant that those who could hunt for food and fight off others would survive.
* The role of hormones in human development is evident from conception as the foetus develops in the womb, testosterone is released if the foetus is male and then after birth during puberty a second surge of testosterone is released.

**METHODS**

CORRELATIONAL RESEARCH

* Correlational research involves measuring two different variables in order to see if they are related in any way.
* Correlation studies do not tell you whether one variable caused another to change, but they are a way of looking to see if a relationship might exist between any two co-variables.
* Co-variables can be measured directly by the researcher, or they could be obtained from secondary data gathered from other sources. In biological psychology, co-variables might include measuring the number of genes a person shares (closeness of family relationship) and a behavioural characteristic such as the amount of aggression they show.
* Plotting scores on these two variables on a graph called a scatter diagram it is possible to see if any relationship exists between them.

When looking at correlational data, there are two types of relationship that may be seen: positive and negative. A positive correlation is seen when both co-variables increase, as one variable increases so does the other, and a negative correlation is shown when one variable increases while the other decreases.

EVALUATION OF CORRELATIONAL RESEARCH

* One key problem is that you can only see a relationship between two variables and it is impossible to tell which is the causal variable (made the other one change). In fact, it is possible that any relationship that seems to exist may merely be coincidental.
* Correlations can often use secondary data (information gathered from the research of others) to investigate whether there seems to be any link or relationship between two variables to see whether further, more expensive research, may yield useful results.
* Researchers may believe that two variables are linked, but to start by conducting a large-scale experiment could prove costly if it quickly emerges that their initial idea was wrong. Starting with a correlation to see if a relationship Seems to exist, and, if it does, then designing an experiment to see if the relationship is causal, may be much more cost-effective.

ANALYSIS OF CORRELATIONAL DATA

Begin the analysis by drawing up a scatter diagram to see if there seems to be any link between changes in the co-variables. If it seems as if the variables do show some kind of link then *investigate* this further by conducting an inferential test of significance called Spearman's rho test on the data gathered (data must be ordinal).



How to do Spearman’s Rho:

1. Rank the scores of each of the two variables measured (remember of any ranks that are tied/same then work out the mid-point)
2. Work out the difference between the ranked positions of each pair of scores.
3. Then square the differences (you found in step 2) in order to get rid of any negative figures and calculate the total of squared difference.
4. Now you have all the information you need to put into the formula and work out the Spearman’s Rho.
5. Once you have your calculated figure (known as observed value) this needs to be compared against the critical table to see if the result is statistically significant or not. If the observed value is equal to or greater than the critical value on the critical table then the result is significant. (remember psychologists look for 0.05 level of significance)

**BRAIN SCANNING TECHNIQUES**

**CAT (computerised axial tomography) scans or CT scans**

These scans involve passing X-rays into the head, but unlike a standard X-ray where the beam is focused on one specific area, multiple beams are passed around the head from different angles to gather more information.

The information from the multiple X-ray beams is interpreted by a computer and a detailed image of the structure of the brain can be seen. This is useful for detecting areas of brain damage following an accident or the positioning of tumours in the brain but it does not give any information about how the brain is functioning.

* The use of X-rays in CAT scans can pose a risk to patients as they involve exposure to radiation and it is advised that they are only used whether the possible benefits in relation to diagnosis outweigh the potential risks. If the scan removes the need for exploratory surgery then this would be preferable, especially as unnecessarily having brain surgery could be much more risky for the patient.
* Pregnant women are advised not to have CAT scans wherever possible as there is some evidence that exposure to X-rays can cause damage to the unborn baby.
* They are very quick to conduct and can give accurate details of brain structure, which can help to guide clinicians in decision making regarding treatment or surgery.
* A CAT scan may help a surgeon to better plan a procedure before surgery takes place by being able to accurately see the layout of the brain structures before physically entering the skull. This may make the procedure faster and more efficient, reducing the risks associated with longer duration under anaesthetic for patients.

**PET (POSITRON EMISSION TOMOGRAPHY) SCANS**

PET scans are a form of nuclear medicine procedure as they involve injecting the patient with a small amount of radioactive material in order to conduct the scan. Patients having a PET scan of the brain will be injected with a substance known as 'fluorodeoxyglucose' (FDG). This is a tracer substance where the radioactive atom is attached to glucose because the brain will use up the glucose as a form of energy. Once the tracer has been absorbed into the bloodstream, a task may be given to stimulate the brain (such as the task used in the Raine et al. study (1997)) and encourage activity. As the brain is working, the glucose will be used up and, as this happens, the radioactive atoms start to break down emitting positrons. During this process gamma rays are produced and it is these that the scanner picks up. High concentrations of gamma rays will be found in areas of high activity as a lot of glucose will have been used up there, while areas of low activity will have fewer gamma rays present. The image produced from this information is in colour with areas of high activity shown by warmer colours like red, and areas of low activity shown by cooler colours such as blue. PET scans can be useful for investigating areas of the brain that are not functioning normally, which could indicate damage or tumours.

* PET scans detect areas of damage by indicating which parts of the brain are showing abnormal levels of activity, and this can help researchers to not only see where problems exist, but also predict what kinds of issues patients might face in relation to the brain activity being shown.
* These scans are, however, more invasive than other techniques such as CAT scans as they require the patient to be injected with a radioactive substance.
* It is not advisable for patients to have too many of this type of scan unless absolutely necessary because it is unclear whether there may be long-term effects of the radioactive substance.

**FMRI (FUNCTIONAL MAGNETIC RESONANCE IMAGING)**

Having a functional MRI scan involves having your head placed inside a very large, very powerful electromagnet. Inside the magnetic field, the nuclei within hydrogen molecules in wafer align themselves with the direction of the magnetic field. -As neural activity increases in the brain, blood flow increases in the active areas to keep up with the demand for oxygen. The oxygen is carried to the neurons in haemoglobin within red blood cells. Haemoglobin, when carrying oxygen, repels a magnetic field, but when it has been deoxygenated it will follow the direction of the magnetic field and it is these changes that the scanner will detect to create an image. The scanner sends the information to a computer that is then able to create a map of activation to show changing levels of neural activity in different brain areas as tasks are being completed.

* The use of high-powered magnetic fields in fMRI scanning, some people are unable to have these kind of brain scans. For example, anyone with a cardiac pacemaker or who has had recent metal surgical implants would not be able to have one of these scans.
* Anyone who is claustrophobic or unnerved by confined spaces or loud noises may become quite stressed during fMRI scanning procedures as they have to lie flat and still in a large tube for the duration of the scan. This can upset some people and therefore may not be suitable for all patients.
* These scans are, however, non-invasive and do not involve any injections of radioactive substances so they do not have any of the potential risks associated with PET scanning.

**THE USE OF BRAIN SCANNING TECHNIQUES TO STUDY HUMAN AGGRESSION**

Raine et al. (1997) used PET scans to look at the brain activity of prisoners convicted of murder and then compared this to a matched control group of non-murderers. Using PET scans they were able to map abnormal brain activity in the murderers' group in areas of the brain associated with impulsivity and risk-taking behaviour; which may explain increased aggressive behaviour.

Other research into violent video games has investigated how the brains of gamers process emotions to see if playing these games may change brain activity, making people more likely to become aggressive. Montag et al. (2011) used fMRI scans and found that gamers showed lower levels of activity in reaction to pictures of negative emotion than the control group did. This dampening of the brain's response to negative emotional stimuli may explain why there is a suggested link between playing a lot of these games and becoming more aggressive, as gamers may not find aggressive actions as 'serious' because their brains do not process them in that way.

Brain-scanning techniques are objective ways of measuring the structure and function of the brain, increasing the reliability of the evidence. However, the evidence makes the assumption that these areas of the brain cause aggressive behaviour. Some might argue that being involved in violent behaviour may change the way the brain functions meaning it is the effect of violence not the cause.

It is difficult to conclusively support either view because that would mean the brains would need to be scanned before showing tendencies towards violence and then compared with scans taken afterwards and we cannot accurately predict who is likely to become violent before it happens.

TWIN STUDIES

* Twin studies provide psychologists with a unique design to test the influence of nature and/or nurture on human behaviour. Monozygotic, or identical, twins share 100 per cent of the same genetic material, while dizygotic, or fraternal, twins share only 50 per cent of the same genes like any two siblings. When investigating twins, psychologists are able to compare behaviour between a group of identical twins and a group of fraternal twins to see which group shared the most similarity between each set of twins.
* The extent to which behaviour is the same between twins is known as the concordance rate. Gottesman and Shields (1966) studied twins over a 16-year period where one had been diagnosed with schizophrenia and found that in monozygotic twins 42 % of their co-twins were also diagnosed with schizophrenia, whereas in dizygotic twins only 9% of the co-twins were diagnosed with the same illness. The concordance rate is higher in monozygotic twins than dizygotic twins they concluded that there may well be a genetic element that could explain why people develop schizophrenia. If the concordance rate was equally high (or low) in dizygotic twins for any behaviour then the researchers might assume that there was no significant genetic component at play and in fact experiential factors may explain the behaviour as twins are generally raised together and will have shared a similar upbringing.
* Coccaro et al. (1997) found in their study of male twins (182 MZ pairs; 118 DZ pairs) that there was a high chance that aggressive traits would be found in both twins suggesting that impulsive aggression could be at least partly due to genetic factors. They had their participants complete 75-item questionnaire used to assess various emotional traits associated with aggression, and then compared the scores of each member of the twin pairs. It was found that a significant concordance rate was shown between twins for measures such as indirect assault suggesting an element of heritability in some features of aggression.

ADOPTION STUDIES

Adoption studies, in principle, are the best method to allow psychologists to measure whether a behaviour is the result of nature or nurture. Groups of adoptees are studied and their behaviour is then correlated with their adopted families as well as their natural families. Adoptees share no genetic material with their adopted families, but they have shared an environment throughout their upbringing. On the other hand, adoptees will share 50 per cent of their genes with each biological parent, but have not lived with them for the majority of their life. If the behaviour of the adoptees shared more similarity with the adopted family, we might assume that the behaviour in question was more likely to be the result of the shared environment. But if the behaviour of the adoptees correlated more strongly with the biological family, and is not associated with the behaviour of the adoptive family, then it could be concluded that the behaviour being studied is caused by a biological component. Cadoret and Stewart (1991) suggested that adopted boys were at an increased risk of attention deficit hyperactivity and aggression as children if they had a biological parent who had been convicted of a crime in adulthood. They also found that the boys were more likely to be aggressive or have a diagnosis of attention deficit/hyperactivity if there were psychiatric problems in members of the adoptive family. This suggests that behaviour as complex as aggression can have a variety of causes and is not significantly attributable to nature or nurture.

**KEY STUDIES**

CLASSIC STUDY: Raine et al. (1997) Brain abnormalities in murderers indicated by positron emission tomography.

AIM- The aim of the study was to see whether there was different brain functioning in a group of murderers to control participants. The expectation was that the murderers would show evidence of brain differences in their prefrontal cortex as well as in other areas that are thought to be linked to violent behaviour.

PROCEDURE- The study examined the brains of 41 people (39 males and 2 females) who were charged with murder (or manslaughter) but pleaded Not Guilty by Reason of Insanity (NGRI) and compared them with 41 controls. The murderers had a mean age of 34.3, were not receiving medication at the time of the brain scan (and had been medication-free for two weeks prior), and urine scans supported this. The controls were the same sex, similar age (mean 31.7), did not take medication, and had no history of psychiatric illness (other than 6 schizophrenics who were compared with murderers diagnosed with schizophrenia). All of the participants were injected with a glucose tracer, required to work at a continuous performance task (CPT) that was based around target recognition for 32 minutes, and then given a PET scan (ten minutes before injection they were given practice trials). The participants were compared on the level of activity in right and left hemispheres of the brain

RESULTS- The key findings of the study were that support was found for the hypothesis: brain dysfunction in the NGRI group was in areas previously implicated in violent behaviour. Specifically, compared to the control group, murderers showed: lower activity in the prefrontal cortex (both lateral and medial areas), lower activity in parietal areas, especially the left angular gyrus and bilateral superior parietal regions, higher activity in the occipital lobe abd identical activity in the temporal lobe. In subcortical areas, murderers also showed: lower activity in the corpus callosum, asymmetrical activity in the amygdala (lower in the left, but higher in the right), asymmetrical activity in the medial temporal lobe, including the hippocampus (lower in the left, but higher in the right) and higher level activity in the right of the thalamus.

CONCLUSION- These brain differences have been associated with many behavioural changes that could be related to violent behaviour. For example, dysfunction in the prefrontal cortex has been linked to impulsivity, lack of self-control and an inability to learn from the consequences of behaviour. The hippocampus, amygdala and thalamus have all been related to learning and it has been suggested that abnormal activity here could result in criminals being unable to modify their own behaviour by learning from the consequences of their actions.

EVALUATION

* Largest sample of severely violent offenders to be studied in this way and compared to matched controls, meaning there is good degree of validity in the findings.
* An effort was also made to eradicate possible effects of medication on brain activity by keeping participants drug-free for two weeks before the scan.
* The researchers also made an effort to rule out potential confounding variables such as the effect of whether participants were right- or left-handed and possible head injuries suffered.
* The use of a PET scan provides reliable comparisons to be made between the groups as all participants were subject to the same procedure, allowing an objective measure of the difference in brain activity to be measured
* One problem with the sample is that it only represents a small number of severely violent offenders as those pleading NGRI are not representative and therefore it cannot be considered a representative explanation of violence.
* The study focused specifically on a subgroup of violent offenders, but the findings cannot be used as an explanation for other types of violent behaviour or indeed criminality as a whole.
* One limitation of this type of research is that it is impossible to be sure that the brain dysfunction is directly related to the behaviour. There could be a number of possible extraneous variables that could interfere with these findings, such as social or situational factors that may contribute to either violent behaviour, brain dysfunction, or both. Therefore the research cannot conclude whether violence is due to biology or environmental influences.
* Ethical issues -if the murderers were indeed mentally ill as they were building evidence to claim that they were, we should question their capacity to consent, especially as they were- trying to establish that they were of diminished capacity and could not stand trial.

CONTEMPORARY STUDY: Brendgen et al. (2005) Examining genetic and environmental effects on social aggression: A study of 6-year-old twins.

AIM- The researchers set out with three key aims:

1. To see if social aggression could be caused by genes or the environment

2. To see if social aggression shared the same cause as physical aggression

3. To See of one type of aggression leads to another type.

PROCEDURE- Participants for this study were recruited from the Quebec Newborn Twin Study (QNTS) and all were pairs of twins born between November 1995 and July 1998. There are a total of 234 twin pairs in this study and data from the sample was gathered longitudinally at 5, 18, 30, 48 and 60 months, and then again at the age of 6 years and it is this final data that the researchers focused on in this study.

The data gathered consisted of two ratings of each twin's behaviour - one by their teacher (rating scale questionnaire) and one by their classmates (booklet with photos). The ratings were gathered in the spring term of the school year to ensure that the twins were well known by those providing the ratings of their behaviour.

Peer ratings of the twins were done by giving each child in the twins' classes a booklet containing photos of every child in the class. Every child was then asked to circle three pictures of children that they thought matched four different behaviour descriptions for example, 'Tells others not to play with a child' (social aggression), and 'Gets into fights' (physical aggression). Each twin was given a physical and social aggression score from the teachers' ratings, and any peer selections on the social or physical aggression descriptors that were made of each twin were also recorded.

RESULTS- Initial findings from the study suggested that there was a much higher correlation between the ratings of MZ twin pairs on physical aggression than between same-sex DZ twin pairs. This was the case in both teacher and peer rating scores for the twins. On the other hand, scores for social aggression were roughly equally correlated in MZ and DZ twin pairs. These findings would suggest that in relation to the first aim, physical aggression may well be caused by genetic factors, whereas social aggression may be better explained by shared environmental factors. In relation to the second aim of the study, a correlation was found between physical and social aggression in the children that was best explained by genes rather than the fact that the twins shared the same environment. This could be the result of aggressive tendencies in general being the result of genetic factors, but the way these tendencies are expressed may be determined by environmental factors such as exposure to other people's aggressive behaviours. Finally, when looking at the third aim of the study, the data suggested that physical aggression may lead to social aggression, but not the other way around.

CONCLUSION- There seems to be a strong genetic component to physical aggression but not social aggression, which is more likely due to environmental effects. Children who were physically aggressive were also more likely to display social aggression, probably because of an interaction between genes and environment. As children grow, they tend to become more socially aggressive because of social conventions on physical violence and developing different ways to express themselves.

EVALUATION

* The study benefits from taking measures of the twins' aggressive behaviour from two different sources: both teachers and peers. This would suggest that the researchers were validating their findings by looking at two different sources of information, which should eliminate or highlight any bias.
* The fact that the teachers and peers were in good agreement with each other also adds to the validity of the findings because it would suggest that neither peers nor teachers were giving a seemingly biased view of the aggressive behaviour of the individuals.
* A strength of the study could be seen in the potential for the research findings to be used to prevent the development of social aggression. If children are showing physically aggressive tendencies then dealing with this may prevent them later expressing this aggression socially. It could be used as an-early indicator to parents or teachers that a child's behaviour could become problematic later on, allowing them to intervene early on rather than waiting until the behaviour has become a habit before tackling it. It would be much easier to challenge aggressive behaviour in a small child while they are still learning, than it would be to change the behaviour of an older child when they have already established a strong sense of their own personality and may be more resistant to change.
* Small sample sizes when looking at the different groups being compared. This makes generalisation difficult because the chance of the sample being representative of the entire population would be very low. The reason for the small sample was a consequence of the way in which the study was conducted. Asking 6-year-old peers to provide ratings before they can read and write themselves, obviously meant that the researchers had to record the data with each child individually, which was a time-consuming process and resulted in the small sample achieved.
* There could be many possible extraneous variables in the lives of this specific group of twins that may explain the aggressive behaviour shown. However, the researchers themselves justified this criticism by saying that the costs in time and effort associated with individually measuring the twins' behaviour across 409 different classrooms meant that selecting an assessment of moderating factors would have been extremely difficult. Another issue with generalising from this sample is that the age group being studied is very specific and it would be impossible to assume that aggression in other age groups will have the same cause

KEY QUESTION: WHAT ARE THE IMPLICATIONS FOR SOCIETY IF AGGRESSION IS FOUND TO BE CAUSED BY NATURE NOT NURTURE?

Luis Suarez gained infamy in 2014 in Brazil after being accused of biting an opposing player for the third time in his football career. Footage appears to show Suarez bite the shoulder of Italian defender Giorgio Chiellini during a clash in the match between Italy and Uruguay on 24 June 2014. Chiellini lowered his top to the referee to reveal what appear to be teeth marks in his shoulder, but no action was taken during the game. However, Suarez later received a four-month ban from all football as punishment for his alleged actions. He is not the first player however to have an outburst of impulsive aggressive behaviour during a World Cup match. In 1998, the usually mild-mannered David Beckham was sent off after kicking out at Diego Simeone, and France's Zinedine Zidane received a red card during the World Cup Final in 2006 after head-butting Italy's Marco Materazzi in the chest. The key point about all of these actions is that they happened on impulse. They were not premeditated actions, but things that seem to happen 'in the heat of the moment'. Footballers are used to having to think quickly and react to situations as they arise on the pitch, so they are naturally very impulsive. But does this same impulsivity that creates successful footballers, also create aggressive individuals who are ticking time bombs of aggression if placed in the wrong situation?

It has been well established by research that aggression can have a biological cause, so one question to consider here is whether to blame people who find themselves in such a situation as this. If their aggression is caused by a biological factor that in many circumstances is actually a positive thing, can we treat them harshly when they use the impulse in a more negative way? Many would argue that the behaviour, regardless of its cause or intention, should be treated appropriately so behaving aggressively deserves punishment. In this case, just because they are footballers with successful careers based on their impulsive tendencies does not mean they should be treated leniently when they lash out.

Psychologists may argue that impulsivity is a behavioural trait which people learn to control by experiencing the urges in different social situations. But the World Cup, for any footballer, could prove to be such a high-pressure situation that the ability to control impulsivity is hindered. While normally able to channel the impulsive urges into their game, the stress felt in a match with nigh importance could interrupt this - causing an aggressive outburst.

An explanation for this could be gained from an understanding of evolution. Impulsivity is a survival mechanism, useful as an ability to think and act quickly and avoid threats. As we have evolved over time to live in large social groups, self-restraint has evolved as a way to allow us to successfully live with others. This impulse control mechanism is controlled by the actions of the prefrontal cortex, which is thought by many to be a highly evolved part of the human brain. Research by Raine et al (1997) found evidence that violent behaviour (in this case, murder) was related to low levels of activity in the prefrontal cortex, suggesting violence is caused by poor impulse control.

Another concept we could use to explain this issue might be the influence of the hormone testosterone on aggressive behaviour. Evidence has found that high levels of testosterone may be linked with behaviour traits such as dominance and competitiveness as well as aggression. The above cases all refer to male sportsmen, and perhaps the same hormone that makes them driven to compete in sport, also makes them more prone to aggression.

Another explanation for this comes from research into expression of the MAOA gene often referred to as the 'warrior gene' because of its links with aggressive and impulsive behaviour. Research has found that people with a version of this gene that shows low activity, or low expression, may be more likely to react to provocation by showing aggression (McDermott et al, 2009). Other research has found that people with this 'low expression' version of the MAOA gene, who also have high levels of testosterone, are more likely to be aggressive, especially if they have suffered a poor upbringing.

The implications for society, if evidence suggests aggression is caused by nature rather than nurture, include the fact that if a person's biology is found to have resulted in them being aggressive, can we really find them criminally responsible for the result of their actions? Luis Suarez, for example, may not be able to control his impulsive reaction to perceived threats as he may have biological features that make this difficult. This would mean that punishing him could be seen as unfair as his biological make-up is beyond his control. Perhaps an emphasis should be placed on investigating whether violent individuals have any biological predisposition that may explain their behaviour, and then focus on helping them rather than punishing them. These biological factors may also change the way society views aggressive behaviour. If a person's biology causes the aggression then this is beyond their control, and therefore the suggestion might be that aggression is a form of illness or a symptom of a disorder. It even suggests that a person could be identified before they show aggressive behaviour, meaning that an implication of research in this area might be in developing mechanisms to predict aggressive behaviour in certain people in order to prevent the behaviour before it occurs.

**PRACTICAL INVESTIGATION: Masculinity and Aggression**

ABSTRACT**-**This study aimed to investigate the nature of the relationship between brain sex and aggression. Ten healthy participants measured the masculinity levels of their brain by using a psychometric test and then engaged in a moderately violent video game that enabled the expression of aggression. Their scores on the game were related to the measured masculinity score on the test. A non-significant positive correlation emerged (p>O.OS) but this was felt to be due to flaws in the methodology, especially in the way the data was measured. Further investigations using more appropriate tests of aggression and masculinity would be necessary for firm conclusions to be reached.

AIM**-** Is there a link between the masculinity of a person and aggressive behaviour?'

HYPOTHESES **-**The alternative hypothesis is there will be a significant positive correlation between a participant's masculinity score on a brain sex quiz and their scores on a moderately violent video game. The null hypothesis is that there will be no relationship between masculinity and aggression and any relationship found will be due to chance.

PROCEDURE**-**The study took place over a double psychology lesson. Following the initial briefing and once participants had given their informed consent, ten volunteer participants (aged between 16-19 years old) were gathered in the atrium and were allocated a number. They were then shown into an IT room and each person was seated in front of a computer preloaded with a brain sex test. They were allowed as much time as they needed to complete the test. The fastest time was 25 minutes and the slowest was 42 minutes. The test was done in silence and was supervised by the researcher who recorded their score against their allocated number once they completed the test. The scores were calculated as part of the computer programme. Once each participant had completed the test they returned to the atrium and were asked to wait until called. They were then shown into one of two small lab rooms. Each participant was seated alone at a laptop set up with a bespoke computer game that required them to do moderate acts of aggression to score points. They were supervised at all times by a research assistant who had minimal interaction with them other than to set up the game and input their participant number. The game offered a practice session lasting 3 minutes and then a 5-minute data-gathering session. All instructions appeared on the screen. The participant's score was logged by their number. Once the game was complete they met with the main researcher in another small room and were debriefed individually or in pairs, and reminded of their right to withdraw. Any questions they had were answered and they were offered the chance to see the results once available. They were thanked for their participation, asked whether they wished to offer any insights into their experience of the study and released.

RESULTS

The scatter diagram above does not illustrate any definite linear relationship between the co-variables, but there is a slight trend from the bottom left to top right that could demonstrate a potential weak positive correlation.

The calculated value of the Spearman's rho test was r,= 0.318. This was less than the critical value of 0.564 for a one-tailed test at p = 0.05 with N 10. Therefore the result is not significant and the null hypothesis can be supported, which states that there will be no relationship between masculinity and aggression, and any relationship found was due to chance.

CONCLUSION- We cannot be reasonably certain that a genuine relationship existed for this study because of the inferential test results, but this does not mean that other factors did not influence the data and therefore challenge the validity of any conclusions drawn.

EVALUTION

* The use of the standardised procedures and the objective measures in the example practical investigation increase the reliability of the data, so it is realistic to expect that the procedure could be replicated and that another researcher could consistently record and interpret the data on both measures in the same way as in this study.
* Pilot study was carried out and ethical guidelines were followed.
* The use of the brain sex test could, challenge this measure as a valid reflection of masculinity as it is very superficial and ignores many other factors that influence masculinity, such as social roles and norms of behaviour.
* The computer game could also be challenged as lacking ecological validity in the way that it measured aggression, sitting at a screen and manipulating virtual characters for points does not necessarily translate into real-world aggressive tendencies, which are likely to be constrained by social regulations. It could be argued that the number of times a character was hit in the game was merely a reflection of the rules of the video game and not an indication of aggression.
* With any correlation, we cannot actually establish a causal relationship between aggression and masculinity as there might be a third variable that affects both co-variables that are not included in the analysis.
* Some participants doing the brain sex test first might have alerted them to the goals of the study, which may have affected how they performed on the video game. Some students also had longer between the brain sex test and the video game, this might have relaxed them and so they did not operate at the same level of focused attention as others who did it straight away.
* Also, although the study ensured that no participant had prior knowledge of the game itself and all participants had the same amount of practice time, it might be that some participants were experienced gamers and had a higher generic skill that could have led to them scoring more points. This means that we measured gaming performance rather than consistently measuring aggression.
* Sample size was small at only ten people which is not representative. This could be especially true because it was a volunteer sample so those who came forward might represent only a certain type of person.
* The study can be regarded as ethnocentric and the findings will not apply to other cultures.
* The study is also limited to explaining male behaviour, so cannot be applied to explain female aggression