

# The Scholar

Issue 9  
April 2018  
[thebrilliantclub.org](http://thebrilliantclub.org)

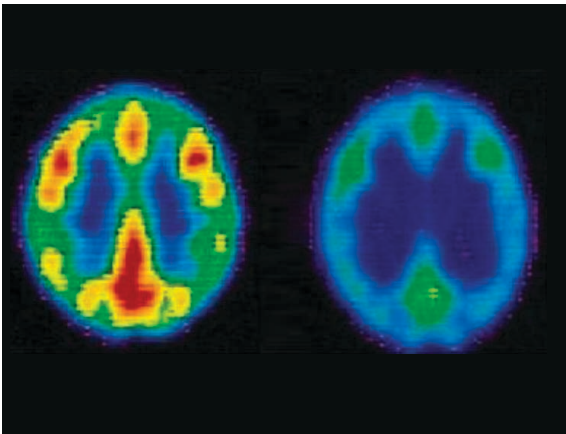


*Highlights include:  
Warming Puts Wind Energy at Risk  
and academic essays on  
Climate Change and Nuclear Power  
from Brilliant Club scholars*



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The Brilliant Club

# What is The Brilliant Club?

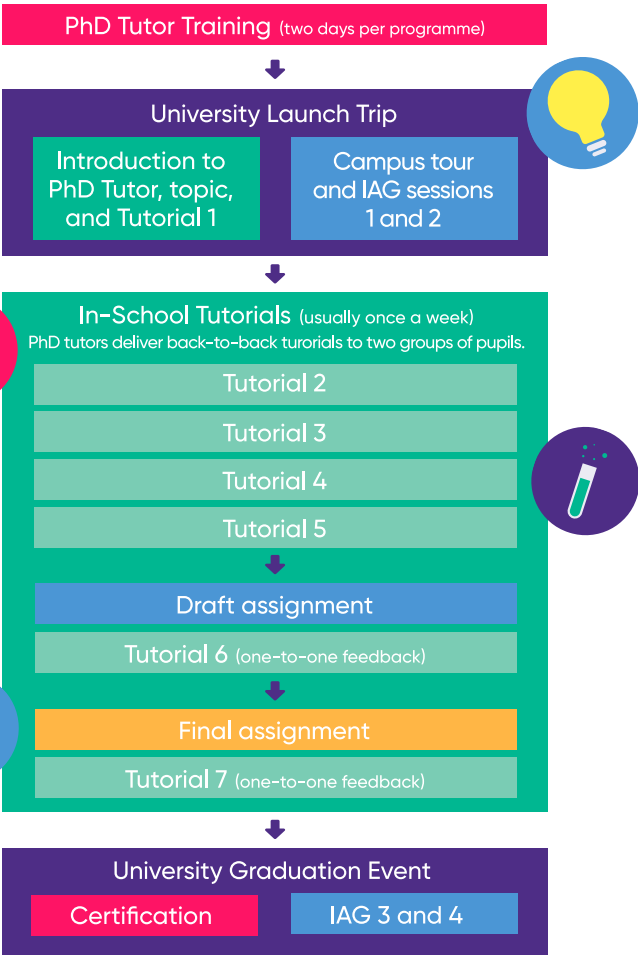
The Brilliant Club is an award-winning charity that exists to widen access to highly-selective universities for under-represented pupils. We do this by mobilising researchers to bring their academic expertise into state schools through two core programmes: The Scholars Programme and Researchers in Schools.

The Scholars Programme trains PhD and postdoctoral researchers to deliver university-style courses with rigorous academic challenges to small groups of pupils. These courses begin and end with information, advice and guidance trips to highly-selective universities.

Researchers in Schools is a unique teacher training route, designed exclusively for PhD graduates. It provides the training necessary for PhD graduates to become excellent classroom teachers and university-access champions within their schools. Both programmes are designed to support pupils to develop the knowledge, skills and confidence necessary to secure places at highly-selective universities.

The Brilliant Club is building a national movement to mobilise PhD researchers to engage with state schools serving low HE-participation communities. At present, we are supporting over 500 PhD tutors from 30 universities to work with more than 11,000 pupils from over 600 schools across the UK. Through The Scholars Programme, our PhD tutors deliver courses of university-style learning to pupils from Year 5 through to Year 12. The courses they deliver focus on fascinating topics ranging from 'Are Some Infinities Bigger than Others?' to 'Making Maps, Constructing Worlds: Geopolitics and Geography'.

As the diagram to the right shows, The Scholars Programme consists of trips to highly-selective universities, a series of tutorials and the completion of university-style assignments, as well as one-to-one feedback for pupils from their PhD tutors. It is the best of these university-style assignments that are debuted here, in *The Scholar*. We are delighted to showcase our pupils' work and celebrate their achievements in the country's only academic journal dedicated to publishing university-style assignments authored by school pupils. Publishing original work is an important component of academia and it is exciting for us to introduce our pupils not only to the world of research but also to the next stage of publishing in academic journals.



Updates

# News from The Brilliant Club

## Welcome to the latest edition of The Scholar!

We are delighted to be able to celebrate twenty of the best assignments written by pupils on The Scholars Programme here in The Scholar, Issue 9. The pupils featured here come from schools across the UK and their work covers a vast array of fascinating topics, from the causes of chronic pain to the representation of nature in literature.

This edition of The Scholar features more articles authored by Key Stage 2 pupils in years 5 and 6, than any other edition! We are very proud of these young scholars and commend them on their courage to take on some big questions in their assignments.

Research shows that early intervention is crucial in promoting fair university access, however 85% of outreach programmes targeting pupils from backgrounds underrepresented in higher education focus on 16 – 18-year olds. To address this in our work, The Brilliant Club runs The Scholars Programme, our university access programme, with pupils from the age of 10.

Our PhD tutors that work with Key Stage 2 pupils receive specialist training on how to deliver courses based on academic research to younger pupils. The courses they deliver are designed by a team of primary specialists in partnership with experts on the topic covered. For example, in 2016 we worked with No. 10 Downing Street and King's College London to create a politics course titled, 'Inside No. 10: The British Prime Minister in the Post-War Years'.

We have also created fascinating courses with UCL Engineering, including a new course entitled, 'Illuminating the Body', in which pupils explore how light can be used to provide information about what is happening inside the body. Pupils on this course also design their own machine for doing this!

On the opposite page we share some exciting updates on our upcoming conference, MP visits to schools running The Scholars Programme and recruitment for our Researchers in Schools programme.

We would like to say congratulations to the pupils published in this edition of The Scholar and to all pupils who completed The Scholars Programme. The programme is designed to challenge pupils and encourage them to take on new academic challenges, so all pupils who graduate from the programme should be very proud of themselves indeed!



The map above shows the locations of all pupils featured.

If you would like to find out how your school can get involved with The Brilliant Club, please visit our website at [www.thebrilliantclub.org](http://www.thebrilliantclub.org) or send an email to [hello@thebrilliantclub.org](mailto:hello@thebrilliantclub.org).

If you are a teacher who would like to find out more about our work with Key Stage 2 pupils, we would love to hear from you! Please get in touch with the contact for your area below:

|                                   |  |
|-----------------------------------|--|
| Scotland and the North of England | Dr Natalie Day<br><a href="mailto:natalie.day@thebrilliantclub.org">natalie.day@thebrilliantclub.org</a>       |
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Updates

# News from The Brilliant Club



## The Brilliant Club Conference 2018

We are delighted to announce that The Brilliant Club will be holding its fifth national conference on Friday 13th of July at Nene Park Academy in Peterborough. This year's conference is titled *Measuring Up: Research, Evidence and Urgency in University Access and Student Success*, and will be delivered in partnership with King's College London, Ormiston Academies Trust, Nene Park Academy, Cambridge Meridian Academies Trust, University of Cambridge and UEA.

We will welcome delegates from a range of sectors to join us for an event which will focus on how to conduct robust and realistic evaluations of interventions, and facilitate the sharing of research and evidence-based practical activity with a view to better supporting young people to access and succeed at university. In particular, we look forward to hearing from keynote speaker Chris Millward, Director for Fair Access and Participation at the Office for Students on his vision for the newly created regulator's role in widening participation.

This year, we are pleased to offer travel bursaries for teachers who would like to attend the conference and are unable to claim travel expenses from their school. We have a limited fund available to refund train travel and bursaries will be granted on a first-come-first-served basis up until 13 May 2018. For more information, please contact [finance@thebrilliantclub.org](mailto:finance@thebrilliantclub.org).

The Brilliant Club Conference aims to support work across the sector to widen access to highly-selective universities for underrepresented pupils. If you would like to find out more and secure your place, please visit [www.thebrilliantclub.org/conference](http://www.thebrilliantclub.org/conference) and follow us on Twitter @BrilliantClub for the latest updates!

## Independent UCAS evaluation shows The Scholars Programme has a statistically significant effect on progression to highly-selective universities

For the last two years, The Brilliant Club has worked with the Universities and Colleges Admissions Service (UCAS) to evaluate the impact of its programmes on progression to highly-selective universities. The UCAS data shows that pupils who completed The Scholars Programme applied, received offers from and progressed to highly-selective universities at the following rates:



To ensure that this impact was not the result of bias in school or pupil selection, UCAS evaluated the effect of The Scholars Programme against 500 control groups of a similar size. Pupils in the control groups were matched for a range of characteristics, including postcode and prior attainment at GCSE. When compared to a control group, pupils who had completed The Scholars Programme were:



This analysis found that pupils who completed The Scholars Programme were significantly more likely to progress to a highly-selective university than pupils in the control groups, having made the conditions of their offer including their A-Level grades.

For more information about this impact evaluation, or about how The Brilliant Club measures its impact for pupils and stakeholders, please email the charity's Research and Impact Director, Dr Lauren Bellaera at [lauren.bellaera@thebrilliantclub.org](mailto:lauren.bellaera@thebrilliantclub.org).

## Our Researchers in Schools programme is now recruiting for its 2018 cohort!

Researchers in Schools is a unique teacher training and development programme. It is specifically designed to utilise the academic expertise of PhD graduates for the benefit of pupils, schools and universities.

We are now recruiting PhD graduates to join our 2018 cohort! This year we are excited to announce that we are working to significantly increase the number of participants training to teach subjects other than maths and physics. While we have focused on these subjects historically, we are now recruiting participants in English, history, geography, languages and the other sciences. We aim to place participants into non-selective state schools in all areas of England.

If you would like to learn more about training to be a teacher with Researchers in Schools, please visit [www.researchersinschools.org](http://www.researchersinschools.org).



## Research Highlights

# nature research



## Climate Change

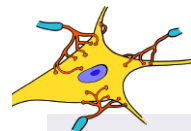
### Warming puts wind energy at risk

Global warming could alter the way air moves around the world, ultimately affecting one of the most popular means of generating clean energy: wind turbines.

Kristopher Karnauskas and his colleagues at the University of Colorado Boulder used ten global climate models to explore how winds might change in two warming scenarios. Their results suggest that, in both low- and high-emissions scenarios, wind resources will decrease across the northern mid-latitudes, mainly as a result of weather patterns associated with accelerated warming in the Arctic. In the Southern Hemisphere, high emissions see wind resources increase on average, because of temperature differentials over land and sea. The effects vary by location, however.

The results indicate that energy planners can't assume the wind available for electricity generation will remain constant over time, and could help to guide more detailed local and regional analyses.

*Nature Geosci.* <http://doi.org/cg8m> (2017)



## Neuroscience

### Brain cells that curb food intake

Mice lose their appetite in response to activation of a brain area that is involved in emotion and cognition.

Eating is prompted, in part, by brain regions that help to maintain the body's energy levels. But hunger pangs are not the only motivation for a trip to the snack bar. In an effort to understand how the brain's emotional and cognitive machinery influences appetite, Yunlei Yang and his colleagues at the State University of New York Upstate Medical University in Syracuse examined the medial septal complex, a group of brain cells that has a role in emotion.

Some of the complex's cells produce a signalling chemical called glutamate. When the scientists turned on these glutamate-producing cells in mice, the animals ate less than half as much as control mice. That makes the region a good starting point for studies of emotionally triggered eating, the team says.

*Proc. Natl Acad. Sci. USA* <http://doi.org/chds> (2017)

## Physics



### Why lattes have layers

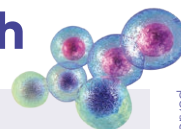
It takes a quick pour to create the stripes in a layered latte.

When a barista makes a latte, distinct horizontal layers sometimes form as the espresso settles into the denser milk. To investigate this process, Howard Stone of Princeton University in New Jersey and his colleagues ran computer simulations and experiments that involved injecting warm dyed water into denser salt water. They found that if espresso is injected fast enough into a glass of warm milk, the espresso-milk mixture closest to the wall of the glass cools, becomes denser and sinks until it reaches a layer of the same density. At that point, it stops sinking and begins to circulate horizontally, forming multiple convection cells that can retain their structure for hours.

The team demonstrated a way to use this technique to create layered gels that could be useful for cell cultures. The method could also be applied in manufacturing and tissue engineering, the authors write.

*Nature Commun.* 8, 1960 (2017)

## Medical Research



### Stem cells defeat autoimmune ills

Stem-cell transplants can help people to survive a rare and deadly form of the autoimmune disease scleroderma.

Scleroderma causes the skin to harden and become immobile. In its most severe form, it affects the internal organs, and is usually fatal. Individuals who receive conventional drug therapy today are no more likely to survive the disease than patients 40 years ago.

Keith Sullivan at the Duke University Medical Center in Durham, North Carolina, and his colleagues tested an innovative approach in a multi-year clinical trial. Stem-cell transplants given after chemotherapy and total-body irradiation significantly improved survival rates, reduced the likelihood of relapse and left some people disease-free.

The results are consistent with two previous stem-cell trials, and should help to establish stem-cell transplants as a standard treatment for individuals with severe scleroderma, according to the researchers.

*N. Engl. J. Med.* 378, 35-47 (2018)

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## Guest Article

# Your Voice in the World

**Professor Julian Wright**

Head of Humanities, Northumbria University



What does it mean to have a voice in society?

Sometimes it feels like the pressure on young people is all about getting a place at university. Should we be thinking more about *being ready for the place*? Are you ready to throw yourself into the advanced learning that university demands? Are you willing to speak up in classes and seminars? Are you ready to write thoughtful, independently-crafted essays? Are you ready to put your voice across, to say what you have to say? University study is all about you and your voice – and to get the most out of university, it's worth having a think about what that means in a little more depth.

What humanities degrees do brilliantly is prepare young people to have their say in society. Our national story is unravelling around us, as competing narratives about the place of Britain in the world battle for position. The stories that modern Americans tell themselves about the openness of American society to the wider world are likewise in upheaval as President Trump stokes the flames of doubt and uncertainty; his pithy, provocative tweets creating narratives of inward-looking 'America First' protectionism. There has never, in my teaching career, been a time when the skills of humanities graduates have been more desperately needed in our global society.

To be able to speak with clarity, authenticity and cultural empathy is the great gift that you gain from a strongly research-driven degree in the humanities. You learn to take your ideas and your insights and deepen them with rigorous research, challenge them by testing them against different cultural contexts, refine them with argument and debate. And above all you develop the independent confidence, as someone who thinks in original ways about great cultural, artistic, political or social problems, to stand up and speak with authority in our wider society.

And while we need people like you to speak out and tell better stories, in Britain, America and the wider world, these are also valuable skills for the world of work. I sometimes say that humanities degrees contain a heavy dose of leadership training. People who can tell the story of the business they are running, the local government organisation they are working in, the charity they are developing, are people who wind up leading those institutions. Scanning the horizon to understand the economic and cultural context in which your marketing business is operating, or being able to set out an inspiring story of a school's place in its community, is the first attribute of a leader. Bring that together with a deep understanding of different cultural perspectives and you have someone who can lead their business in a shifting global economic context. Add the rigour you gain from having developed your own research projects and you have someone who can hold their employees to high standards for independent, self-motivated work. All these are skills that are embedded in degrees in history, literature, the arts, philosophy or language.

But at the heart of the better society we want to build are people who can speak clearly and confidently. Your next step will train you to speak out with an authoritative, articulate voice in society. Use The Scholars Programme seminars to get you ready for the discussions and debates that your future university tutors will want you to participate in. Make sure you are leading the debate, and take this confidence into your university, where you will help your peers speak up and drive the seminar debates from day one. We need your voice.

**Professor Julian Wright**

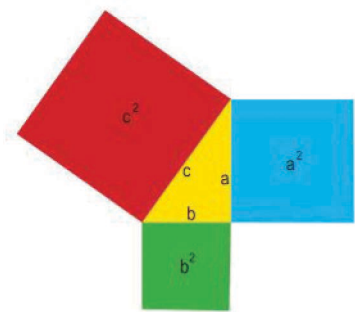
# STEM

## What Is Pythagoras' Theorem?

Year 5, Key Stage 2

S. Ainsley, Eldon Grove Academy, Hartlepool.  
 Supervised by O. Oyeniyi, University of Sunderland.

The Pythagoras Theorem tells us that with a right-angle triangle the hypotenuse (the side opposite to the right angle) multiplied by itself is equivalent to the two legs (the other sides) squared and added together.



This can be written as the formula:  
 $a^2 + b^2 = c^2$

It is useful because if you know the length of two of the sides of a right-angled triangle this can be used to work out the length of the other side.

We can use this understanding when designing and building structures or making items from wood. This is because if I know the length of two straight lines I can use this information to work out the length of a diagonal line that would connect them.

For example, we could use it when building a roof with a slope. If we know the height of the roof and the length it will cover we can use Pythagoras' equation to find out the diagonal length of the roof's slope. We can then cut the correct size for the supporting timber and work out how many tiles are needed to cover the roof.

Pythagoras' Theorem can also help us find the shortest way between two points. For example, if I am on a ship and want to get to an island and I know two lengths of the distance, North and West for example, I can use this to work out the shortest route to take. If the island was 200 miles north and 100 miles west I can use the equation to find the distance from my ship to the island and also the direction I need to follow to get there.

As well as helping you to find the missing side to a triangle, Pythagoras' Theorem can also be used to find the missing side lengths to squares and rectangles.

Builders use the theorem to help keep walls at right angles and this helps to build houses and make sure that windows, doors and floors are put in straight.

A further example of an everyday use of the theorem might be finding the distance a plane has to travel from one place to another. The distance between the x value ('across' the earth) and the y value ('up' the earth), without taking into account the curvature of the earth and the altitude, represents the a and b values in the formula. The c value represents the distance travelled between the two airports:



Babylonian maths 'proved' the theorem in the clay tablet called Plimpton 33. This tablet was made approximately 4000 years ago. It is written in an ancient language called cuneiform script. It was translated into modern language about 100 years ago. Unfortunately, parts of it had broken away so researchers had to guess the numbers that were missing but even though it was broken the researchers could see that it proved the theorem.

The tablet gave the measurements of side a and side b and the outcome of the diagonal. For example:

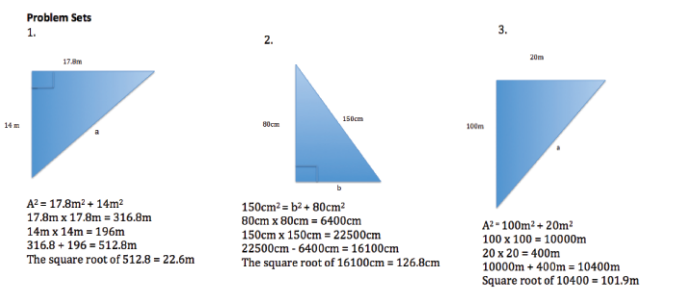
Side A = 119, Side B=120, Diagonal=169  
 $119^2 + 120^2 = 28561$  ( $c^2$ )  
 Therefore c = the square root of 28561 (169)

This proves the equation works. It also works for the other numbers on the tablet, shown below:

| The Plimpton 33 Tablet |        |          |
|------------------------|--------|----------|
| Side A                 | Side B | Diagonal |
| 119                    | 120    | 169      |
| 3367                   | 3456   | 4825     |
| 4601                   | 4800   | 6649     |
| 12709                  | 13500  | 18541    |
| 65                     | 72     | 97       |

### Bibliography:

1. James, Primary Facts <http://primaryfacts.com/3296/pythagoras-facts-and-information/> (1st July 2017)
2. Jan Zamboni, Real Life Uses of The Pythagorean Theorem <http://sciencing.com/real-life-uses-pythagorean-theorem-8247514.html> (2nd July 2017)
3. Annamath, Pythagorean Theorem, Why the Pythagorean Theorem is Important <http://righttrianglemath.blogspot.co.uk/p/why-pythagorean-theorem-is-important.html> (3rd July 2017)
4. The Scholars Programme Course Handbook, Key Stage 2 Programme, Ancient Mathematics and Pythagoras' Theorem, p. 19.



### PhD Tutor's comment:

'It was absolute fun and joy meeting staff and pupils at the Eldon Grove Academy in Hartlepool. The students were bright and eager to learn, which made my six tutorials on Pythagoras theorem as easy as it could ever be. S. displayed a unique passion for mathematics, which made his work outstanding. He received a mark of 91 out of 100 (first class!) for his final assignment. Without a doubt, with his current craving for knowledge, S. is poised to perform to an excellent standard at A-levels and subsequently at an undergraduate programme of his choice.

## How Many Engineers Does It Take To Make An Ice Cream?

Year 5, Key Stage 2

G. Avendano, Keir Hardie Primary School, London.  
 Supervised by R. Farnum, King's College London.

### Introduction

Hello, I'm G. and I am taking part in The Scholars Programme with The Brilliant Club. We have been learning about engineers that make ice cream and even got to learn how to make it ourselves. The engineers work things out with the engineering design process. The engineering design process starts with a problem to solve, ideas to solve the problem, a plan to know what you will do to carry out your ideas, to follow your plan and to improve on your solution for the next time (problem, ideas, plan, do and improve). This process can be used to solve everyday problems and has helped us to make our lives easier.

I learned that engineering is the application of science and maths to solve problems. Engineering figures out how things work and finds practical uses for scientific discoveries. Engineering is everywhere in the world around us and it helps us to improve the way we work, travel, stay healthy and entertain ourselves. It is all around us and has helped shaped the world we live in.

Let's say I wanted to make the perfect ice cream, as ice creams are all different textures, flavours, colours, consistency, etc. I would have to choose what kind of ice cream I wanted to make and then have to think up different ideas of how to achieve my goal, then elaborate a plan to make my ideas come into action, perhaps make a list or draw a diagram. Next I would follow my plan and finally I would think of different ways I may be able to improve or better my solution.

### Problem

I want to make tasty bubble gum flavoured ice cream, one that is not too smooth or too creamy, but a little icy and not overly sweet.

### Ideas

- I will need to use:
- Milk
  - Bubble-gum
  - Cream (of course)
  - Sugar
  - Vanilla extract
  - Egg yolks
  - Food colouring
  - Salt (yes, it is strange but ice cream needs a bit of salt as well)

I got this recipe from the houseofyumm.com website.

I almost forgot a very important ingredient: Air – and it is free too! The amount of air added to ice cream is known as overrun. If the volume of ice cream is doubled by adding air, the overrun is 100%, which is the maximum allowable amount of air that can be added to commercial ice cream. The less expensive brands usually contain more air than the premium brands. One side effect of adding a lot of air to ice cream is that it tends to melt more quickly than ice cream with less air. (I got these cool facts from the American Chemical Society website [www.acs.org](http://www.acs.org))

Another interesting fact about ice cream is that the air incorporated in the ice cream helps the flavour to be released into the mouth slower therefore it does not taste sickly or overly sweet (I got this fact from the [www.acs.org](http://www.acs.org)). I will be incorporating air to my ice cream because as I mentioned I don't want it to be overly sweet, but not too much air because I don't want it to melt too quickly.

### Plan

I will call my ice cream Bubble-Gum Delish, as in delicious! I want it to be not too creamy and not overly sweet (as some

bubble-gum ice creams tend to be), mine will be a little icy (therefore refreshing in the hot summer days) but still also a little creamy. It will also have some actual bubble-gums in it, but no too many to make it too sweet or sickly.

What makes ice cream so smooth and creamy is the fats it contains but as I said I don't want my ice cream too creamy, so I won't be using a high percentage of fat.

### Do

In order to manufacture this ice cream the way I want it, would require the help of different types of engineers; mechanical engineers, biochemical engineers, chemical engineers and industrial engineers. I would need a mechanical engineer to help choose the right freezing method or equipment for the ice cream, a mechanical engineer would also help me to choose how to achieve best results with the minimum energy use to reduce the detrimental impact of CO2 emissions on the environment.

I would need a chemical engineer to help me choose the right agents I should use to get the right texture of the ice cream. I think this is very important for my recipe because I would want my ice cream to be hard and not as creamy as a normal ice cream and a chemical engineer could help me with that. I would also need an industrial engineer to help me decide the adequate machines and the most effective manufacturing process that will ensure we can make the ice cream we desire at the most affordable price and in the quantities that we may require.

A biochemical engineer would also help us with the making of our ice cream as they would advise us on the different ways we would achieve a great bubble gum flavour. They work with additives and also colourings to make our ice cream look delicious and taste delicious using many natural ingredients as well as some good natural colourings to make the ice cream look and taste awesome. We also need to achieve the right viscosity by finding a way of having just the right size of ice crystals.

### Improve

The good thing about my ice cream is that it is a flavour that everyone would most probably like. Also, it is not going to have chunks of flavouring for people who don't like that. My ice cream is also less expensive because it doesn't need much stabiliser or emulsifier or fat and that is very expensive. However, it is not very healthy and requires quite a bit of sugar.

I think people with a sweet tooth may like my ice cream to be sweeter, people who like hard bits on their ice creams may not want any added bubble-gums in the ice cream and those who like their ice creams very smooth and creamy may want to add more fats to my ice cream to make it so. My target audience would be children as I think most of them like bubble-gum and also ice cream therefore would love to have them together and as it will be a little icy would be the ideal treat for those hot summer days when you want something cold but no too icy, like ice lollies.

That is the engineering design process; I hope you enjoyed it as much as I did!

### PhD Tutor's comment:

'Our 'ice cream engineering' curriculum is one of my favourite classes to teach with The Brilliant Club. Together, Keir Hardie students and I explored the systems behind our frozen treats: From the traffic engineering that makes lorry transport possible to the environmental engineering allowing wind power to run factories, we owe a lot to big-picture engineers! G's essay is a great example of the kind of work young pupils can do and reflects his hard work and engaged participation in class.'



# How Was The Spread Of Ebola Controlled?

Year 7, Key Stage 3

A. Abdalla, Ark Walworth Academy, London.  
Supervised by K. d'Apice, Goldsmiths, University of London.

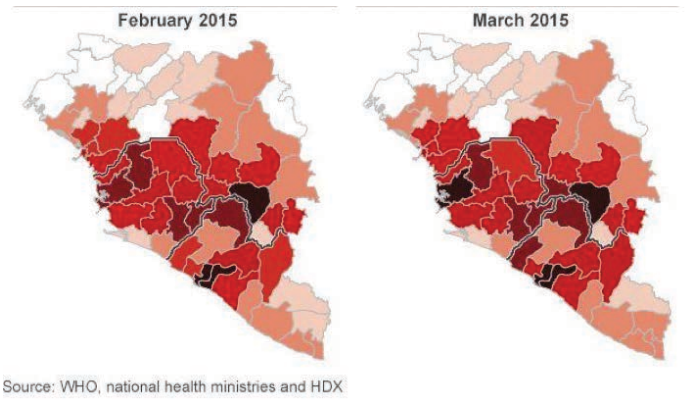
**Introduction:**  
For professionals to understand how Ebola was controlled, we will try to explain what Ebola is, and the starting point of the contamination. We also be looking at the signs and symptoms to identify Ebola. The points described above will help us to see how Ebola spread and to identify how Ebola was controlled, which is needed for scientists or medics who need to resolve how the virus was first spread.

**What is Ebola?**  
The Ebola virus, also known as Hemorrhagic Fever, was discovered in 1976 [2]. It was first discovered in the region of Africa. It is a fatal illness that can rapidly make its way through a West African society.

**The Starting Point of Ebola:**  
Some scientist who were recently studying this contagious illness say that this virus might be caused by wild animals [4]. On the other hand, people may argue that researchers theorize that Ebola comes from people eating infected pieces of “bushmeat” – the meat of primates and other wild animals that are sold mainly in markets [4].

**The Signs and Symptoms of Ebola:**  
The evolution period, which is the time from infection with the virus to onset of the symptoms is 2 to 21 days [7]. Humans are not infectious until they gain symptoms [5]. The first symptom is the sudden onset of fever, weakness, muscle pain, headache and sore throat. This is followed by vomiting, diarrhea, rash, symptoms of impaired kidney and liver function, and in some cases, both internal and external bleeding (e.g. blood in the stools). Laboratory findings show low white blood cell at this point.

**Spread of Ebola**  
Ebola can be spread in several ways. Examples of this include: being spread by close contact with the infected blood, secretions, and organs or by handling infected animals such as fruit bats, monkeys and gorillas. The disease can also be spread from human to human [2].



Source: WHO, national health ministries and HDX

**How is the spread of Ebola controlled?**  
The spread of Ebola is controlled in several ways including, practicing good hygiene to get rid of bacteria and avoiding contact with body fluids such as saliva [3]. Healthcare workers could be exposed to people with Ebola and in order to control an outbreak they have to wear appropriate personal protective equipment, isolate people with Ebola,

try to avoid direct contact with the bodies of infected people and make sure to notify health officials if they have contact with body fluids. Sources of information and research are designed to help people make choices for the healthcare professionals in West Africa.

Other ways that the spread of the Ebola virus is controlled is by bringing external international healthcare professionals to help the patients as there is a weak healthcare system in West Africa; doctors are overworked and paid very little [10]. More awareness and funds are given so medics and doctors can buy necessities such as clean water, food, clothes and equipment such as medicine.

**How did West Africa control the Hemorrhagic Fever?**  
West Africa controlled the Hemorrhagic Fever by educating people on how Ebola can be transmitted and tried to isolate and treat the infected people. When the recent outbreak began, healthcare workers in Liberia, Guinea, and Sierra Leone were initially fighting blind; doctors had to learn from the beginning how to treat Ebola. The odds of survival increased rapidly with early, effective symptom management. With the help of more than 10,000 volunteers globally, health workers slowly taught people to avoid unnecessary physical contact. They had to forget their traditional ritual of washing corpses, a practice that increased the spread of the disease.

The Ebola outbreak was controlled by quickly recognizing and isolating patients to prevent new contaminations. Anyone that had been in contact with a patient without the protection used by doctors had to be monitored for at least three weeks to see whether they become ill too [6]. If they did, they were immediately taken to hospital, where they were treated and nursed separately from other patients. Doctors and nurses who treated these patients had to wear protective clothing and follow strict rules to prevent contamination and the spreading of the disease. The outbreak was also controlled by handling and comparing data in the different regions of West Africa to monitor the spread.

Other tools used included a satellite to monitor Ebola. The International Charter was activated in October 2014 to assist in the management of the Ebola crisis in West Africa [8]. In airports, screening and monitoring of travelers was used to help prevent the spread of Ebola. [9].

As some people started to get better, the community started to gain trust in the doctors. Vaccines were given to patients for their bodies to fight against the virus. This helps the body to trigger an immune response. The antibodies that are then created help the body to fight against most of the types of infection that are causing the Ebola virus.

**Who is most at risk?**  
During the outbreak, people who were at higher risk of the Ebola virus were health workers, family members of infected people or others in close contact with infected people and mourners who had direct contact with bodies during burial rituals [6].

**Can Ebola be prevented?**  
People can protect themselves from infection with Ebola virus following specific infection prevention and control measures. These include hand washing, avoiding contact with the bodily fluids of individuals who are suspected of or confirmed to have Ebola, and refraining from handling or preparing bodies of persons who are suspected of, or confirmed to have died from Ebola.

**Is there an Ebola vaccine?**  
An Ebola vaccine proved extremely protective against the deadly virus in a huge trial in Guinea. The vaccine, was studied in a trial that involved 11,841 people during 2015. Out

of the 5,837 people who received the vaccine, no further Ebola cases were recorded 10 days or more after vaccination. In comparison, there were 23 cases 10 days or more after vaccination out of those who did not get that specific vaccine. The trial was led by World Health Organization (WHO) with Guinea's Ministry of Health, Medicines, Norwegian Institute of Public Health, together with other international partners. A ring vaccination process was chosen for the trial, where some of the rings are vaccinated quickly after the case was detected.

**Conclusion**  
Overall, the Ebola virus has been successfully controlled globally and internationally. we have also seen a growing understanding of the virus mechanism in the human body and how the virus spread, which has helped the international community to build a plan and stop the virus from spreading further. For now, it has been controlled and luckily the virus was put to an end. However, some may argue that the Ebola virus was not controlled nor handled in the correct manner. This may be because professionals and scientists took a while to discover a cure and did not try to handle the problem quickly. Professionals underestimated the gravity of the situation.

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**PhD Tutor's comment:**  
A. is an intelligent student who diligently applied herself during our Brilliant Club tutorials on understanding viruses. Her inquisitive nature was evident in tutorials as she often asked questions to extend her knowledge. A.'s mark in the final assignment reflects her motivation and ability, well done!

## Can The Spread Of Ebola Be Prevented In Less Developed Regions Like Africa?

Year 8, Key Stage 3

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Supervised by N. Lamb, University of Sheffield.

**The Big Picture**  
Ebola Virus Disease (EVD), is a rare but fatal illness caused by infection with viruses belonging to the genus Ebolavirus in the family Filoviridae (Gatherer, 2014) and it is spread through direct contact with infected bodily fluids or tissue, such as vomit or blood (Tam, 2014). Even after a person dies (Tam, 2014), the virus is still present, therefore mourners at burial ceremonies who have direct contact with the body can also transmit Ebola (Ebola Virus Disease, 2017). The disease is mostly found in West Africa and can have a high mortality rate of 90%, however death rates have in some instances been around 25% (Ebola Virus Disease, 2017). 'Between December 2013 and April 2016, the largest epidemic of Ebola Virus Disease (EVD) to date generated more than 28,000 cases and more than 11,000 deaths in the large, mobile populations of Guinea, Liberia, and Sierra Leone.' (After Ebola in West Africa –

Unpredictable Risks, Preventable Epidemics, 2016). There were more than 1,300 reported deaths (Hamilton, 2014) and since then many more people have died from the ruthless spread of the Ebola virus. This topic is important to investigate because it concerns issues that are prevalent across the globe, and it helps to determine what impact the 2014 Ebola virus disease outbreak (EVD) in West Africa has had on several nations. At the moment, I think Ebola can be contained but a global effort will be required to successfully combat it (Chris McGreal, 2014). I also think it is unlikely that this disease will become a pandemic.

**Main Body**  
I believe that Ebola can be controlled and eventually cured, however Ebola has proven itself to be incredibly difficult to contain. Barack Obama was reported to have said, "the Ebola virus both currently and in the past, is controlled if you have a strong public health infrastructure in place" (Chris McGreal, 2014). This sends members of the public a positive and reassuring message because a lot of people trust political figures such as the president. Although, in less developed regions of Africa this is a big issue as they are currently not receiving the funding that is necessary to further develop their healthcare facilities (O'Carroll and Moore). Some African countries are 'working with European countries and the World Health Organization' to consider "whether an experimental drug could be distributed in Africa." (Chris McGreal, 2014). The source comes from The Guardian, a British daily newspaper founded in 1821, (History of the Guardian, 2002). This shows that it is stable and reliable because the company has managed to survive for a long period of time which increases its credibility. However, it might be considered a glorified tabloid that reports biased information by some because they might want to generate interest in their stories. Despite other articles they produce, this source seems entirely factual whilst using unbiased language, along with declarative sentences such as "Barack Obama has said a global effort is required to combat the spread of Ebola which he blamed on weak and overwhelmed health systems in West Africa." (Chris McGreal, 2014). Also, the source is written by Chris McGreal who is an award-winning foreign correspondent for The Guardian, doesn't seem to have any prejudice surrounding the topic of West Africa – instead he maintains a neutral viewpoint throughout the the article, so I would consider this a reliable source. The key information from the source is that it is possible to control Ebola as long as the world works together.

Another article, mentions that Ebola has spread because, "lack of resources have stymied the battle to combat Ebola in Liberia, leaving the country teetering on the brink of collapse" (Nassos Stylianou, 2014). It is making the point that the reason why Ebola continues to spread is due to the lack of resources that are being provided. This message is also proven when the source says, "it was not until August that the virus really took hold in the capital Monrovia, a densely packed and notoriously poor city in the Montserrado district," (Nassos Stylianou, 2014) meaning that areas which are less developed will suffer far worse from Ebola, along with any epidemic that reaches them as they don't have the medical facilities to provide consistent help. The source comes from BBC News, a broadcasting company, who have maintained a good reputation for almost a century (History of the BBC). Additionally, the author of this article, Nassos Stylianou, has worked for the BBC as a news journalist for several years (Nassos Stylianou, 2014) – this means that he is a proficient employee who produces accurate work, also because he has been trusted to write many articles regarding this subject. The author also doesn't have any biases on the topic of the Ebola outbreak, instead he maintains a neutral opinion throughout the entire article. The key information is that Ebola has only proceeded to spread because many healthcare facilities aren't being improved (Nassos Stylianou, 2014) and some are deteriorating as they can't cope with the number of patients who are infected.



The complication of less developed regions not having enough funding seems as if it could become a problem of the past, due to countries such as the USA donating over £400m (Dearden, 2014) to the 'UN crisis fund' (Dearden, 2014). However, this article also indicates that 'international donations to a UN fund to combat the crisis are falling far short of the amount needed' (Dearden, 2014). This could be because China is not contributing enough to fight Ebola (Sanchez, 2014) or that some countries haven't provided the total amount they pledged (Sanchez, 2014). It's making the point that in order to prevent Ebola, more donations are necessary because otherwise it's not conceivable to fund other services (Salient), which include the weak healthcare systems, burial teams, contact tracers, and many others (WHO, 2015). This article also tells me that 'the US and Britain are the largest national donors to a UN crisis fund', and that 'the UN has requested almost \$1 billion (£620 million) to combat the crisis' (Dearden, 2014). President Obama had also been encouraging other nations to provide support in tackling this disease along with warning them that funding this dilemma is compulsory to containing Ebola: "This is not simply charity," Obama said, warning that the best way to prevent the spread of the virus was to contain the "raging epidemic" in West Africa (Sanchez, 2014). The source is from The Independent, a daily newspaper, launched in 1986 and have enjoyed a reputation for quality and innovation (Blackhurst, 2012). This proves that they are respectable and reliable. Furthermore, the author of this article, Lizzie Dearden, who doesn't have any biases on the topic of the Ebola outbreak, instead she stays unopinionated throughout the entirety of the article.

The first and second article slightly contradict each other because the first source (Chris McGreal, 2014) has a more promising outlook on the future, whereas the second source (Nassos Stylianou, 2014) focuses on the problems that are causing the prevention of stabilising the Ebola virus disease. Overall, they both project similar information which is that in order to prevent Ebola becoming a pandemic, the public healthcare systems in West Africa need to be improved. In contrast, the third source (Dearden, 2014) discusses the funding of Ebola which is necessary to 'contain the virus' (Sanchez, 2014).

Conclusion

In conclusion, I believe that Ebola will not become the next international pandemic. Although, nations across the world have significantly struggled with Ebola, the reasons why that has happened have been identified. This includes the weak healthcare facilities in areas such as Sierra Leone, to staff who haven't been trained on controlling diseases and aren't aware of how Ebola is spread (Shute, 2014). Despite this, considerable progress has been made in preventing Ebola from becoming widespread and sweeping across many countries (Lafferty and Rowe, 1998), as it has been funded by over 'US \$459 million' (WHO, 2016) and provided with support, therefore successfully tackling Ebola has become a reality. 'A pandemic is prevalent throughout an entire country, continent, or the whole world,' however Ebola hasn't reached that level, and will not in the foreseeable future because we are managing to contain it. The most reliable sources that I used to form this conclusion are the first (Chris McGreal, 2014) and the third source (Dearden, 2014). In comparison, they both provide more detail and facts about Ebola than the second source (Nassos Stylianou, 2014).

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PhD Tutor's comment:

'I was completely blown away by A.'s work. The Northampton School for Girls was my first placement with The Brilliant Club and I had no idea it was even possible for pupils to produce work of this quality. In particular, I thought the referencing was very impressive. References were frequently used, reliably sourced, correctly referenced and sources beyond references suggested throughout the course were used. I also thought A. had great participation in tutorials, adapting very well to the independence given in the classes. Well done A.!'

Brain Oscillations And Brain Disorders

Year 9, Key Stage 4

A. Hoang, Handsworth Wood Girls' Academy, Birmingham.  
Supervised by S. Kalyanapu, Aston University.

Brain disorders such as bipolar disorder and epilepsy will be looked at in order to gain an understanding of how brain oscillations affect these conditions, and whether this can help with further medications. Additionally, there is information provided on how transmission signals and action potential work in playing a role that affects the overall function of the brain, and how this links to certain brain disorders.

To begin with, brain oscillations include transmission signals – also called synapses – which take place at the two ends of a neuron cell with a minuscule gap between them. Their main function is to transfer electric nerve impulses between them from the presynaptic neuron to the postsynaptic neuron by using chemical neurotransmitters (stored inside the synaptic vesicles) which can be seen in Figure 1.

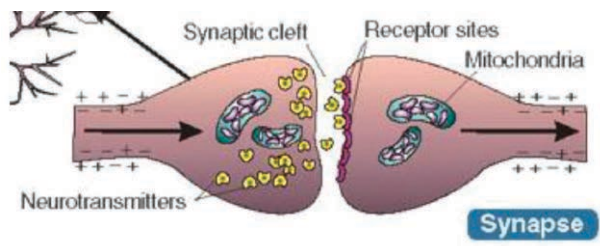


Figure 1 – Synapse With Two Neurons [2]

Synapses occur so that the two cells can communicate, with the involvement of three steps: the presynaptic neuron sending the information, the neurotransmitters traveling across the gap and then giving it to the postsynaptic neuron to receive [3]. The neurons in the first step would send nerve impulses along the axon (a long, thin projection from the cell as seen in Figure 1) to arrive at the end of the presynaptic neuron – the axon terminal. There, it would come into contact with the synaptic vesicles containing pockets of chemical neurotransmitters that would trigger it into being released [4] into the synaptic cleft – the microscopic gap between the neurons. Diffusion would then fall into place as the molecules contained in the neurotransmitters move from a higher concentrated place to a lower concentrated area, passing the impulses for the receptors (located on the membrane of the postsynaptic neuron) to receive.

Action potential plays a large part in this; the receptors which are specialised proteins would only accept certain types of ions (charged atoms) to enter through their ion channel [4]. Therefore, the presynaptic neuron goes through a change in their electric potential that would allow them to activate these receptors [5] and fully send the neurotransmitters into the next neuron. This is mainly due to the fact that it is a semi-permeable type of membrane [6].

The main ions involved are sodium and potassium. Action potential occurs so that the cell changes in its electric potential, traveling along nerves or muscle fibres whilst remaining relatively short-term [6]. There are four main stages to action potential: resting potential, depolarization, repolarization and hyperpolarization (also known as the refractory phase) [5].

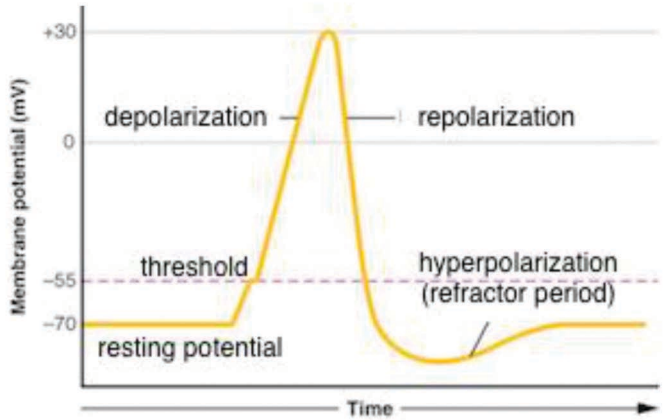


Figure 2 – An action potential graph [7]

In Figure 2 of the resting potential stage, the neuron cell can be seen at -70 mV, an inactive state. This means it needs an impulse to reach the threshold of excitation in order for action potential to occur [6]. The principle it acts on is 'all or none', so the cell must reach this threshold or action potential cannot take place at all [6]. It will need a form of stimuli, which can be heat, touch or pain that includes electricity, pressure or chemicals [5]. The inside of the cell has cytoplasm with a negative electrical charge of K+ (potassium), whereas outside of the cell the fluid that surrounds it contains a positive charge of Na+ (sodium). Even though both substances are positive, a transport protein called the sodium-potassium-pump moves more sodium out of the cell than moving potassium in [6], causing an imbalance in the cell's concentration gradient.

After there has been a stimulus that initiates it to reach the threshold (which is usually -55 mV, see Figure 3), Na+ would rush in, entering the cell through the channels that have been opened the moment it reached the threshold. This is called depolarization – stage two. It allows the cell to become positively charged, bringing the potential up to rise closer to potential zero. However, it doesn't stop when it passes this point, and continues to rise until the action potential peaks at +30 mV [5]. The ions would equalize the concentration gradient of the cell.

It is a common misconception that there are different action potential peaks because it can respond to a number of different stimuli. This is not true: all action potential peaks reach +30 mV because it is all the same process [8].

Once it has reached this action potential peak, it needs to decline to go back to its resting potential state to balance out the sudden inward flow of sodium [8]. This is the third stage: repolarization. The gates that opened for the sodium ions would close, preventing the flow while the K+ (potassium) channel would open at the same time [9]. Letting it exit would reduce the number of K+ ions inside and allow the cell to restore back to its regular state of -70 mV.

The final stage of hyperpolarization happens shortly after the third step; this is because potassium would continue to be depleted even after it has reached -70mV, making it more negatively charged than normal [5]. Although it would only be temporary since there is the sodium-potassium-pump to get the cell back to its resting state [9].

Brain oscillations are the rhythmic, repetitive electrical activity that occur in response to the central nervous system, and often happens spontaneously [10]. There are five typical types of brain oscillations that take place in everyday life as demonstrated in the table (Figure 3).



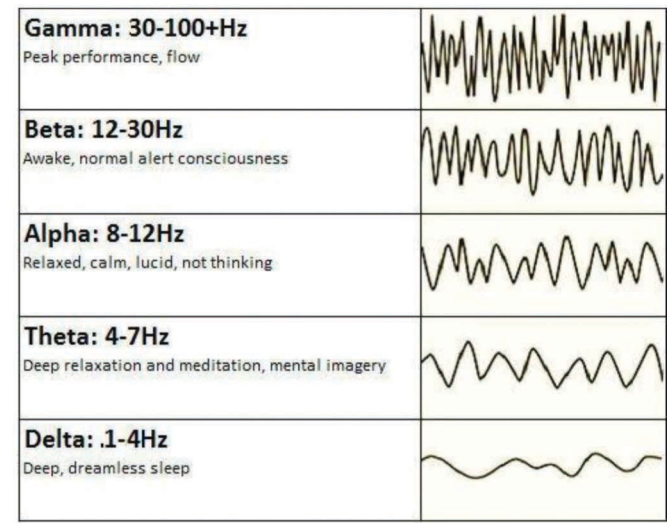


Figure 3 – Table of types of brain oscillations and their frequency range [11]

Different types take place for a specific task or function. For instance, the delta oscillation is one of the slowest and takes place when the person is in a deep sleep, and can be found in the neocortex or the thalamus [12]. Theta tracks the activity of the hippocampus wake behaviour (a ridge in the floor of the ventricles in the brain that is the centre for memory process [13]) and the REM sleep (rapid eye movement) [14].

These brain oscillations can be linked to disorders such as bipolar disorders and epilepsy because they center around a specific area of the brain, resulting in an abnormal type of wave that causes the disorder. However, both disorders have different underlying causes that can provide a stark contrast to each other in terms of how brain oscillation affects the brain activity.

Bipolar disorder for example, is connected with the beta oscillations which is associated with the attention and cognitive activity [15]. It occurs in the premotor cortical areas of the brain (see Figure 4), and in a healthy person this range would be between 13-30 Hz as shown in Figure 3. In bipolar patients, however, these oscillations noticeably reduce in their frequency and amplitude [17].

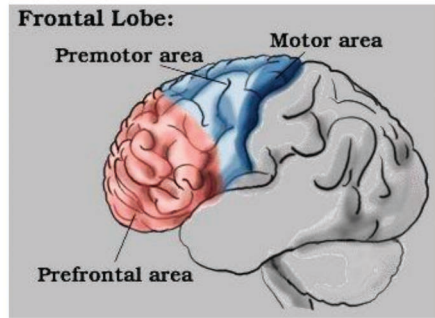


Figure 4 – Premotor cortical area of the brain [17]

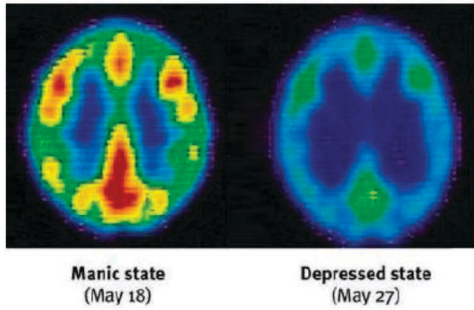


Figure 5 – PET scan of bipolar disorder [18]

This disorder is a condition that affects the person's moods which results in them having periods of depression and mania, often swinging extremely from one to the other. If left untreated, the depression can last from up to six to twelve months [19]. It can affect a wide range of people which suggests age is not a main factor, although it's more common among teenagers between 15 and 19, and rarely begins after 40. Furthermore, both genders have an equal chance of developing bipolar disorder [19] and environmental factors have not been proven to contribute to the condition.

Yet another source claims that another type of brain oscillation is involved in bipolar disorder: A. Özerdem et al [20] investigated the long distance gamma waves, which are critical for communication in the neurons. In addition, this oscillation is linked to recalling memories and storing them in the brain, but occurs during working memory and learning [21]. It said that there was a 'present disturbance in functional long-range connectivity' [20] between two locations in the structure of the brain (frontal and temporal), which relates to the impairments of the memory and attention in bipolar disorder. In the conclusion, it remained uncertain whether gamma oscillation reductions affected the disorder, but it had raised a useful question [20], which means it can still be taken into consideration.

Epilepsy is another disorder that causes the person to have sudden recurrent seizures that involves loss of consciousness (or convulsions) and sensory disturbance [22]. The brain is in constant electrical activity, and a seizure would occur when there is a sudden, intense burst of electrical activity that leads to disrupting how the brain usually works. This is temporary but if it occurs more than once then it is an epileptic seizure, resulting in being diagnosed with epilepsy [22]. The severity of the seizure varies as every person is different; some may experience a 'trance-like' state, others feel no awareness at all or they simply convulse [23]. It depends on the extent of the abnormal electrical activity and the specific area of the brain that was affected which can determine the type and length of seizure [24].

The possible causes of epilepsy are congenital abnormalities in the brain (abnormal development); lack of oxygen during birth; infections such as meningitis; brain tumours or cerebral thrombosis [25] (this occurs when a blood clot forms in one of the brain's venous sinuses [26]).

Patients with this neurological disorder have higher frequencies in the oscillatory activity which ranges from 100 – 500 Hz, which was recorded using depth microelectrodes [27]. This puts the oscillation frequency on a very fast level, above the average, normal gamma oscillation of 30-100 Hz (Figure 3). In recent years there have been effective treatment methods that have been proven to help with the disorders. For epilepsy, antiepileptic medicines would be given to stabilise electrical activities in the brain, helping it prevent the overstimulation of nerves, which is the cause of fits or seizures [27]. Anticonvulsant drugs are also prescribed by doctors and control about 70% of seizures in patients [27]. However, sometimes patients need to resort to surgery to remove a part of their brain that is causing the seizures, but only if it occurs in an area that would not result in permanent damage or a disability [28].

On the other hand, bipolar disorder has three main classes for treatment: mood stabilisers, antipsychotics and antidepressants – the latter being something that is rather controversial in its effectiveness for the condition [29]. Psychotherapy is also involved along with the medicine the doctor provides, which would typically be Depakote (lithium carbonate) as it is the most widely used drug of treatment for this disorder [29]. This is categorized as a mood stabiliser. Yet in spite of it being effective at reducing mania, the doctors still have no certain answer on how it works, but continue using it

as it has prevented a relapse in depression. Therefore, it 'evens out' the mood swings on both sides of bipolar disorder by affecting the chemical signals in the brain and making the cells more resistant to stress [30]. Unlike epilepsy, you cannot remove a part of your brain as a cure since it takes place in the main regions like the medial prefrontal cortex [31].

The importance of brain oscillations are becoming increasingly evident, especially in sensory-cognitive processes [10]. The two disorders differ in the rate of the oscillation frequencies yet they both concern the gamma oscillation. By being able to further analyse these brain waves in particular parts of the brain, such as the mesial temporal lobe where oscillations were visually identified near the time of seizure in epileptic patients [32], a better understanding can be applied to prevent further abnormal brain activities from taking place. Due to the brain oscillations' role in neurogenic communication and electrical activity, it is essential to be able to learn more about this topic in order to be able to gain better knowledge about how it affects brain disorders, and what is going wrong in the brain so doctors can create a definite cure. This would hopefully allow patients to have the rest of their lives free of these disorders, relieved of stress and being able to lead a normal, healthy life.

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PhD Tutor's comment:

A. is a very enthusiastic student, it was a real joy to teach someone who is so hardworking. She was interactive in the tutorials and did her homework every week. She is very good at receiving feedback and working on it. Her final assignment was above my expectations and I was particularly impressed by her exceptional writing skills and academic style.

How Have Animal Models Of Learning Influenced Our Understanding Of Human Learning?

Year 9, Key Stage 4

A. Pike, Ysgol Garth Olwg, Pontypridd.  
Supervised by S. Mistry, Cardiff University.

Research using animals occupies a central and fundamental role in fields related to neuroscience and psychology. Discoveries past and present have been key contributors to our growing understanding on how we form memories and learn (1). The question however is, how have animals influenced and developed understanding? Many questions arise such as; have animal models of learning truly had a positive influence on human understanding of learning; or is their use an unnecessary cost? Could humans be used as an alternative to animal models; or their use too influential- if so why is there such a controversy regarding the subject?

I have decided to research the effect of caffeine in animal models of learning and memory, with the intention of discovering whether caffeine is efficient in memory, and whether or not caffeine assists the increase in learning. My main focus will be considering if animal models have had a major influence on human understanding in this area (the effect of caffeine on learning and memory), and, if so, how. Before going on to explain both arguments on how animal models of learning have had an influence, of sorts; I will explain why the topic of caffeine is of relevance to you, the reader. Declared many a time in advertisements "The World's Most Popular Drug" (2) caffeine dominates supermarket shelves. Caffeine is a stimulant, consumed daily by 80% of the world's population (13) – in fact, 90% of North American adults consume some form of caffeine daily, making it the most widely used psychoactive drug of all time (3). Disguised in energy drinks and proudly advertised in cups of coffee; many claim that caffeine boosts learning and helps concentration.

As any university student will confirm, the worst time to take a class is first thing in the morning. Unfortunately, many classes are only offered during the time when most students are at their physiological low point of the day (morning), as measured by body temperature, skin conductance, and heart rate (11) (12). Many students rely on caffeine to get them through those early classes, claiming that it assists learning. Whether caffeine lives up to these claims or not has been solved by many an experiment with the use of animal models- ending the rumours and stating substantial facts.

In many ways animal models have had a majorly positive influence on our understanding of caffeine and its effect on human learning. For example, a study looked at the effect caffeine has on memory tasks; inhibitory avoidance and habituation to a new environment (5). The analysis used 372 adult male Swiss mice, bred by the scientists themselves. It concluded that caffeine differentially effects the different stages of memory processing; this effect depends on particularities of the memory task under study, and when the caffeine is administered (5). By researching the effects of caffeine, the study manages to show its effect on memory- therefore widening our understanding on how we learn – an evidently positive contribution. However, this study used mice- how does this link back to human learning?

Many ask why nonhuman animals are used to study in these fields; the simple answer is related to evolution- humans share similar ancestry with species of monkeys, rats



and mice (6). A mouse's genetic, biological and behaviour characteristics closely resemble those of humans, therefore many symptoms of human conditions can be replicated in mice (8). All of these factors contribute to why science uses animal models. It allows experiments to be operated without the long procedures to avoid violating a human participant's fundamental rights- undeniably a positive influence and a great method of sparing time. As a result, we have access to many studies on 'the effect of substances on learning and memory' such as the aforementioned article (5)- a number which would dramatically decrease if animal models were not used.

Another positive reflection on animal models' influence on the understanding of human learning is a study focused on caffeine's effect on rats facing the Morris Water Maze Test (9). A Morris Water Maze test is a simple procedure that usually consists of six day trials, in which rats are placed in an open swimming arena. The aim of the task is to assess the rats' spatial learning and the time it takes to locate a submerged platform hidden in the arena. Using 12 adult male Wistar rats, the scientists measured the distance rats travelled before reaching the platform (9). They discovered that post-training administration of caffeine improved memory retention at the doses of 0.3-10 mg/kg (the rats swam up to 600 cm less to find the platform) but not at the dose of 30 mg/kg (9). Pre-test caffeine administration also caused a small increase in memory retrieval (the escape path of the rats was up to 500 cm shorter) (9). The study suggests that caffeine improves memory retention but not memory acquisition in rats- and therefore possibly, in humans (9). In simpler terms, if you were to revise for a test and then take it later that day caffeine will help you recall the information you had revised. However, caffeine does not enhance your ability to store the information learned.

Influencing our understanding of human learning, the study shows the effect caffeine has on memory retention and acquisition in rats; and the suggested effect it has on humans. Animal models have had a positive influence on our understanding in this area because it would have proven near to impossible to conduct this exact experiment with humans. Yes, there are many variations one could use with humans as alternatives, but the water provides a physical, unavoidable obstacle for the rats to overcome.

Again, the question arises; what if there were no need to test on animals, what if these models could have been replaced by humans? Animals prove a quicker and more efficient way of testing. Take a rodent, for example, a mouse. One has the ability of breeding animals, such as mice, in a controlled manner and environment (7). Mice are also relatively inexpensive and can be bought in large quantities from commercial producers that breed rodents specifically for research (8). This allows experiments to be repeated multiple times and still have dependable results because the mice used have been bred in uniformity. Other than sex differences, mice are almost identical genetically. This also helps make the results of medical trials more uniform (8). Also, mice, being one of the most common species found on earth, can be tested more efficiently and faster than on humans because of their generally mild-tempered and docile behaviour (8).

Human research protections emphasize specific principles aimed at protecting the interests of individuals and populations, sometimes to the detriment of the scientific question. This is significantly different from animal research guidelines, where the importance of the scientific question being researched commonly takes superiority over the interests of individual animals (10). While many argue this unfair, animal models of learning have been hugely beneficial to fields related to neuroscience and psychology-

as demonstrated in the vast research into caffeine's effect on learning. By analysing the effect of caffeine, we can see it's outcomes on memory. Nonetheless we would not be able to analyse without results, and there would be no results without the experiment. I would go on to state that 'there would be no experiment without animal models', but this would prove untrue. Without these experiments and their discovery, our understanding of how humans learn may be much less. However, it is unclear whether the same level of knowledge, we now have on the subject, could have been reached from different, non-invasive methodologies, perhaps without the use of animals at all.

On the other hand, many would argue that animal models of learning have had a negative influence on our understanding of human learning. Many consider the use of animals 'wasteful' and 'unnecessary'. In many areas of research on caffeine's effect on learning and memory the use of animals was not needed, raising the question 'If animal models were not needed in certain experiments what's to prove they are vital in neuroscience experiments and other related fields?' A prime example of this is a study that suggests caffeine enhances memory performance in young adults during mornings (14). The study was conducted on students aged 18-21, whom were divided into two groups. One group drank caffeinated coffee whilst the other drank decaffeinated coffee (14). The experiment was conducted twice; once, early morning and once in the afternoon. The study stated that in the morning experiment, the participants who drank caffeinated coffee were significantly more awake by the end than those who drank decaffeinated coffee (14). As quoted from the study "participants in the caffeinated group performed significantly better than the decaffeinated group in the test" (14). However, in contrast to the morning testing session, caffeine did not influence memory performance of students in the afternoon (14). The study went on to compare the results of the memory test across time of day, and concluded caffeine only improved explicit memory performance during the morning testing session (14). They later suggested that caffeine is only effective when physiological arousal levels are low- when humans are tired or drowsy (14). The study was conducted without the use of any non-human model. This could rightly suggest that the use of animals in other studies are unnecessary- or have had a wasteful, negative influence (14).

Another study used 95 young adults to discover caffeine's effect on mood and memory (15). All subjects were randomly assigned to administer doses of caffeine either before taking the study's test or after (15). The study found that caffeine had no significant effects on cognitive, learning, and memory performance (15). However, in general, high-to-moderate users of caffeine performed better at a certain memory task (recalling words) than low users, particularly at the beginning of the lists (15). Again, no animal models were used in this study. The results- being valid and reliable- were merely taken from human-only tests. This disproves the statement many arguments uphold 'The use of animals is vital in science and research'.

I believe that animal models of learning are more reliable than human models of learning. I think this because animals can be bred in uniformity where their genetics are close to identical and so is their intelligence. Humans are biased by personal opinions and beliefs, animals are not. A weakness in the use of human models is, as suggested in a previous study, the possibility that the difference in memory performance and learning was affected by the participants' perception of a benefit of caffeine, rather than the caffeine itself (14).

Briefly, the effect of caffeine on human learning is suggested

to vary depending on which learning task is conducted. It does not fully assist learning but consolidates memories - when consumed after learning (4). Caffeine has its greatest influence in a person's memory performance during their non-optimal time of day.

In conclusion, I believe that the use of animals in scientific research has furthered our understanding of the pharmacological processes of learning and the effects different substances have on our memory. I am of this state of mind because the majority of experiments and articles have used animal models of learning.

Regarding arguments that humans could be used as alternatives to animal models and that it would have a positive effect on our developing understanding, I disagree. There are many advantages on using animals as learning models, such as the efficiency of the tests and the time (and paperwork!) spared (8). Also, there is currently no need to pay animals for their use in experiments - merely the costs to buy or breed them - which proves inexpensive (8). Therefore, animal models of learning have influenced our understanding of human learning positively; providing a truth\* (\*suggestions with scientific authentication) amidst rumours regarding caffeine's effect on learning and memory.

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**PhD Tutor's comment:**

'As my first Brilliant Club placement in Ysgol Garth Olwyg, I could not have asked for a better school. The staff and pupils were dedicated and incredibly engaged with The Scholars Programme. From the first homework presentation A. did in front of the class, I could see she thought laterally. Her way of presenting the content in a completely different way than I have ever experienced was incredible. Her essay received an 85, which is fantastic for a Year 9 pupil! It was a joy to read her essay and she was able to formulate a great argument about the effect of caffeine on memory. What I can say is this: wherever A. ends up, she will be an invaluable asset to any undergraduate programme and I wish her all the best.'

**Nuclear Power: Is It Safe?**

**Year 10, Key Stage 4**

**A. Ali, Wellacre Academy, Manchester.  
Supervised by R. Worth, University of Manchester.**

In the world today, the energy requirements needed to run our daily lives is slowly yet steadily increasing and because fossil fuels, which are currently the main fuel source we use to power our civilisation, are greatly contributing to global climate change due to their high carbon dioxide outtake, we need an alternative [1]. This makes fossil fuel unviable for large scale energy production in the present and near future. This fact has made many people turn to the idea of using renewable sources and nuclear power, which has led to the debate on whether or not nuclear power is safe. The aim of this paper is to clarify the facts on nuclear power and find out whether or not it is safe .

The method that will be used to create a scientific and reliable report will be: only using peer reviewed, recent governmental data, as well as scientific journals (this is because it appears that old reports done by the UK government, such as the original Windscale Reactor fire paper that was released, were made not to inform scientists and the general public on what happened, but instead designed to lessen the public fear of nuclear power ), reliable news outlets (such as the Guardian and BBC) and other independent, reliable sources to avoid bias (for example, a union of nuclear scientists would be more reliable than a blog with an agenda). Therefore, this report will attempt to not use any data from sources that may have any agenda, whether it be for or against nuclear power.

One of the main problems with nuclear power is the high levels of ionised nuclear waste created by fission that ranges from anything that has been in contact with the reactor (low-intermediate-level waste), to the spent nuclear fuel (high-level waste). Some of the intermediate and all of the high-level waste requires heavy shielding, cooling and storage underground, however they are currently stored in dry cast containers until such sites can be located [2].

Nuclear waste would not be such a major problem with nuclear power plants if it wasn't for the fact that it is difficult to find long term solutions to the problem. For example, in the United States of America, while plans have been made to turn Yucca mountain into a large nuclear waste repository, the plans haven't been acted upon for years and it appears that the plans won't be acted on any time soon . The need for a large repository is needed where 1 out of 3 Americans live close to a nuclear plant or its storage and a leak of any kind could be detrimental [4], However, while dry cast storage is useful for mid-term storage of nuclear waste and it poses low risk for environmental contamination, it is by no means a long term solution, due to the fact that above ground sites take up land and if these were to be attacked, large amounts of nuclear waste could be repurposed and weaponized. Due to this, many agencies like the 'Union for Concerned Scientists' believe that while dry cast storage is a good option currently, in the long term high level nuclear waste would be at its safest buried underground in large repositories where it can wait out its long half -live in relative safety [3].

There is another solution to the nuclear waste problem other than underground and dry cast storage. This is the Generation 4 Reactor designs which are currently being designed and are expected to be in service anytime between 2020-2030 [6]. Generation 4 plants are expected



to be able to solve two large problems of nuclear power: the large amounts of nuclear waste generated by Gen 2 and Gen 3 reactors, as well as the fact that instead of the nuclear waste being radioactive for tens of thousands of years, it will only stay radioactive for a few centuries. This is due to the fact that the majority of Gen 4 designs are able to reuse old reprocessed nuclear waste and when given fresh fuel rods (either Uranium or Thorium) almost all of the fissile material is used, making it a lot more efficient than reactors that are currently in service today [7].

Many fear another Chernobyl-level accident in the coming years. Large environmental groups such as Greenpeace, warn that nuclear power is "inherently dangerous", that "safe reactors are a myth", that accidents cause "the release of large quantities of deadly radiation into environment" and that during normal operation, radioactive elements are discharged into air and water sources [8]. Firstly, the points which state that nuclear power is dangerous and can't be made safe can't be backed up by evidence. There have only been three major and well-known nuclear accidents; these are Three Mile Island, Chernobyl and Fukushima accidents. The Three Mile island reactor caused no deaths from radiological exposure as well as no long term environmental damage, however it did release small amounts of radiologically contaminated gasses and the accident exposed the possible vulnerabilities of nuclear power. The Fukushima accident caused no health issues to occur due to radiological exposure, however there was environmental damage leading to a 20Km exclusion zone around the reactor. Finally, the Chernobyl reactor is the only one to cause both environmental and health consequences with a death toll of 56 (a number of these deaths are due to environmental contamination leading to thyroid cancer). While nuclear power has proved to be somewhat dangerous in these events, they have all been learning experiences for the industry and these accidents have led to new reactor designs and safety protocols, significantly lessening the chance of accidents of this scale happening again [9].

Another of the points, which states that during normal reactor management radiologically contaminated materials are discharged into the environment, is false. The simple design of a pressurised water reactor (which many different types of reactor share a similar design scheme to) completely disproves this point. In a nuclear reactor there are two loops: one inside the nuclear reactor with a heat exchange coming out of the side; and one outside the reactor, surrounding the heat exchange then taking the steam that bubbles and using that to turn a turbine and condensing it then reusing it as shown in figure 2[10]. This means that the water in the secondary loop is not contaminated by radiation, so it is safe to be let into the water and airstreams, which happens to some of the water in the condensing phase. When water is contaminated in an emergency situation, such as a break in the pressure vessel or water loops allowing water to flow in, the reactors are designed to let in fresh water and not to let out contaminated water. This means that the majority of contaminated water is kept in the system and can be stored in liquid radioactive waste systems until they are below safe radiation levels and are then discharged into local water sources [11]. However, a report of 11 nuclear power plants was published which showed that the cooling intakes can, although rare, cause large amounts of environmental damage due to the fact that marine life can get stuck in them. The amount of damage varies from plant to plant with most plants causing a relatively small amount of damage, but a few were causing large amounts of environmental damage. One of these reactors located in California was killing nearly 32 times the amount of marine life than all the other plants in the study combined, meaning that while inconsistent, this is an issue that needs to be addressed and accounted for when building new reactors [12].

While researching this topic, multiple biases were found. Most of them were against nuclear power and most of the sites that had this bias were either using false data or, more commonly, they were taking data out of proportion. An example of this would be that some environmental groups as well as shock media sites claiming that it was satellite imagery of either caesium 137 or standard nuclear waste released into the ocean by the Fukushima disaster [13], while in fact it was a computer simulation of water displacement after a tsunami by NOAA (it is even measured in cm while radiation levels are measured in sieverts).

There has also been a lot of worry about suspected increases in cancer rates which came under the public spotlight in 2016 after it was reported by multiple environmental groups as well as news outlets that there was an unexpectedly high amount of thyroid cancers that shouldn't have manifested so soon after the reactor accident. Large names in the environmental and anti-nuclear world have claimed that these were caused by radioiodine from the reactor, similar to what occurred during the Chernobyl disaster where radioiodine fell over Eastern Europe causing it to be induced by cows which tainted milk causing large amounts of thyroid cancer in under 18's. It appears, however, that this isn't the case, as when the ultrasound test to find thyroid cancer was used on a population not affected by the radiation, it was discovered that the number of small cysts/bumps was only slightly less common compared to the population near Fukushima when the accident occurred and there were only slightly higher cancer rates in the exposed population. It is now theorised that the higher number of bumps found was due to the fact that more people than ever in Japan had the ultrasound test used on them and that the data Japan already originally had was not proportional to the amount of people screened .

Finally, anti-nuclear groups such as Greenpeace constantly warn that nuclear power is unclear, unsafe and is taking money as well as resources away from clean and renewable energy sources such as hydro, wind and solar. This is simply untrue. While nuclear may take some resources away from the renewable sources, in return it gives us intensive, carbon free, safe and reliable power because while the renewable sources may be even cleaner than nuclear energy, they are far from reliable and don't produce as much energy. An overcast day, droughts or even a calm day could cause multiple sites up and down a country to become either temporarily inactive or to produce a very low energy yield. The other point that these environmental groups try to push is that nuclear power is unclear and unsafe. The global average for deaths from nuclear power per Trillion kWh is only 90 with the Chernobyl and Fukushima accidents added and without them the deaths in the U.S are 0.1 per Trillion kWh. Both of these figures are the lowest in global deaths with even renewable energy sources having a higher death rate than nuclear [15]. This is due to the fact that with proper planning, design and retirement of the waste, it is one of the safest forms of electricity production on the planet. Environmental groups try to warn of another Chernobyl or Fukushima event, however the chances of these happening again are incredibly low. This is because in the European Union and USA RBMK reactors are banned and the ones that are active have plans to be phased out by sometime in the 2020's. If another type of reactor, for example the PWR or AGR reactors, were in use by the Soviet Union, it is unlikely that a Chernobyl type accident would have occurred. Also, a Fukushima type accident could have been averted or made less serious if the proper safety precautions were put in place, however Tepco (the company who ran the Fukushima plant) were worried that 'improvements to the safety of the plant could highlight risks in the plant's structure fuelling the anti-nuclear lobbyists' [16], which does highlight the need for tighter regulation concerning

plant safety created and enforced by the governments of all countries which use nuclear power.

In conclusion, the safety of nuclear power is a complex issue which people need to be educated on and which certain decisions need to be discussed and attended to by the governments of all countries which use nuclear power. This is because while nuclear power is one of the safest forms of power generation we possess, there are still some issues, such as how we are going to store high-level nuclear waste in the long term because while dry cast storage is good for the medium term as temporary storage, we need to be able to lock the waste underground where it is at its safest. Also, they need to decide how extensively Generation 4 nuclear plants will be implemented due to the fact that these can drastically shorten the half-life of nuclear waste. These reactors leave less nuclear waste as they use more fissile material than Gen 2 and Gen 3 reactors, making Gen 4 reactors more efficient. Also, Gen 4 reactors are able to reuse existing, reprocessed nuclear waste and create power with it. Nuclear is one of the safest forms of energy we possess with less deaths per kWh than any other source currently used by today's society. The amount that nuclear power is used for power generation should increase not only to drastically increase the supply of power but to make power generation even safer than it already is and the longer that we use nuclear power, the more we learn and the more efficient and safe it can become.

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### PhD Tutor's comment:

'A. showed an excellent capacity to retain and explain complex information, and relate complex ideas to each other, from a very early stage in the programme. Given the freedom to fully explore the topic with a relatively open question (Nuclear Power: Is it safe?), he ran with it and even taught me a few things along the way! After the intensive course delivered over The Scholars Programme, I thoroughly enjoyed reading this piece which reflects A.'s natural intellectual curiosity and enthusiasm towards learning a new subject, as well as his drive to deliver that information effectively. Well done, A. – keep it up.'

## Understanding The Relationship Between Inflammation And Disease: The Role Of Inflammation In Rheumatoid Arthritis

Year 10, Key Stage 4

H. Coleman-Gorlah, Varndean School, Brighton.  
Supervised by L. A. Callender, Queen Mary, University of London.

Rheumatoid arthritis is an autoimmune disease which causes a loss of movement, pain and swelling in the joints – typically hands and feet. It is caused when the immune system mistakenly targets the body with antibodies near the joints. This causes the synovium, a thin layer of cells that cover the joints, to become inflamed and release chemicals which damage or erode bone, ligaments and tendons. This results in pain and stiffness. Inflammation plays a key part in rheumatoid arthritis, being a major step of its pathogenesis. Rheumatoid arthritis does not have a known specific cause, but there are risk factors including age, weight, and genetics. Rheumatoid arthritis cannot be cured as such, but there are multiple ways to ease its symptoms and provide more comfort for the ill person. These include disease-modifying anti-rheumatic drugs (DMARDs) and other biological treatments (NHS, 2016). People are also encouraged to try and minimise the risk factors mentioned earlier where possible. This essay will explain the symptoms of rheumatoid arthritis and how they relate to the immune system.

### Inflammation and the Immune System

In order to understand rheumatoid arthritis, it is important to understand the concepts of the immune system and inflammation. The immune system is the part of the body which protects it from disease and pathogens. The immune system can be split into two parts: innate and adaptive immunity.

The innate immune system consists of physical barriers such as skin, which are the first line of defence, and reactions like producing tears or mucus. The skin physically stops any pathogens from entering the body, meaning they must travel through broken skin or other entrances such as the mouth. Tears and mucus both contain an enzyme called lysozyme that destroys the cell wall of many hostile organisms (Gene Mayer, 2017). In addition, due to its viscosity, mucus can trap pathogens. On a cellular level, cells such as macrophages and neutrophils will act to defend the body. Macrophages are phagocytes (meaning they engulf dead or hostile cells) which reside in tissues, and upon detecting a foreign body they will try to engulf them through a process known as phagocytosis. This process is not adapted to specific cells but is caused upon detection of any foreign cell. Neutrophils are granulocytes, meaning they contain and produce granules. A granule is a small vesicle containing cytotoxic proteins – meaning they cause cells to undergo apoptosis or death – and upon detecting a hostile cell the neutrophil releases the granule, spreading these proteins into the bloodstream around it and killing the threat.

Adaptive immunity is the branch of the immune system comprising of components that specifically adapt to stop pathogens. When a pathogen enters the body for the first time, there will be antigens – specific markers to distinguish cells – on its surface. Two types of lymphocyte, a type of leukocyte, will make use of these: B and T lymphocytes. B lymphocytes produce plasma cells. These specially adapted cells will produce antibodies, chemicals specifically designed to fit to the pathogen's antigens. This is a way of marking the cell so that phagocytes and T cells know to target it. The T cells work by puncturing the surface of a hostile cell and



delivering cytotoxic proteins via tubes known as microtubers. This specific targeting ensures there is no collateral damage of other cells. During this whole process, cells which are adapted to combat the specific pathogen in the body will have slowly proliferated, ensuring there are enough of them to effectively neutralise the threat. After this threat is gone, some of the lymphocytes will remain while others undergo apoptosis. This means that next time the same pathogen invades the body, the immune response will be much quicker as all the cells will need to do is reproduce and proliferate. This differs to the innate immune system because there are certain cells specialised to deal with certain pathogens, which deliver a more targeted, albeit slower, response.

Inflammation is the process of these cells, or leukocytes, becoming highly concentrated in an area such as a cut or wound. This happens in order to defend the body from threats. Generally, there are five signs of inflammation: redness, heat, swelling, pain and loss of function. Redness and heat are both caused by an increase in blood flow – this is because the cells need to gather around the affected area. Swelling is caused because of the higher concentration of fluid and cells. The pain acts as a flag to tell the person there is a problem with their body. Loss of function tends to be a result of the aforementioned factors, for example if a joint is too painful or swollen to move properly (Parakrama Chandrasoma, n.d.). The purpose of inflammation overall is to act as an emergency response to a threat, and quickly remove or disable the pathogen.

**Rheumatoid Arthritis**

Aside from basic risk factors, there is no consensus on the specific cause of rheumatoid arthritis. Little is known about its triggers or what prompts it. However, there are risk factors. Smoking is an important one and is associated with the severity of rheumatoid arthritis. A study found people who had smoked for 25 years or more were 3.1 times more likely to have rheumatoid factors. This is potentially due to a direct effect on the lungs, although there is currently no concrete data to support this assertion (Kenneth G Saag et al, 1977).

Another factor is hormonal. Women are much more likely to get rheumatoid arthritis. This is because of the potentially protective effects of both the oestrogen and progesterone hormone: studies show that during the postovulatory stage in women, when the hormones oestrogen and progesterone are both at higher levels, joint pain is decreased (Cirino, 2016). This potentially suggests that these hormones have a protective effect against rheumatoid arthritis. This is also in agreement with the evidence that women who are post-menopause, and therefore have less of these hormones, tend to be more likely to get rheumatoid arthritis. Resultantly, it can be inferred that women who have lower levels of these hormones due to events like menopause or lactation, are much more likely to be at risk of rheumatoid arthritis.

Weight is also a key factor. Roughly two thirds of people with rheumatoid arthritis are obese or overweight. The main role it plays, however, is increasing the severity of rheumatoid arthritis among those who actually have it. Being chemically active, fat cells (or adipose) are a source of cytokines – small proteins used to signal cells. Many of these cytokines that adipose tissue produces are the same as those which inflamed or affected tissue, especially in rheumatoid arthritis, releases. The result is that more fat means more of these cytokines are in circulation, aggravating the pre-existing inflammation already present in people with rheumatoid arthritis.

The joint erosion in rheumatoid arthritis is also likely to be compounded in overweight or obese people. This is because if more weight or strain is placed on the bone, more erosion is likely to be caused (Delzell, 2015).

**Pathogenesis**

Rheumatoid arthritis is caused when cells mistakenly attack the body, specifically the area around joints. Cells such as macrophages and other leukocytes gather at the synovium – a collection of cells around joints. The synovium, or synovial membrane, surrounds and encases a viscous white fluid called synovial fluid or synovia. This fluid lubricates and eases the movement of joints. During the process of rheumatoid arthritis the synovium becomes inflamed, making movement more difficult. The synovial tissue also becomes more sensitive, and painful during movement.

A key feature of the synovial tissue's inflammation is that when macrophages are harboured in it, they can potentially change into, or emit cell signals that promote the growth of osteoclasts (Schett, 2007). Osteoclasts are bone cells which break down and erode bones into minerals. This ensures the transferral of calcium into blood. While osteoclasts are important, too many osteoclasts compound bone damage and can be severely harmful.

In addition, B cells, which will also gather at the inflamed site, contribute to the number of osteoclasts by releasing a signalling molecule called RANKL. RANKL promotes the degradation of bones through osteoclast production, and while B cells are useful in maintaining protective immunity, the danger of RANKL means they are also a key part of the illness (Kirstie Saltsman, 2016).

B cells also produce chemokines and cytokines which promote angiogenesis (Silverman, 2003). Angiogenesis – the creation of new blood vessels – is important in rheumatoid arthritis because it sustains the pannus (EM, 2004). A pannus is an abnormal layer of tissue which can form in diseases such as rheumatoid arthritis. In rheumatoid arthritis specifically, the pannus forms from the synovium, and can extend into and through the affected joints. This also erodes and prevents the growth of bone, making B cells more important.

**Treatments**

While there is no true cure for rheumatoid arthritis, many treatments exist to ease or lighten the pain and symptoms of sufferers. Probably the most common of these are DMARDs – disease-modifying anti-rheumatic drugs. Methotrexate is one of the more common DMARDs. It reduces inflammation in the body (though it is not known exactly how it works (Poinier & Shadick, 2014)). This reduction means that the impact of rheumatoid arthritis in affected joints will be lessened, although due to methotrexate's immunosuppressive properties it can have a negative effect on the immune system's effectivity.

If methotrexate is not sufficient, it may be taken in combination with a biological treatment or another DMARD such as leflunomide, which blocks white blood cell development. As with methotrexate, this has potential side effects due to its suppression of the immune system.

Biological treatments are also a possibility. These are a newer type of treatment, and are injected only if DMARDs are ineffective on their own (NHS, 2016). They include infliximab, which affects a cytokine produced mainly by macrophages called TNF alpha (Maini & Feldmann, 2004). This particular cytokine makes it easier for inflammation to happen, for example in vascular cells it promotes transendothelial migration and makes the adhesion of leukocytes easier (Bradley, 2008). Inhibiting the production of TNF alpha reduces some of the severity of inflammatory diseases such as rheumatoid arthritis.

Another biological treatment is rituximab, which lowers the amount of B cells. As established earlier, B cells contribute to

rheumatoid arthritis through angiogenesis and osteoclast production. Lowering the amount of B cells therefore lowers bone damage, among other things.

As mentioned earlier, the female hormones oestrogen and progesterone may have a protective effect on rheumatoid arthritis. Research shows that women who undergo HRT (hormone replacement therapy) to increase these hormones reported that the frequency of their rheumatoid arthritis seemed lower (Cirino, 2016). However, when rheumatoid arthritis did happen, it is possible these hormones worsened the severity.

**Conclusion**

This clearly shows how inflammation plays a key role in the pathogenesis and sustainment of rheumatoid arthritis. The inflammation itself creates pain, swelling and contributes to loss of function, while the nature of inflammation means that cytokine producing cells like B cells or macrophages will gather at the affected joint, creating more problems, for example osteoclasts. The example of rheumatoid arthritis shows the importance of inflammation in many diseases, and, despite its protective nature, the extent to which it can be damaging to our own body.

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**PhD Tutor's comment:**

'I thoroughly enjoyed my time at Varndean School. H. is a very intelligent student who gave every tutorial 110%. I was extremely impressed with H.'s final assignment. It was completed to a highly professional standard and was a joy to read. It was very evident that H. had done a lot of independent research for the final assignment and his hard work definitely paid off as he graduated with a 1st. I have no doubt that he will continue to succeed in his academic studies.'

# Can We Predict The Course Of A Brain Disease?

**Year 10, Key Stage 4**

**M. Kistowska, English Martyrs School, Leicester. Supervised by M. Clarke, University of Nottingham.**

The aim of this article is to determine whether the future course of Multiple Sclerosis (MS) can be predicted in patients. Specifically, it will look into brain lesions and brain atrophy and how the two combined can predict future treatment that may be required for the patient. Predicting the course of MS is very important for individual patients in order to create more personalised treatment plans and determine whether the MS of the patient will develop or remain stable.

**What is Multiple Sclerosis?**

MS is a brain disease that affects 2 million people worldwide, mainly young women (De Stefano et al, 2014). It is the most common cause of neurological disability in young adults and occurs in the central nervous system, when the myelin, a protective layer in neurons, becomes damaged. A neuron consists of dendrites and cell body (soma) which contains the organelles and nucleus. This part is connected to the axon terminal by an axon. Axons are long strands (up to 2m) of the nerve cell which conduct electrical impulses from the soma and are covered in myelin sheath. Myelin contains lipids which don't allow the signal to pass through them so, the signal has to 'jump' over it. Therefore, the myelin speeds up nerve impulses, while protecting the axon.

In MS, the immune system begins to turn on the body and attacks the myelin in neurons by releasing pro-inflammatory substances (e.g. cytokines), causing neuroinflammation. They attack the myelin as the white blood cells (T-cells) mistake it for foreign invaders. Due to the chemicals released, myelin gets damaged, exposing the axons (these may become damaged too), and forming brain lesions. This process is referred to as demyelination.

In MS, only the myelin in the central nervous system is damaged, while myelin from the neurons in the peripheral nervous system remains healthy. This occurs because Schwann cells produce myelin for the peripheral nervous system, whereas myelin in the central nervous system is supplied by oligodendrocytes.

MS comes with many symptoms, depending on where the brain lesions are located. Symptoms range from balance problems to muscle spasms and blurry vision. MS can also cause cognitive impairment where the patient may have issues with thinking, learning and planning. Also, it has been found that 50% of people with MS have developed depression, allegedly due to threats and losses that follow living with an unpredictable and disabling disease (Patten et al, 2017).

**What are Brain Lesions?**

Brain lesions form in areas of demyelination. These could be described as scars in the brain as multiple sclerosis means 'multiple scars'. Some lesions can heal and disappear over time, however others may stay or grow larger.

Brain lesions can be detected using an MRI (magnetic resonance imaging) scan. An MRI scan uses strong magnetic fields and radio waves to form detailed images of inside the body. In order to see clearly, a contrast agent is injected into the patient; it will most often be gadolinium-based. New lesions can be detected using gadolinium as they appear very bright.

There are different MRI scans which have different properties and uses. A T1 scan shows the lesions as dark patches and the myelin as a light grey. The older the lesion, the darker it appears. If a lesion is quite old and a lot of damage has been done, the lesion will be referred to as a 'black hole'. These are irreversible and cause the worst disability, meaning the patient is likely to have a high EDSS (extended disability status scale) score (a ten-point scale used to measure disability). In a T1 scan, gadolinium is used to highlight active damage as it cannot enter the brain unless there's inflammation.

On a T2 scan, brain lesions will appear white and myelin appears darker. A study by O'Riordan et al, 1998, showed that there is a significant relationship between the number of lesions at the beginning of the illness and the type of MS that develops in the future. An MRI T2 scan was performed on 81 patients with clinically isolated syndrome (CIS), then repeated 10 years later. CIS refers to the first neurologic symptoms that last at least 24 hours. These symptoms are caused by inflammation or demyelination of the central nervous system and are often the first indication of MS, before diagnosis. At presentation, 54 of the patients had an abnormal brain MRI; 45 of these patients developed MS. Some of these had a relapsing/remitting disease (RRMS – the disease seems to improve but then relapses) and others had a secondary progressive disease (SPMS – the disease constantly gets worse with no signs of improving). 30 patients had either 0 or 1 lesion at presentation and only 1 of these patients progressed to having an EDSS of 5.5 10 years later. 20 patients had around 10 lesions at presentation; 14 of them had an EDSS of 3, the rest 5.5. Those patients with around 10 lesions at presentation developed the highest number of new lesions over 5–10 years. In conclusion, showing that the number of lesions at the beginning of MS can help predict the development of MS 10 years into the future.

#### What is Brain Atrophy?

Naturally, as people age, the brain shrinks (0.1–0.3% per year). However, the rate of shrinking is much larger in someone with MS (0.5–1.35% per year). Brain atrophy is the shrinking of the brain caused by neuroinflammation and neurodegeneration.

The brain is made up of the centre (white matter) which is the axons covered in myelin and the cortex (outside – grey matter). The cortex contains the soma of the neuron and consists of folded bulges called gyri that create dips called sulci. Inside the centre of the brain, there is a butterfly-like structure, these are the ventricles. The ventricles contain cerebrospinal fluid (CSF). When the brain shrinks, the ventricles and sulci expand and the gyri get thinner.

Brain atrophy is proceeded by neuroinflammation. The release of pro-inflammatory substances causes demyelination and then further axonal damage will lead to neuronal loss through axonal loss. As the axon gets damaged, the rest of the neuron is no longer in contact with the other end and no nutrients are delivered to it, therefore the disconnected end will eventually die. This is neurodegeneration and it leads to brain atrophy. Neuroinflammation is believed to cause RRMS and neurodegeneration is thought to reflect irreversible damage which leads to SPMS.

Brain atrophy can be measured over time using MRI scans and there are two approaches to measuring it. Measuring brain atrophy cross-sectionally consists of measuring volume of white and grey matter and CSF (used to make comparisons between patients).

Measuring brain atrophy longitudinally consists of calculating the percentage change in brain volume between two time points, allowing observation of atrophy overtime.

Brain atrophy has been found to occur in patients from early on in MS with CIS. However, some reports suggest that the rate of atrophy can vary throughout the course of the disease. Also, grey matter volume loss predicts more advanced forms of MS more strongly than loss of white matter volume.

A number of cross-sectional studies state that brain volume loss correlates with disability progression in MS. In a study, it was found that MS patients with greater brain atrophy showed a larger progression of disability than those who were stable. Long term disability is associated with loss of spinal cord volume more than loss of grey matter volume. A correlation between spinal cord volume loss and disability was also found, showing the importance of combining spinal cord and brain measures.

Longitudinal tests have found that brain atrophy at the start of the disease predicts disability progression in the future. Also, although the impact of brain volume on disability progression may vary at 1 year, it can predict disability progression over 10 and 13 years.

A correlation between brain atrophy and intellectual damage suggests early brain atrophy can predict long term mental changes (Smith et al, 2012).

#### Can the Course of MS be Predicted?

The future of a patient's disease can be estimated by looking at the number and type of lesions they have at the beginning of the disease. If the individual has many lesions or if they have a 'black hole', their MS is more likely to develop into a more harmful disease. However, if the lesions are small and minimal, they may heal. The lesions of MS typically appear within the optic nerves, spinal cord, brainstem and the white matter; it is rare for the lesion to be within the grey matter (Kidd et al, 1999).

The course of MS can also be determined by the rate of brain atrophy in a patient. The higher the rate of yearly brain atrophy, the more likely it is for them to develop a more severe case of MS.

It is also vital to look both at lesion load and brain atrophy combined as, if both occur excessively in a patient, the risk increases. A study found that whole brain and central atrophy, lesion volumes and lesion volume change can predict the subsequent disability and extremity of the disease. The best model to predict the course included both central atrophy and lesion volume change, implying that both relate to long term clinical outcome. Out of the 261 patients that were included in the study, 8 died due to a cause related to MS, showing a large lesion load and rate of atrophy can cause the patient to develop 10 points on EDSS. For those patients with the most lesions and highest rate of atrophy, their EDSS increased by the most after a 10-year follow-up (Popescu et al, 2013).

If predictions were successful, more personalised treatments would be offered. This would reduce the likelihood of unnecessary side effects for those with a less severe predicted case of MS, as they wouldn't be prescribed strong drugs and would avoid the drugs' side effects. Those with many lesions and a high rate of brain atrophy would be put on more aggressive drugs from the start of their illness.

#### Limitations

There are a few points which limit predicting the future course of MS in a patient. For example, there isn't enough evidence for less common presentations of MS, like an individual with a few lesions but a high rate of brain atrophy. Also, the MRI scanners that are used may present different results depending on the scanner used. One may detect a small

lesion, however another scanner may not. Brain atrophy also occurs at such a small scale that not all scanners may be able to detect it clearly enough to get an accurate percentage. Lastly, if an individual is dehydrated, their brain naturally shrinks slightly. During an MRI scan, the patient must be hydrated as shrinking of the brain due to dehydration must not be confused with brain atrophy.

#### Conclusion

Overall, the course of MS in a patient can be predicted as, if at the start of the disease the patient has an abnormal MRI, the chance of the MS progressing increases. The higher the lesion load and rate of brain atrophy in a patient, the worse their illness will be in the future. If doctors used this information to predict the course of MS in an individual, they could offer more personalised treatment depending on how severe their illness is likely to become. However, there are limitations to predicting the course of MS this way. As previously stated, different MRI scanners may present different results. Therefore, in order to ensure results are more accurate, I would personally suggest scanners to be standardised. If all hospitals used the same type and same quality scanner, all scans would be the same, reducing the risk of inaccurate treatments.

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#### PhD Tutor's comment:

'M. was a star pupil who from the very start showed a great interest in the subject and never failed to produce work of the highest standard. In her final assignment, M. discussed what happens to people with Multiple Sclerosis and how we could potentially use information from their MRI scans to make predictions about the future course their disease is likely to take. M. used a variety of sources, many of them not covered during our tutorials, to lead an informed discussion about the topic and its significance to MS patients.'

## What Do You Think Causes Chronic Pain, How Will You Test Your Hypothesis, And How Can You Use This Knowledge To Develop Better Treatments?

#### Year 11, Key Stage 4

**F. Ahmed, Wembley High Technology College, London.**  
**Supervised by D. MacDonald, University College London.**

What is chronic pain? Chronic pain is described as pain that lasts over a long period of time due to your body constantly firing impulses to the brain. This causes pain to persist for long periods of time, and in some cases, even when the injury has healed. Chronic pain is most commonly caused by diseases that cannot be cured, or have not yet been,

meaning the patient must endure the pain. In this essay I will be looking into rheumatoid arthritis and erythromelalgia in detail and concludes the main causes, problems and treatments of chronic pain.

A well known cause for chronic pain is the disease rheumatoid arthritis. Rheumatoid arthritis is an autoimmune condition meaning that it attacks healthy tissue, such as your joints. With this disease, your body produces antibodies and attacks the tissue surrounding your joints as it thinks it is protecting your body from a virus, infection or bacteria. This results in your body attacking the healthy tissue in the lining of your joints, causing the synovium to become inflamed and release chemicals that damage nearby bones, cartilage, tendons, ligaments (1). The number of cells in the lining of the joint, the synovium, increases but as the antibodies continue to attack the joints, the synovium becomes inflamed, continuing to produce chemicals that only damage the body further. This results in deformed joints and loss of movement. The symptoms include joint pain and swelling, stiffness, tiredness, anaemia, flu-like symptoms. The condition tends to progress slowly, however, for 1 in 5 patients the condition may progress rapidly (2). This condition results in chronic pain as the impulses are constantly being sent to the brain as the antibodies attack the joints, and impulses are also sent when surrounding bones, cartilage, tendons and ligaments have been damaged.

To test that someone has rheumatoid arthritis, you could use an x-ray to view the shape of the patients joints to determine if they have become deformed, or if the space between the bones have narrowed. If the x-ray displays that the joints have become deformed or the space between the bones has narrowed, then it shows that they suffer form rheumatoid arthritis as the antibodies have attacked the joint tissue causing the space between the bones to narrow, and the synovium releasing chemicals that damage surrounding bones resulting in deformed joints. The issue with using an x-ray is that it does not display the pain the patient is going through or to what degree (3).

A simpler way of detecting a sufferer is to check for joint swelling and how easily they can move, as if the patient has difficulty moving then it shows that their joints have been damaged and the swelling displays that their joints have been inflamed. This way you could test for pain by having the patient try to move: if the patient have severe difficulties trying to move, then it is evident that the patient is in a lot of pain. Depending on how well they can move, you can determine how painful the joint is. The problem with this is that different patients can endure different amounts of pain, meaning that some patients will be able to move although they are feeling a lot of pain whilst another patient will not be able to move although they may not be feeling as much pain. You could also touch the joint that has swelled and use the patients reflex of how quickly they move to determine how much pain they are going feeling, but different patients have different reaction times, meaning that the results may not be an accurate representation of the patient's pain. You could simply ask the patient to rate, out of ten, the amount of pain they feel and use their number to understand how much pain they feel. However, people endure pain differently and might exaggerate or understate when they rate their pain. A blood test could be used to see if there is a specific antibody, known as a rheumatoid factor, in the blood. This test is used as 80% of rheumatoid arthritis sufferers have the antibody in their blood, however, 5% of people who do not suffer from rheumatoid arthritis also have it which means that the test is not completely accurate, and it does not display the pain the patient is experiencing.

In modern medicine, there is no cure for rheumatoid arthritis. To reduce the damage of rheumatoid arthritis, anti-



inflammatory drugs can be used to reduce the inflammation of the joints, hence reducing the swelling and pain as the joints are less sensitive. If the swelling of the synovium has been reduced, then the amount of chemicals that it produces that damage nearby bones and cartilage will also be reduced, overall. This means there will be less damage to the body and the patient will feel less pain. This is because, if there is less damage being done to the body, the brain will receive fewer impulses and the patient will feel less pain. An example of this is NSAID'S (Nonsteroidal Anti-Inflammatory Drugs) which reduce inflammation and pain. Other drugs that also reduce pain and inflammation and are easy to obtain over the counter are ibuprofen and naproxen sodium. The side effects of using these drugs include ringing in ears, stomach irritation, heart problems, kidney and liver damage. Another potential way to stop rheumatoid arthritis is stopping the immune system antibodies from attacking healthy tissues. This would stop the damage being done to the joints, which would allow the patient to move and stop the pain as the impulses are not being sent to the brain because antibodies are no longer attacking the joints (4). Other drugs such as DMARD's (Disease-Modifying Antirheumatic Drugs) are used as they slow the progression of the disease and stop the tissue and joints from being permanently damaged by supressing your immune system so that fewer antibodies attack your joints and less damage is caused. The side effects of these drugs include lung infections and liver damage. This is caused because the immune system has been supressed meaning that the body is more exposed to other infections and viruses. These significant side effects mean these drugs are not an effective enough cure (5).

Another cause of chronic pain is erythromelalgia which is a rare condition that causes a burning sensation in the feet, most commonly, but in some severe cases can cause burning in the hands, face and other parts of the body. People who have this condition tend to suffer from episodes in which parts of the body that are affected worsen in pain, become itchy or the skin begins to feel warm, tender and turn red. Further symptoms include the skin becoming purple, swelling and a more than the usual amount of sweat in that area (6). For some sufferers the symptoms and pain might be mild for many years and progress slowly but gradually, but in some cases it can be sudden, very painful and continue to get worse quickly, becoming severe in a few weeks. The actual cause of erythromelalgia isn't known completely, but an assumption has been made that it is due to the malfunction of constricting and dilating blood vessels causing abnormal blood flow. However, for some people who suffer from erythromelalgia, it is caused by a fault in a gene. This means it can be inherited and run in families. Through the study of families that have suffer from this condition, a further discovery has been made; that the condition is due to a mutation in the sodium channels Nav.17 where responses to stimuli have been exaggerated in mutated channels and impulses have been sent at high frequencies to pain sensing neurons. This would cause chronic pain as sodium channels have been mutated and release impulses randomly at high frequencies, for long periods of time, although it may only be a reaction to a small stimulus. Due to the lack of clarity surrounding the cause of the condition, it is unclear if it is primary or secondary to an unknown or underlying disorder (7).

To diagnose erythromelalgia the patient can take pictures of their feet or the part of the body that suffers from an episode as the skin can turn red due to the skin being tender and the skin can become discoloured and turn purple. These signs will allow the doctor to know if the patient has the condition, but it will not measure the amount of pain the person is in. Erythromelalgia can also be diagnosed by putting the patient's feet or hands in warm water to see what happens. People with this condition, who feel pain regularly, feel temporarily relaxed or soothed when their foot or hand is in

warm water. Doctors can also find out how much pain they are in by asking if the water completely or partially removes the pain from their skin. The problem with this diagnosis is that people can endure pain at different levels due to their age or lifestyle meaning that it may not be accurate to ask a patient how much their pain is soothed by putting their foot or hand in warm water. Another diagnosis is a blood test which is used to find out if the erythromelalgia is caused by excess platelets and blood cells in the body, but this method of diagnosis also doesn't account for the patient's pain (8).

For some patients, where erythromelalgia is caused by a primary disease, treating the original one can relieve the patient of the condition. However, with other patients where the condition appears to be primary, drugs that affect and control the sodium channels can reduce the pain the patient is feeling greatly. Examples such as lidocaine block voltage gated sodium channels, meaning fewer electrical impulses are sent to the brain and the patient feels less pain overall (9). To treat or handle the condition, local measures can be taken by cooling or increasing the temperature of the extremity by putting it in warm or cool water as this can relieve the patient of the pain momentarily. Although it can relieve pain, the problem with local measures is that they fail to treat the condition and the patient will continue to suffer from it (10). Aspirin is used in most cases to relieve some of the pain, aches and swelling and reduces inflammation, but it also doesn't cure the condition and only allows the patient to endure it.

Chronic pain can be caused by many factors, such as rheumatoid arthritis and erythromelalgia. Due to these diseases, patients are in pain consistently, in many cases, for years. By researching into arthritis and erythromelalgia, I have understood that in order to eradicate chronic pain, the sodium channels must be blocked as the pain is due to the sodium channels and the constant firing of electrical impulses that the sufferer of the disease endures. Simply curing the disease would remove the pain as the person does not suffer from it anymore. However, in most cases, and the two I have described above, the disease/condition is incurable, or the cure has not yet been found, meaning that the pain will continue to persist. Therefore, to ensure that the sufferer of the disease does not suffer chronic pain, treatments to efficiently block sodium channels would be most effective and it would remove the pain indefinitely.

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**PhD Tutor's comment:**

I very much enjoyed my time working with the pupils of Wembley High Technology College. The students were all engaged, enthusiastic and enjoyable to teach, a real credit to their school. F. showed insight and independent thinking in her essay, using her own research to answer the question in an interesting and original way by tackling the scourge of arthritis pain. In class, F. revealed herself to be bright and thoughtful, making careful and considered contributions to the discussion. Whichever university she chooses will be lucky to have her!

**Finding Copper**

**Year 12, Key Stage 5**

**A. Ahmed, Year 12, Swakeleys School for Girls, Uxbridge.  
Supervised by R. Strachan, University College London.**

**Executive Summary:**

By identifying the most suitable place to find and extract copper, we can help ensure that the funds invested into this project will be worthwhile. Firstly, the basics about the Earth's structure will be explained to give an understanding of which region copper is formed in. Building on that knowledge, we will then recognise the different types of plate boundaries and identify which plate boundaries are associated with the formation of copper, and which are not. It is then useful to establish which boundaries link with the different types of faulting. For example, the destructive plate boundary associated with copper is also associated with a type of faulting called reverse faulting. These ideas intertwine to give a deeper understanding of exactly how and where copper is formed. Once the concepts have been explained, we will be looking at where we can actually apply the concepts learnt to enable us to find the most ideal and economically viable area to search for copper. Delving into South America, we will pinpoint the exact locations that we plan to investigate, such as the areas near south Peru's plentiful copper mines. These areas contain immense amount of copper, indicating that undiscovered resources may be found nearby.

**Geological Background:**

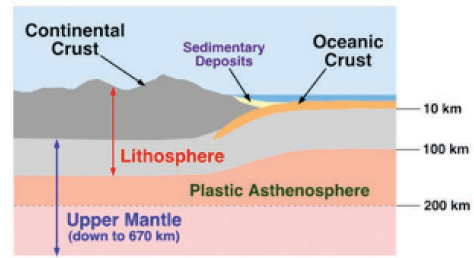


Figure 1: Layers of the Earth (Structure of the Earth, 2014)

**Plate Tectonics:**

The structure of the Earth is divided into three fundamental layers; these are the crust, mantle and core. In the centre of the Earth, the core is segmented into a central solid core and an outer liquid core. Surrounding the core is the mantle, which is the thickest layer and made mostly of solid rock. Lastly, enveloping the mantle is the thin crust; this layer is solid and can be either oceanic or continental (displayed in figure 1) (Strachan, 2017). Within the crust, many valuable ores can be found and extracted, including copper (Knauer, 2015).

However, the layers are not entirely separate. The lithosphere is the section consisting of the crust and the upper mantle and is also the section of the Earth responsible for tectonic plates. The lithosphere is segmented into many pieces, and these individual pieces are known as tectonic plates (Michigan, 2006). Tectonic plates can exist as either

continental or oceanic. The movement of these plates allow for ores such as copper that were deep in the mantle to be pushed to the surface caused by the extreme amounts of pressure and heat (Sowerbutts, 2013).

As the Earth's mantle continues to shift and move, this causes heat to build up and cause convention currents. This movement results in various plate boundaries being formed. There are four main types of plate boundaries that are found in the Earth's lithosphere. They can be destructive, constructive, conservative or colliding (Hanks, 2014).

The destructive plate boundary is associated the most with copper ores due to copper being found often on this type of boundary (Sowerbutts, 2013). When an oceanic plate and continental plate meet, this causes the heavy oceanic plate to descend underneath the continental plate, as shown in figure 2. The immense amount of heat caused by this contact can cause the oceanic plate to melt, causing hot fluid called magma to rise through the boundary to the crust. The rocks formed from the magma when it cools often contain copper and are called porphyry deposits. These deposits contain copper in the form of crystals (Strachan, 2017).

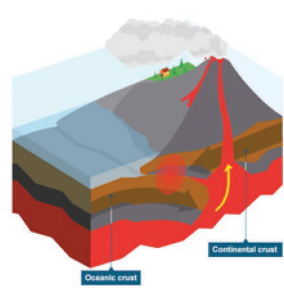


Figure 2: Destructive Plate Boundary (BBC, 2014)



Figure 3: Conservative Plate Boundary (BBC, 2014)

Another type of plate boundary is the constructive plate boundary. This type of boundary is characterised by two plates pulling away from each other and can occur between two oceanic plates. Due to the plates pulling apart, known as rifting, the crust often thins out (Strachan, 2017). Earthquakes are more unlikely, however still possible due to the movement of the plates. In the area where the plates have pulled apart, volcanic activity is likely to take place, causing magma that was deep underground to rise to the surface. The magma exposed is likely to have a flowing consistency with fewer rocks incorporated (Weebly, Constructive Divergent Margins, 2016).



Figure 3: Collision Plate Boundary (BBC, 2014)

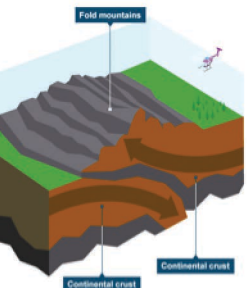


Figure 4: Constructive Plate Boundary (BBC, 2014)

Conservative plate boundaries occur when two tectonic plates pass each other horizontally (shown in figure 4). Friction still occurs, however volcanoes do not form as a result, nor is landscape created or destroyed. Boundaries such as these are close to the surface which is dangerous due to the possibility of earthquakes surrounding the boundary (Benson, Hill, Taylor, Herdson, & Sherlock, 2007). A



good example of this boundary is the San Andreas Fault, which will be described in depth later.

Lastly, the collision plate boundary occurs between two continental plates that are being pushed together. This causes immense amounts of pressure to build up between the plates. The heat generated may also result in the plates deforming due to their ductile nature. As seen in figure 5, huge mountains are formed because the plates crumple and deform under the pressure. Lots of folding is included, in which the ductile plates change shape but do not break (Strachan, 2017).

Faulting:

Plate margins occur between tectonic plates that have formed due to convection currents. These plate boundaries have resulted in further deformation of the Earth's upper crust, which is known as faulting. Faulting can occur in three main types: normal faulting, reverse faulting and strike-slip faulting (Strachan, 2017).

Normal faulting is the extension of the crust in a given region and happens with constructive plate boundaries. When the two tectonic plates pull apart (like in figure 4), magma that was settled underneath rises and then cools along the margin. This causes the crust to extend and thin out further.

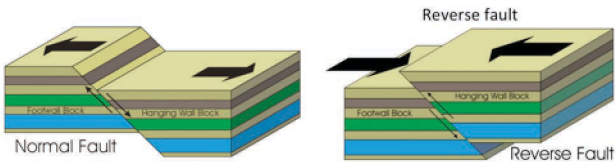


Figure 4: Normal Fault (Weebly, Faults and Seismic waves, 2012)

As the plates pull apart, a block descends to form a hanging wall block while the upper block is called the footwall block. This kind of faulting can also lead to rocks being displaced and dragged further down into the earth.

Reverse faulting usually takes place with destructive plate boundaries but can also occur with collision plate boundaries. The friction and pressure from the boundaries produces a reverse fault. In a collision plate boundary, two tectonic plates are pushed together and compressed, which causes a block to be forced upwards and forms the hanging wall block.

The footwall block therefore descends underneath the hanging wall block. Copper is mainly found in reverse faults due to their association with destructive margins. The movement of the hanging wall block causes layers of rocks to be dragged upwards, nearer to the surface. These rocks may contain ores, in particular, copper. The action of raising the rocks to the surface then enables the copper to be more visible, and therefore easier to extract.

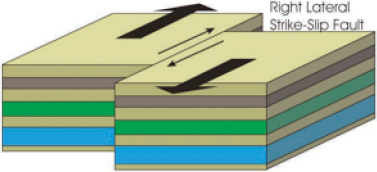


Figure 6: Strike Slip Fault (Weebly, Faults and Seismic waves, 2012)

Lastly, strike-slip faulting is the result of two blocks moving past each other in a horizontal movement. This type of faulting often takes place at conservative plate boundaries and can cause features of the landscape (such as rivers) to

be displaced. Figure 6 displays right-lateral strike-slip faulting; however left-lateral strike-slip faulting can also happen. Whether the strike-slip faulting is defined as left-lateral or right-lateral depends on the movement of landscape. If the landscape has seemed to move to the right, then it is defined as a right-lateral strike-slip. Similarly, if it has seemed to move to the left, then it is concluded as a left-lateral strike-slip (Amherst, 2017).

A well known strike-slip fault is the San Andreas fault which occurred between the North American plate and the Pacific plate. The strike-slip was concluded as a right-lateral strike-slip fault as the North American plate and Pacific plates slid past each other. The fault has been identified as 800 miles long and runs through California (Benson, Hill, Taylor, Herdson, & Sherlock, 2007) (Lynch, 2005-2017).

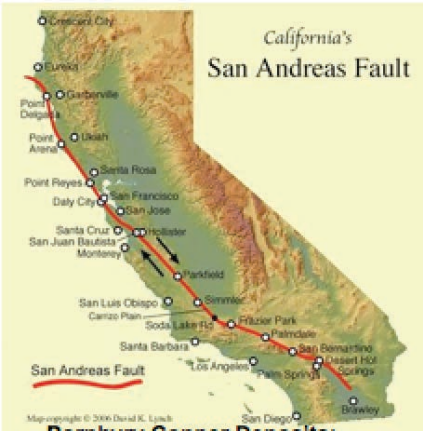


Figure 9 San Andreas Strike Slip Fault © (Lynch, 2005-2017)

Porphyry Copper Deposits:

Copper follows destructive plate margins, particularly around Chile and the west region of North America. Destructive plate boundaries result in plutons (magma chambers) to form under volcanoes. The plutons provide the fluid that seeps through the rocks to form the deposits. These rocks often contain crystals, some larger than others depending on the conditions and duration of the cooling process. These porphyries are then pushed up by the movement of plate tectonics, folding and reverse faulting. As the plates move towards each other, reverse faulting takes place where rocks previously buried are now exposed and the ore deposits are shifted upwards to the surface (Australia, 2016). We can then identify these crystals and extract the commodities required from them.

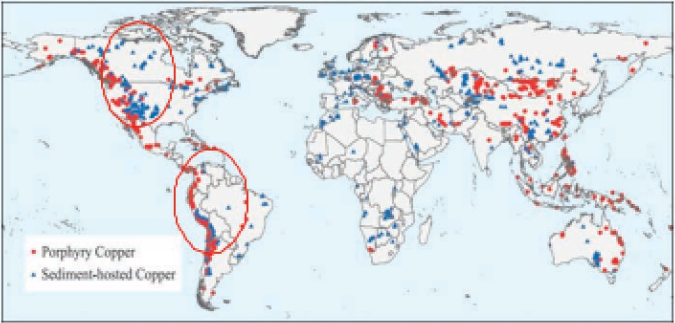


Figure 7 Map showing copper deposits around the world (USGS, 2008)

Many copper deposits can be found in the areas highlighted on the map in figure 10, the destructive plate boundaries are shown as red, this is where copper is primarily found within reverse faults. The figure above displays the destructive plate boundaries in red. The margins are quite prominent in South America (Chile in particular). They are also found in large quantities near Asia; however they are less easily accessible due to their position in the ocean. Therefore, proposing to investigate South America for its copper

resources would be the most appropriate and easily accessible region for this project.

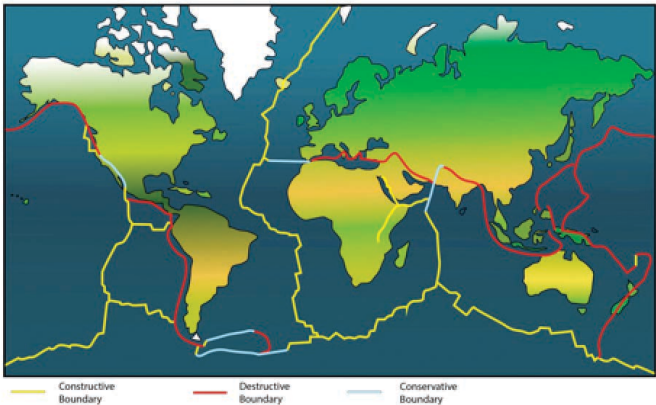


Figure 8 (Strachan, 2017)

Discussion:

Escondida in Chile has the largest resource of copper in the world; therefore Collahuasi in Chile would have a good amount of extractable copper available, however it has been reported that the copper is of lower grade, meaning that it would be more beneficial to look elsewhere (Barrera, 2017).

An overview on the copper deposits found in Peru proved to be relevant to our expedition in Chile (Laverdure, 2016). North of Chile, the mining industry in Peru is described as successful because of the large quantities of minerals available for extraction. The geological setting for Peru is quite similar to that of Chile, meaning that Peru will potentially contain enough valuable resources worthinvesting in. Many sources prove that this region of the earth is abundant in copper deposits, and as a result would be the smartest place to explore.

Primarily, exploring Chile seemed like the optimum proposal because of its history of having successful copper mines. However, recently Chile's copper industry has been facing some drawbacks that will affect business and further trades. These include strikes by the workers due to disagreement between them and the contractors of the mine. Also, heavy rains have disrupted the mining processes (Yeomans, 2017) (Cambero, 2017). Due to these factors, it would be wiser to invest in the land found in Peru. It is worth noticing that the Peruvian government is welcoming investment into copper by foreign companies. Peru is believed to have around 200 mines currently operating, which shows to be promising to new investors (Laverdure, 2016).

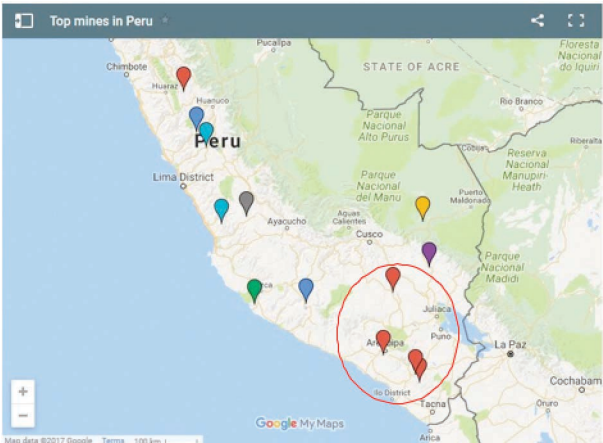


Figure 9 (Mining Production Data, 2017)

Figure 11 displays a multitude of top mines scattered across Peru. The red markers symbolise copper mines that are currently active. Using this data, we can interpret that the south of Peru possesses a generous amount of copper, and exploring this area would be advantageous for the expedition. Searching the area around Juliaca and Puno (displayed on the map above) may provide us with the copper deposits we have been searching for.

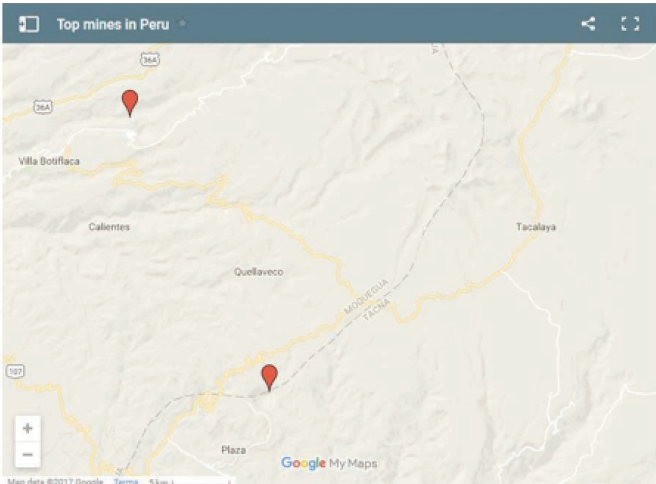


Figure 10 (Mining Production Data, 2017)

Delving further into the map, it is visible that there are many unexplored towns nearby that may contain the resources needed. Towns such as Tacalaya and Quellaveco would be worth exploring. The existing copper mines could be investigated as well to observe any patterns or continuous deposits.

Peru lies between the Nazca tectonic plate and the South American plate, as seen in the figure below. In the region we are going to search in South Peru, the area has been labelled as a central volcanic zone. This further highlights why this area would be suitable to explore. We are more likely to discover porphyry deposits in a volcanic zone that has a destructive plate boundary. The plutons under the volcanoes caused by tectonic plate movement will eventually cool to form crystals, some of which will contain copper in the form of ores.



Figure 11 (VolcanoCafe, 2014)



**Conclusion:**

After careful consideration of all the factors involved, such as business disputes, weather and accessibility, proposing to begin the search in Peru is believed to be the most economically beneficial. Though Chile has the largest copper mines and produces the most copper per year, this may also mean that the area is beginning to run dry, which is why looking elsewhere would be favourable.

Peru's government is also welcoming new trade for copper, making it worthwhile to invest in. Since Peru's mining industry is newer than Chile's, it is more likely to find fresh and new deposits available. Companies are usually attracted to Chile's great and flourishing history with copper mining and tend to overlook the opportunities that Peru has to offer.

Particularly in the area where the Nazca tectonic plate is located, there are immense amounts of mountains and volcanoes which will be exposing copper for extraction. The fact that there are already mines near the area we intend to explore clarifies the presence of copper in that specific area and will aid our search. Though we will not be using the exact same location, the mines act as indicators to where in the region copper can be found.

To conclude, the area that we plan to explore is promising with many sources indicating the likelihood of discovering deposits. Therefore, investigating the south of Peru as opposed to Chile would be the most economically viable and holds the potential to provide the best outcome for this project.

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**PhD Tutor's comment:**

'In this applied geology topic, A. has produced an exceptionally high-level report for a mineral exploration proposal. In her writing, A. displays independence of thought and well-reasoned arguments, drawing upon knowledge gained on the course as well as her own individual research; she demonstrates very good understanding of challenging concepts and their practical application. A. consistently took each challenge to a new level working with enthusiasm, drive and inspiration. It was a delight to teach her and I have no doubt that the skills she has shown throughout this course will lead her to great things in the future!'

## How Do Different Memorisation Techniques Affect Our Ability To Recall Information?

**Year 12, Key Stage 5**

**G. Callaghan, Blessed William Howard Catholic High School, Stafford.**  
**Supervised by J. Runacres, Birmingham City University.**

**Abstract:**

This study investigated the effectiveness of three different methods that are used to optimise encoding; each method relying upon a different component of the short-term memory to retain the information. The varying success of the three different tests could suggest a distinction between different components of the short-term memory, hence providing further evidence for the working memory model. A repeated measures design was utilised, in which a group of 16 participants, aged 16–60 years old, each undertook three tests using different methods of memorisation: mnemonics, auditory, and visual. The outcome of this research was that the auditory encoding technique provided the strongest retention of information within the short-term memory, and the mnemonic technique proved to be the weakest, because fewer words were recalled when using this method of encoding. This indicated that the working memory model is an accurate depiction of memory, as it provided evidence to support the idea that the short-term memory is split into separate components.

**Introduction:**

Memory is the capability of an organism to store and then recall information that has been processed through their senses. It is comprised of three main stages: encoding (the processing of new information from sensory stores into the storage), storage (creating a permanent record of information) and retrieval (calling back stored information for use) (Graf and Schacter, 1985).

Over the years, many attempts have been made to conceive a model which explains the cognitive function of the brain, a notable example of one of these attempts is the multi-store memory model (Atkinson and Shiffrin, 1968). The working memory model (Baddeley and Hitch, 1974) was then designed to combat criticism of the limitations that its predecessor – the multi-store memory model – had, particularly regarding the oversimplification of the short-term memory. This new model was founded when Baddeley and Hitch undertook an experiment in which, using dual task technique, they discovered that the brain could remember verbal and visual information at the same time, leading to a more complex description of the functions within the short-term memory.

Strikingly, one similarity between the two models is the parallel processing; both models suggest a sequence of stages for memories to be formed. For example, in the multi-

store memory model, information is collected at the sensory store and is then transferred to the short-term memory when attention is paid to it and eventually transferred to the long-term store after rehearsal. Similarly, in the working memory model, the information is also distributed in a parallel way by the central executive to the slave systems – visuospatial sketch pad and phonological loop – before being transferred to the long-term store.

Both models have an initial stage at which the information is collected from an organism's surroundings, yet their explanations of this stage are somewhat different. In the multi-store memory model, the sensory store is the stage where physical and chemical impulses within our environment are detected by our sensory organs. It typically has a duration of between ¼ and ½ second and is encoded in a sense-specific way with a limitless capacity (although this is difficult to verify as there is no current way of reliably measuring the capacity of the human brain) (Atkinson and Shiffrin, 1968). Encoding is the process of receiving, processing, and combining information and is split into four primary types: visual (for images and visual sensory information), acoustic (auditory stimuli), elaborative (uses information that is previously known to relate it to the new experience) and semantic (specific meanings of contexts) (Katona, 1940). Contrastingly, the working memory model exhibits this sensory stage as a 'central executive' – a supervisory function concerned with managing and filtering attention, as well as processing information to each of the slave systems (Baddeley and Hitch, 1974).

Furthermore, both the multi-store and the working memory model have a short-term memory facility, nevertheless, one of the largest differences between the two models is how this function is presented. Within the multi-store memory model, the short-term memory is a way of storing information for a brief period, between 15–30 seconds (Atkinson and Shiffrin, 1971). This happens when information from the sensory store is attended to. To then enable the items to stay in short-term memory they must be repeated verbally, by a method known as rehearsal in acoustic encoding (Baddeley, 2009). The suggested capacity of the short-term memory is that the number of items which can be stored at one time can be 7+/- 2 items before displacement occurs (Miller, 1956).

The consensus is that the working memory model is a successful reworking of the multi-store memory model because it provides additional descriptions of how the short-term memory is split up into varying components. These three sections are: an episodic buffer (allows communication between the central executive and the long-term memory), the phonological loop (a slave system containing auditory information with both an inner ear for remembering words that we hear and an articulatory process which maintains rehearsal) and the visuospatial sketchpad (provides visual and spatial information temporary storage). Clearly, this more elaborative description of the short-term memory is more useful when trying to understand how the brain works and these sections have been validated by considerable evidence. A case study once testified that a brain-damaged patient KF could recall verbal but not visual information immediately after its appearance. This is supportive of the working memory model's separation of the short-term stores into phonological and visual memory, as patient KF only lost one of these functions in the accident (Shallice and Warrington, 1970).

A similarity between the two models is that they both have the same final component: the long-term store. This is encoded semantically and has unlimited duration and capacity. However, the limits of the long-term memory are very difficult to test so there is no empirical evidence proving its duration as unlimited. Items are moved to the long-term

memory after they have been rehearsed enough within the short-term memory and transferred to the long-term memory; these can then be retrieved when needed (Atkinson and Shiffrin, 1968). Both models are criticised for their inadequate explanation of the long-term memory, particularly the working memory model. There is a prevalent notion that the working memory model should have included evidence provided by Tulving (1972), which suggested that there was a distinction between episodic, semantic, and procedural memory.

Moreover, despite the working memory model being a significant improvement from the multi-store memory model in terms of the detail provided within the short-term memory description, it is far from an all-encompassing depiction of the cognitive function. For instance, the working memory model has come under heavy criticism for its depiction of the visuospatial sketch pad (VSS) as being dependent on primarily visual information. Yet, Lieberman rationalises that blind people who have no visual information can have good spatial awareness, hence suggesting that the visuospatial sketch pad needs two components within itself (one for visual information and one for spatial information) (Lieberman, 1980). Correspondingly, the multi-store memory model has likewise been criticised for not accounting for how each stage works, and so it can be seen that both models need further research to gain the full picture of memory.

Due to this fact, a research project was undertaken to develop the understanding of the memory models by investigating whether certain methods of retaining information are more effective than others, hence leading to a potential conclusion that some areas of the short-term memory are stronger than other areas. This would support the working memory model's idea that the short-term memory is split into multiple sections. This research is concentrated on three techniques to optimise encoding: mnemonics, auditory in the form of hearing words (processed within the phonological loop section of the short-term memory), and visual with images (processed within the visuo-spatial sketch pad of the short-term memory). Mnemonics are strategies used to remember information by an association with another word or concept. They involve focused learning which aids in their transferral to the long-term memory, helping the learner to recall them easily (Bellezza, 1996).

Numerous similar studies to the one proposed have been undertaken in this field, most suggesting that visual memory recall is the strongest. For example, Standing (1970–1973) demonstrated that visual memory is superior to auditory memory by showing observers 10,000 images for a few seconds and reported that they could identify them later to 83% accuracy. Furthermore, an almost identical study was repeated in 2008 by Cohen and concluded the same results. In 2007, O'Hara commenced a study that tested the effects of mnemonics with elderly people to see if it aided their memory. An assessment was conducted of the delayed recall effect prior to, and immediately after, mnemonic training and at the 5-year follow up. Here, the mnemonic form of encoding allowed participants to remember more than other forms of encoding, suggesting mnemonics is the most useful encoding technique for long-term storage.

Overall, this study aims to provide an insight into which encoding technique is most effective in aiding recall, and how the strength of the short-term memory differs between the separate sections, therefore providing evidence to support the working memory model.

**Aim:**

To investigate the cognitive processes involved in encoding new information, and to evaluate the effectiveness of

different methods that can be used to improve our ability to recall new information.

This topic is a useful area of research because the maximisation of the brain's cognitive function is a vital part in the development of new skills for an individual. Thus, to gain an understanding of the best way in which to encode new information would be beneficial; it would lead to faster ways of retaining new information and be applicable to many areas of everyday life. It will also provide more evidence for the working memory model by showing that the different components of the short-term memory work separately.

**Method:**

A repeated measures design was used to discover which method of encoding was most effective.

Participants – To complete the research project, 16 participants were obtained, between the ages of 16-60 and of both genders, via opportunity sampling (a method by which participants are selected when the opportunity arises).

Materials – A room free from extraneous confounding variables (such as: noise, other people, or visual distractions) was used to ensure that the participants’ attention was not distracted when completing the study, so the accuracy of the results was not impeded.

A timer was used to ensure the same amount of time was allowed per activity that participants undertook.

Sheet 1 – A sheet of paper with 20 random words arranged with the first letter of each word forming a mnemonic constituting of all the first letters of the words.

Sheet 2 – A sheet of paper with 20 random words, each with an associated picture.

Sheet 3 – A sheet of paper with 20 random words for me to read to the participants three times so that they can hear it auditorily and ask them to repeat each word back to me.

Ethics – The entire study was conducted in agreement with ethical standards. For example, informed consent was obtained, all participants completed a consent form, and were informed that they had the right to withdraw at any stage.

Procedure – Firstly, participants were given the necessary information about the study that they would be involved in to allow them to decide if they would give their consent to take part (if they agreed they were instructed to fill out a consent form). Subsequently, the first sheet (as listed in the ‘materials’ section above) was provided to the participant. This explained the first memorisation technique that they must then use to remember as many words within the 1 minute 30 second time limit as possible. After the 1 minute 30 second time limit was reached, the resource sheet was covered and the participant was instructed to write down as many words as they could remember. Next, the participant completed each of the other two sheets in the same manner as stated before.

After collection, the data was analysed and the results were condensed mathematically so that patterns could be identified to aid in identifying the most successful technique. Tables were constructed to show how many words the participants had remembered via each technique of memorisation, and a mean value was calculated for the number remembered within each method. Furthermore, the range and standard deviation of the results was calculated to see how spread out the results were.

**Results:**

From the data, group 1 (auditory) proved to be the most effective encoding technique because it had the highest mean: 15, compared to 13 for visual and 9 for mnemonic. Both groups 1 and 2 had the smallest standard deviation of 2.6, while the data for group 3 seemed to be far more spread at 4.4. This is also true for the range as group 3 had the largest range at 16, as well as the largest standard deviation. This suggests the results were far more varied for group 3 and hence, tended to differ between people.

Again, within figure 2, the bar chart clearly depicts how strong the technique used for group 1 (auditory encoding) was in comparison to the other two techniques and the same results are indicated in a pie chart form to show the constitution of total words called by each group.

Figure 4 depicts a box plot for each group. The median is the line within each coloured box, so here it can be understood that group 1 (auditory encoding) had the highest median of 14, where group 2 (visual) had 12 and group 3 was significantly lower at 7. The highest bar level represents the highest non-outlier score found, where the lowest bar level represents the lowest non-outlier score found. Outliers, such as 19, are represented by a coloured dot and are calculated by 1.5 multiplied by the interquartile range, which is found as the boundary of each full coloured box. The interquartile range was greatest for group 3 at 6.5 and smallest for group 2 at 2.75. This is also true for the range; group 2 had the smallest range at 7 (excluding outliers) and group 3 had the largest range at 16.

Below a collection of graphs have been created to more clearly illustrate the data:

|                    | Group 1 (Auditory) | Group 2 (Visual) | Group 3 (Mnemonic) |
|--------------------|--------------------|------------------|--------------------|
| Mean               | 14.5625            | 12.6875          | 8.75               |
| Range              | 10                 | 9                | 16                 |
| Standard deviation | 2.6                | 2.6              | 4.4                |

Figure 1: A table showing the three methods of encoding in their groups, with data calculated for each technique used.

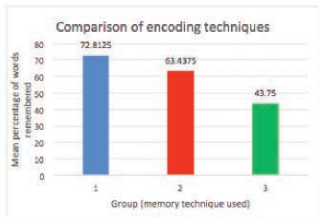


Figure 2: Bar chart showing a comparison of encoding techniques.

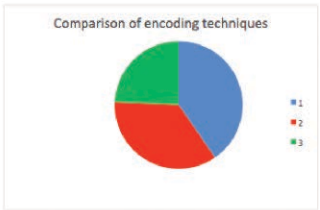


Figure 3: Pie chart showing a comparison of encoding techniques.

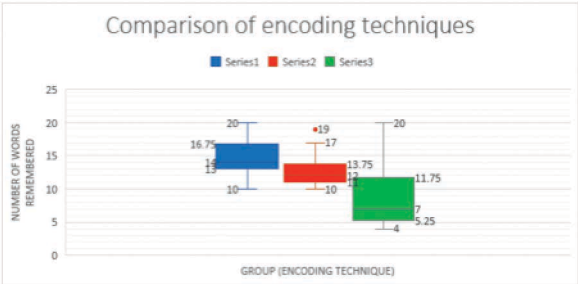


Figure 4: Box plots showing a comparison of encoding techniques.

**Discussion:**

The results clearly show that the auditory test was the most effective method of encoding, while mnemonics were the weakest which clearly achieved the aim of this research (to determine the optimum encoding method). Strikingly, this result is a sharp contrast to previous results showing visual encoding to be the strongest method of encoding information (Cohen, 2009; Standing, 1970-1973). This difference in results may have been caused by an imbalance in how difficult the tests for each encoding technique were; it is difficult to state with accuracy how easy a particular word or image is to remember.

Similarly, the results are also in opposition to O'Hara's (2007) findings that mnemonics were the optimum encoding technique, however, an explanation for this could be due to the fact that O'Hara tested long-term memory recall rather than short-term memory. Hence, this suggests that some encoding techniques may be strongest initially but weaker for encoding information for storage in the long-term memory. This illustrates that the different encoding techniques can affect how long the information can be stored for. A potential area for future research could be to test which encoding technique was the most successful when storing items in the long-term memory. In this possible study, participants’ retention could be tested after several different time periods and the encoding techniques could be compared to discover which was the most effective for each length of time.

Limitations: A major disadvantage of the opportunity sampling method is that the results may be biased. This is because the participants sampled are often from one particular group (for example: age, intelligence, gender), and thus participants sampled are not representative of the population as a whole. Therefore, to further improve the accuracy of these results, systematic sampling with a larger group of participants should be used to ensure that they were not bias. Moreover, only three types of encoding techniques were examined; if more were included, perhaps a clearer difference observation would be seen between the techniques as there would be more methods to compare. Additionally, another limitation of this research was the short timescale, because it made it difficult to research this topic in detail and for the findings to be expanded upon. To develop this research further, future research could concentrate on the effectiveness of each encoding technique to learn foreign language vocabulary. This would be beneficial as storing this new foreign vocabulary, and testing it a few days later, would ascertain which encoding technique was superior in allowing the most information to be transferred to the long-term memory. It would be necessary to conduct this study with foreign language vocabulary rather than pre-known words because certain words in an already known language may hold significance for people, hence making them easier to remember through semantic encoding. Another way of combating this problem would be to use trigrams (meaningless three-consonant syllables, e.g. HBA) and to avoid rehearsal, the Brown-Peterson technique can be used, in which participants count backwards aloud in threes for 30 seconds delay before recall (Peterson & Peterson, 1959; Brown, 1958). However, an obvious drawback of the use of trigrams is the low ecological validity; people do not often need to recall this kind of information in real life situations.

In summary, it was observed that auditory encoding provided the strongest recall ability of the three tested methods, while mnemonics were the weakest. This is important because it demonstrates that auditory learning plays a fundamental role in our memory and should be used to optimise recall within students of all ages.

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**PhD Tutor's comment:**

'I really enjoyed working at Blessed William Howard's School, the staff were welcoming and all students involved were mature and hard-working. G. showed herself to be a diligent student, able to grasp the often complex ideas introduced within the course and produce work of an extremely high standard. I was particularly impressed with the standard of G.'s writing, which was better than most undergraduate work I have seen. G. will be an invaluable addition to any university programme and I wish her the best of luck in the future.'

## What Is Dementia And Why Is Early Diagnosis Important? How And Why Does Gait Analysis Contribute To This?

**Year 12, Key Stage 5**

**M. Robinson, St Bede's Catholic Comprehensive School & Byron Sixth Form College, Peterlee. Supervised by R. McArdle, Newcastle University.**

Dementia is an umbrella term for a group of syndromes that cause cognitive impairments that impact activities of daily living. Dementia can affect people of any age, but is far more common in older people – one in six people over eighty and one in fourteen people over sixty-five have a form of dementia (Alzheimer's Society, 2007)<sup>[1]</sup>. The number of dementia patients is expected to rise in the UK by 156% over the next 38 years from the 2013 figures of 815,827 people to 2,092,945 patients (Alzheimer's Society, 2013)<sup>[2]</sup>. Economically, the cost of dementia is huge: according to a German memory clinic's investigations, the cost of diagnosing dementia alone can range from anywhere between €501 to €659 (Bernhard Michalowski, 2017).<sup>[3]</sup> This essay will discuss dementia and its subtypes, including the importance of dementia's early diagnosis. In addition, this essay will discuss the relationship between cognition and gait, and how analysing gait can contribute to diagnosing dementia earlier, as well as how forms of cognitive impairment can support this view. While there are several forms of dementia, this essay will discuss two in particular.



**Alzheimer's Disease**

Alzheimer's disease is the most common form of dementia (Alzheimer's Association, 2016)<sup>[4]</sup>, and is a neurodegenerative disease that begins in the hippocampus region of the brain which initially causes memory problems. However, as the disease progresses beyond the hippocampus region, other cognitive domains i.e. movement, also experience problems. This occurs when cells in the brain known as neurones begin to soften and tangle, causing neurofibrillary tangles. Amyloid plaques also form between the individual neurones (Kooresh Shoghi-Jadid et al, 2002)<sup>[5]</sup>, causing transmission between cells to be cut off and the brain begins to atrophy. Common symptoms of Alzheimer's include memory loss, challenges with planning and solving problems, and difficulties with completing tasks due to a loss of attention. Sleep disorders are also common in Alzheimer's, which can cause more confusion with regards to diagnosis of Alzheimer's and other similar forms of dementia (Donald. L. Bliwise, 2004)<sup>[6]</sup>. The speed at which these symptoms advance from mild to more extreme varies greatly from person to person. As the disease progresses, both cognitive and functional domains decline severely. Many neural changes occur during the course of Alzheimer's, including the atrophy of multiple areas of the brain such as the frontal lobe, which leads directly to the manifestation of attentional and movement problems.

**Dementia with Lewy Bodies**

Dementia with Lewy bodies is another form of dementia that affects around 10% of all dementia patients (Alzheimer's Association, 2016)<sup>[4]</sup>. According to McKeith, dementia with Lewy bodies affects approximately 100,000 people in the UK alone (Ian McKeith, 2015)<sup>[7]</sup>. Symptoms of dementia with Lewy bodies include Parkinsonisms, slowed movement, cognitive fluctuations and visual hallucinations. Problems with attention and alertness are very common in patients with this form of dementia, though any such issues are likely to fluctuate greatly over the course of a day, by the hour or even every few minutes. Sleep disorders are also common symptoms of dementia with Lewy bodies. A person may fall asleep very easily during the day, but struggle with falling asleep at night. The most common issues associated with this are confusion, hallucinations and violent movements as they attempt to carry out their nightmares in real life. This night-time sleep pattern is called rapid eye movement sleep behaviour disorder, which can be very distressing or even physically harmful for any bed partners. Patients with this form of dementia typically suffer from memory issues before any motor problems arise, while Parkinson's with dementia occurs when the opposite is true and motor problems manifest first. Dementia with Lewy bodies is a progressive disease, meaning that its symptoms become worse as time passes. Despite many distinctions between Alzheimer's and dementia with Lewy bodies, their similar pathologies can cause numerous problems for those suffering from either of these syndromes. Due to these problems, research is being done to provide earlier and more accurate diagnosis for dementia.

**Early Diagnosis and Misdiagnosis**

The epidemiology of dementia is a field that has seen an increase in recent years, due in part to the increasing prevalence of dementia and its subgroups. As dementia first begins to cause atrophy in the brain twenty to twenty-five years before the first problems occur (Sujata Ray, Dr. Susan Davidson, 2014, pg. 10)<sup>[8]</sup> this can make determining the cause of dementia problematic. This is due to the symptoms first fully appearing after several decades worth of damage to the brain has been sustained. This factor can make an early diagnosis of dementia very difficult but numerous different methods are being used and researched in order to counteract this. Firstly, research into mild cognitive impairment has allowed researchers to try and track when the first noticeable changes of dementia occur in their patient. Mild

cognitive impairment can act as a precursor to the effects of fully onset dementia as this impairment leads to dementia – Alzheimer's disease if the impairment is amnesitic, or dementia with Lewy bodies if it is non-amnesitic. Cognitive tests such as MMSE (mini mental state exam) and brain scans have been used to varying degrees of accuracy in an attempt to ascertain when dementia first begins to affect the brain. However, brain scans in particular are not always feasible or provide diagnostic accuracy due to a combination of both high cost and a lack of clear neuropathological correlates that are definitely associated with dementia.

A further problem with the MMSE is how significantly it can be affected by other outside factors that do not necessarily correlate with the effect of dementia. For example, there has been some evidence that the MMSE is affected by largely environmental factors like age and gender (Ingrid Arevalo-Rodriguez, 2015)<sup>[9]</sup> and some other tests such as the Montreal Cognitive Assessment (MCA) may in fact be superior to MMSE for specific forms of dementia (YH Dong, 2010)<sup>[10]</sup>. This issue has led to intense research into certain biomarkers, with the goal being to be able to use these in clinical settings to act as methods of discerning a person's cognitive state. Biomarkers are any naturally occurring molecule, gene or characteristic by which a particular pathological or physiological process, or disease, can be identified. Blood, cerebrospinal fluid (CSF) and brain scans are commonly used tests for biomarkers. These procedures are not always used, however, due to their expensiveness and the unpleasantness for the patient undergoing them, especially lumbar punctures and brain scans. Some labs, having done prior research into biomarkers, are trying to use these biomarkers to predict when the first change happens in a person's brain, which will eventually allow the researchers to pinpoint when the changes will occur before they do so. These results are not subjective, like the aforementioned MMSE, and are therefore more reliable for use in a clinical setting.

There are very high misdiagnosis rates in dementia, especially between Alzheimer's and dementia with Lewy bodies. For example, patients who in actuality have dementia with Lewy bodies have several symptoms that are symptomatic as being Alzheimer's disease, including but not limited to amyloid plaques of a similar density and distribution, and the fact that several other symptoms like attention and memory issues are common between multiple forms of dementia. Due to dementia with Lewy bodies' heterogeneous nature, these make clinical profiling for the illness very difficult. Furthermore, cognitive fluctuations and visual/auditory hallucinations make diagnosis of dementia with Lewy bodies increasingly difficult due to both the short span of time the patient spends with a consultant or doctor, and the subjective nature of reported auditory and visual hallucinations. Correct diagnosis of the dementia subtypes is very important due to the different methods of treatment for each form: in particular, anti-cholinergic medication is used to treat the effects of memory loss from Alzheimer's but actually worsens the effects of dementia with Lewy bodies (Ian McKeith et al, 2017)<sup>[11]</sup>. As with any other illness or disease, the earlier the diagnosis, the more likely the patient will survive and the less drastic change they will experience as their condition worsens. In order to track dementia and its subtypes even earlier, research has turned to the link between gait and cognition.

**Gait and Cognition**

Gait was once thought to have been an automatic function, but it is now understood to use complex cognitive processes that work together at once. This essay will use a validated model of gait to aid the interpretation and dissemination of results from clinical studies. Gait has several main components that can be measured during investigations or experiments. These include: pace; rhythm; asymmetry, where both limbs of

a pair swing at once as opposed to alternatingly; and postural control, which is the regulation of sensory information in order to maintain an upright position. The gait domain of pace is most commonly used in an attempt to measure the relationship between cognition and gait, though there are several problems with this. Such problems include the fact that pace is a sensitive marker, in that it can help denote a person's overall health and lifespan but does not provide sufficient specific detail to be worth quantifying it without another domain of gait. In a study conducted by scientists at Albert Einstein College of Medicine, out of 27,000 people who were tested over a 12 year span, 10% were found to have had motoric cognitive risk syndrome (MCR) (Alissa Sauer, 2014)<sup>[12]</sup>. The researchers involved in the study believed that the condition in and of itself was a factor in cognitive decline. The fact that a large proportion of patients with dementia were found to have had MCR syndrome gives credence to the link between gait and cognition, especially when coupled with the other results from the test: namely that participants with MCR syndrome performed worse on global cognitive tests than non-MCR participants and the fact that those who had MCR were twice as likely to develop Alzheimer's disease than those without MCR.

**The dual-task paradigm**

Gait and cognition have also been linked through the dual-task paradigm. The dual-task paradigm (the DT paradigm, as it is often referred) is the simultaneous execution of two tasks. With regards to research into the link between gait and cognition, these two tasks almost always consist of one walking task, and either one other motor task or a cognitive task. The cognitive contribution to gait control is supported by experimental evidence offered by this paradigm, including the uninterrupted performance under DT and the interference that expresses the change on walking between dual-task and single-task performance (Marissa Amboni et al, 2013)<sup>[13]</sup>. Disord says that, when the simultaneous performance of two tasks leads to a competition for attentional resources, it can also cause the brain to 'subconsciously decide which activity to prioritise' when no specific instructions are given about which of the two tasks to focus more on. The attentional effect of dual-tasking is larger in subjects with cognitive impairment than in controls, and an increase in the DT complexity further worsens the gait measures (M. Montero-Odasso et al, 2012)<sup>[14]</sup>. Furthermore, when one compares the different grades of impairment, such as between mild cognitive impairment and Alzheimer's patients, more severe cognitive impairment is associated with more detrimental dual-tasking effects on gait. In addition to these, numerous different correlations have been drawn between cognitive and gait domains. Pace and attention have been connected in multiple studies including by Raminder Parihar, Joe Verghese and Jeanette R. Mahoney (2013)<sup>[15]</sup> and Joe Verghese, and Emmeline Ayers (2014),<sup>[16]</sup> which show that some researchers have proposed that the co-existence of gait and cognitive impairments may 'be related to a common underlying pathology' – the cause of each impairment is the one and the same. In addition to this, there have been recorded correlations between pace and executive function impairment. This is likely due to the fact that gait control is mediated by circuits in the frontal subcortices, which is also known to mediate executive and attentional functions. The co-existence of these two impairments is not necessarily indicative of a type of dementia having formed or forming, although such an existence of these may warrant an early form of diagnosis being made available for the patient which could potentially save a life or help to control the quality of that person's life.

**Conclusion**

In conclusion, Alzheimer's and dementia with Lewy bodies are the two most common forms of dementia and they become more and more common as time passes. Accurate

diagnosis of dementia and its subtypes is paramount in order to alleviate the burden of misdiagnoses and the effects of inaccurate treatment methods including ineffectual or inappropriate medicine. The link between cognition and gait is present; characterised largely by the decline in pace and other gait domains as the condition of dementia worsens in its term. Analysing gait could help lead to an earlier diagnosis of dementia and associated syndromes such as mild cognitive impairment which can in turn be used to further improve dementia patients' quality of living and increase their lifespan. In addition to these, biomarker research can also shed light on the intricacies of dementia's pathology and prognosis, and further allow an earlier and more accurate diagnosis of such cases. However, because of their high cost, a more affordable method of tracking the earliest stages of dementia must be found as an alternative to lumbar punctures and brain scans. Gait analysis is both cost effective and is comparatively easier to conduct than brain scans and other complicated and far more expensive procedures. Future studies into dementia should work to expand the literature of the topic, conducting research into other cognitive domains that are rarely tested such as variability and asymmetry.

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**PhD Tutor's comment:**

'M. has consistently demonstrated his hard work and dedication in the classroom and through his homework. He took onboard and implemented feedback throughout this course and as a result has written a university-standard essay. I am both proud and privileged to have worked with him and I am confident he will excel in whatever he chooses to do in the future.'



# Arts and Humanities

## What Do Representations Of Nature Tell Us About Ourselves And How Are They Used In Literature?

Year 6, Key Stage 2

G. Huby, Marshland Primary School, Doncaster.  
Supervised by O. Casasola, University of Leeds.

In this paper I will discuss what representations of nature can tell us about ourselves and how they are used in literature. To illustrate my point of view I will use a variety of texts including: *Aesop's Fable, The Town Mouse and the Country Mouse*, William Wordsworth's poem *Upon Westminster Bridge* and the sonnet *Spring*, by Gerard Manley Hopkins.

The settings found in literature often have many natural aspects to them such as the environment and the weather. Our personality and who we are as a person will affect how we view the literature. For example, travel brochures may describe a place as 'a natural paradise, relaxing and laid back'[1]. For someone who wishes to relax this may be their idea of utopia, but it equally could be dystopia to someone who likes to be busy and adventurous. Settings can be viewed differently by different people; for example, some people may see mountain climbing as a fun and exciting experience if they are an adventurous or athletic person but to someone else this could be frightening, perhaps if they were a timid person or if they had a phobia of heights. As well as settings being influenced by our personality and past experiences, the setting of a text can be influenced by the writer's choice of words. The same setting can be described differently giving the reader an altered perspective.

In *Aesop's Fable, The Town Mouse and the Country Mouse*, the country is described as 'poor but peaceful, whereas the city is grand yet frightening, with the moral of the story being poverty with security is better than plenty in the midst of fear and uncertainty' [2]. In this fable the town mouse and the country mouse both view their home as being the best and their view is influenced by where they live, what experiences they have had in the past and how they've adapted to their own unique and individual environments. When looking at the view of cities we can contrast this with the poem *Upon Westminster Bridge* by William Wordsworth, where the city is viewed as 'a sight so touching in its majesty'. He describes the tranquillity, calm mood and quietness of the city first thing in the morning by saying 'the beauty of the morning: silent, bare' and 'never did the sun more beautifully steep' [3]. This shows that the city in its full glory is both majestic and beautiful. Both pieces of work are about the city but they both portray it in a different manner; one as grand but frightening and the other as calm and beautiful. Our individual experiences of cities will also affect how we interpret the literature. A writer may be able to subvert our views and expectations by their choice of words. William Wordsworth subverted my view of cities with his poem *Upon Westminster Bridge*.

In the sonnet *Spring* by Gerard Manley Hopkins the poet's purpose is to entertain the reader, yet also it is to persuade them that spring is the loveliest season of the year. As shown in the first line of the poem 'nothing is so beautiful as spring' Interestingliterature.com says that the poem is 'a powerful evocation of the beauty of spring' [4]. This text brings out the positive qualities of spring and puts them

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into a sonnet. The true beauty of the season makes it sound like utopia. Gerard Manley Hopkins has purposefully highlighted the best parts of spring in order to influence and persuade his readers.

Nature and the natural world are often used by writers of all genres to display feelings and emotions. Nature can be one of the simplest ways to show emotion as it can create either a good or bad atmosphere by using only a small description of the setting. When writing, an author may attempt to portray anger and rage or sadness and worry with the use of thunder storms, black clouds gathering along the horizon, dark skies and raging seas, whereas a quiet garden or secluded beach maybe used to display calmness and joy. An example of this technique is shown in the book *School for Good and Evil* by Soman Chainani which describes, 'thunder exploded ahead and they smashed headfirst into a raging lightening storm' [5]. This quotation shows that the mood is full of anger and worry.

Although using the weather is a great way to show emotion there are other ways to do so, some of which include using colours and surroundings. When black and dark colours are used this could be indicating that something bad or grim could happen or that someone is sad. Red could be used to signify rage, whereas white is often used as a sign of purity and goodness. Symbols of nature such as clouds, seas and skies can also be used with colour to reflect a person's feelings, emotions and thoughts. Using nature to show feelings is an excellent literary technique as it can launch strong scenes and powerful emotions. For instance, bright blue skies and white fluffy clouds can create a happy atmosphere, whereas dark skies with rolling black thunder clouds creates a much more depressing scene.

To conclude, I think that using nature and the natural world is one of the best ways to influence and captivate a reader since it can be used in all styles of literature such as: poems, sonnets, stories, factual texts and fables. It is also extremely easy to add nature to anything that you write as all you need is some imagination, inspiration and a short description of the natural world surrounding you. All readers are aware and familiar with nature, so it is something everyone can understand and enjoy regardless of their age, gender and culture.

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### PhD Tutor's comment:

"G. Huby is a brilliant student who actively engaged with the discussion in class with critical analysis on the material. She is an ambitious pupil with exceptional talent. Her talent has shown both in creative and academic writing. G. would be an invaluable presence to any undergraduate programme and I am confident she will be a successful young woman."

## Why Was There A French Revolution?

Year 8, Key Stage 3

B. Leggatt, Blatchington Mill School and Sixth Form College, Hove. Supervised by S. Bankes, The Open University.

In this essay, I will outline what I believe to be the various and accumulative causes of the French Revolution. In France, running up to the revolution of 1789-1799, the political system was comprised of three estates: the nobility, the clergy, and the commoners. France had a population of around twenty four million, yet the nobility and the clergy made up only 2% of this population, whereas the commoners made up the remaining 98%. However, when it came to making decisions that affected the country, the three political groups were given an equal say. The nobility and the clergy often voted the same way, which rendered the commoners' vote practically obsolete. This, allied with the various contributing social factors of the time created a climate for the revolution.

One of the reasons that the French Revolution started was because of crop failure. Most of the citizens of France were peasants, and this meant that they were reliant on cheap sources of food like bread. However, in 1788, there was a bad harvest and this meant that bread became much scarcer, and the prices skyrocketed. The average French peasant at the time earned around fifteen sous per day, yet, at the peak of the bread prices, bread was worth about 14.5 sous. This would mean that the average worker had practically no money left by the end of the day to spend on any other necessities.

In 1789, King Louis XVI made an effort to raise money for the country by putting in place higher taxation, due to the fact that France was bankrupt. However, he was trying to raise the money from the peasants, who, as he was fully aware, had no money. Due to this, the third estate formed their own national assembly in one of the King's tennis courts, and demanded that a new constitution was made, or they would not leave. The central figure of the national assembly was Jean Sylvain Bailly, who was making demands to the king on the behalf of the third estate. While this was happening, the food crisis was worsening, and this lead to the peasants rioting in the countryside.

Another of the widely accepted reasons for the start of the revolution can be explained through Marxism. Karl Marx was a historian who lived from 1818-1883, and he developed the theory of Marxism to explain the growth of societies over time. He believed that, in every society, people were divided into classes, with the people at the top of the social hierarchy exploiting those at the bottom. The dominant classes are constantly utilising the less dominant classes' labour to achieve their goals. He also stated that history starts to develop when the lower classes gain 'class consciousness'. 'Class consciousness' is when enough people become aware of their situation and change it through a revolution. This revolution often moves the lower classes to the top of the social hierarchy, thus creating a new lower class, which will eventually revolt again, and the cycle will repeat.

To explain the cause of the French Revolution, a Marxist historian such as George Lefebvre would link the domineering effect that the Nobles had over the peasants to Marxism. The nobility did this using feudalism, which was the dominant social system in medieval Europe. Peasants would live on the land of a noble, and they would be obliged to give him food and allow him to hunt on their land in exchange for military service. The second point of Marxism is class struggle, which is demonstrated by the peasants' relationship to the nobility.

The nobles were exempt from most taxes, which angered the bourgeoisie who were the middle class, as they had to pay huge sums of money for taxes such as the Taille.



Source 5

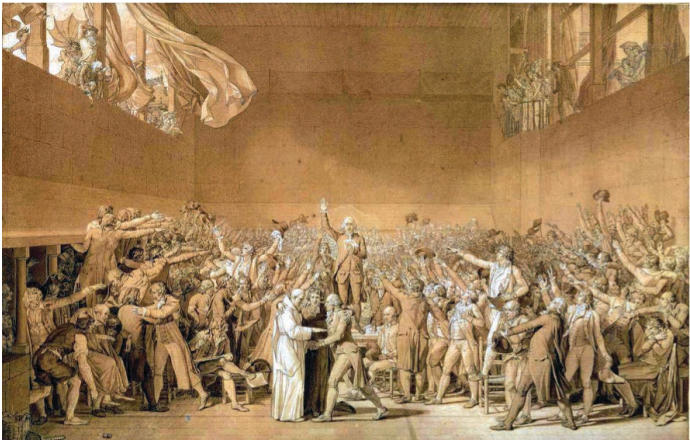
The 'crushing' weight of the taxes that the average peasant had to pay is shown in source 5. It depicts a noble and a priest, who were members of the first and second estate respectively, standing atop a peasant, whose shovel is lying beside him. From the image of the shovel, we can infer that the weight of the taxes employed by the richer classes stopped the average worker being able to do his job. Since the bourgeoisie and the peasants developed this anger against the nobility, a Marxist would argue that they developed a class consciousness, which led to the peasants revolting.

However, source 6 shows the composition of the third estate, the political party that supposedly supported the peasants. There were no peasants/artisans in the third estate, which meant that the peasants did not have any say in how the country was run. The third estate was actually comprised predominantly of magistrates, who would have been a higher class than the peasants. This could contrast the Marxist explanation of the revolution, as it negates the idea of specific social classes opposing each other. This belief is shown in the quote "the nobility and bourgeoisie of the Ancien Regime look more and more as though they were a single social group" The magistrates would have had similar beliefs to the peasants, even though they were more powerful.

Another reason for the start of the revolution is the influence of the intellectual development of the country. During the 1600s, Europe was at the centre of the Enlightenment. The Enlightenment was a time when people started to challenge old beliefs and traditions, and many argue that this was one of the causes of the French Revolution. Many philosophers contributed to this development of ideas. One philosopher, Rousseau, thought that the people of a country should rule over themselves, and that the governing body should decide the laws based on the general will of the people. We see this in the extract from his book, *The Social Contract*: 'since no man has any natural authority over his fellows, and since force alone bestows no right, all legitimate authority among men must be based on covenants.'

At the time of the French Revolution, literacy was increasing across France and this enabled many people to start to read Rousseau's works. His ideas challenged the political system that was in place at the time, favouring the hard working, lower class man. In the *Declaration of the Rights of Man*, made by the National Assembly that formed in one of the king's tennis courts, it states 'law is the expression of the general will.' This is a direct reference to Rousseau's book, *The Social Contract*. In his book, we can find the quote 'only the general will can direct the energies of the state'. These both talk about the 'general will' of the people, which shows that the Third Estate must have read Rousseau's works.





Source 6

Another historian, Montesquieu, had very different views to Rousseau on how a country should be run. Instead of everyone being sovereign over themselves like Rousseau suggested, he believed that power should be split amongst various political groups. This was very similar to the way that France was run at the time, as the only political groupings were the nobility, the clergy and the commoners. Montesquieu believed that this system of power would prevent one group from becoming too powerful and totalitarian. However, the France of 1789 was a clear example of the fact that Montesquieu's ideas were not correct, thus the French people did not integrate them into the *Declaration of the Rights of Man*.

In conclusion, I believe that there was not one singular cause for the French Revolution, but multiple that each contributed to the development and climax. I compared and contrasted the Marxist, intellectual and social explanations of the revolution, but each seemed equally valid. The social explanation in particular seemed to give strong evidence to back up both the Marxist and intellectual views. I did find it surprising that the peasants had been so oblivious to the fact that the first and second estates were exploiting them for a large period of time before the revolution, but I suppose the situation was not obvious until people started to read the works of Rousseau and others alike. I think that Rousseau's concepts gave the French people what they needed to develop the class consciousness outlined in Marxism, and this led them to become more and more aggravated over time and eventually revolt. This, mixed with the food crisis worsening in rural France sent the country into a state of panic, which caused the revolution.

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**PhD Tutor's comment:**

'I am delighted to see B.'s essay included in this edition of The Scholar. B. worked extremely hard during the course, sharing so many ideas in group discussions and researching independently. The historical detail he brings to his essay and the confidence with which he structures his argument allow him to write with real authority and maturity. He demonstrated great diligence, creative thinking, and an excellent attitude to work, all of which will stand him in very good stead in the future. I really enjoyed escaping London to teach at Blatchington Mill School - it's not often I get to paddle in the sea before teaching. I'm so grateful for the support of lead teacher, Mr Maxted, and the engagement of all the students who took part in The Scholars Programme. I received some excellent work from this group and they should be proud of their scholarship.'

**Analysing Bluebeard**

**Year 8, Key Stage 3**

**S. Lumbuyaka, All Saints Catholic School, Dagenham.  
Supervised by E. Pilsworth, University College London.**

In this essay, I will be examining and analysing the story *Bluebeard* using the theory genre studies. *Bluebeard* is a story which I think has been based on the classic genre, 'chivalric romance', but has been revamped to be quite different from this genre. The story *Bluebeard* is about a 'powerful lord' from the lands of France, whose nickname was *Bluebeard* due to the glints of blue in his shaggy black beard. He was gifted with good looks and charm but was very unlucky when it came to marriage. He was constantly getting remarried as his wives had always fallen ill (or so he always said). The story begins when he has wed his most recent wife. Her sense of curiosity and wonder is what landed her in a frightening near death experience. Bluebeard warned her not to enter the little room in which all his dead wives' bodies rested, yet she chose not to listen and came to a very gruesome discovery. Luckily, her two brothers came to her rescue; otherwise there would have been a very different and gorier outcome to the story. The story has been adapted several times; my essay will be about the most famous surviving version of which was written by Charles Perrault and was first published in January 1697.

I found this story quite surprising as it doesn't really follow the guidelines of its genre to what you would expect. From reading the first paragraph, you would think that you were reading another classic chivalric romance. The writer mentions Bluebeard being a handsome, charming and respected lord who goes away to war, so naturally, I thought that I was reading an adventurous story about a quest of some sort, where the hero saves a 'damsel in distress' on the journey. However, the writer puts a complete twist on a very simple story line by portraying Bluebeard as the villain. 'You must die!' he says to his wife when she comes to the realisation that he was in fact the reason for all the mysterious deaths. This shocking turn of events presents Bluebeard in a very negative light, completely contrasting what his character is 'supposed' to be.

When Anna enters the castle, she greets Bluebeard and says, 'you seem rather pale.' Bluebeard replies 'Not at all, we're quite well.' which makes me see behind the charade he was trying to pull. Throughout the story there is a deception of Bluebeard being a good person and unsuspecting when in reality, Bluebeard completely contradicts what we assumed his character was. 'Nobody found anything strange' he says. Nobody presumed that there was anything for him to hide. Little do they know of the secrets behind his 'shaggy black beard'. All the materialistic things that attracted women to Bluebeard, such as his beautiful houses, plates and utensils made of precious metal and plenty of fancy furniture, only masked his true personality. Also, his multi colored beard seems to reflect the many flaws that lie beneath the surface, the imperfections that are deemed unimportant but are in actual fact, quite major. Also, the language that Perrault uses in the text demonstrates the transition between the personalities of Bluebeard. How can one person go from addressing their wife as 'darling,' to counting down the minutes until her death? How can one person be so deceiving? This storyline utterly strays from the basic direction of its genre making it more unpredictable which I think is very effective.

Genre studies itself is a useful theory; it allows us to see how a classic genre has been manipulated by the writer into

something they can call their own and then decide what we, the readers, take from the story or whether a story fits the 'criteria' of its genre and to what extent. When applied to the story *Bluebeard*, genre studies has made me recognise how the story has been adapted into a different version of chivalric romance. The beginning of the story fits the expectations of chivalric romance by painting Bluebeard as a flawless and very honorable person with the language that Perrault uses in the opening paragraph. In a classic chivalric romance, the main components are a near perfect hero, an evil enemy and a quest fighting evil. I suppose the story did have these key elements, but there was a role reversal in the middle of the story. Bluebeard, who I thought exuded moral values and goodness was in fact the villain all along. The wife's brothers then come and take his place as the hero of the story, saving the damsel in distress which is a different take on the story line. Instead of the prince or knight and the fair maiden meeting and falling in love, it is the wife's brothers that come to her rescue. It is not exactly the 'happily ever after' you would expect. It even says at the end that it was a 'sad story'. Yes, good did triumph against evil, however the rest of Bluebeard's 'poor wives' were still dead, the wife did not meet her 'knight in shining armor' and along with this traumatic experience, 'the young lady had completely lost all her sense of curiosity'. Bluebeard completely defies our expectations by the end of the story, tainting the chivalric code.

Examining the text through genre studies has shown different meanings to the text. Specific elements of the story that show how much the story differs from its genre would have gone unnoticed without this technique. For example, the story starts off by praising Bluebeard, however, it does say that 'there was something about him that made you feel respect, and a little uneasy...'. At first, I didn't take any notice of this line in the text, but, after analysing this sentence through genre theories, it implies the ending; that Bluebeard isn't so perfect after all. There was something about him that was off putting, yet no one could put their finger on it as it is completely out of character for people like Bluebeard to cause any suspicion in their stories. They are supposed to be very trustworthy and righteous.

I think the writer has effectively copied what a basic chivalric romance should be in quite an original way by adding the crucial factors of the genre without making it predictable. We are able to make assumptions of what we think the characters should be and have those ideas be frustrated to the point where the characters have been turned into the complete opposite of what we predicted. I think the reason behind this was so Perrault could set himself apart from other authors from this genre, making his work more interesting. He pushed against the boundaries which gave fantastic results using suspense and other techniques. There was a level of uncertainty as we didn't know what was going to happen next. I had no idea of whether Anna was going to come to the young maiden's rescue (which would go against how the role of the female is supposed to be played) or whether another male lead would save Bluebeard's wife. Also, as quoted from the handbook, 'as time went on, the stories became very imaginative and somewhat unbelievable as they were so farfetched' which brings me to the second reason why I believe the author of this story decided to write it in a manner where it differs from its genre. As chivalric romance stories were usually very absurd and creative, I think that Perrault wanted to tone down the story and make it more realistic. There were no magical elements to the story either, no savage monsters to conquer which added to the effect of realism, steering away from the typical finish to the story. In a classic chivalric romance, we expect there to be a very straight forward thread of events, so it is easy for us to foretell the happily ever after coming at the end of the

story. Chivalric romance itself is essentially about the quest or journey that the hero goes on. Writers usually put emphasis on the sense of excitement and thrill and less on the romantic side. In a chivalric romance, there is a knight/king (who is near perfect), a fair maiden in need of rescuing and a villain. The knights had, 'fantastic adventures killing giants, dragons and ogres to protect their fair maiden.'

In conclusion, I don't think that the story *Bluebeard* fits its genre because of how it is structured. By this, I mean how there was a role reversal between certain characters, making us question the outcome at the end of the story which made the story overall more capturing than any classic. The reason for this was because of how our expectations of the tale *Bluebeard* were completely ignored, and I think Perrault knew this, which is why he decided to take a different route in the story and surprise his audience, which I think worked very efficiently.

**References**

1 The Scholars Programme Handbook

**PhD Tutor's comment:**

'S.'s engagement with the complex ideas covered in our 'Introduction to Literary Theory' course was impressive, and her contributions to discussion were always thoughtful and original. Her final piece took a very sophisticated approach to genre studies, discussing Perrault's version of the fairytale *Bluebeard* as an inverted Chivalric romance. Congratulations, S.!

**Urban Farming: The Future Of Sustainable Food Production And Consumption**

**Year 10, Key Stage 4**

**B. Houghton, Cheadle Hulme High School, Stockport.  
Supervised by M. Loroño-Leturiondo, Manchester Metropolitan University.**

**Abstract:**

This essay outlines how our current food production industry has contributed towards climate change. It highlights the importance of food sustainability for both the present and future well-being of our planet. In the essay, I will explain my initiative: urban farming spaces. These eco-friendly spaces will be based in towns within Greater Manchester. I explain my ideas along with similar ideas from other environmentalists around the world and show how much eco-friendly food production is both needed but also how beneficial it can be on an individual, communal and global level.

**Keywords:**

Local, Organic, Environmentally-friendly

**Introduction:**

Climate change is a significant shift in Earth's weather and temperatures over a long period of time. It has been occurring naturally for thousands of years and as NASA reports, just in the last 650,000 years, there have been seven cycles of glacial advance and retreat (NASA, 2017) – so why is it such a major concern now? A recent article states that the Earth's average temperature has increased about 2.0 degrees Fahrenheit since the late 19<sup>th</sup> century, although most of the warming has reportedly occurred in the past 35 years (Business Insider, 2017). But climate change is not such a distant threat as people once believed.



In fact, we can now see the devastating consequences the changing climate brings to both our lives now and our future within our very own community: Greater Manchester. The Guardian reports that the government's recent estimates predict that extremely wet winters –a result of global warming– could become up to five times more likely over the next century. This would consequently increase the risk of more severe flooding which puts schools, hospitals and many homes in the UK at risk of damage (The Guardian, 2013). Government figures show that about 330,000 properties are currently under threat of potential flooding, but climate change could increase this number to between 630,000 – 1.2 million by 2018 (The Guardian, 2013).

It is important for us to acknowledge that climate change is happening and to understand how our actions contribute towards it. We have a responsibility and a moral culpability to protect our planet and do the best we can to reduce our effect on climate change. The consequence of what we do today is long term so we need to think about what is best for not just the current generation but those to come; they will have to live through the impact of our actions and the severe impact of climate change. To protect the future of our planet and the people living on it, we must act now. We need to encourage a lifestyle that does not compromise the environment or people living around us. To do this, we need to behave sustainably and develop a way of consumption that will support the long-term future of our planet.

To live sustainably, we need to critique and rethink our current industries. Right now, our current farming system is a large contributor to the extreme rate of climate change. Before it even gets to our dinner table, our food is produced, processed, packaged and transported which collectively releases an excessive amount of CO<sub>2</sub> into our atmosphere. Farming in particular, is responsible for emitting significant amounts of methane and nitrous oxide, two dangerous greenhouse gases. The European Environment Agency has in fact reported that agriculture alone accounts for 10% of the EU's greenhouse gas emissions (European Environment Agency, 2015). Along with mass importation of produce and inefficiently used land space, another major issue with current agricultural practices is the use of pesticides. A further study has stated that the recent use of pesticides, artificial fertilisers and other intensive farming techniques have damaged the water, soil, wildlife and climate that are essential in our current food production industry (sustain.web.org). Not only that but the number of pollinators, like bees, are declining at an alarming rate.

We need to quickly re-invent our farming system to protect and conserve our environment. My initiative has been designed to be mindful about the future by implementing more sustainable methods now, before it's too late. Urban farming spaces are a great idea to decrease the amount of imported produce, which will in turn decrease the net amount of CO<sub>2</sub> emitted by the food industry and help to tackle climate change. Additionally, locally-run allotments will be easier to ensure no pesticides will be used. Using the free spaces within our cities for farming will not harm our planet's biodiversity or endanger species to the extent that using rainforest space does and whilst my proposal is small scale, there is an opportunity for this approach to grow and become a larger scale alternative to current damaging methods of food production.

**My Community: Greater Manchester**

I have chosen to implement my initiative within the towns of Greater Manchester. I think this would be an ideal place to do so because there are numerous towns that have been heavily industrialised. There are underused urban spaces owned by public sector bodies which would be ideal for urban growing spaces. I think it is important to both utilise these spaces to support sustainable behavior whilst also adding more green

spaces to our towns and cities. This will help to tackle some of the most environmentally harmful issues with the food industry and raise awareness for climate change and encourage cohesion within communities.

**Problem Formation: Pesticides, Wasted Land and Food Miles**

Crop production on a mass, international scale has led to the use of extreme amounts of pesticides which have had a detrimental effect on our society. In the upcoming decades, the global demand for food is expected to increase up to 70% (The Guardian, 2011) which will add more pressure onto a farming system that is already one of the economic sectors with the largest environmental impact. So how can we supply this growing demand whilst managing the effects of food production and consumption on the environment?

Using more land to farm would undoubtedly have serious environmental consequences, not to mention most of the land suitable for agriculture is already in use. Somehow, we must find new space to farm that doesn't endanger the planet's biodiversity. This is a huge issue which my initiative aims to help solve.

Also, the recent damaging trend to have exotic foods, not sourced locally within the UK, available all year round has led to a large demand for imported food. As the Guardian reported, now the UK is not self-sufficient in food production; in fact, more than half of our food and feed comes from overseas. Since 1986, as demand for imported produce has increased, CO<sub>2</sub> emissions associated with the production and transportation of food has risen by 15%, (the Guardian, 2016) and food imports increased from 13.5m tonnes in 1992 to just over 16m tonnes by 2002 (pollutionissues.co.uk, 2017). Our everyday meals have reached an all-time high net food milage (the distance our food has traveled from its point of origin to UK supermarkets). Alarmingly, even a single banana can have traveled approximately 3176 food miles which is equivalent to a six and a half hour flight. This distance traveled by an aeroplane creates approximately 312kg of carbon that is emitted into our atmosphere (foodmiles.com, 2018). These carbon emissions contributing to climate change are simply unnecessary, so my initiative promotes buying locally sourced food, to reduce the food industry's carbon footprint.

**Evidence: An Article About Communal Allotments**

My evidence is an article from the New York Times: "Food from Around the World, Homegrown in New York". The article explores The United We Stand Community Garden, a community garden, like my initiative, in the South Bronx. The garden is within the city, among the public housing projects of the South Bronx. The article includes interviews with locals that plant there; one local, Alex Gonzalez, expresses how much he enjoys the community garden and states that the food grown here "is fresh" and that he "likes to eat this way". In fact, he enjoys it so much that he would grow more, if he had more space. Efrain Estrada, another member of the community highlights that another advantage of the garden is that he grows peppers for his wife to make into her own sauce because "it's very expensive to buy". This article shows that community gardens are beneficial to locals as the produce grown is both more fresh and inexpensive. The article also goes on to give more examples of successful community gardens across the US with the biggest being the GreenThumb program, which has grown 553 gardens during the summer alone (New York Times, 2017). I chose this article because it shows how initiatives similar to my own proposal have been a success. It takes a closer look at a single garden and highlights how the growing areas can benefit people on an individual level, within their communities. But I think it is also important to recognise how the article demonstrates that community gardens can be successful anywhere – in varying conditions and spaces – and collectively contribute to a more eco-friendly society.

**My Initiative: Organic Farming Spaces Within Cities**

There are many alarming issues within food production and consumption today; my initiative will tackle some of the most threatening problems facing our environment. The detrimental effects of pesticides, excess packaging waste and the massive amounts of pollution from the transportation of our food are all huge contributors to climate change. My aim is to encourage sustainable and eco-friendly diets within Manchester to help tackle climate change within my community. My initiative aims to provide alternative methods to common farming practices that will help to solve or at least reduce the flaws in our current agricultural system. I want to convert derelict and underused spaces within our cities and towns into farming spaces to grow fresh, organic crops, which will be run by a group of volunteers.

The first challenge would be to find and negotiate with land owners, typically public bodies or large corporations. However, there is not a shortage of space and as you can see from the evidence above, land can be found even in the most densely populated cities, such as New York. In return for the use of their space, we will manage and maintain their potential eyesore land, which we will convert into the farming space.

Unlike supermarkets, the fruit and vegetables will be grown naturally, without any pesticides, sold locally and sold without any unnecessary packaging. The lack of pesticides will help to maintain the number of pollinators within our community. Selling the food locally will eliminate both the physical and environmental costs of food transportation, and will result in less CO<sub>2</sub> gas being released. Finally, the crops grown will be sold without any unnecessary plastic wrap, labels or boxes. This will decrease the amount of plastic waste, which currently is a threat to our wildlife since plastics are not biodegradable. At weekends, the space will be used for a market, where the fruit and vegetables will be sold, along with produce from other local farmers and products from small businesses nearby to support and encourage people to buy locally. These weekend markets will be fun family-friendly events with live music and food stalls as well as the shopping stalls. There will be an entrance price to help fund the growing spaces as well as the volunteers. This will be a great opportunity to raise money for future investment (from entrance price, customer money and any possible donations) and let everyone know about my initiative, as well as spreading awareness for the cause: sustainable food consumption. This is important as educating communities on the principles of sustainable eating and making them aware of the effect our current way of life has on our climate is vital to encourage change.

To encourage the use of my initiative, volunteers will receive discount on all produce grown and sold there. For regular customers, they will receive a loyalty card which will provide them with discounted access to the weekend markets. To advertise these growing spaces, we will put up posters in local community spaces such as schools, youth clubs and town centres. The weekend markets will also be a chance to involve the community and show that we can live sustainably and care for the environment without limiting ourselves and still having fun.

A key issue that my initiative might face is the initial start-up fund for equipment such as tools and seeds. My solution to fund the project is to seek support from grant giving bodies interested in encouraging community cohesion and regeneration schemes.

**Conclusion**

To conclude, our current food industry needs to become more sustainable. By implementing urban farming areas, we can educate communities on how to become eco-friendly consumers because I believe awareness and education is the first step towards change. We can promote the importance of

buying locally sourced and seasonal produce, growing organic crops and using the space within our towns to its full potential. This will collectively reduce our effect on climate change and encourage people to be more mindful of how they can help minimise their contribution to global warming.

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**PhD Tutor's comment:**  
'B.'s work is excellent. It meets the quality and standards of academic work. She is imaginative and creative in her initiative, yet she reflects on the technicalities making the reader believe it can be implemented. She has demonstrated an excellent ability to conduct independent research in relation to the sector of her choice: food. She understands the use of references (which many people find complicated) and the selected piece of evidence is relevant and very well integrated. There is a good balance of factual data with her own narrative. It is well written, engaging, and easy to follow. There is a perfect flow from the broad (global climate change) to the specific (the food sector in Greater Manchester), which was one of the key requirements of the assignment: to understand the local impacts as well as the human component of climate change. Brilliant!'

**Is Poetry Dead?**

**Year 10, Key Stage 4**

**D. Ozpalas, Hornsey School for Girls, London.  
Supervised by C. Hurley, University of Kent.**

The relevance of poetry in modern society is often debated, with some stating it is merely a luxury for the educated upper class and unimportant with the advances and discoveries of the 21st century. However, the integration of contemporary poetry into the modern world means it has greater pertinence in people's lives. Additionally, the universal definition of poetry is not limited to simply text on paper written by a poet. Poetry can currently be described as "literary work in which the expression of feelings and ideas is given intensity by the use of distinctive style and rhythm" [1], or in even more general terms, as "a quality of beauty and intensity of emotion." [1] This raises questions as to how generic the real definition of poetry is, and whether it can refer to works beyond text, such as works of art, music, films or animations. If so, this broadens the definition of poetry, and allows one to conclude that poetry isn't in fact "dead". In this essay, I will be exploring five forms of modern poetry which have wider contextual links and hold a relevance to the society of the 21<sup>st</sup> century.

The first poetic piece I have chosen to analyse is *Home* by Warsan Shire. *Home* is a contemporary poem, and the topic discussed in this poem proves that poetry can have a significant relevance in people's lives in the 21<sup>st</sup> century. The author is British-Somali poet Warsan Shire, who was born in Kenya but raised and currently lives in London. *Home* was published in 2009, after spending time in Rome with some refugees who had fled their homelands of Somalia, Congo, Eritrea and Sudan. The poem was written as an account of how it felt to be an undocumented refugee living in Europe.



The poem begins with very abrupt and direct words in lines 1 – 3, giving the sense of an imperative instruction. The first 3 lines appear to be of similar lengths, immediately creating a sense of pattern and order for the reader. These almost identical lines could indicate the calm before a war, where people are unsure whether a conflict is going to start. However, line 4 breaks this pattern, with one much longer line, which shows the abrupt entrance of war in people's lives. In the following stanzas there is no correlation to the order seen in lines 1-3, suggesting that nothing is truly ordered or manageable after the conflict begins.

Additionally, by making each line seem factual and imperative, Shire leaves no room for opinion in the reader's mind: she wants them to know that her words are the truth. The poem, which I would imagine could be performed as a slam poem or as spoken word, moves towards prose in the following stanza. The lines "the boy you went to school with/ who kissed you" adds human emotion and anecdote to the poem, making it clear that Shire is trying to humanise refugees, opposed to how they are often portrayed by the media. This romantic and childlike image is quickly juxtaposed with a harsh, cruel image of "a gun bigger than his body" to display the unnatural and perverted essence of war. The imagery of this war not only resonates with the general understanding of war, but is also incredibly applicable to the myriad of wars and crises occurring on our planet today, such as the civil war in Syria and famine in Yemen and Somalia. Additionally, it suggests how children and adolescents living in countries of war do not get the chance to live their childhoods or experience innocence, as it is torn away from them by patriotism and fighting. This cynical view of patriotism may also relate to the propaganda used in the First and Second World War, showing that the cruelty of war stretches across continents, and is not simply limited to the Middle East.

*Home* is written in second person, evident by the abundant use of "you". This indicates that the poem is clearly directed at the audience, as the issue of misunderstandings about refugees and other displaced people can only be changed by human beings educating themselves on the matter. As an open poem, it is free verse, and there are no consistent patterns or a rhyme scheme. However, integrated within the poem are a few examples of assonance, such as "factory" and "body". This lack of a formulaic rhyme scheme could mean that in countries of war, little to nothing remains the same after the conflict begins. The rare examples of assonance demonstrate how in war torn countries, not even the little details can be distinguished as elements from the past, and the lives of people there are completely transformed. *Home* also has uneven line lengths. This chaotic and intricate structure symbolises the lack of routine and normality within the life of a person living in a country at war or of a refugee. It suggests that the situation for refugees is not glamorous or just to have a better life, but to escape one's homeland out of dire necessity. In conclusion, *Home* by Warsan Shire is mainly conventionally poetic since there are stanzas, even though they are irregular and break off randomly. However, it is written in free verse without a standard structure, and the provocative and vivid imagery which manipulates the reader's emotions is what I believe makes this piece truly poetic in an unconventional sense, as it makes the reader contemplate subjects that may make them feel uncomfortable or uneasy. The contemporary issues that are explored in this poem prove that poetry can be relevant in modern society.

The second poem I have chosen to analyse is *Not a Humanising Poem*. The poem is another contemporary poem, which explores discrimination and the compulsion for Muslim poets to be "relatable". Suhaiymah Manzoor-Khan refuses in her poem to be "recognisable" and rather recognises how it is

important to be accepting of Muslims and other religious and ethnic minorities when they aren't similar to us. Manzoor-Khan is a Cambridge University graduate, a third generation Pakistani born in Bradford, as well as a Muslim woman. She has a blog called "Brown Hijabi" and the majority of her poetry focuses on race, religion and feminism.

The poem begins with personification: "some poems force you to write them". By giving poetry human emotions, Khan is flipping conventional roles, which reveals to the audience that this poem will be out of the ordinary, and will rebel against normal poetic conventions. Khan further demonstrates examples of personification as she reveals how her "pen and paper goad her" to "write a humanising poem." Personification universally connects readers with the objects being personified. By giving them humanlike attributes, poets can use personification to make descriptions of non-human entities more vivid, or can help readers understand, sympathise with, or react emotionally to non-human characters. [3] However, this use of personification could be a clear use of irony: Khan's poem wholeheartedly rejects the feeling that some Muslims face of being forced to appear endearing and human. Thus, her poem which forces itself to be written could be a metaphor for Muslims, and how people often forcefully 'personify' them.

Furthermore, *Not a Humanising Poem* includes repetition to emphasise and instil the poet's opinion within the reader. Khan pleads with the audience to "love us when we're lazy. Love us when we're poor. Love us in our back-to-back council estates." The repetition creates emphasis on the phrase "love us", and by doing so reinforces the idea that it is imperative to love minorities in every walk of life. Additionally, the repetition creates a sense of urgency and panic, thus convincing the audience that only appreciating certain types of immigrants is a dangerous act, as it excludes and alienates many communities. Alternatively, rather than as an empowering device, the repetition may have been used desperately or as a plea, revealing the more vulnerable side to poems which deal with discrimination, as they ultimately are based on the pain and discomfort of the experience of prejudice.

The third and fourth poems I have chosen to analyse are selections from Claudia Rankine's poetry collection *Citizen: An American Lyric*. Claudia Rankine is poet, essayist, playwright and the editor of several anthologies. She is the author of five volumes of poetry, two plays and various essays. [3] Rankine was born in Kingston, Jamaica but educated at Williams College and Columbia University. *Citizen* was published in 2014, and has been described as both criticism and poetry.

The topic of whether Rankine's book is poetry is debated – Claudia Rankine's book "may or may not be poetry" [4] however many believe "the question becomes insignificant as one reads on". [4] I will be exploring the meanings behind Rankine's works and whether they can be classed as poetry.

The front cover image conveys a disembodied hood of a green hoodie, hung on a wall with a contrasting plain white backdrop. The rim of the hood is propped up as if covering an invisible head. The image is a reminder of Trayvon Martin's death, as he was wearing a hoodie when he was murdered by George Zimmerman. The image of the decapitated hoodie firstly symbolises the fear that black people may have, as black people wearing hoodies are often stereotyped as being dangerous or armed. The shredded form of the item of clothing suggests a sense of hatred of black people, where hundreds of innocent black men and women are shot for no reason but their race. Additionally, the white background represents how black people and the racism towards black people appears incredibly visible in America,

and majority white countries generally. It also suggests the differences in mentalities and visible differences in beliefs towards people of different skin colours. I believe this artwork is poetic because it conveys a message that is eloquent and powerful in the same way that words can.

On page 52 of Claudia Rankine's book *Citizen*, the words: "I do not always feel coloured" are written and repeated on the entire page. The form of this poem appears to be just text on paper, possibly written on a notebook or journal. This simple form could portray how Rankine's message is clear and concise, as well as the fact that the meaning behind her message is a fundamental one that should never have to be developed or explained. "I do not always feel coloured" could indicate that at times in Rankine's, and other black people's, lives, they sometimes forget their skin colour. They forget that they have a feature, completely out of their control, which dictates many of their future experiences and the treatment they receive from other people. Alternatively, while this poem could be negative, it could also be a positive message, as they may believe that they feel so comfortable in their society, they forget about race.

On page 53, it says "I feel most coloured when I am thrown against a sharp white background." This is firstly clearly indicated by the visual aspect of the text, and the words are written in bold black writing and the background is a bright white colour. This suggests to the audience how Rankine believes there are some areas of society where black people do not feel as if they are part of or are united with their community, and so feel as they are noticeable and do not fit in. Towards the bottom of the page, the black sentences seem to merge together to form an intangible mesh of words. This symbolises how, when in a "coloured" community rather than a white one, non-white people feel less conspicuous and more at ease. One possible interpretation from this is that Rankine believes that some ethnic minorities do not do enough to integrate into societies, and so only feel comfortable when with people of their own race. This may be a problem for Rankine, as it would mean there was no cohesion within society. On the other hand, another interpretation could be that Rankine believes that white people do not do enough to make people of colour feel welcome or comfortable in society, evident by micro-aggressions, police brutality targeting black men, and the beauty industry which advertises a white face and features as the ideal standard of beauty. These factors, in Rankine's eyes, may be a more toned-down version of the immense segregation and racism faced by black people in the 1900s. Even though those acts are now seen as horrific, the forms of discrimination in the present day have a similar effect, and thus leave black people feeling incredibly alienated and ostracised in predominately white societies. I believe these two pages are poetic and can be classed as poetry as they use not only words but imagery to portray their message, and their form cleverly indicates a hidden meaning.

The final piece I have chosen to analyse is an excerpt from *Citizen: An American Lyric*. This poem depicts one form of racism: micro-aggressions, where a neighbour harshly judges an innocent black man for simply walking around. The poem deals with an incredibly modern and harmful form of racial discrimination which is less direct than blunt racism but just as harmful.

The form of the poetry is in story-like narrative form, where the events are simply being described. This could be a way of indicating that events like this are common occurrences in the lives of black people, that they simply occur and are not unordinary. To some, these events are just part of their daily gossip with friends, depicting what happened, and there are never any consequences for the injustice that occurs.

The poem is written in second person, evident by the use of "you". This technique cleverly makes the poem more personal and relatable to the reader, even if they are not black. It reminds the audience that the racism in the poem could have been directed towards anyone, that the chance of being born black is completely random and therefore the effects of racism are everyone's problem [4], not just those being affected by it. Additionally, the use of "you" also makes the reader more aware of their actions, rethinking if any of their behaviours could have been interpreted as racist or discriminatory.

The poem also uses simplistic and basic terms, and there are no uses of punctuation apart from very basic forms such as commas and full stops. There is a lack of sophisticated language devices. Even when people are speaking, there are no speech marks to show this. This portrays how these actions faced by black people have been part of their daily lives, to the extent that speech marks do not have to be used to differentiate between the black and white speakers, as it is clear who is facing the prejudice in the poem. This links to the police brutality faced by many African-Americans, where they are often shot and killed as a result of the prejudices they face by white police officers, who shoot them because they were "acting shady" or "showing signs of aggression or anger". Black people are five times as likely to be shot, and despite making up only 2% of the total US population, African-American males between the ages of 15 and 34 comprise more than 15% of all deaths logged this year by an ongoing investigation into the use of deadly force by police.[5] This poem suggests how the black person featured in the poem was lucky, and if he had shown any other signs of aggression, his fate would have most likely been much worse. This poem is incredibly significant in the 21<sup>st</sup> century, and shows a side to poetry that is not at all dull, but thrilling and real.

In conclusion, the relevance and powerful messages of all five of these poetic pieces prove that poetry can still be alive and important in our modern day. Poems can explore issues greater than love, and thus have a vital impact on people's lives. For example, Rankine's poems on micro-aggressions allow for readers to rethink their lives and make better choices as to not harm others. Additionally, the wide definition of poetry means it does not have to be restricted to just traditional poetry; it can include many different forms and thus target many different audiences.

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### PhD Tutor's comment:

'D.'s essay on contemporary poetry and politics is first-class work. She is an accomplished essayist, who uses many sophisticated writing techniques to convince her reader of the salience of her arguments. It was a pleasure to teach D., and any university would be lucky to have her.'

# Social Sciences

## Emotional Eating

Year 9, Key Stage 4

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Neath. Supervised by A. Pink, Swansea University.**

Emotional eating is the concept of using food to make yourself feel better or comfort yourself when you are feeling emotional. This is otherwise known as stress eating and it is described as, "eating to satisfy emotional needs rather than physical hunger"[1]. Some experts have even estimated that 75% of over eating is caused by emotions, however emotional eating is believed to be the result of many factors rather than just a single cause. A recent study has shown that the foods that emotional eaters crave are often referred to as comfort foods, these are foods which have either high-calorie or high-carbohydrate values and have minimal to no nutritional value, such as; chocolate, cookies, crisps, chips and pizza. Around 40% of people eat more when stressed, then another 40% eat less when stressed and the minority of people (20%) experience no change in their intake of foods when exposed to stress [2].

One of the biggest myths about emotional eating is that it is only prompted by negative feelings, which is true, people often turn to food when they're stressed out, lonely, sad, anxious, or bored. But emotional eating can be linked to positive feelings too, like the romance of sharing dessert on Valentine's Day or the celebration of a holiday feast. Sometimes emotional eating is tied to major life events, like a death or a divorce. More often, though, it's the countless little daily stresses that cause someone to seek comfort or distraction in food. Emotional eating patterns can be learned: a child who is given candy after a big achievement may grow up using candy as a reward for a job well done. A child who is given cookies to stop crying may learn to link cookies with comfort. The trouble with emotional eating (aside from the health issues) is that once the pleasure of eating is gone, the feelings that cause it stick around, so it hasn't really solved anything. You will often feel worse about eating the amount or type of food you did [3].

Some of the relevant personality traits that are associated with emotional eating include Alexithymia. Alexithymia comes from the Greek word for "no words for emotions" (Sifneos,1973). It is characterised by a reduced ability to identify and describe emotions, a concrete thinking style and a limited imagination. Around 10% of the general population would be classed as being alexithymic and it is more common in males. It is a personality trait and not classed as a clinical disorder but puts individuals at risk of certain psychological disorders, such as depression, anxiety and hoarding behaviours. It is usually measured by a self-reported questionnaire, with the Toronto Alexithymia Scale (TAS-20) being the most commonly used. Individuals who are alexithymic may have difficulty in understanding their bodily sensations and misinterpret them. A good example of this is when an individual is particularly nervous before presenting at a conference, they may have difficulty understanding that the "butterflies" in their stomach feeling is normal and instead think they are hungry.

I have decided to look at a study conducted by Bennet, Greene and Schwartz-Barcott which was conducted in 2013 and compare it to a study by van Strien and Ouwens in 2007. I shall pick apart these two studies and state their strengths and weaknesses and also their limitations. The study conducted by van Strien and Ouwens is quantitative

as it is using various surveys and is analysing behaviour statistically, but I would question whether you can really judge someone's emotions so they fit into a certain category or a test score. Can you gauge how they are feeling by looking at a number? Of course, the formula that they use will always work and you will always get a specific score, but that score cannot fully describe how that person is feeling.

This brings me on to demand characteristics, which is when if the participant knows what's going on they might change their answers from what they actually think to the 'right' answer in order to please the experimenter, when this happens the data that was collected usually becomes useless. Another benefit to using a quantitative research style is that anyone can perform the experiment; as in this case it was a survey style method with lots of pre-printed sheets detailing what they had to fill in, so you don't really need any skilled personnel or qualifications to add up a test score. Perhaps what's needed for this experiment is a qualitative system like the Benet, Greene and Schwartz-Barcott cogitation, whereas it may not have been as rigid a system as its counterpart and that more free-flowing aspect gives it the ability to branch out and discover things that van Strien and Ouwens most certainly could not. The downside to this is only a skilled person could perform the "in depth analysis" of the participants data compared with van Strien and Ouwens' quantitative technique, which revolves around a certain formula to try and picture someone's emotions in a number. Qualitative experiments are better for understanding complex behaviours whereas quantitative experiments will struggle in that respect but it can be very easy to use that type of method to understand simple things e.g. what type of crisps do you enjoy the most. A quantitative method like van Strien and Ouwens can also cover a lot more people as it can be performed by anyone, it is over with relatively quickly and there is a definitive answer straight away due to the formula. On the other hand, a qualitative method like Benet, Greene, Schwartz and Barcott would take much longer, only qualified individuals can perform it and there is extensive research into the participants' answers as they "reread the notes several times to identify the range of emotions experienced by the participants and to check for the accuracy and completeness of the transcription".

Now onto one of the other personality traits that we did not cover in the tutorials. The trait that I will be exploring is conscientiousness, it is how careful and cautious a person is. This trait has been linked to cognitive restraint in many research articles. Cognitive restraint is when you consciously prevent yourself from eating in order to prevent weight gain or encourage weight loss. A study by the University of North Carolina-Chapel Hill got female students to complete questionnaires assessing their conscientious personality. For the next eleven weeks the women were told to record their experiences with anxiety dieting and binge eating. The study found that women who were more anxious tended to binge eat and diet a lot more often than a woman who is less anxious. However, when looking at the women's individual anxiety levels, binge eating but not dieting increased simultaneously with her anxiety levels. While in this study anxiety is a constantly changing emotional state, conscientiousness was assumed to be a stable personality trait, surprisingly the researchers found that women who were more conscientious engaged in higher amounts of binge eating.

An important assertion this study made was that "without understanding what triggers binge eating and dieting, it's hard to change the pattern of behaviour. Some forms of psychotherapy, like cognitive behaviour therapy (CBT), can help people become more aware of their own patterns

related to anxiety and binge eating and then learn how to better respond to emotional triggers to binge eat." The need to understand what causes the women individually to binge eat is crucial as if they do not know what triggers their emotional eating problems, they cannot design a suitable plan to change their patterns. If doctors and researchers can't help people change their eating tendencies then obesity - which is already a very important public health matter and is the top cause for the amount of life years lost - shall continue to grow. The culmination of this problem is that obesity will become even more lethal to humans and severely cut our life span down unless more research is like this done to help people come away from emotional eating habits and turn their lives around.

I also looked at another study conducted by Patrick C.L Heaven, Kathryn Mulligan, Robyn Merrilees, Teneille Woods and Yasmeen Fairouz, which was called '*Neuroticism and Conscientiousness as Predictors of Emotional, External, and Restrained Eating Behaviours*'. The study consisted of investigating the extent to which external, emotional and restrained behaviours are located within a mainstream personality taxonomy among a non-clinical sample. The five-factor model of personality was selected because it enjoys wide spread support and because personality research has become dominated by this approach. The study then goes on to talk about how each of the eating disorders (external, restrained and emotional) will be significantly associated with feelings of low self-efficacy. This is especially relevant to external eating as external eaters are susceptible to cues that may appear unexpectedly. This means external eating will also be greatly associated with impulsivity and restrained eating will be associated with depression and low self-efficacy. Due to restrained eaters strict dieting regime conscientiousness is a big factor in particular cautiousness, self-discipline and achievement striving. Emotional eating will be significantly associated with mainly negative emotions as stated by Van Strien is his study, thus it will be related to anxiety, depression and self-consciousness as well as emotionality.

To conclude, I believe that by assessing all of the research I have looked at such as the *Effects of Distress, Alexithymia, Impulsivity on Eating* by van Strien and Ouwens, and the *Perceptions of Emotional Eating Behaviour* by Bennett, Greene and Schwartz-Barcott, I firmly believe that personality traits explain emotional eating tendencies very well. For example, if we look at a particularly impulsive person we can see that frequent episodes of impulsivity can and have been proven to lead to extremely self-destructive behaviours as it plays a key-role or manifests as a primary symptom in several eating disorders. Eating disorders associated with the highest degree of impulsivity include classic anorexia nervosa, bulimia nervosa and a form of anorexia called binge/purge anorexia. In the U.S., an estimated 20 million females and 10 million males suffer from a clinically significant eating disorder at some point in their lifetimes. So, if you are more impulsive than the average person then you are more likely to engage in emotional eating. The same can be said about the Greek word alexithymia; by being alexithymic you often can only describe the simple emotions such as being happy or sad but have great difficulty and on occasion no luck whatsoever trying to describe the more complex emotions such as, loneliness, depression, frustration. If you cannot describe these feelings alexithymic people will often misinterpret the emotion that they are feeling e.g. the butterflies in your stomach for hunger and will binge eat to gain the satisfaction of dealing with the 'butterflies'. However, often after gaining that satisfaction for a short time the person will feel regret and guilt over either how much they ate or what type of food they just ate, usually

both! I think personality traits define and explain emotional eating habits very well as the traits associated with emotional eating are usually very prominent like alexithymia or sometimes very severe like conscientiousness and impulsivity. Both, as I've explained previously are personality traits associated with emotional eating.

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van Strien and Ouwens (2002), Effects of Distress Alexithymia, Impulsivity on Eating  
Bennett, Greene and Schwartz-Barcott, (2003), Perceptions of Emotional Eating Behaviour  
e topic and took the opportunity to research his own relevant interests to further expand it, which he presented well in his essay. I know D. will do well in his GCSE's and I wish him all the best for the future.'

### PhD Tutor's comment:

'It was a pleasure to work with D. on this programme. He was engaging from the very start and was confident in articulating his opinion well, especially during classroom debates. D. showed a great level of understanding of the topic and took the opportunity to research his own relevant interests to further expand it, which he presented well in his essay. I know D. will do well in his GCSE's and I wish him all the best for the future.'

## The Effect Of Audiovisual Product Placements On Choice Of Biscuit Brand

Year 12, Key Stage 5

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Supervised by B. Armstrong, Lancaster University.**

### Abstract:

We conducted this research as product placements are frequently used by marketers, but despite their popularity, there's little research on their effectiveness. We conducted an experiment where we had an experimental group watch a clip with a biscuit (KitKat) product placement embedded in, and a control group watch the same clip without the placement in. We later offered them two biscuits (KitKat and Club) to see if the placement influenced choice. From the results it is evident that people who watched the placement were influenced by it and were more likely to pick the brand featured. There was no relationship between recall of the placement and hunger levels on choice. Lastly, there was a significant relationship between gender and recall of the placement identified from the results (this is a trend sustained from previous research). From the research we concluded that the results resemble trends from previous research and show that audiovisual product placements can effectively influence consumers.

### Introduction:

Product placements are a form of advertisement where brands pay to have their product featured in movies and television. They are a popular way of advertising and will be for years to come, with the amount spent on them globally being expected to grow by 27.9% annually until 2020 (Калач & Шыраба, n.d.). They are also expected to outpace the use of traditional advertising and marketing. This naturally raises a whole host of questions for brands and marketers alike. Advertisers want to know why they are so popular and if they are so effective, how to optimise efficiency to benefit brands. Ergo the intention of this study is to expand the knowledge on how product placements affect consumers and to pinpoint specifically what those effects are, e.g. better recall of brand, increased likelihood of choosing the brand, etc.



Research in the past has attempted to gather data to find out what a fruitful product placement is composed of. Such studies include Russell's (2002) and Gupta and Lord's (1998) research that similarly found that auditory placements not only affect consumers positively, but are also better recalled because they resonate with a consumer on a deeper level. Evidently, it is clear audio placements do better, so we wanted to use an audiovisual placement as these are more prevalent in everyday product placements that consumers are exposed to. Also, Russell (2002) used a theatre methodology which cannot account for the connection between characters and the consumers, as traditional TV clips do. Perhaps that is why they have found that audio placements were better recalled because the participants were perhaps more motivated to comprehend what they are seeing rather than for enjoyment purposes. As for Gupta and Lord's (1998) research, it only used older films from the 1980s such as Big with the most modern one being released five years ago, that perhaps had a similar effect on participants as Russell's (2002) study. We wanted to steer away from these methodological flaws and conduct a study using a TV clip from a regional friendly soap the participants are familiar with: Coronation Street.

The mere-exposure theory by Zajonc (2001) suggests that people tend to develop a tendency to prefer things because they are familiar with them. The more a person is exposed to a certain thing, the more their fondness of it grows. Product placements seek to utilise this mere-exposure effect by having consumers exposed to their product readily, thus prompted to buy it. Previously, Auty and Lewis (2004) have tried to research the effect of previous exposure on choice and also how implicit and explicit memory plays into the influence of product placement and which of the two types of memory has a more staggering effect on choice. Interestingly, their research supported the mere-exposure effect and suggests that continuous repeated exposure leads to more positive feelings about the product. However, no difference in choice was found between those who correctly recalled the brand and those who did not, suggesting that explicit memory has little to do with choice. In our research we want to also see how explicit recall of the brand in the placement affects choice. This is to see if Auty and Lewis' (2004) findings can be replicated by using an older sample, as the problem with using children is that the material and spaces in their environment affect how agreeable children are. We simply do not know if they were concentrating on the clip being shown or paying attention to the questions the researchers asked properly. Additionally, Campbell, Mohr and Verlegh's (2012) persuasion knowledge theory suggests that people can be affected by education, media exposure and other things to develop defensive mechanisms to prevent placements from influencing them. These people identify what a placement is trying to persuade them to do and often then resist it by doing the opposite. This means that if the placement from the clip is recalled, the placement may backfire and prompt them to resist the intended influence. With these previous findings considered, we outlined these hypotheses:

**Hypothesis 1-** Participants who are exposed to the placement are significantly more likely to pick the brand of biscuit featured (KitKat) than those who have not been exposed to the placement.

**Hypothesis 2-** Participants who recall the brand placement are significantly less likely to pick the biscuit brand featured.

There has been little attempt to see how demographic differences such as gender correlate with the effectiveness and recall of placements. We suspected that because previous research (Auty & Lewis,2004 and Gregorio &

Sung,2010) has clearly found some trends between gender and how they engage with placements, such as the fact females often recall placements more than males, that these individual differences play into how influential and memorable placements are. We wanted to take this further and see if we can replicate these results to see if such trends still prevail. As far as gender differences are concerned, the findings have been rather contradictory, with Nelson and McLeod's (2005) research finding no gender differences in adolescents' liking or awareness of placements; and Gregorio and Sung's (2010) results indicating that males engage with product placements more than females, suggesting they are more influenced by them. Despite placements affecting males more, they are actually recalled more by females. Gregorio and Sung's (2010) research was done in 2010 and took a modern approach, with the questionnaire being conducted online, a space where a lot of the modern population is constantly engaging. Therefore, guided by their research, we hypothesised on gender differences:

**Hypothesis 3-** Males are significantly more likely to be influenced by the product placement than females and will pick the brand of biscuit featured in the placement.

**Hypothesis 4-** Females are significantly more likely to recall the placement than males.

Formerly, Gibson (2006) conducted research into food choice and its relation to a person's underlying emotional mechanisms. The research found that depending on the type of food: a person's irritability can be reduced and feelings of positivity grown. Notably, it was high energy foods with a fatty texture that were found to mitigate effects of stress and lift moods. Past research such as Karreman, Stroebe and Claus' (2006) research indicated such a relationship between a need state and picking a brand to satisfy that need exists. Their research found that people who were thirsty were more strongly affected by the Lipton Ice prime and were more likely to choose Lipton Ice than participants who were not thirsty. The participants clearly had a desire to consume and that placement offered them up a solution to satisfy that need. With a biscuit being such a high fat, sweet treat we thought that hungry or irritable people would be more influenced by the placement, which would highlight in their minds the brand as a fix for their hunger.

**Hypothesis 5-** People part of the experimental group who indicated a higher hunger level on the post-experiment survey: are significantly more likely to pick the brand featured in the placement.

**Results:**

The independent variable of our study was whether or not the participant saw the TV clip with the product placement featured in it. We wanted to measure how that affected choice, so we recorded which of the two biscuit brands offered the participant chose, and this was our dependent variable.

We found that in the experimental group, more participants (86%) picked the KitKat (the brand featured) than the Club

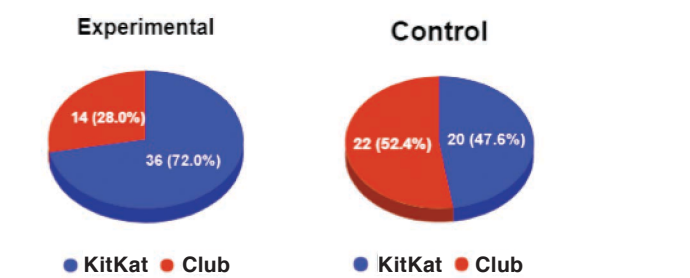


Figure 1. Pie charts showing what biscuit brand (KitKat or Club) participants of each group chose.

(14%); whereas in the control group, less participants picked the KitKat (48%) than the Club (52%). Therefore, our hypothesis is supported as it is evident that people in the experimental group picked KitKat more often than Club and the control group saw people pick a similar number of each brand, with the KitKat being picked less often than in the experimental condition.

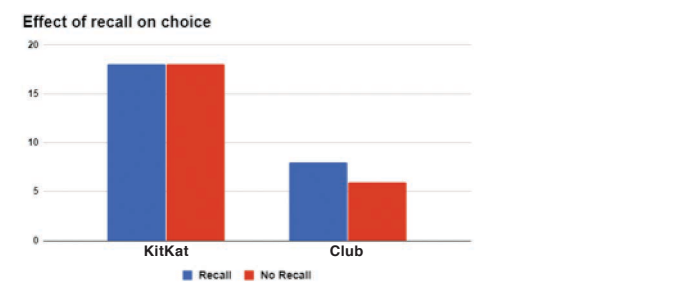


Figure 2. Bar chart reflecting the effect of recall on choice of brand.

Of the people who recalled the placement, more of them chose the KitKat (69%) over the Club (31%). Of the people who did not recall the placement, again more of them picked the KitKat (75%) over the Club (25%). Hence our hypothesis is not supported as no significant effect of recall on choice was found, as there isn't a significant difference in choice between those who remember the placement and those that do not.

In terms of gender and influence of the placement, we found that in the experimental condition, males picked the KitKat (69%) more often than the Club (31%). Similarly, females picked the KitKat (75%) more than the Club (25%). Therefore, the hypothesis is not supported as there was no significant difference in choice prevalent.



Figure 3. Bar chart showing the number of females and males that recalled and did not recall the placement.

In term of gender and recall, we found that of the male participants, most of them forgot the placement (62%) with a few recalling it (38%); whereas of the female participants, more of them remembered (67%) and fewer forgot it (33%). Ergo females do recall placements more so than males, meaning our hypothesis is supported.

Finally, in terms of hunger levels, people in the experimental group who picked the KitKat had an average rating of 5.78 and the people who picked the Club had an average rating of 5.14. This isn't a significant difference, therefore our hypothesis isn't supported and hunger does not mediate product placement influence.

**Discussion:**

From our research, it is clear that product placements successfully influence and prompt consumers to choose a certain brand. This shows that product placements are extremely effective; the placement being displayed in the clip only once and still having such a staggering effect on choice shows what a great form of advertisement it is. The results

obtained have also replicated the findings from Auty and Lewis' (2004) research where they found that placements do influence choice, thus our results are reliable as they are replicable. However, our results don't support our second hypothesis that was to do with recall. The thinking behind that prediction stemmed from Campbell et al's (2012) research which led us to believe that if participants recalled the placement, they would be turned away from choosing a product the company was trying to coerce them into buying, as consumers like to feel as though they have autonomy. Instead, our results showed that recall had no influence on choice, much like Auty and Lewis' (2004) research suggesting it's more valid research. Recall may not have had an effect on choice because the placement may have been congruent and did not steer people away from the product, as it may have if it was incongruent and disruptive to the audience's enjoyment of the show.

We found that some predictions on gender differences were incorrect despite what Gregorio and Sung's (2010) research suggested; males were not more influenced by the placement as there was no relationship between brand choice and gender found. Our research did, however, sustain a trend prevalent in both Aunt and Lewis' (2004) research as well as Gregorio Sung's (2010), which shows that females do recall the placement more than males. Hunger levels were another individual difference we investigated and despite Karreman et al's research strongly suggesting a relationship between choice and hunger exists, we found no causal relationship. This should be further tested as previous research has strongly suggested such a causal relationship exists and if future researchers use a larger sample they may be able to exemplify significant differences we have not. They could also delve into researching factors other than hunger and how these relate to the influence of placements, such as mood and stress levels. Research such as Gillespie, Joireman and Muehling's (2012) has indicated that different mental states affect how placements are perceived and if they are more favourable or influential. With education or work being such a pronounced part of the public's lives, it is expected that they come home in varying mental states every day; this can impact on how influential placements are, so should be studied.

A prominent strength of our study was the diversity of our sample which had people from the ages of 16-46. A lot of the research in this area tends to use students and therefore the findings can't always be generalised to the wider population because of the pronounced participant variables that affect results, e.g. educational level. Our study was also done in an ethical manner as we not only debriefed our participants, but we also gave them the right to withdraw in a substantial time frame, and the information of who to contact laid out clearly. Most importantly, our study has great real-life application as it has contributed to research in this area and will allow brands to better understand how they can effectively utilise product placements to influence their target market, which will overall benefit society.

In the future, researchers should focus even more on demographic differences to ascertain what type of placement is most influential for different people by studying differences such as: varying IQs, different ethnicities, varying cultures and different personality types, i.e. Adorno's (1950) Authoritarian Personality Theory. People with a higher IQ may exhibit better recall. People with varying cultures may have been primed as to how to respond to placements, meaning only certain placements may influence them. Personality types would be interesting to study as the authoritarian personality is quite obedient to authority figures, so they may be quite obedient to what a blatant placement wants them to do. It is clearly an

important avenue for marketers to follow up, as society is now more diverse and brands need to aim to target all people to thrive.

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**PhD Tutor's comment:**

'H. is an outstanding student who produced an impressive assignment. The essay demonstrates a sophisticated level of understanding of complex psychological theories and critical thinking. H. used existing academic research and psychological theories to effectively develop and substantiate her hypotheses and interpretation of the experimental findings. I am confident that H. will excel in whatever she chooses to do in the future.'



